Monitoring physical activity in children

Monitoring Physical Activity in Children

by

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ABSTRACT

Two main research problems were addressed within this thesis. Firstly, the construction of a self-report measure of physical activity (questionnaire) designed specifically for use with children and secondly, the use of the measure to provide information on the activity levels of a sample of British children.

Every effort was made in designing the self-report, to address as many of the problems associated with the current measures as possible, and thereby to design an instrument which may improve upon existing measures. The process involved a detailed review of the literature, implementation of a number of recommendations from the literature, and a series of preliminary and pilot studies to determine the content and feasibility of the questionnaire forms and the feasibility of the administration procedures. Following the preliminary studies, the scoring procedure for the self-report measure was developed and the final format of the questionnaire established. The final version was an interviewer administered questionnaire comprising two forms, a school day and a weekend form.

Once designed, the measure was evaluated. The evaluation of the questionnaire involved studies of the validity and reliability of the measure as well as the reliability of interviewers trained to administer the questionnaire. The results of these studies proved favourable throughout and it was declared that the measure was a valid and reliable measure of physical activity. The use of the self-report measure to gather the activity information on a sample of British children in part two of the research was thus well justified.

Part two of the research involved the administration of the self-report measure to gather activity information on a final sample of 199 pupils. The questionnaire was administered according to the method and protocols established in part one of the study. The findings of the study revealed the majority of the pupils to be inactive. Low activity levels were reflected in the pupils' activity scores and in the amount of time they spent in hard/very hard activity in particular. It was declared that the health of many pupils in this study may be at risk and if these findings reflect the activity levels of British children generally, then we may expect there to be serious consequences for the future health of our young population.

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PUBLICATIONS

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Cale, L., Waring, M., & Almond, L. (1992). A review of children's physical activity levels. Proceedings of the 6th Ichpher-European Congress. (pp. 86-89). Prague, Czechoslovakia.

Cale, L., & Almond, L. (in press). Physical Activity Levels in Children-The Implications for Physical Education. Proceedings of the FIEP World Congress. Israel.

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Please note that although this thesis has referred to British children throughout, the studies outlined were in fact conducted on English children only. The results may, therefore, be representative of English children only.

CHAPTER 1

INTRODUCTION

1.1 The Importance of Physical Activity

Evidence highlighting the importance of physical activity to health is now stronger than ever and the benefits of physical activity to health are an increasing source of public interest (Royal College of Physicians, 1991). Major organisations including The Royal College of Physicians, The British Heart Foundation, The American Heart Association and The Centre for Disease Control in Atlanta have made particularly strong pronouncements on the benefits of physical activity and the ill effects of physical inactivity on cardiovascular health. Perhaps the strongest yet have been made by The British Heart Foundation and The American Heart Association. A report by the British Heart Foundation Working Group (Hardman, 1991), has acknowledged how "*The relative risk of physical inactivity may be greater than commonly accepted and may approach that attributable to smoking, hypertension and hypercholesterolaemia.*" Indeed, the report declares how "Physical activity is seldom regarded as an important risk factor for coronary heart disease"...but how "there is now sufficient research evidence to suggest that this view should be reconsidered..." The American Heart Association (AHA), however, after reviewing the evidence, go beyond this. They recently declared inactivity as a risk factor for coronary artery disease, along with smoking, high blood pressure and high blood cholesterol levels. In a position statement made in 1992, the AHA stated:

> *"There is a relation between physical inactivity and cardiovascular mortality and inactivity is a major risk factor for the development of coronary heart disease."*

Such conclusions have been drawn following substantial evidence from over 40 studies which have been conducted over some 40 years of research.

Studies conducted with adults have shown a relationship between regular participation in physical activity and increased longevity (Paffenbarger, Hyde, Wing & Hsieh, 1986; Blair, Clark, Cureton & Powell, 1989) and decreased risk of coronary heart disease (Paffenbarger & Hyde, 1984; Powell, Thompson, Caspersen & Kendrick, 1987). According to Powell et al., (1987), physically inactive people have almost twice the risk of developing coronary heart disease than those who engage in regular physical activity. Pekkanen et al., (1987) report how physical activity has been shown to increase life expectancy by more than 2 years over the population average. Regular physical activity can also help to prevent and manage a number of other medical conditions including non insulin-dependent diabetes mellitus and osteoporosis (Siscovick, LaPorte & Newman, 1985), and has been associated with lower rates of stroke (Salonen, Puska & Tuomilehto, 1982). Beyond the effects on mortality, several studies have reported that regular physical activity is associated with improved lipid profiles (Wood et al., 1983; Haskell, 1984), reduced levels of diastolic blood pressure (Montoye, Metzer & Keller, 1972; Hagberg ,1988; Reaven, Barrett-Connor & Edelstein, 1991), obesity (Leon, Conrad, Hunninghake & Serfrass,1979; Thompson et al., 1982) and back pain (Frymoyer, 1988). Physical activity can furthermore improve musculoskeletal strength and flexibility and weight bearing activity is thought to be useful in the prevention and treatment of osteoporosis (Aloia, Cohn, Ostuni, Cane, & Ellis, 1978; Aloia, 1981). In addition, physical activity has been shown to have a number of psychological benefits. An extensive literature has developed which links exercise with affective/emotional changes such as reductions in anxiety, tension and depression and increases in feelings of well-being, mood and improved self-concept (Folkins & Sime, 1981; Dishman, 1986; Morgan & Goldstein, 1987; Martinsen, 1990; Petruzzello, Landers, Hartfield, Kubitz & Salazar, 1991). The major health benefits of physical activity are summarised in table 1.1. The Allied Dunbar National Fitness Survey report (1992) also includes a good summary of the health benefits conferred by an active lifestyle.

Despite intense interest in and knowledge about adult physical activity, surprisingly little is known about children's participation in physical activity or the relationship between children's physical activity and health (Simons-Morton, O'Hara, Simons-Morton & Parcel, 1987). Sopko, Obarzanek & Stone (1992) claim that studies in youth have been limited and not sufficiently extensive to produce conclusive results. However, a number of researchers do acknowledge

Table 1.1 Health Benefits of Physical Activity

Physical Activity can:
1) Increase Longevity
2) Decrease the risk of Coronary Heart Disease
3) Prevent and/or help in the management of non insulin-dependent diabetes mellitus.
4) Prevent and/or help in the management of osteoporosis.
5) Decrease rates of stroke
6) Improve lipid profiles.
7) Reduce levels of diastolic blood pressure.
8) Reduce levels of obesity
9) Reduce back pain
10) Prevent or be useful in the treatment of osteoporosis
11) Reduce anxiety/tension
12) Reduce depression
13) Increase feelings of well-being
14) Improve self-concept

that physical activity has many physiological and possibly psychological effects that influence the health of children (Gilliam & MacConnie, 1984; Montoye, 1985; Pate & Blair, 1978; Shephard, 1984; Rowland, 1990). Regular physical activity has been shown to improve cardiovascular and other components of health-related fitness in children (Bar-Or, 1983) and there are an increasing number of studies which indicate that there is an inverse relationship between physical activity in children and coronary heart disease risk factors such as blood pressure (Fraser, Philips & Harris, 1983; Fripp et al., 1985, Strazullo et al., 1988) serum lipoproteins (Durant, Linder & Mahoney, 1983; Gilliam & Burke, 1978; Thorland & Gilliam, 1981) and obesity (Clark & Blair, 1988; Walberg & Ward, 1985). Indeed, the recognised associations between physical activity and such risk factors appear to be similar in both adults and children (Sallis, Patterson, Buono & Nader, 1988).

These associations are considered to be particularly important in children because coronary heart disease (CHD) is known to have its origins in childhood (Lauer, Conner, Leaverton, Reiter & Clarke 1975; Newman et al., 1986) and because CHD risk factors track over time (Freedman, Shear, Shrinivasan, Webber & Berenson, 1985; Lauer, Lee & Clarke, 1989). The results of research support the notion that children display the same health risk factors and profiles as adults and that such factors appear to be relatively stable into early adulthood (Armstrong, 1992; Despres, Bouchard & Malina, 1990; Gilliam & MacConnie, 1984; Montoye, 1986). The Bogalusa heart study revealed how many children already possessed one or more of the clinical risk factors associated with heart disease: hypertension, obesity, or adverse lipoprotein changes (Berenson, 1986).

Furthermore, physical activity during childhood is not only of such interest because of its concurrent relationships with risk factors, but also because of its possible influence on future adult participation in physical activity (Simons-Morton et al., 1990). Active children will develop skills, enjoyment and habits that will increase the likelihood that they will be active as adults (Blair et al., 1989; Ross & Gilbert, 1985; Simons-Morton et al., 1987; Simons-Morton, Parcel, O'Hara, Blair & Pate, 1988). Two major reports recently published in Britain, The Health of the Nation (1992) and the Allied Dunbar National Fitness Survey (1992) also strongly support this view and emphasise the need to establish active lifestyles at a young age. The Health of the Nation Document points out that "the maintenance of healthy lifestyles such as balanced diet and exercise in adulthood is more likely if established during childhood." The Allied Dunbar National Fitness Survey results showed that adult participation in physical activity in later years was strongly associated with behaviour at an earlier age. Twenty five percent of those who said they were very active aged 14-19 were very active now, compared with only 2% active now who were totally inactive at that early age. As a consequence of these findings, the survey report declares that "the exercise habit needs to start early, preferably in childhood as there is much more chance that people will continue or resume exercise in later years."

1.2 Monitoring Physical Activity

The measurement of physical activity in children has become an important field of interest and challenging enterprise because of its influence on health and accurate measurement is required to adequately document health consequences (Sallis, Buono, Roby, Micale & Nelson, 1993). However, historically, methodological problems have impeded research in physical activity epidemiology (Caspersen, 1987; LaPorte, Montoye & Caspersen, 1985). Physical activity is so complex a life element that its measurement and assessment tend to be as highly complicated and difficult as they are important (Paffenbarger, Blair, Lee & Hyde 1993). Its measurement is hampered considerably by the current state of measurement techniques and problems with definition, reliability and validity are widespread in existing measures (Williams, Klesges, Hanson & Eck, 1989). According to Saris (1986) obtaining activity information from children is even more difficult than it is for adults.

Methods of assessing physical activity in adult and child populations have included physiological, mechanical, observational and self-report measures (Blair, 1984; Klesges & Klesges 1987; LaPorte et al., 1985; Montoye & Taylor, 1984; Saris, 1985; Wilson, Paffenbarger, Morris & Havlik, 1986). All reviewers have concluded that there is a need to improve the assessment of physical activity, particularly among children. In epidemiological studies of physical activity, self-report is the recommended method of assessment (Saris, 1985; Washburn & Montoye, 1986; Wilson et al., 1986) and will therefore be the concern in this research. Many researchers however, have expressed concerns about the accuracy of such measures (Baranowski, 1985; Bernard, Killworth, Kronenfeld & Sailer, 1984; McGowan, Bulik, Epstein, Kupfer & Robertson, 1984; Powell et al., 1987).

Two major constraints on the accuracy of self-report are identified as the definition of the desired variables and the human cognitive processes (Baranowski, 1988). In terms of the problems with definition, Haskell (1985) states that the physical activity stimulus to achieve health related outcomes has not been clearly established. A main concern in studying and measuring activity levels has been to try to establish whether or not children are in fact doing sufficient exercise of an appropriate intensity to optimise their functional capacity and to attain health benefits. However, the exact nature, duration and intensity of activity required to produce health benefits is open to debate, especially for children. It is not known for example, what kind and how much physical activity will most clearly prevent cardiovascular disease, or promote health. Paffenbarger et al., (1993) acknowledge how the health issues of appropriate physical activity are still being explored and debated by clinicians, physiologists, dieticians, exercise scientists, orthopaedists, epidemiologists and others. In 1988 the American College of Sports Medicine (A.C.S.M.) published an opinion statement on Physical Fitness in Children and Youth which acknowledged this problem and gave the following guidance:

> *"The amount of exercise required for optimal functional capacity and health at various ages has not been precisely defined. Until more definitive evidence is available, current recommendations are that children and youth obtain 20-30 minutes of vigorous exercise each day."*
>
> adapted from the A.C.S.M. Opinion Statement on Physical Fitness in Children and Youth, 1988.

Simons-Morton et al., (1988), in a review of the published physical activity recommendations for children, concluded that appropriate physical activity for children should entail large muscle groups moving dynamically for periods of 20 minutes or longer, three or more times a week, at an intensity that elicits heart rates equal to or in excess of 140 beats per minute. This recommendation is in keeping with the amount of physical activity suggested by Morris et al., (1973) as being associated with a low incidence of coronary heart disease in adults. Armstrong & Bray (1991) have more recently questioned the applicability of such definitions of appropriate activity to children however, recognising that sustained periods of physical activity for such lengths of time are not features of children's habitual physical activity. In contrast, other researchers claim that it is the energy expenditure associated with physical activity which is important because it may reduce health risks, improve physical fitness, optimise growth and encourage future participation in physical activity (Bar-Or, 1983; Gilliam & MacConnie, 1984; Shephard, 1984; Saris, 1985).

The second major problem identified with self-reports is concerned with cognition related error. Memory decay, recall primarily of rare events and planned activities and lack of motivation in form completion are all sources of error associated with self-report, particularly in children. Telama et al., (1985) emphasise the extent of this problem, stressing that the applicability of adult questionnaire and interview methods to children is restricted by children's limited ability to perceive, retrieve and analyse lengths of time and to recall their activities for longer periods.

Given that the interest in physical activity levels stems largely from the evidence that it has important health consequences, the accurate measurement of physical activity must be a primary concern. Indeed, Caspersen (1989) identifies the development and application of reliable and valid measures of physical activity for the surveillance of physical activity patterns as a major methodological concern in physical activity epidemiology. Sallis (1991) remarks however, that in the past measurement development has been a secondary research endeavour and that few investigators have pursued a systematic line of inquiry in this area. According to Sallis (1991), physical activity self-reports should be developed and evaluated as rigorously as any psychological or behavioural assessment instrument. A number of other researchers hold similar views. Paffenbarger et al., (1993) recommend that future research on physical activity and health should include work on developing a questionnaire for the assessment of physical activity in children in particular, and similarly LaPorte et al., (1983) and Sopko, Obarzanek & Stone (1992) acknowledge the need for questionnaires for the assessment of physical activity in children. Baranowski et al., (1984), also recommend that efforts "be made to develop valid and reliable measures of self-reported aerobic activity among children" and Baranowski et al., (1984) and Sallis et al., (1993) both confirm the need for instruments of adequate reliability and validity for children. Baranowski et al., (1984) state "working on the assumption that a form can be created which maximises the ability of the child to accurately report aerobic activity, alternative forms need to be designed and tested for their validity."

Clearly, there is a strong consensus that current self-report measures of physical activity are inappropriate for gathering accurate activity information from children. As a result of the concerns expressed by researchers over the accuracy of current self-report measures (Baranowski, 1985; Bernard et al., 1984; McGowan et al., 1984; Powell et al., 1987) and the recognition and conclusions of others (Blair, 1984; LaPorte et al., 1983; LaPorte et al., 1985; Montoye & Taylor, 1984; Saris, 1985; Wilson et al., 1986; Klesges & Klesges 1987), that there is a need to improve the assessment of physical activity, particularly among children, a major aim of this research is to construct an alternative self-report measure designed specifically for use with children. The instrument will aim to address many of the problems associated with the current measures and techniques in an attempt to improve upon existing measures. The development and evaluation of this measure will follow a systematic and vigorous line of inquiry including validity and reliability assessments.

1.3 Physical Activity Levels of Children

Despite acknowledgements of the significance of physical activity to children's health and the importance of gathering accurate activity information, a review of related literature reveals that there is limited information available on the physical activity levels of British youth. Concern has been expressed however, that the physical activity levels of children have declined in past decades (Gortmaker, Dietz, Sobol & Wehler, 1987; Ross, Pate, Lohman & Christensen, 1987) and a number of international studies have indicated that physical activity levels in children are low (Saris, Binkhorst, Cramwinckel, Waesberghe & Veen-Hezemans, 1980, Gilliam, Freedson, Greenen & Shahraray, 1981; Gilliam, MacConnie, Greenan, Pels & Freedson, 1982; The Canada Fitness Survey, 1981, Hebbelinck & Shephard, 1986; The Australian Health and Fitness Survey, 1985; The National Children and Youth Fitness Study, McGinnis, 1987). Similar findings have also been reported by some British researchers (Hendry, 1978; Armstrong, 1989; Armstrong, Balding, Gentle, Williams & Kirby, 1990; Armstrong, Balding, Gentle & Kirkby, 1990a; 1990b; Sleap & Warburton, 1990; Armstrong & Bray, 1991; Armstrong, Williams, Balding, Gentle & Kirby, 1991). Indeed, a number of researchers are now concerned that levels of activity have declined to such an extent that they are likely to be detrimental to health. Morris (1988) summarises such concerns:

> *"For lack of exercise we are bringing up a generation of children less healthy than it could be and many of whom are likely to be at high risk in later life of serious disease and shortened life expectancy."*

Similarly Armstrong (1989) has reported how "many children seldom experience the intensity and duration of physical activity associated with low CHD in adults," and Armstrong et al., (1990a) reported that "British children have surprisingly low levels of habitual physical activity and many seldom undertake the volume of activity believed to benefit the cardiopulmonary system."

Whilst there are concerns over British children's activity levels, these are based on limited evidence. By comparison, the United States, Canada and Australia have conducted large-scale national fitness and activity surveys to assess how active their young populations are (The National Children and Youth Fitness Study, McGinnes, 1987; The Canada Fitness Survey, 1981; The Australian Health and Fitness Survey, 1985, Hebbelinck & Shephard, 1986). As yet there is no information on such a scale in Britain. Clearly, more information is desperately required to determine just how active or inactive young people in this country are, and to determine the extent of the alleged inactivity problem.

While there is well founded evidence highlighting the importance of physical activity to children's health and concern over children's low activity levels, there is limited activity information available on British youth. The second aim of this research is to provide information on the physical activity levels of a sample of British children.

1.4 Summary of Research Aims

In summary, the aims of this research are twofold:

1) To design a self-report measure of physical activity specifically for use with children which improves upon existing measures.

2) To provide information on the activity levels of a sample of British children.

The self-report measure will be designed, evaluated, and following rigorous testing of its adequacy will be used to assess the physical activity levels of the sample of British children.

1.5 The Structure of the Thesis

The thesis is divided into two parts and nine chapters. Part one addresses research problem one, the design of the self-report measure, and part two addresses research problem two, the assessment of the activity levels of a sample of British children.

In part one, which covers chapters two to five, a review of the literature associated with the methodological issues of monitoring physical activity is made and the stages involved in the development and evaluation of the self-report measure are described. Part two, chapters six to eight, reviews the literature on children's activity levels and deals with the assessment of the physical activity levels of a sample of British children using the self-report measure. The final chapter, chapter nine, summarises the research findings, discusses their implications and proposes recommendations for future work in the area.

PART ONE

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

The review of literature presented in this chapter deals with the methodological issues of monitoring physical activity and is divided into two sections. Section one provides a detailed description of the various methods of monitoring physical activity which are available and outlines the major characteristics, advantages and disadvantages of each of these methods. Section two meanwhile, focuses specifically on self-report measures of physical activity. It addresses the reliability, validity and problems associated with existing self-report measures and reviews the recommendations and guidance given by researchers in the field for the future assessment of physical activity by self-report.

SECTION ONE MONITORING PHYSICAL ACTIVITY

2.2 Monitoring Physical Activity

Before something can be accurately measured, it needs to be defined (Hensley, Ainsworth & Ansorge, 1993). No universally accepted definition of physical activity exists, though Caspersen, Powell & Christenson (1985) have suggested perhaps the most accepted general definition of physical activity:

"Physical activity is defined as any bodily movement produced by skeletal muscles that results in caloric expenditure."

For the purpose of this research, the above definition is therefore adopted.

Physical activity can be measured in a variety of ways. Hensley et al., (1993) acknowledge how as many as 30 to 40 different procedures for assessing physical activity have been proposed. Methods of assessing physical activity levels range from physiological, mechanical, observational to self-report measures, with each method having a range of different measures or techniques to choose from. Each method is now reviewed separately in this section and the advantages and disadvantages with each method are highlighted. The section is organised as follows:

2.3 Physiological Measures

2.4 Observational Measures

2.5 Mechanical Measures

2.6 Self-Report Measures

2.3 Physiological Measures

Heart Rate

Of all physiological variables, heart rate is probably one of the easiest to register with least inconvenience to, and interference with the subject (Saris, 1986). Heart rate monitoring has therefore become a most popular means of measuring physical activity and has been used increasingly as a valid and practical indicator of physical activity among children (Durant et al., 1993). Advances in micro-electronics have allowed heart rates to be detected and stored over long periods of time using small equipment. It must be noted however, that physical activity is not directly measured in this way, but rather the relative stress being placed on the cardiopulmonary system by the activity is monitored.

Different techniques may be used to record heart rate, including telemetry, tape recorders and solid state recorders. All methods are based on the accepted principle that heart rate is linearly related to energy expenditure (Freedson, 1989). Montoye (1975), reported that when work is carefully controlled, VO_2 and heart rate are closely related and the relationship is linear over most of the range when the measurements are taken. A common telemetry system which has been used widely on British youth is the Sport Tester 3000 (Armstrong, 1989; Armstrong et al., 1990; 1990a; 1990b; Armstrong et al., 1991; Armstrong & Bray, 1991). It consists of a lightweight transmitter which is fixed to the chest with electrodes, and a receiver and microcomputer which is worn as a wristwatch and is capable of storing and replaying minute-by-minute heart rates for up to 16 hours. If the device is interfaced with a microcomputer, the development of a simple programme allows sustained periods with heart rates above threshold values to be readily identified. The Sport Tester has been reported to be a reliable and valid means of recording heart rates with children (Tsankas, Bannister, Boon & Milner, 1986) and a measure which permits almost total freedom of motion (Leger & Thivierge, 1988)

However, heart rate measures do have their limitations. Several factors other than physical activity can influence heart rate. The same subject may show variation in heart rate from day to day at a given work load, and some day to day variation must be accepted. The interpretation of continuous heart rates can also be difficult because not only is the metabolism of the child reflected in the measure, but also the transient emotional state, the prevailing climatic condition, the specific muscle groups that perform the activity and type of muscle contraction (isotonic versus isometric). High ambient temperature, humidity, and emotional state have all been shown to raise heart rate, despite oxygen consumption being the same (Anderson, Liv, Stamler, Van Horn & Hoeksema, 1981; Payne, Wheeler & Salvosa, 1971; Stenberg, Astrand, Ekblom, Royce & Saltin, 1967). In terms of the muscle groups performing the activity, heart rate response is greater for arm work than work done with the legs and arms, despite the energy cost being the same (Anderson et al., 1981; Payne et al., 1971; Stenberg et al., 1967). Static or isometric exercises have also been shown to raise heart rate above that expected on the basis of the work load (Hansen & Maggio, 1960).

Saris et al., (1980) has demonstrated the effect physical fitness level has on heart rate and thereby on the resulting physical activity assessment. He demonstrated that 5 year old children with a high physical performance spent 50% less time in the heart rate ranges of 125-176 beats per minute and 177-200 beats per minute compared with children of a low performance capacity, despite movement counters demonstrating no substantial differences in daily physical activity. Another issue surrounding heart rate measures has been the question of how many days of monitoring are necessary to characterise usual or habitual heart rate as an indicator of physical activity. Durant et al., (1993) report that just over 4 days of recording are necessary to achieve a reliability of 0.80. If this is the case, then the measure does not appear to be very time or cost effective. In adults one of the major problems identified with heart rate monitoring is the generally observed low heart rate during normal activities. Dauncey & James (1979) demonstrated that accuracy is especially low at the lower heart rates. Such concerns have led researchers away from translating heart rate responses into energy expenditure equivalents, to use heart rate to calculate minutes engaged in moderate or vigorous activity, i.e., minutes spent with the heart rate above a certain threshold or level of intensity.

Despite obvious limitations in using heart rate as a measure of energy expenditure, however, the technique still remains to be one of the best and most practical alternatives available for measuring daily energy expenditure in children (Saris, 1986). Freedson (1989) and Freedson (1991) similarly recommended heart rate monitoring as a valid and practical measure of children's physical activity. Durant et al., (1993) suggest that this is based on the assumption that children who spend longer periods of time in higher heart rate ranges are generally more active than children whose heart rates are in the lower ranges. If used in conjunction with accelerometers or other motion sensors, heart rate monitors, it is suggested provide useful data (Hensley et al., 1993).

Caloric Intake

Physical activity can be quantified by determining energy intake, assuming of course that individuals are in approximate caloric balance. Various methods may be used to determine energy intake but the most common include weighing and analysing the energy content of food consumed over a period of time, or recalling what has been eaten over 24 hours. The recall method is the most practical though problems are often encountered with it. The accuracy of the data obtained from the food records depends on the subject's ability to recall and describe the amount of food consumed. Acheson, Campbell, Edholm, Miller & Stock (1980) reveals that dietary recall can result in underestimation of caloric intake of 21-33% depending on the kind of questionnaire used, while weighing the food and estimating caloric content from food tables can result in underestimates of 7%.

In very young children, parents are the only reliable source of information of a child's food intake. While older children can be expected to be able to recall their own food intake, the task is not considered to be easy. Indeed, children between 8 and 12 years of age have been found to report lower intake values than expected from energy output or body weight (Boulton, 1981). Quantifying physical activity based on energy intake in children, therefore, is not advisable as it can lead to systematic errors in the results (Saris, 1986). Further problems with dietary surveys include the fact that individuals vary in size and metabolic rate and these considerations must be taken into account if caloric intake is to be interpreted in terms of physical activity (Montoye & Taylor, 1984). Problems may also arise in the assumption that energy consumption and energy expenditure are in equilibrium. According to Garrow (1974), this assumption is only correct if energy intake is measured over at least 5-7 days and when changes in the growing body mass are also taken into account.

The Direct Measurement of Energy Expenditure

Methods for determining energy costs of various activities have been practised for many years. The method requires the subject to wear a mask or nose clip and mouthpiece and to breathe into a Douglas bag. It involves the use of an open respiratory circuit system in which the volume of expired gas is measured and a gas sample is taken for analysis of oxygen and carbon dioxide. On the basis of volume and the fraction of oxygen, it has been shown that energy expenditure can be calculated most accurately, within -2 to +4% (Croonen & Binkhorst, 1974).

The necessity of wearing a face mask or mouthpiece with a nose clamp makes the method inappropriate for children. Saris (1986) explains how in young children especially, the interference with normal activities is unacceptable. Durnin & Passmore (1967) have described an alternative method whereby oxygen consumption is measured for a few characteristic activities. In addition, an activity diary is kept and the daily energy expenditure is predicted from these data. The obvious disadvantage here though, is that the accuracy is dependent upon the co-operation and recall ability of the subjects in recording their own activities (Acheson et al., 1980).

Doubly Labelled Water Technique

An alternative and promising technique for measuring energy expenditure is the doubly labelled water technique. This method is based on the use of oxygen in energy metabolism and the elimination of carbon dioxide as the product of aerobic respiration (Lifson, Gordon & McClintock, 1955). The method requires an individual to drink a quantity of water with a known amount of isotope molecules $^{2}H^{1}H^{18}O$. The isotopes dilute in the body within several hours. The labelled hydrogen isotopes are eliminated in the urine, sweat and by water vapour loss, while the labelled oxygen isotopes leave the body as both water and carbon dioxide. By measuring the concentrations of labelled hydrogen and oxygen in the urine and the concentration of oxygen and carbon dioxide in the expired air, oxygen consumption and energy expenditure can be calculated during a specific time period.

The advantages of this technique are that it is reported to be very accurate, simple and non invasive (Seale, Rumpler, Conway & Miles, 1990). The subject is required to drink a glass of water and provide some urine samples. The method is also reported to have particular potential in children (Saris, 1985). Schoeller (1983) highlighted the possible sources of error with the technique based on the results of measurements in seventeen subjects between the ages of 8 and 34 years. A theoretical coefficient of variation in energy expenditure was calculated to be between just 4 and 8%. The optimal length of measurements for children was 3 to 14 days.

Klein et al., (1984) and Westerterp, DeBoer, Saris, Schoffelen & TenHoor (1984) have reported on the validation of this method as compared with the respiration chamber technique. Tentative conclusions were made claiming that the method can reasonably measure integral energy expenditure over periods of up to 2 weeks. The technique is, however, costly and as a result is restricted to use primarily in controlled clinical energy balance studies and related research settings (Hensley et al., 1993). It also provides only an overall estimate of energy expenditure for the entire observation period (Saris, 1986).

2.4 Observational Measures

Direct observation represents another technique used to measure physical activity. Methods of observation differ but all involve the monitoring of an individual's activity over a specified period of time. Recent technological advances permitting complex observational codes to be entered, stored and analysed by portable computers makes this method appealing for assessing physical activity (McKenzie & Carlson, 1989). Observation can be a useful measure for methodological studies (Baranowski et al., 1984), documenting patterns of activity (Baranowski, Tsong, Hooks, Cieslik & Nader, 1987), and evaluating school based studies (Parcel et al., 1987).

Observational measures can provide very detailed information on specific types of activities, without the danger of losing valuable information. It is considered a valid method for obtaining physical activity data because it requires little inference. As a result, it is often used as a criterion method for validating other measurements of physical activity including self-reports and mechanical and electronic monitoring (McKenzie, 1991). Baranowski et al., (1984) and Baranowski (1988) state that observational systems may provide a gold standard against which other systems could be compared. Observational procedures are flexible and allow researchers and practitioners to quantify diverse dimensions related to physical activity. They are recognised as a particularly useful measure for use with children, from whom accurate and detailed self-report data are difficult to obtain (Baranowski et al., 1984). Children engage in physical activity relative to many different environmental factors such as location, the presence of others, type of facilities, toys and equipment available and whether the environment allows for free play or structured activity. According to McKenzie (1991), observation allows for these variables to be studied with limited response burden on the subjects.

Some of the more common observational techniques used with children include the Fargo Activity Timesampling Survey (FATS) (Klesges et al., 1984), the Children's Physical Activity Form (CPAF) (O'Hara, Baranowski, Simons-Morton, Wilson & Parcel, 1989), the Activity Patterns and Energy Expenditure system (APEE) (Epstein, McGowan & Woodall, 1984) and the

Behaviours of Eating and Physical Activity for Children's Health Evaluation System (BEACHES) (McKenzie et al., 1991).

As with other measures, there are certain disadvantages associated with observational techniques. McKenzie (1991) highlights a number of problems with such measures. Events studied must be observable and be able to be coded, and are therefore limited to events seen or heard. Observers or recorders must be present in the environment where relevant behaviours occur thereby the situations where data can be collected are limited. Perhaps one of the major problems with observation though, is that it may result in reactive behaviour, i.e., the alteration of behaviour due to the presence of an observer. The results obtained may not therefore, be a true reflection of the individual's actual activity level. Observers must be trained to reduce subject reactivity and to be objective about what they see. Training observers, developing the observational system, preparing the coding conventions and conducting the observations is all very time consuming and requires a good deal of diligence on the part of the researcher. The technique is thus, not considered to be appropriate for large population studies.

2.5 Mechanical Measures

Physical activity involves movement of the body, of the trunk or of the extremities and many mechanical devices have been proposed and developed to obtain objective estimations of such movements over certain periods of time. Perhaps the simplest device for recording activity in this way is the mechanical or electrical movement counter. The pedometer is the most common example of a mechanical counter which was used as early as 1926 (Lauter, 1926). Researchers who have since used the device include Stunkard, (1960); Kemper & Verschur, (1974) and Saris & Binkhorst (1977). The pedometer is worn on the hip and assesses distance covered using a lever arm, spring and gear assembly. Steps are counted in response to the impact of the foot striking the surface which causes the lever arm to move vertically (Gayle, Montoye & Philpot, 1977; Kemper & Verschur, 1974). Pedometers are simple to operate and involve little interference or inconvenience to the subject wearing them. Readings have also been shown to correlate well with observational ratings in 4-5 year old kindergarten children (Saris & Binkhorst, 1977).

Montoye & Taylor (1984) report that the commercially available brands of pedometers are not reliable enough to use in research on physical activity. The same pedometers have been shown to give different results when worn by different individuals (Gayle et al., 1977; Washburn, Chin & Montoye, 1980) and give varying readings depending on which side of the body the instruments are worn. This is due to the fact that the walking gait of many people is such that impact will be greater with one particular foot. Saris (1985) also notes how instruments can vary considerably due to variations in spring tension. Another major disadvantage with pedometers is that they do not record intensity of movement. Saris & Binkhorst (1977) and Washburn et al., (1980) report that at slower speeds the pedometer tends to underestimate distance walked while with fast walking or running, distance is overestimated. Furthermore, pedometers are not useful for all activities. Because they depend on impact, they are inappropriate for skiing, bicycling, isometric (static) exercise and arm activities. For these reasons Hensley et al., (1993) report that pedometers are not recommended to accurately record the amount of physical activity performed.

The actometer proposed by Schulman & Reisman (1959) represents another mechanical technique which quantifies physical activity. This instrument is similar to a self-winding wrist watch where movement causes a rotor to turn. It is worn on the wrist or ankle and measures accelerations and decelerations in one plane. The assumption made here is that the measurements may more closely reflect energy cost. It has the advantage over the pedometer in that it records not only the movements themselves but also their intensity. The stronger the movement, the faster the rotor will turn. In a study conducted on children (Saris & Binkhorst, 1977) actometer readings were found to reflect differences in energy expenditure levels during walking and running with reasonable accuracy. Actometer scores correlated much better than pedometer scores with activity scores obtained through an observational method. On this basis, Saris & Binkhorst (1977) concluded that simple movement counters are useful in studying physical activity. The instrument has, however, been found to display large inter-instrument variation and it is advised to calibrate all actometers to the same standard (Johnson, 1971).

In addition to the movement counters, several more sophisticated electrical devices have been developed and utilised in different studies. The Large-Scale Integrated Motor Activity Monitor (LSI) is slightly larger than a wrist watch and may be worn on the arm, leg or hip (Foster, McPartland & Kupfer, 1978; LaPorte et al., 1979). It uses a mercury switch sensitive to a 10 degree tilt in a single axis to register physical activity. Montoye & Taylor (1984) identify at least two advantages compared with the pedometers. Firstly, because the counter operates on tilt rather than on impact it may be more useful than the pedometer or actometer as it may be used in a greater number of activities, and secondly the standardisation of the different instruments should be better as mechanical springs are not used. The cost of the device however, means that it's use is prohibitive for many applications.

More elaborate electronic switches have also been devised such as the biomotometer, (Schulman, Stevens & Kupst, 1977). The biomotometer uses three mercury-wetted microswitches mounted on a plane parallel to the ground. Movement in almost any direction will trigger at least one of the switches. A problem with the device however, is that there is the possibility of double or triple counting from the various switches (Montoye & Taylor, 1984).

The caltrac accelerometer has recently become increasingly popular in physical activity research. The caltrac is cheaper than many other devices and is relatively easy to use. The instrument is worn on the non-dominant hip and is sensitive to, and counts vertical acceleration. A corresponding estimated caloric expenditure appears on a liquid crystal display. Caloric expenditure is based on a basal metabolic rate estimated from height, weight, gender and age, plus total caloric expenditure from activity as measured by vertical acceleration.

Problems have been found with the device however. Mukeshi, Gutin, Anderson, Zybert & Basch (1990) tested its validity among pre-school children and concluded that it did not accurately reflect children's energy expenditure. As with other devices the Caltrac is also not capable of recording all types of activity. The caltrac does not measure energy expended in activities where there is no acceleration of the body (as in cycling, rowing) and it can not be worn in water. Furthermore, it does not account for the added energy cost of climbing stairs or running and walking uphill (Hensley et al., 1993).

2.6 Self-Report Measures

Self-report measures are probably the most commonly used type of measure of physical activity. Sallis (1991) believes "it is reasonable to ask subjects to report their own physical activity because they have experienced it and many physical activities are salient events that even children are likely to remember to some extent." Self-report instruments for physical activity assessment have been used in three areas of investigation. These include epidemiological, behaviour change and correlational studies (Baranowski, 1988). Epidemiologists have used self-report measures essentially for studying relationships to cardiovascular disease (CVD), (Powell et al., 1987) and mental health (Brown & Lawton, 1986; Stern, 1982). Behavioural scientists have used self-report measures as a dependent measure, testing methods for increasing physical activity (Baranowski et al., 1984; Dishman, 1982; Epstein, Wing, Thompson, & Griffin, 1980), and as an independent measure relating activity to indicators of CVD risk (Haskell, Taylor, Wood, Shrott & Heiss, 1980), weight loss (Epstein, Wing, & Thompson, 1978), and mental health (Blumenthal, Williams, Needels & Wallace, 1982; Brown & Lawton, 1986). Sallis et al., (1986); Mirotznick, Speedling, Stein & Bronz (1985) and Wankel (1985) have used self-report measures also in an attempt to identify who exercises, who does not, and why.

There are three types of self-report measures which are commonly used for measuring physical activity levels. These include:

Concurrent or end-of-the-day diaries

Retrospective reports on self completed forms

Retrospective interviewer conducted forms

Each self-report measure, whether of the same type or not, varies in the specificity with which mode, duration, intensity and frequency are assessed; they vary in the period of time covered by the report; and they vary in the nature of the resulting data, i.e., whether the data are reported as ratings, activity scores with arbitrary units, time, calories expended, or other summary scores (Sallis, 1991).

Diaries

The diary method is a useful tool for measuring physical activity and has been used in a number of studies. Edholm (1966) recommended that in keeping a diary, a prepared form is useful. This form is most convenient and involves using a simple code. The code must be designed for the particular group of subjects to cover the activities in which they are engaged. It has been found that, in general, some fifteen code letters can adequately cover the habitual activities of any individual. When using diaries, entries must be made on weekends and weekdays and sampling should take account of seasonal variations.

Diaries do, however, require a good deal of co-operation and time from subjects for completion (Montoye & Taylor, 1984). They are also not appropriate for use with all populations, for example, in the case of illiterate samples or very young children. Hensley et al., (1993) fear that because recording activity is so time consuming this may interfere with normal physical activity. They claim that if an individual is asked to record all physical activity for a 48 hour period, the individual is inclined to do less physical activity than normal because it is easier to record less data. It also demands a good deal of the researcher's time to code and analyse the activities reported. Furthermore, with this method, information is collected for only a relatively short period of time and the long-term pattern of habitual activity of the individual is not measured.

Anderson, Rutenfranz, Masironi & Seliger (1978) suggest that if diaries are to be useful, they must be kept for at least several days.

Self completion and Interviewer conducted Forms

Perhaps the most commonly used self-report measures are the retrospective reports on self completed forms and the retrospective interviewer forms. Questionnaires may be self administered or completed in reply to questions by an interviewer. Several self completion and interview questionnaire procedures for assessing habitual physical activity in population studies have been developed and analysed extensively and these will reviewed later in this chapter. Baranowski (1988) explains that while self completed forms are more efficient from the point of view of the investigators resources, some have found an interviewer is necessary to conduct probing and to maintain attention over a long period of time. Baranowksi (1988) identifies a number of advantages with retrospective reports. He notes that they are convenient to administer, cost effective when compared to other methods, unobtrusive and non-reactive. Furthermore, he acknowledges how they may cover details of activity for the previous days, weeks, months or even years and how they can be used to measure a variety of physical activity variables over time and from one source. For example, self-report measures can be used to study physiological types of activity, lifestyle related types of physical activity or activity phenotypes. They can also be used to assess duration, intensity, frequency, the physical location, the social environment, as well as self generated reasons for activity or inactivity. They are therefore a most versatile measure of assessment.

A primary disadvantage of self-report instruments is that they may not sample all types of physical activity behaviours, and, as such, may misclassify activity habits. Though frequently used, Sallis (1991) remarks that actual observable behaviour is not directly assessed by self-reports, rather the data are memories of the behaviour of interest that have decayed, been filtered through perceptions and biases and been tainted by competing memories, social desirability and misunderstandings of instructions. According to Hensley et al., (1993), the accuracy of instruments may depend on the respondent's level of education, age, gender, type of physical activity surveyed and the time involved. Indeed, Baranowski (1988) has discussed the considerable demands self-report places on the cognitive abilities of children to recall events from the past. Finally, it should be realised that the multiple self-report methods are not interchangeable and may not always be appropriate in all circumstances. Instruments designed for measuring activity patterns over a long period of time, for example, would not be useful to evaluate a shorter period of time. Clearly each instrument needs to be crafted to meet the perceived needs and strengths of particular research problems and settings (Baranowski 1988). The problems and issues of reliability, validity and accuracy of self-report measures is dealt with in considerably more detail in the subsequent section of the review.

SECTION TWO A REVIEW OF SELF-REPORT MEASURES

2.7 Self-Report Measures

Self-report instruments have been used extensively in the measurement of physical activity but many investigators have concerns about the accuracy of such measures (Baranowski, 1985; Bernard et al., 1984; McGowan et al., 1984; Powell et al., 1987). Dishman & Steinhardt (1988) state that the "minimal requirements of an instrument for the recall assessment of physical activity necessitate that it provide reliable and valid measurements, that its administration is feasible, and that it will not alter habitual physical activity patterns." Despite this proposed standard however, the reliability and validity of many self-report measures is reported to be poor (Lamb & Brodie, 1990) or unknown (Washburn & Montoye, 1986), and as a result, data from physical activity self-reports are often viewed with suspicion (Sallis, 1991). This section provides an up to date review of the most popular self-report measures which have been developed and used in physical activity research. To allow for comparison between measures and to familiarise the reader with existing instruments, the characteristics of a number of self-report measures are described and studies reporting on the validity and reliability of such measures are reviewed. To begin with however, the issues of reliability and validity are discussed generally. A brief review of adult self-report measures is made followed by a more detailed and critical review of children's self-report measures and the issues of reliability and validity of self-report measures in children. The latter part of this section discusses the potential sources of error in self-report measures and identifies recommendations and new directions for the future methodological study of the self-report of physical activity. The section is thus organised as follows:

2.8 Reliability and Validity of Self-Report

Reliability refers to consistency and whether two administrations of an instrument produce the same result. Validity refers to the extent to which an instrument measures what it is supposed to measure. For a self-report measure to be declared reliable and valid therefore, it must be capable of obtaining the same information from the same person on two separate occasions, and in doing so be measuring actual habitual physical activity (Lamb & Brodie, 1990). Lamb & Brodie (1990) acknowledge how, throughout their history, reliability and validity have been fundamental aspects of physical activity self-reports but how they have always been found difficult to fully establish. Problems in conducting reliability and validity studies arise because the most appropriate way to assess reliability and validity is not really known and there is no accepted criterion method of assessing physical activity (Baecke, Burema & Frijters, 1982; LaPorte et al., 1985). In the case of studies of validity, for example, there are no methods with almost no error against which to assess self-reported activity. Hensley et al., (1993) remark how in the past several methods of assessing physical activity have been validated against criteria that are perhaps less than the "gold standard."

The validation of self-report has often had to rely upon indirect methods, such as the assessment of cardiorespiratory fitness, body composition and activity diaries and energy (dietary) intake. According to Baranowski (1988), observation methods provide one candidate for a gold standard but of course there are problems inherent within observational procedures themselves. The extent to which an observer affects the level and the memory of activity performed for example, has not been conclusively documented. Alternatively, heart rate monitors with recording devices represent another means by which self-report measures may be validated.

Similar problems are evident in reliability studies. To examine reliability a test-retest procedure is traditionally the optimal method (Lamb & Brodie, 1990). However, unless a retest occurs within a short time after the initial test, it may be that it is actually the subject's reliability that is being examined. If the period of activity recall is 7 days, for example, then a retest delay may be affected by memory (if the subject is asked to recall activities from the same period as before). Alternatively it may be affected by the stability of the subject's physical activity habits if a different 7 day period is considered. Jacobs, Ainsworth, Hartman & Leon (1993) note how for questionnaires with a short time frame, such as the 7-Day Recall, readministration after one month measures a combination of short term stability of physical activity behaviour in addition to questionnaire reliability and how this applies more strongly for longer gaps between administrations. Lamb & Brodie (1990), acknowledge how many studies have either failed to account for these factors or clarify their reliability method. A further problem associated with reliability and validity checks include the population to which the instruments have been applied differing across studies. This makes it difficult to compare coefficients across studies and generalise the published values (Baranowski, 1988).

Researchers such as Washburn & Montoye (1986); Baranowski (1988); Lamb & Brodie (1990) and Sallis (1991), acknowledging the importance of reliability and validity in relation to self-report measures, have published comprehensive reviews of studies which have addressed such issues. A summary of coefficients of validity and reliability for a number of self-report measures was produced by Washburn & Montoye (1986) and these have since been updated by Baranowski (1988) who reported on nine most commonly used self-report measures. Lamb & Brodie (1990) provided a critical review of physical activity questionnaires focusing on five key aspects, one of which was validity and reliability. Other aspects included format and content, time to administer, mode of measurement/scoring and popularity. However, of most interest is the work produced by Sallis (1991) who has reviewed the reliability and validity of children's physical activity self-reports, as well as measures based on others' reports of children's activity. The studies referred to by Sallis (1991) are outlined in detail later. Firstly, a description of the characteristics and reported reliability and validity of the more common adult self-report measures is made.

2.9 Adult Physical Activity Self-Reports

A number of well known and well established adult self-report measures have been developed in the past. Measures such as the Health Insurance Plan Questionnaire, The Tecumseh Questionnaire, The British Civil Servants Questionnaire, The Paffenbarger Physical Activity Questionnaire, The Minnesota Leisure-Time Physical Activity Questionnaire and The Framingham Physical Activity Questionnaire have all been assessed in terms of their reliability and/or validity. According to Lamb & Brodie (1990) there are currently at least 38 different questionnaires available which assess physical activity in some way or another.

For the purpose of this research only the most popular adult questionnaires will be reviewed. The reason for reviewing this selection is that aspects of the design of a number of the measures are employed in the design of the self-report measure in part one of this thesis. The characteristics of such measures are therefore the major concern and are more important than the actual reliability and validity information derived for such measures. While the researcher appreciates that there are severe limitations with the findings of a number of the reliability and validity studies described, it is not the intention to review these studies critically. Rather, a critical review is restricted to the children's self-report measures later in this section

The Health Insurance Plan Questionnaire (HIP)

The Health Insurance Plan Questionnaire (HIP), (Shapiro, Weinblatt, Frank & Sager, 1965) was a short two part self completion instrument covering both occupational and leisure-time physical activity (LTPA). The LTPA part asked questions relating to the frequency of participation in walks, housework, gardening and sports, with each category carrying a weighting factor that varied according to the frequency category.

In terms of the validity of the instrument, Frank, Weinblatt, Shapiro & Sager (1966) reported a significant relationship between overall level of physical activity and early mortality following initial myocardial infarction among 301 males (aged 25-64 years). Mortality was found to be three times greater in the least active group than the most active group. Hennekens et al., (1977) also showed a reduced risk of coronary death with increasing leisure-time physical activity among 568 males aged between 30 and 70 years of age. However, a comparison between the HIP leisure-time physical activity ratings of 198 middle-aged males with those obtained from another well known questionnaire, the Tecumseh Questionnaire, revealed a correlation of only r=0.29 (level of significance not reported) (Buskirk, Harris, Mendez & Skinner, 1971).

The Tecumseh Questionnaire

The Tecumseh Questionnaire was originally designed for use in a community health study (Reiff et al., 1967). It was a modified and revised version of an earlier questionnaire designed by Wessel, Montoye & Mitchell (1965). Subjects were required to complete a 99 item self administered questionnaire covering occupational, leisure-time, sports, gardening and other physical activities during the preceding year. They also received an in-depth home interview which enquired about the frequency and duration of each activity reported. Each of the activities were assigned a MET value and a LTPA index was calculated based on the average daily number of METS expended during the year in leisure activities.

Skinner, Benson, McDonough & Hames (1966) attempted to validate the questionnaire by examining its association with a measure of cardiorespiratory fitness. Daily overall activity metabolic index (AMI) had a non significant correlation (r=0.13) with performance on a submaximal treadmill test among 54 males (aged 40-59). Buskirk et al., (1971) also found a non significant correlation between overall AMI and daily caloric intake among 198 males of the same age (r=-0.10). However Montoye, Block, Metzner & Keller (1976) found that when caloric intake was divided by body weight, and the overall levels of physical activity of 1,300 men aged 16-65 were re-classified as active, moderately active or sedentary, active subjects were found to consume significantly more calories than sedentary subjects. Other more indirect sources of validation have been reported by Montoye and colleagues. Some active subjects were found to have significantly more favourable physiological characteristics. For example, a better glucose tolerance (Montoye, Block, Metzner, Keller & Arbor, 1977), a lower blood pressure (Montoye et al., 1972), lower body fatness (Montoye et al., 1976) and lower serum uric acid (Montoye et al., 1967). Montoye et al., (1976) also reported an inverse relationship between physical activity and serum lipid levels.

The British Civil Servants Questionnaire

The British Civil Servants Questionnaire was originally a 2-day recall questionnaire (Alderson & Yasin, 1966). The questionnaire was interviewer administered and covered leisure-time activities only. It was originally designed for, and administered to more than 100 male executive-grade officers (aged 40-54) over a 14 month period. The length of all activity engaged in out of work was recalled for the previous 2 days and the procedure was repeated on four separate occasions. Eight days of LTPA were thus gathered. All activities were assigned to one of five categories: sedentary, light, moderate, strenuous and sport, based on published values of oxygen consumption for different activities. Each category was allocated a score from 1-5 (sedentary to sport), and each activity reported was scored for each 5 minute period it was engaged in. For example, an hour of football would be allocated 60 points (12x5). The sum of each 5 minute period of LTPA provided an average daily activity score . Subjects were then divided into thirds and classified as inactive, middle active or very active groups based on their activity score.

The reliability of this procedure for measuring LTPA was established by determining the stability of individual scores. A correlation of r=0.67 was reported between the weekend days and the total 8 day score and a correlation of r=0.55 was obtained between the work day and weekend scores (Alderson & Yasin, 1966). A weeks weighed dietary survey was carried out and skinfold measures taken on a sample of 32 in an attempt to validate the questionnaire (Yasin, Alderson, Marr, Pattison & Morris, 1967). Subjects who were classified as active on the 8 day record had a higher average energy intake than the inactive subjects, though the correlation between activity scores and energy intake was not significant (r=0.27). However, the active subjects were found to have lower skinfold measurements than the inactive subjects and a negative association between activity levels and skinfolds was found to be significant (r=-0.31).

The Paffenbarger Physical Activity Questionnaire

The Paffenbarger Physical Activity Questionnaire was developed for use in a longitudinal study of physical activity and heart attack risk among 16,936 male Harvard University alumni (Paffenbarger, Wing & Hyde, 1978). The questionnaire was a one page self administered questionnaire which asked respondents to recall how many flights of stairs they climbed in an average day, how many city blocks they walked in an average day and what sports they played and for how many hours per week. The questionnaire also asked the number of times the subject sweated per week through physical activity. The various activities were assigned energy expenditure values from the literature and were classified as light (> 5 kcal/min) or strenuous (> 10 kcal/min). An overall index of physical activity expressed in kcal/week was then calculated.

The reliability of the questionnaire was originally examined by comparing self administered reports obtained from a sample of 410 with reports obtained via a telephone interview. No significant differences between the two sets of responses were found. LaPorte et al., (1983) also examined the test-retest reliability of the questionnaire among 59 postmenopausal females aged 45-74. One year apart, correlation coefficients for total weekly energy expenditure, blocks walked, flights of stairs climbed and sweat episodes were r=0.73, 0.42, 0.54 and 0.46 respectively. Cauley, LaPorte, Black-Sandler, Schramm & Kriska (1987) examined the short term reliability of the instrument from a 4 week test-retest. The 4 week test-retest coefficients were superior to those over a year. This time correlations of r=0.76, 0.97 and 0.89 were obtained for energy expenditure, blocks walked and flights of stairs climbed respectively.

In a larger study, Cauley et al., (1987) also assessed the validity of the questionnaire by comparing it with an estimate of energy intake and the output of a Large-Scale Integrated Activity Monitor (LSI). In an intervention group assigned to walk 7-9 miles per week, a modest correlation ($r=0.33$) ($p < 0.01$) was found between total activity registered by the LSI and total energy expenditure assessed by the Paffenbarger questionnaire. However, a low and non significant correlation was found between energy intake and the questionnaire index ($r=0.02$). Among the control group, a lower correlation between the LSI and questionnaire was achieved ($r=0.17$).

Evidence supporting the validity of the questionnaire was obtained from the original Paffenbarger study of Harvard alumni. It was reported that the relative risk of first heart attack was significantly less for both those with a physical activity index greater than 2,000 kcal/week and those engaged in strenuous sports. Paffenbarger, Wing, Hyde & Jung (1983) later reported that alumni falling into the same categories (i.e., having an activity index > 2,000 kcal/week and engaged in strenuous sports) had a 35 and 30% respectively, lower risk of developing hypertension. Cauley, LaPorte, Kuller & Black-Sandler (1982) also found that postmenopausal women (referred to earlier) who expended 2,000 kcal/week or more had significantly higher, and therefore more favourable levels of HDL cholesterol. Total weekly physical activity and strenuous activity were independently correlated with HDL cholesterol ($r=0.25$ for total activity and $r=0.27$ for strenuous activity respectively).

<u>The Minnesota Leisure-Time Physical Activity Questionnaire (MLTPAQ)</u>

The Minnesota Leisure-Time Physical Activity Questionnaire (MLTPAQ) (Taylor et al., 1978) represents another popular questionnaire for assessing LTPA which has been used in at least 18 published studies. It was developed as a shortened version of the Tecumseh Questionnaire and was designed to obtain information about leisure-time physical activities only. Subjects were required to indicate what activities they had engaged in during the past year from a given checklist. An interviewer then spent an average of 20 minutes per person obtaining additional and detailed information about the activities. Details of how many months the activities were performed for, the frequency with which they were performed and the average duration on each occasion were sought. Interviewers were provided with notes outlining the procedure for conducting the interviews. An activity metabolic Index (AMI) was then calculated in the same way as in the Tecumseh (from established energy costs of activities).

Validation of the questionnaire among 175 males involved a direct comparison between participation in healthy physical activities and aerobic capacity. Leon, Jacobs, DeBacker & Taylor (1981) found significant correlations between exercise duration in a treadmill test and total LTPA (r=0.41) and heavy LTPA (r=0.44). However in an identical study conducted on Belgium males by Sobolski et al., (1981), exercise duration was found to have a low association with total LTPA (r=0.08) and heavy LTPA (r=0.11).

The questionnaire has also been validated against the Large-Scale Integrated Activity Monitor (LSI) in a sample of undergraduate students (LaPorte et al., 1979). A significant correlation was obtained between the LSI reading and the MLTPAQ when the device was attached to the waist (r=0.69), but a non significant correlation was obtained when it was attached to the leg (r= 0.43). LaPorte and colleagues also assessed the validity of the questionnaire in a sample of boys aged 12-14 years. The results from the questionnaire were compared with 2-day readings from an LSI and a 3-day dietary survey. Neither the LSI nor the dietary records were found to correlate with the MLTPAQ.

The reliability of the questionnaire was investigated by Folsom, Jacobs, Casperson, Gomez-Marin & Knudsen (1986) who examined its test-retest reliability over 5 weeks among 140 male and female subjects in a community health programme, and over 2 weeks among 150 males at high risk of CHD. For the male and females subjects, correlations between the measures were high. Correlations ranged from 0.79-0.88 for total, light, moderate and heavy LTPA scores. Slightly lower correlations were observed in the male only subjects ranging from 0.69-0.82.

The Framingham Physical Activity Questionnaire

The Framingham Physical Activity Questionnaire was an interviewer administered questionnaire designed to assess habitual activity (Kannel & Sorlie, 1979). The procedure required subjects to report the number of hours usually spent resting (including sleep), the number of hours spent at work and the time spent in extra-curricular activities. Five activity categories; basal, sedentary, slight, moderate and heavy were identified and given a weighting of 1.0, 1.5, 2.4 and 5.0 respectively. The sum of hours spent in each category provided a physical activity index.

Garcia-Palmieri, Costas, Cruz-Vidal, Sorlie & Havlik (1982) assessed the repeatability of the questionnaire by 3 separate assessments 2.5 to 3 years apart. Correlations were found to be low (r=0.30-0.59). Garcia-Palmieri et al., (1982) also investigated the validity of the questionnaire by means of comparison of physical activity with health-related factors in the Puerto Rico Heart Health Study. Low negative correlations were found between physical activity and resting heart rate, blood pressure, relative body weight and serum cholesterol among 8,793 male subjects (aged 45-64). The significance or otherwise of these correlations was not reported. An inverse association was also found between physical activity and the incidence of CHD. Likewise, the Framingham Study (Kannel & Sorlie, 1979) reported a relationship between physical activity and mortality caused by CHD but the result was not significant.

The 7-Day Recall Physical Activity Questionnaire

The 7-Day Recall Physical Activity Questionnaire was developed for a five city community-based health education programme in California in 1979 and 1980 (Sallis et al., 1985). The questionnaire was an interviewer administered recall of leisure and occupational physical activities. The questionnaire, which took about 10 to 15 minutes to complete, involved subjects recalling the time they had spent during the past 7 days in activities displayed to them on lists. The lists comprised moderate, hard and very hard activities. An advantage of this questionnaire was that most people spend most of their waking hours in light activity and since time in light activity was ignored during the interview and was obtained by subtraction, most individuals had to account for only small blocks of time. Interviewer instructions outlining the interview technique were also provided for the recall.

Gross, Sallis, Buono, Roby & Nelson (1990) more recently outlined a training programme for the 7-Day Recall comprising four 1 hour structured sessions. Sessions included a familiarisation of the questionnaire and manual, interview practice with corrective feedback and scoring practice. The scoring procedure for the questionnaire involved calculating energy cost in $kcal \cdot kg^{-1} \cdot day^{-1}$. Blair (1984) has described this procedure in some detail. Activities were classified into one of four activity categories: light, moderate, hard and very hard. Light activity was defined as slow walking, sitting, doing homework or unstrenuous sports such as bowling, archery or softball and was assigned a MET equivalent of 1.1-2.9 METS. Moderate activity was defined as those activities that made you tired after about an hour and was given an energy expenditure value of between 3 to 4.9 METS, while hard activity, recognised as activity which made you tired after about 10 minutes was assigned a MET equivalent of 5.0 to 6.9 METS. In making the energy cost calculations, the following average MET values were assigned to each category of activity:

SLEEP	= 1 MET
LIGHT ACTIVITY	= 1.5 METS
MODERATE ACTIVITY	= 4 METS
HARD ACTIVITY	= 6 METS
VERY HARD ACTIVITY	= 10 METS

To calculate energy cost in $kcal \cdot kg^{-1} \cdot day^{-1}$, the hours spent in each activity category were simply multiplied by the average MET value for that category and all categories were summed.

The reliability of the 7-Day Recall was determined by conducting a 2 week test-retest on a self-selected sample of 58 drawn from the original community-based health education programme. Correlation coefficients for the number of hours spent in each intensity category ranged from r=0.08 for moderate activities to 0.61 for very hard activities. Total energy expenditure was not significantly different over the 2 weeks and had a reliability correlation of r=0.67. Taylor et al., (1984) investigated the validity of the 7-Day Recall among 30 male subjects (aged 34-69) in a cardiac rehabilitation programme. The questionnaire was compared to a daily self-report log of physical activity and a solid-state activity monitor. Total daily hours of energy expenditure were well correlated between the recall and self-report log methods (r=0.81). No significant differences were found between mean daily energy expenditure obtained by any of the three methods.

Dishman & Steinhardt (1988) have also reported on the validity and reliability of the recall among a sample of university students. An identical correlation to that which was achieved by Taylor et al., (1984) was obtained between the 7-Day Recall and a 7-day activity log (r=0.81). The test-retest reliability of a self administered version of the recall was examined in students involved in a 9 week exercise intervention study. Physical activity was found to be consistent over 9 weeks in the control subjects (coefficient of internal consistency, p_1,=0.89 and 0.90 for total and vigorous activity recall).

<u>The Baecke Questionnaire</u>

A self administered questionnaire which assessed physical activity in three dimensions: a) physical activity at work, b) sport during leisure-time, and c) physical activity during leisure-time (excluding sport), was developed by Baecke et al., (1982). For physical activity at work and physical activity during leisure-time, questions were scored on a 5-point scale ranging from never (1 point), to very often (5 points), and summed. The sport category was scored by taking into account the intensity of the sport played, the amount of time the sport was played per week and the proportion of the year in which the sport was played. The sum of all sports produced a sport index.

The reliability of the questionnaire has been assessed in a sample of Dutch males and females. A 3 month test-retest produced correlations of r=0.88 (work index), r=0.81 (sport index) and r=0.74 (non sport leisure time index). Cauley et al., (1987) assessed the validity of the questionnaire comparing it with three other estimates of physical activity. In an exercise intervention study involving 255 postmenopausal women, the LSI monitor was found to have low correlations with the leisure-time and sport index (r=0.20 and 0.17) in the exercise group, and the Paffenbarger Physical Activity Questionnaire had an equally modest association with the leisure-time index (r=0.19). Only the work index was found to be significantly associated with the third measure, energy intake (r=0.31). Among the control group few significant correlations were found and these were only modest.

The Godin & Shephard Leisure-Time Exercise Questionnaires

Finally, a further two forms worthy of mention are those developed by Godin & Shephard (1985) and Godin, Jobin & Bouillon (1986). The 1985 form required subjects to indicate the average number of times per week they participated in strenuous (heart beats rapidly), moderate (not exhausting), and mild (minimal effort) exercise lasting for more than 15 minutes. A second question asked about the weekly frequency of engaging in regular activity long enough to work up a sweat. A 2 week test-retest of the questionnaire among 53 subjects revealed correlations of r=0.94, 0.46, 0.48, and 0.74 for strenuous, moderate, mild and total activities respectively. Validation was sought among a sample of 306 self-selected adults aged 18 to 65 years with percentile measures of estimated VO_2 max and percentage body fat. Correlations between LTPA and VO_2 were low, yet significant for total and strenuous activity (r=0.24 and 0.38 respectively). Total and strenuous categories were also significantly related to body fat (r=0.13 and 0.21 respectively). Discriminant functional analyses indicated that the questionnaire was able to discriminate the majority of 'fit' from 'unfit' people according to their VO_2 max scores and the majority of thin from fat people based on their body fat measures.

The second form (Godin et al., 1986) comprised just one question. The form asked "How often did you participate in activities long enough to get sweaty, during leisure-time within the past 4 months?" Responses were assigned various numeric values: "not at all," =0, "less than once a month," =2, "about once a month," =4, "about 2 or 3 times a month," =10, "about 1 to 2 times a week," =24, and "3 or more times a week" =48. A 2 week test-retest reliability of the question among male subjects (n=29) was not found to be high (r=0.64). Three criteria were used to assess validity; VO_2, body fat and level of muscular endurance. Over 60 self-selected adults were assessed. Strenuous activity over the past 4 months was found to be significantly correlated with each validity criteria with correlations ranging from r=0.38 to 0.54.

Summary

As can be seen from the review of adult self-report measures, indirect means of validation seem to be the most popular methods adopted in the studies. In some studies physical activity measures have been found to be related to body composition, caloric intake, VO_2 max or cardiorespiratory fitness, and to the risk of heart attack or mortality caused by CHD. Other means of validation have included the relationship of physical activity to caloric intake, blood pressure, lipid levels and improved glucose tolerance, while other studies have compared physical activity with the LSI monitor, a daily self-report log and other established questionnaires.

However, in analysing the results of the validation studies, it becomes evident that in many cases, the correlations obtained with such external criteria are not high, and in a number of cases not significant. A correlation as low as r=0.02 is reported in one instance, for example. Indeed, the majority of correlations can be seen to range from between just 0.10 to 0.30. The highest correlation reported across all of the validation studies was 0.81, obtained between the 7-Day Recall Questionnaire and self-report log methods.

In terms of reliability, it seems that the test-retest method is the most popular means of assessing the reliability of measures. Test-retest measures were made over varying intervals of time ranging from 2 weeks in 7-Day Recall and the Baecke Questionnaire, to 2.5 to 3 years in The Framingham Physical Activity Questionnaire. A time interval of 1 month was selected in the case of The Paffenbarger Physical Activity Questionnaire, while a 5 week period was selected in the Minnesota LTPAQ. The test-retest coefficients obtained tended to be generally quite high, particularly for instruments covering usual patterns in activity such as The Paffenbarger Physical

Activity Questionnaire and The Minnesota Leisure-Time Physical Activity Questionnaire, as opposed to those identifying specific events in specific time frames. In both of these measures correlations above r=0.80 were obtained. Indeed, Baranowski (1988), drew a similar conclusion following his review of a number of these studies. He stated that "the same instrument when applied to the same group of people, asking for patterns in habitual activity, have reasonably high reliability coefficients." It should be recognised though, that this doesn't necessarily mean that the instruments are precisely measuring true activity patterns, but it may be that some stable self perception of observation of one's own usual activity is producing consistent responses at the two points in time.

2.10 Scoring Procedures

The questionnaires described outline a number of different procedures for scoring physical activity. Physical activity levels are reported as ratings, activity scores with arbitrary units, or more popularly as estimates of energy expenditure. The Tecumseh Questionnaire, The Minnesota Leisure-Time Physical Activity Questionnaire, The Paffenbarger Physical Activity Questionnaire and the 7-Day Recall Physical Activity Questionnaire all relied on estimates of energy expenditure based on established energy costs. The methods employed to make the calculations in these questionnaires are of particular interest for the purpose of this research. The costs used in these questionnaires are expressed in the form of METS i.e., ratios of work metabolism to basal metabolism (WMR/RMR). The basis of the calculations is that resting or basal metabolism (one MET or RMR) requires 3.5 ml of O_2 per kilogram of body weight per minute. This is equal to approximately 1 kilocalorie (kcal) per kilogram per hour ($kcal \cdot kg^{-1} \cdot hour^{-1}$). Thus, activities requiring 3 METS (WMR/RMR) will expend 3 $kcal \cdot kg^{-1} \cdot hour^{-1}$. This expression eliminates the necessity of considering the subject's body weight and converting to calories. The method assumes that a task performed by a heavy individual raises the metabolism to the same extent (in percentage terms) as the same task performed by a lighter individual, even though the caloric expenditure might be different. Reiff et al., (1967) claim that since most activities involve moving one's own body weight, errors in making this assumption are probably not serious.

The energy costs of the activities used in the calculations have been derived from the literature. The Tecumseh Questionnaire and The Minnesota Leisure-Time Physical Activity Questionnaire devised their own tables of metabolic costs based on the work by Passmore & Durnin (1955), and the 7-Day Recall Questionnaire adopted the intensity codes from the Minnesota Leisure-Time Physical Activity Questionnaire. Blair (1984) does recommend when using the 7-Day Recall however, that energy cost tables by Katch & McArdle (1977) also be used to help to assign activities to particular categories. Energy cost lists have also been produced by Torun (1983), Bouchard et al., (1983), and just recently a whole compendium of physical activity energy costs has been developed by Ainsworth et al., (1993). The compendium of activities is a classification system based on the "best representation" from published lists and selected unpublished data. The list was compiled primarily using the lists from the Tecumseh Questionnaire (Reiff et al., 1967), The Minnesota LTPAQ (Folsom et al., 1985), Katch's Physical Activity List (Katch & McArdle, 1988; McArdle, Katch & Katch, 1988), the 7-Day Recall (Blair et al., 1985) and the American Health Foundation's physical activity list (Leon, 1981). This compendium has the advantage of grouping activities by purpose and providing flexibility in determining energy costs.

While providing useful estimates of energy expenditure, it should be recognised that such scoring procedures do have their limitations and they cannot be expected to provide precise quantitative values. Many of the established intensity codes have been obtained in highly standardised, experimental situations and are rarely available for the free living situation , while others have not been derived from actual measurements of oxygen consumption at all (Taylor et al., 1978). Rather, they have been estimated from the energy costs of activities having similar movement patterns (Ainsworth et al., 1993). Taylor et al., (1978), identify three main limitations with working with intensity codes in establishing energy expenditure. Firstly, the use of a basal (resting)-to-work metabolic rate for the calculations is not exact, since basal metabolism is not consistent at 1 kcal/min, as often interpreted. Secondly, individual variation in the vigour of performing activities can have a marked effect on actual energy expenditure. Taylor et al., (1978) note how judgement must therefore be exercised in choosing exercise intensity codes, aiming for a reasonable representation of each activity as typically performed. A third concern is the fact that some activities do not have intensity codes and therefore estimations become necessary in categorising certain activities. Serious inaccuracies may also arise using energy costs if there is frequent change in the activity being measured. With such changes, the steady state values for energy expenditure as given by the tables may not actually be reached.

A closer analysis of the different classifications systems used in a number of studies also reveal discrepancies as to what value represents light, moderate or heavy intensity activity. In scoring the Minnesota Leisure-Time Physical Activity questionnaire, light activity ranged from 2-4 METS and moderate from between 4.5-5.5 METS. These values were higher than those identified by Blair (1984) for the 7-Day Recall Questionnaire. Bouchard et al., (1983) identified nine categories of activity, ranging from sleeping to intense work and high intensity sport activities/sport competition. Examples of selected activities which fell into each category were given. While each coding system may suit the purpose of the individual researchers, the differences limit the comparability of results across studies and, according to Ainsworth et al., (1993) add confusion to the field.

Given that the concern in this research is in children, the applicability of energy expenditure values to children is also worth considering. Unfortunately, only limited research on measured energy expenditure in children during physical activity is available. Durnin & Passmore (1967) give energy expenditure values for children in a number of different activities but the values are by no means comprehensive. The application of adult energy expenditure values to children has therefore tended to be the common practice. Bouchard et al., (1983) estimated energy expenditure in children and adults and used the same energy costs for both and Wallace, McKenzie & Nader (1985) similarly calculated energy expenditure in children using the 7-Day Recall Questionnaire method. These studies are reviewed in more detail later in the review (see 2.11). In terms of applying adult values to children however, Durnin & Passmore (1967) have noted that when comparisons are made between adults and children a number of activities are approximately the same. For instance, they found no differences in the energy expenditure of adolescents when sitting and standing. They concluded therefore that "for practical purposes the rates of energy expenditure of adolescents when sitting and standing are the same as those of adults."

Torun (1983) however, expressed concern about the inapplicability of energy cost values measured in adults for use in children. He summarised large differences in the energy cost of activities performed by adults and 2-4 year old children. However, in studies which have considered the energy cost of activities performed by adults to children of other age groups, the error has been shown to be considerably less, particularly after the age of 9-11 (Taylor, Lamb, Robertson & MacLeod, 1948; Bedale, 1923; Cullumbine, 1950; Legun & Moltschanowa, 1935). Indeed, the comparison made by Torun (1983) illustrated that in older children the differences were so small that none of the activities would need to be categorised any differently for adults and children in terms of their intensity.

2.11 Children's Physical Activity Self-Reports

In contrast to adults, relatively few self-report measures of physical activity exist for children. Some studies have adopted existing adult self-reports, while others have developed alternative procedures. However, a number of studies have been cited which have used self-report measures with children and which have provided information with regard to the reliability and validity of the measures. These studies, the characteristics of the self-report measures used, and the findings in relation to the validity and reliability of the measures are now outlined in some detail. Unlike the brief overview of adult self-reports, the children's measures are reviewed critically. The children's measures tend not to be as well established as the adult measures and as such they have not been given specific names, but are detailed in the separate studies and organised chronologically.

In 1974, Seliger, Trefny, Bartunkova & Pauer conducted a study which aimed to provide a comprehensive overview of the activity patterns of eleven 12 year old boys over a 24 hour period to help to elucidate the relationship between habitual physical activity and physical fitness. Subjects kept personal records of their activity over 24 hours and throughout the period their heart rate was recorded. Physical fitness was assessed separately by performance on a cycle ergometer. Attempts were made to quantify the various activities which were reported into seven intensity categories, ranging from sleep to heavy intensity activity. The recorded heart rates during the period were compared to the various activity levels. The different intensities of activity were reflected in changes in heart rate response. Interestingly though, the study revealed no statistical significance between activity levels and performance scores achieved in the ergometric test.

Shephard, Jequier, Lavallee, LaBarre & Rajic (1980) examined the effects of adding 5 hours of Physical Education per week to the primary school curriculum. Physical activity was measured by means of activity diaries and retrospective questionnaires. Twenty four hour records were obtained from 281 students for a typical Wednesday and a typical Saturday in spring and autumn. The students were required to complete a diary sheet listing the principal activities during each half hour segment of the days investigated. The reported activities were then classified into categories of sleep, very light/light activities, leisure activities (not organised by adults), leisure activities (organised by adults), school recreation, required physical education and unidentified activities. In addition, 297 students completed a daily retrospective physical activity questionnaire under teacher supervision during a typical week in March. In the retrospective report students responded to questions relating to their journey to school, total weekly walking distance, sports participation, household chores, sedentary activities and sleep.

With regard to the reliability of the measures in the study, correlation coefficients for the diary record between spring and autumn were low ($r=-0.03$ to 0.27), though it was recognised that this could have reflected seasonal variations of activity rather than a lack of reliability. As a measure of validity, comparisons between the prospective diary records and the retrospective activity histories were made for the same week, and the average daily time given to sleep and to television watching was computed. Coefficients of correlation between the two methods of assessment were $r=0.44$ for hours of sleep and $r=0.53$ for hours of television watching.

In 1981, Thorland & Gilliam compared serum lipids between habitually high and low active pre-adolescent males. Evaluations of 55 boys aged 8-11 years were made. Habitual physical activity was determined by a 5-day activity record. From the records daily estimates of the duration of participation in different categories of activities were recorded and, based on average values for the 5-day period, a representative profile of typical participation in different work intensity categories was devised for each child. On the basis of their profile subjects were divided into a lower active or higher active group. Results revealed that greater exposure to activities classified as moderate to very highly intense was consistent with lower triglycerides and higher HDL cholesterol.

Linder, Durant & Mahoney (1983) also conducted a study concerned with serum lipids and physical activity, but in this case the study dealt only with the reliability of the self-report measure used. The study aimed to measure the effect of physical conditioning on serum lipid and lipoprotein levels in adolescent males. The physical activity levels, nutritional intake, physical working capacity and fasting serum lipid and lipoprotein levels were assessed in 50 boys aged between 11 and 17. Physical measurements were also taken. Physical activity level was determined by means of a standardised questionnaire administered during a personal interview. Information sought included the usual number of hours spent watching television each day, the number of hours usually spent reading and studying each day, the number of team sports played during the previous school year, the number of sports or physical activities performed at least 3 days a week for at least 1 hour at a time, the number of days spent jogging and the number of days spent riding a bicycle. The questionnaire was re-administered to the subjects 8 weeks later. The mean test-retest correlation coefficient for the items on the questionnaire was $r=0.70$, with a range of $r=0.49$ to 0.99. It was concluded that the questionnaire was a reliable measure of physical activity.

Bouchard et al., (1983) investigated both the reliability and validity of a method which assesses energy expenditure in children and adults. An activity record was developed which required a detailed account of activity for every 15 minute period over 3 days. Activities were qualified on a scale of 1-9, (corresponding to a range of 1 to 7.8 METS and higher), using published values for energy costs of activities. The costs were established from different sources (Durnin & Passmore, 1967; Consolazio, Johnson & Pecora, 1963). A validity study on a sample of 150 children investigated the relationship between energy expenditure, physical working capacity and body fatness. The results showed that mean energy expenditure per kg of body weight was significantly correlated with physical working capacity expressed per kg of body weight ($r=0.31$). Mean energy expenditure was also negatively related to body fat ($r=-0.08$). A reliability study was also conducted involving 61 subjects. The study indicated a highly reproducible procedure as shown by an intraclass correlation of $r=0.96$ for mean kcal of energy expenditure over 3 days. It was declared that the 3-day activity record is a procedure suitable to estimate energy expenditure in population studies.

In 1984, Baranowski et al., conducted two studies which dealt specifically with the reliability and validity of self-reports of aerobic activities. Study one compared two forms, a daily self-report completed each evening and a weekly summated retrospective report. The instruments were employed to record the amount of aerobic activity the children performed. The data from the two kinds of forms were compared over the same time period. Analyses covering the overlapping time period revealed differences in mean minutes engaged in aerobic activity and no significant relationships were found for children between the two sets of data for any time period. The investigators concluded that they could not establish whether the summative or the daily self monitoring data had more error, or both had high amounts of error. On the basis of the results it was concluded that further effort should be expended in developing self-report methods of higher validity and reliability, particularly among children.

In the second study, a self-report measure was combined with an observational measure of physical activity. Twenty four third to sixth grade children were assigned to six different forms on which they recorded their aerobic activity. The forms were compared against continuous observations of their behaviour. The forms varied along two dimensions. The first dimension varied time interval for report. Aerobic activity was reported for the day as a whole and for the day segmented into before, during, after school and after supper for school days, and morning, afternoon and evening for weekends and days during the holidays. The second dimension varied response format. One type required a reporting of exact minutes engaged in aerobic activity. A second type (the dichotomous option), required a discrimination between no activity or activity of short duration (less than 20 minutes) from a long duration (20 minutes or more), and a third type, the trichotomous response format required children to report no activity, less than 20 minutes and 20 minutes activity or more. The observations were conducted by trained observers for 2 days and observations were recorded for every two minute interval.

Results revealed that the percentage agreement between observer and child self-report across all forms and days was 73.4%. Increased accuracy was obtained by segmenting the day into functional components and having children record aerobic activity within each component rather than consider the day as a whole. The trichotomous response format achieved consistently high percent agreement between observation and self-report. The exact minutes format tended to produce much lower percent agreement on the day as a whole form, but interestingly a much higher percent agreement for the segmented day form. In fact, for the segmented day, the exact minutes format provided the highest percent agreement. However, no statistically significant main effect for response format was obtained.

Godin & Shephard (1984) conducted a study in which the principle aim was to examine societal norms toward exercise as perceived by school children. The issues of the reliability and validity of the physical activity measure used were also addressed. In the study, the physical activity habits of a sample of 698 junior high school students were assessed by means of a leisure-time exercise questionnaire (Godin & Shephard, 1985, see 2.9). The questionnaire required the children to report how many times on average they did strenuous, moderate or mild exercise for more than 15 minutes during a 7-day period. A weekly activity score was then calculated for each child by summing indices based on the reported weekly frequency of exercise at the three intensity levels, multiplied by the corresponding anticipated multiples of resting energy expenditure. A 2 week test-retest reliability coefficient of $r=0.84$ was obtained for the instrument. In terms of validity, the scores reported by child and adolescent swimming competitors differed significantly from the scores reported by average children.

In 1985, Wallace, Mckenzie & Nader carried out an investigation to assess the validity of the 7-Day Recall in children (see 2.9). Their intention was specifically aimed at determining how many days a child could accurately report the mode, frequency, duration and intensity of activity for an estimate of daily caloric expenditure. Subjects comprised 11 boys aged 12 who were attending a summer camp. The children's activities were documented by a counsellor every 15 minutes for a week without them knowing. On the day following the last day of activity documentation the children were asked to complete the 7-Day Recall Questionnaire. The interviewer asked the children to report how many hours they had engaged in moderate activity, difficult activity and very difficult activity and the number of hours they had slept each night for each day during the week. Energy cost values (expressed in METS) were then used to estimate the total energy expenditure for each category of activity and average daily energy expenditures were calculated for each child.

The results indicated that there was no significant difference between the daily energy expenditure reported by the counsellors and the children for 1-7 days of recall. Forty six percent accuracy for mode of activity, 75% accuracy for intensity and 98% accuracy for day was reported. The estimates of accuracy are somewhat inflated however, for if an event was not recalled by mode, it was not included for calculation in the estimates for the other types of activities. The conclusions drawn from the study were that the 7-Day Recall appeared to measure the children's ability to recall their general physical activity during the previous week accurately and that it appeared to be applicable to children as a summary tool of their total energy expenditure. However, despite the fact that the results showed that the recall could accurately estimate daily energy expenditure, the researchers do acknowledge that the accuracy of the method of measuring the mode or intensity of the exercise is still questionable. In the study, the children remembered that they had engaged in activity but they had trouble reporting the specific details. Furthermore, they were found to be able to recall activity of the previous day reasonably accurately but had difficulty with days further back in time.

As part of a more extensive project concerned with atherosclerosis precursors in Finnish children, Telama et al., (1985) provided information on the reliability of a questionnaire method used to estimate the habitual physical activity of a sample of 3-6 and 9-18 year olds. The level of physical activity of the 3-6 year olds was assessed by a questionnaire designed to be completed by the parents. The questionnaire asked parents to report on such matters as the average number of hours their child spent playing out-of-doors, how much time their child moved when playing compared with other children, whether their child showed signs of breathlessness when playing or whether they were interested in a particular sport. The questionnaire designed for the 9-18 year olds asked about the frequency of participation in physical activity, the intensity of the activity, the kind of sports most often done, participation in extra-curricular activities, membership of sports clubs, frequency of participation in training at a sports club and so on. On the basis of the answers given a physical activity index was calculated to identify the most passive and the most active boys and girls.

Reliability was assessed by means of interrelating variables (questions) within the questionnaires. The best reliability values were recorded for variables depicting participation in sport club training, a fact, the authors claim which may have been due to the regular character of this type of event. Index reliability was estimated on the basis of internal consistency. For 3-6 year olds, the coefficients ranged from 0.57 to 0.63, and for the 9-18 year olds from 0.56 to 0.79.

Murphy, Alpert, Christman & Willey (1988) examined the relationship between parental activity reports and a child's maximal oxygen consumption (VO_2). The sample comprised 213 children aged 6-18. Physical activity was assessed by parents responding to the question "How would you classify your child's current level of activity?" Alternatives included sedentary, slightly active or active. Examples of the kinds and amounts of exercise falling into each category were given to help parents classify their children. VO_2 was determined in each child on a cycle ergometer. Results revealed that parental reports of greater activity were associated with greater VO_2. Sedentary children had the lowest VO_2, slightly active children had intermediate values and active children had the highest VO_2. Murphy et al., claimed that in epidemiological or population surveys a parent's response to a single multiple-choice question can provide a useful estimate of a child's fitness.

Sallis, Patterson, Buono & Nader (1988) investigated the associations of physical activity and cardiovascular fitness with cardiovascular disease risk factors in 268 adults and 290 children. Physical activity was assessed by means of the 7-Day Recall and by a simple self rating of activity level. The question "Compared to others of your age and sex, how much physical activity do you get?" was rated on a 5-point scale from "much less active" to "much more active." It was found that the activity rating was significantly correlated with heart rate and body mass index in boys and diastolic blood pressure, heart rate and HDL/LDL in girls. The significant correlations ranged from +/-0.15 to 0.27. However, energy expenditure derived from the 7-Day Recall was correlated with HDL/LDL in the girls only. Interviewer reliability of the 7-Day Recall was also assessed in the study. Forty three of the sample were re-interviewed on the same day by different interviewers. The combined reliability of the energy expenditure index was r=0.78. This, according to the authors, indicated that the quality of the interview procedure is acceptable.

In 1988, Tell & Vellar conducted a study which examined the aerobic fitness, resting pulse rate and self-reported physical activity along with prevalence of cardiovascular disease risk factors in 785 Norwegian children aged 10-14 years. The self-report questionnaire gathered information on the frequency and intensity of physical activity. The key question asked was "How often do you exercise in your leisure-time (for at least half an hour), so that you get out of breath and sweat?" Response alternatives were daily, 2-3 times per week, once per week, 2-3 times per month, or not that often. Cardiovascular fitness (VO_2 max) was predicted from heart rate measured during submaximal bicycle exercise. For both boys and girls, fitness level was significantly and positively related to physical activity ($r=0.11$ for the boys and $r=0.12$ for the girls).

Murphy et al., (1990) conducted a study which assessed the validity of a children's self-report of a different type. In this study, 92 children provided self-reports of their physical activity. Physical activity was assessed by means of the children selecting one of three posters that most closely resembled their typical daily activities. The posters illustrated children performing sedentary activities, moderate intensity activities and vigorous activities. The measure was validated against measured oxygen uptake during maximal cycle ergometry. The children who reported themselves to be active according to their poster selection were found to have significantly greater oxygen uptake than those who reported themselves to be sedentary. The authors concluded that, while preliminary, the results were the first to indicate that children's self-reports can provide a valid index of maximal oxygen uptake.

In 1990, Noland, Danner, Dewalt, McFadden & Kotchen conducted a study to determine the validity of self-report measures of physical activity in young people. The study explored how well measures of children's activity obtained from parents, teachers and the children themselves predicted observed behaviour at school and in the home. Subjects comprised 21 children aged 3-5 years. The physical activity self-report measures included a parental questionnaire, a teacher questionnaire and a child interview. The parental questionnaire was a six item questionnaire concerning the physical activity of their child. Parents were asked to rate on a 5-point scale their child's activity level for different times during the day. They were also asked to rank their child's activity level on a 5-point scale as compared to boys and girls of the same age, other children of the same sex, and two reference children, one described as active and one described as passive. The teachers completed a parallel form to the one completed by the parents. The child interview involved an individual interview to determine activity preferences. Pictures of various activities depicting both active and passive activities were presented to the children on cards and the children were required to choose which pictures they liked to do best.

Results revealed that the measures were generally ineffective in predicting observed physical activity. There were no correlations between parent rating of activity or teacher rating of activity and actual activity during 20 minutes observation at school or 6 hours observation at home. Parent and teacher ratings of children's activity levels were also found to be highly variable across time and situation. Children's activity preferences however, were significantly related to the proportion of high intensity physical activity performed. From these results Noland et al., (1990) remarked how difficult it is to predict and assess the activity levels of young children.

Simons-Morton et al., (1990) conducted a study which focused on the type, location, average daily number and frequency of participation in moderate to vigorous physical activities (MVPA) by preadolescent children. A form for assessing children's self-reported frequency of total daily (MVPA) was constructed based on the work of Baranowski et al., (1984). The form consisted of 10 activity category choices, reflecting the most potentially popular aerobic activities among this age group, as well as an "other" space. A sample of 44 third grade children (8-9 year olds) were observed during physical education classes by trained observers using a standard observation form. The physical activities reported in the "during schools" column of the form by each child were compared with the physical activities each child was observed to engage in during physical education class the previous day, i.e., the day corresponding to the period of the self-report. The percent agreement between the reported and the observed number of MVPA's of greater than 10 minutes was 86.3%, with a greater number of activities reported than observed.

Klesges, Haddock & Eck (1990) examined the relationship between physical activity measures with measures of weight and blood pressure in a sample of 222 children. A multimethod factored approach to the assessment of physical activity was used which included direct observation, motion sensor evaluation and parental reports of the children's activity levels. Four separate parental reports were used: a hyperactivity score on the SNAP checklist (Swanson, Sanaman, Deusch & Barren, 1983), to assess nervous activity level; the general activity level factor on a revised version of the Dimension of Temperament Survey (Windle & Lerner, 1986); the competitiveness factor on the Matthews Youth Test of Health (Matthews & Angulo, 1980), to measure competitive activity; and the Energy Balance Questionnaire of the Studies of Children's Activity and Nutrition (Klesges, Fulliton, Isbell, Eck & Hanson, 1989). No consistent relationship was found between the various physical activity factors and cardiovascular risk factors of weight and blood pressure. Individual physical activity measures also failed to correlate with children's physical activity. The authors concluded that the results indicated that physical activity is not related to obesity and blood pressure in children. However, they did suggest that other interpretations of the findings were possible, for example, that the activity protocol was insufficiently accurate to detect subtle differences, or that the children were not participating in enough aerobic activity to affect their blood pressure and weight.

Biddle, Mitchell & Armstrong (1991) conducted a study which compared self-report measures with continuous heart rate monitoring. Three types of self-report were used in the study, the 7-Day Recall Questionnaire, a self administered 7-Day Recall Questionnaire and The Godin & Shephard Leisure-Time Exercise Questionnaire. Subjects comprised 93 children (mean age 12.2 years). Little concordance was found between the estimates of physical activity given by the children in each of the recall measures and only modest correlates were found between heart rate and some of the recall measures. Self-reported vigorous activity was significantly correlated with the recall of very hard activity ($r=0.30$), and self-reported moderate activity was correlated with leisure-time estimates of moderate activity ($r=0.38$). Other correlations between the questionnaire and recall measures were low and non significant. A significant relationship was obtained between the percentage of time children spent with their heart rate above 159 beats per minute (bpm) and the self administered recall estimates of the number of hours spent in moderate ($r=0.30$) and vigorous ($r=0.34$) physical activity, but no significant correlations were found between the time children spent with the heart rate above 139 bpm and any of the recall/questionnaire measures. On the basis of these findings it was claimed that self-reported levels of physical activity, elicited through either interview or recall questionnaire, were not strongly related to heart rate estimates of physical activity.

Sallis, Buono, Roby, Micale & Nelson (1993) conducted a study to assess the reliability and validity of three self-reports of physical activity. Subjects were 102, fifth to eleventh grade students (10-17 year olds). The measures which were assessed included the 7-Day Recall, the Godin-Shephard Leisure-Time Exercise Questionnaire and a one-item activity rating scale. The one-item activity rating has been described earlier (Sallis et al., 1988). Correlations ranging between 0.22-0.39 among the different physical activity self-reports for the total group supported the validity of all measures. Heart rate data were used to validate the self-reports of physical activity on the 7-Day Recall. Heart rate records were compared with recalls of very hard activities on the same day and a correlation of 0.53 for the total group was established, supporting the validity of the reports. Validity was found to improve with age but validity coefficients were significant in all age groups. The test-retest reliabilities were r=0.77 for the 7-Day Recall, r=0.81 for the Godin-Shephard Questionnaire and r=0.93 for the simple one-item activity rating. For the 7-Day Recall and the Godin-Shephard Questionnaire reliability improved with age but was significant at all ages. Sallis et al., (1993) concluded that the data indicate that physical activity recalls of children as young as the fifth grade are of adequate reliability and validity to use in research on physical activity in children.

Another recent study aimed to develop and evaluate several formats of physical activity self-reports for fourth grade children (Sallis et al., 1993). Subjects were 35 girls and 34 boys from a public school in Southern California. Four forms, the Yesterday Activity Checklist, the Weekly Activity Sum, the Weekly Activity Checklist and 7-Day Activity Tally, were evaluated in the study. The forms were developed following a pilot study of a 2 week recall. It was concluded that fourth grade children were not able to recall activities over 2 weeks therefore forms were developed which required recall over shorter periods. The first three forms included a list of 20 physical activities commonly performed by children. Metabolic equivalent scores (METS) were used to estimate the relative intensity of activities and were assigned as follows: light activities (walking, four square, gymnastics, volleyball, horseback riding) were scored as 3 METS; medium activities (dancing, hiking/climbing, tennis/smashball/baseball/softball, basketball, football, frisbee/kickball) were scored as 5 METS; and hard activities (jumping rope, jumping jacks/sit ups, running/jogging, soccer, skateboarding/skating, swimming laps, bicycling, boogie boarding/surfing, aerobic dance) were scored as 9 METS. All forms instructed the children to report only those activities which they did out of school and in which they engaged for at least 15 minutes continuously. Checklists were scored by multiplying the frequency of each activity by its MET score and summing the METS. Duration was not considered. The 7 Day Tally asked subjects to indicate by each day in the last week whether they had done an activity that was hard enough to make them get tired, breathe hard or sweat.

The forms were validated against the Caltrac activity monitor. Each student wore the Caltrac three times during the week of monitoring prior to completing the forms. All forms were then administered to the students twice, a few days apart. Test-retest reliability was assessed with the scores from the first and second administrations. Intraclass reliabilities were r=0.60 for the Yesterday Activity Checklist, r=0.51 for the Weekly Activity Sum, r=0.74 for the Weekly Activity Checklist and r=0.68 for the 7 Day Tally.

Validity was assessed by Pearson correlations with Caltrac activity counts. The Weekly Activity Sum had the highest correlation of any measure on occasion one (r=0.40), but the correlation was not significant on occasion two (r=0.15). The first Yesterday Activity Checklist was significantly correlated with the previous day's Caltrac score (r=0.33) and the Weekly Activity Checklist correlated significantly with the mean Caltrac scores at both administrations (r=0.34 for occasion one and r=0.26 for occasion two). However, the 7-Day Tally did not correlate significantly with the mean Caltrac at either administration. On the basis of these findings the authors declared that the data provided some support for using the Weekly Activity Checklist and the Yesterday Activity Checklist, however they cautioned that the validity data are not strong. They concluded that the data highlight the limitations of children's self-reports.

Summary and Discussion of Children's Self-Report Findings

The studies described reveal a number of different self-report measures which have been validated and/or had their reliability checked in a number of ways. The characteristics and major findings of the studies are summarised in table 2.1 at the end of this chapter. Some measures gather exact information about participation in specific activities, making calculations of energy expenditure from the activities reported, while others tend to gather more general information and provide a less quantitative appraisal of physical activity. Methods of validation range from comparing self-report activity measures with direct measures of observation and heart rate response to indirect methods of determining the relationship of physical activity to fitness assessment, body composition and CHD risk factors. On the basis of the results obtained from the studies, various conclusions have been drawn and a number of claims have been made. The review will now go beyond a description of the studies to review the methodologies adopted and their findings much more critically. In this way it will attempt to clarify just how much confidence can be placed in the findings, the conclusions and claims made, and ultimately in the self-report measures themselves.

The conclusions drawn from the studies are mixed. A number of researchers speak very favourably of self-report measures claiming the instruments to be valid and/or reliable. Linder et al., (1983), for example, conclude that the standardised questionnaire used in their study was a reliable measure of physical activity and Bouchard et al., (1983) declared their 3-day activity record to be a procedure suitable to estimate energy expenditure in population studies. Similarly, Wallace et al., (1985) concluded that the 7-Day Recall appeared to measure the children's ability to recall general physical activity accurately and Sallis, Buono, Roby, Micale & Nelson (1993), in an assessment of three self-report measures, concluded that physical activity recalls of children are of adequate reliability and validity.

While it is encouraging to read such conclusions which support the validity of the measures used, the findings must nevertheless be treated with a degree of caution. On closer analysis of the studies it becomes evident that some of the reported findings are in fact rather tenuous.

Relationships between measures of cardiovascular fitness, body composition and heart rate, for example, are in some instances only slight. The conclusion drawn by Bouchard et al., (1983) for example, that the 3-day activity record was a suitable procedure for estimating energy expenditure, was based upon significant correlations between physical activity and physical working capacity of only r=0.31 and correlations between energy expenditure and body fat of r=-0.08. Similarly, Sallis et al., (1988) reported significant correlations between physical activity rating and cardiovascular risk factors ranging from +/-0.13 to 0.27. Tell & Vellar (1988) also reported significant, yet low correlations of r=0.11 in the boys and r=0.12 in the girls between fitness level and physical activity. Such correlations, while being significant, only indicate very weak relationships between variables. There is really only little concordance between the measures with a large percentage of unexplained or error variance. Rather, it seems that the correlations are a reflection of the large sample sizes used in these studies.

On the whole the reliability studies produced higher correlations, with some researchers reporting correlation coefficients higher than r=0.70 (Linder et al., 1983; Bouchard et al., 1983; Godin & Shephard, 1984). These studies reported coefficients of 0.70, 0.96 and 0.84 respectively. Safrit (1990) states that reliability estimates of below 0.70 are rarely acceptable. While these studies meet and exceed this criteria, unfortunately others do not. Shephard et al., (1980) found correlations of only 0.03 to 0.23 for their diary record and Telama et al., (1985) reported correlations ranging from 0.57-0.63.

Some researchers however, do express concern over self-report measures and view them less favourably. For example, Baranowski et al., (1984), finding no significant relationships between the two self-report forms used in their first study (study 1), draw the conclusion that efforts should be expended in developing methods of higher validity and reliability, particularly among children. Noland et al., (1990) highlight the difficulty of predicting and assessing the activity levels of young children following their assessment of parental reports, teacher reports and child interview methods, and Biddle et al., (1991) acknowledge how in their study, self-reported measures were not strongly related to heart rate estimates of physical activity. They found significant correlations of 0.30 and 0.34 between recall measures and heart rate yet put these results into perspective claiming that their results confirmed the view that questionnaires and other self-report methods provide a mixture of rather "rough" and "vague" information. More recently, Sallis et al., (1993), finding correlations ranging from between 0.15-0.40 between the Caltrac and four different self-report forms, concluded that the data highlighted the limitations of children's self-reports. Such conclusions are in the minority though, and it seems that a number of researchers could be making somewhat exaggerated claims over the validity of existing self-report measures on the basis of the size of the correlations they report.

Of course an important factor to be taken into account in reviewing the studies relates to the problem of determining the reliability and validity of self-report. This problem was highlighted earlier in the review. The fact that no gold standard method of assessing reliability and validity exists is a cause for concern. A number of validation studies have used heart rate monitors against which to compare activity measures (Seliger et al., 1974; Sallis et al., 1988; Biddle et al., 1991; Sallis, Buono, Roby, Micale & Nelson, 1993), but it is known that heart rate is affected by other factors including emotional state, the climatic condition (temperature and humidity), and the specific muscle groups that perform an activity (Anderson et al., 1981; Armstrong & Bray 1991). Comparison of cardiovascular fitness between high and low active groups has proved to be another popular validation method (Bouchard et al., 1983; Murphy et al., 1988; Tell & Vellar, 1988; Murphy et al., 1990), but it is known that cardiovascular fitness is largely determined by one's genes as well as by physical activity level (Bouchard & Malina, 1983). Saris (1985) notes how if the studies of Klissouras, Pirnay & Petit (1973) are to be accepted, physical fitness is mainly inherited and physical activity has relatively little influence in childhood. Another problem with using cardiorespiratory fitness as a validation method is that it has been suggested that it reflects almost exclusively heavy intensity activity (Jacobs et al., 1993). This problem also relates to body composition measures and as a result Jacobs et al., (1993) advise that both cardiovascular fitness and body composition should not be used as sole validation standards.

Observational techniques have been employed in a number of the validation studies (Baranowski et al., 1984; Wallace et al., 1985; Noland et al., 1990) but again problems exist with observational methods. Observing individuals, particularly children, may result not only in reactive behaviour, but could also make children more aware of their activity and therefore better able to recall it, thus artificially increasing the accuracy of the measure (Baranowski et al., 1984; Baranowski, 1988). Klesges & Klesges (1990) also acknowledge this problem stating "It has been argued that if subjects are aware that their diet or exercise patterns are being monitored, they are likely to be sensitised to the process and likely to provide more accurate information than otherwise may be the case." It may be then, that it is the measures against which the self-report methods are being validated which are at fault. These may be as inaccurate, or even more inaccurate than the self-report physical activity measures themselves. However, this has yet to be proved. Reliability studies tend to rely on the test-retest method but this too can be problematic where physical activity is concerned. As was discussed earlier, it is difficult to determine the extent to which a subject's memory or the stability of their physical activity habits influences the results.

In scrutinising the studies more closely it could also be argued that the methods of validation chosen by some researchers in their studies were not entirely appropriate. Shephard et al., (1980) for example, validated two recall measures by comparing the number of hours sleep reported and number of hours of television watching reported in each recall method. However, it cannot be assumed that just because an agreement in the reporting of sedentary activities such as sleep and watching television is found, that there will be agreement in the reporting of more intense and physical activities. Godin & Shephard (1984) assessed the validity of the Leisure-Time Exercise Questionnaire by comparing the activity scores reported by swimming competitors and average children. It was found that the measure was able to differentiate between the two groups in terms of their activity level. However, given that the swimmers were deliberately selected as such an extreme group, this seems a rather crude indication of validity. The appropriateness of the validation method adopted by Bouchard et al., (1983) can also be questioned. Bouchard et al., (1983) correlated energy expenditure from the 3-day record with cardiovascular fitness and body composition. However, if aerobic activity is necessary to achieve cardiovascular fitness, an activity measure emphasising energy expenditure can be expected to have only a modest relationship with cardiovascular fitness. Energy expenditure includes kilocalories expended from nonaerobic as well as aerobic activity, and indeed may be comprised of no aerobic activity at all.

Another problem with some of the studies reviewed, is that while all of them address the issues of reliability and validity, for a number of them it is only a minor concern. Many are concerned primarily with other issues and the reliability and validity data is inferred from the studies rather than being highlighted as an important aspect of the findings. The primary purpose of the study by Thorland & Gilliam (1981) for example, was to compare serum lipids between habitual high and low active pre-adolescent males. Similarly, the study by Linder et al., (1983) aimed to measure the effect of physical conditioning on the serum lipid and lipoprotein levels of male adolescents, and the study by Godin & Shephard (1984) aimed to examine societal norms towards exercise as perceived by school children. In such studies, the emphasis is on finding significant relationships between variables rather than on the accurate and meticulous administration and assessment of the instruments being used.

It is evident then, that there are limitations to a number of the reliability/validity studies. Despite such limitations however, the review has nevertheless provided at least some evidence for the reliability and validity of self-report. On a more positive note, self-reported physical activity has been found to correlate with objective measures in a number of instances. While it is easy to be critical of the studies and existing self-report measures, Baranowski (1988) rightly cautions that we should not be overly derogatory of self-report as "while there are limits to the validity and reliability of self-report measures, there are limits to any measure of activity." Indeed Sallis (1991) is of the view that "all measures are subject to substantial error and should be considered rough approximations of physical activity." The fact that so many studies have addressed the issues of reliability and validity of self-report in children represents a major step forwards in physical activity research. The studies serve as proof of the increasing interest, concern and importance now being placed upon this area of work.

2.12 Sources of Error In Children's Self-Report

It is clear from such reliability and validity studies that there is error in all self-report measures of physical activity. If we are to try to improve and refine existing measures and/or develop new self-report measures, it is important to identify the sources of these errors, for only then can efforts be made to reduce them.

Baranowski (1988) identifies two of the major sources of error in self-report: the definition of the desired variables and the human cognitive processes. Haskell (1985), has pointed out that the physical activity stimulus has not been clearly defined to achieve health related outcomes. A main concern in studying and measuring children's activity levels has been to try to establish whether or not they are doing sufficient exercise of an appropriate intensity to optimise their functional capacity and to attain health benefits. However, the exact nature, duration and intensity of activity required to produce health benefits is open to considerable controversy, especially for children. It is not known for example, what kind and how much physical activity will most clearly prevent cardiovascular disease, or promote health. Paffenbarger et al., (1993) acknowledge how the health issues of appropriate physical activity are still being explored and debated by clinicians, physiologists, dieticians, exercise scientists, orthopaedists, epidemiologists and others. Blair et al., (1989) similarly reveal how uncertain and controversial the whole issue is, stating how it is uncertain whether physical activity sufficient to increase physical fitness is required for health benefits.

As a result of such controversy, different researchers have measured different aspects of physical activity in children. Some have been concerned with measuring caloric expenditure associated with any type of activity (Taylor et al., 1978; Bouchard et al., 1983; Wallace et al., 1985; Sallis et al., 1988; Sallis, Buono, Roby, Micale & Nelson, 1993), while others have been concerned with measuring aerobic activity of specific durations, intensities and frequencies

(Seliger et al., 1974; Thorland & Gilliam, 1981; Baranowski et al., 1984; Simons-Morton et al., 1990). In adults Morris et al., (1973) and Epstein et al., (1976), found that leisure-time activities of 7.5 kcal/min or more were associated with low incidence of future CHD. This tends to focus attention on the need for an instrument to classify activity on an intensity scale of caloric expenditure. In the Minnesota Leisure-Time Physical Activity Questionnaire heavy intensity activity was defined as any activity having an intensity code of more than 6 (i.e., approximately 6 kcal/min). This cut-off point was selected as it was felt it constituted those activities which demanded greater than 50% of maximal oxygen intake. According to Karvonen, Kurtola & Mustala (1957), conditioning of the cardiovascular system occurs when non-athletes work at a rate which is larger than 50% of their maximum oxygen uptake.

Davey Smith & Morris (1992) recommend that both measures of energy expenditure and aerobic activity should be considered. They identify two principal dimensions of physical activity: 1) total physical activity (energy output) and 2) aerobic exercise (involving the dynamic, rhythmic contraction/relaxation of large muscle groups). According to Blair, Jacobs & Powell (1985) and Caspersen et al., (1985), the dimension associated with caloric expenditure results in the physiological effect of energy utilisation and thereby enhances weight loss or control , which in turn may be useful in preventing or managing CHD, diabetes mellitus and obesity (Blair et al., 1985; Powell et al., 1987). The dimension that corresponds to aerobic intensity on the other hand, enhances the ability of the cardiorespiratory as well as other systems to perform a given workload and may have a beneficial influence on cardiovascular disease (Morris, Everitt, Pollard & Chave, 1980; Paffenbarger et al., 1983). Adequate data on these dimensions, Davey Smith & Morris (1992) explain, will provide accounts of two other dimensions also: 3) muscle contraction, which increases muscle strength and endurance and 4) weight bearing exercise, which strengthens bones and gives protection against osteoporosis and fracture. Similarly the movement of joints through their range maintains flexibility. Elements of all of these, they claim are involved in the growth and development of children and are thus vitally important.

The human cognitive process raises a different set of issues. It is not within the scope of this review to enter into a detailed analysis of memory and information processing models, suffice is to say here however, is that the limitations of the human memory and more particularly the child's memory must be acknowledged. Saris (1986) acknowledged how obtaining activity information from children is even more difficult than it is from adults. Indeed, an article by Johnson & Foley (1984), draws attention to a set of common assumptions which are made about children's memory which state briefly that when compared to adults, children are believed to notice less, omit more, forget faster, be more susceptible to suggestion and to intermingle imagination and perception in remembering. The implications these assumptions have in terms of attaining an accurate recall of physical activity from children are evidently highly significant.

Children may omit important activity information simply because they are unable to remember what activities they have done. Diaries are not so problematic in this respect but problems are encountered when children are asked to recall their activities and events over the past days or week. The 7-Day Recall validated by Wallace et al., (1985); Sallis et al., (1988); Biddle et al., (1991) may not be the best way of obtaining accurate activity information from children as it requires them to recall their events of the past week. Wallace et al., admit that while the children in their study remembered that they had engaged in activity, they had trouble reporting the specifics. A closer look at the results of this study reveals that while children could reasonably accurately recall activity of the previous day, they had difficulty with days further back in time. Clearly this is evidence of memory decay over time. Similarly, Sallis et al., (1993) experienced memory decay in fourth grade children (9 year olds) involved in a pilot study of two instruments requiring a 2 week recall. They concluded that fourth grade children were not able to recall activities over 2 weeks.

Alternatively, sources of error may stem from the respondent failing to attend to the characteristics of activity which are salient to the investigator, and thereby failing to encode the necessary information (Baranowski, 1988). What may be vital information to the researcher may not be deemed as important by the child completing a form or responding to an interviewer.

Thus, vital activity information could be overlooked thereby contaminating the data and activity profile obtained. Questionnaires which ask children to report frequency of participation in particular categories of activity may be more susceptible to this type of error. For example, the Godin Shephard Leisure-Time Exercise Questionnaire asks children to report how many times they do strenuous, moderate and mild exercise in 7 days. Children may either overlook activities, not classifying them in to any of the categories provided, or they may misclassify activities.

A few studies outlined in the review relied on parental reports of children's activities (Telama et al., 1985; Murphy et al., 1988; Noland et al., 1990; Klesges et al., 1990). However, while one may assume that adults' memories are more reliable than children's, this may not necessarily be the case. Furthermore, it cannot be assumed that parents are well informed of their child's activities. Uninformed parents reporting on their child's activity may be the source of a large amount of error and may therefore reduce the validity of the activity information obtained. Indeed, in the study by Noland et al., (1990), no correlation was found between parent or teacher ratings of children's activity. Parents consistently rated their children as more active than the teachers did. Of course, who made the most accurate judgement and report of the child's actual activity level is not known. It might have been the case that both sets of reports were inaccurate and therefore neither of them valid.

Further problems may arise in self-report if respondents are asked to make precise judgements of time, particularly if they are without a watch. Many of the studies discussed in this review feature self-report measures which require children to report duration of physical activity (Baranowski et al., 1984; Wallace et al., 1985; Biddle et al., 1991). Sallis (1991) remarks how young children may be ill-equipped to either tell time or estimate it. Baranowski et al., (1984) explain that children may not be expected to accurately estimate time because many do not wear watches and their days are often organised for them by school and parents. This minimises their need to accurately estimate time. Richards (1964) however, does acknowledge the importance of age in the ability to reproduce time and explains how time perception improves as an individual's concept of physical time develops with age. Similar concerns exist about children's abilities to report frequency and intensity of physical activities. Many self-report instruments, have either assumed that children have such skills or have accepted whatever approximation process the respondent devised to meet the desires of the investigator (Baranowski, 1988). Again though, the capacity of children and adolescents to accurately report physical activity is believed to be age related (Sallis, Buono, Roby, Micale & Nelson, 1993).

Recall problems aside, other sources of error may result in self-report if the length of assessment is inappropriate. Insufficient detail and accuracy may be gained if the measure is too short, but equally inaccurate information may be gained if the measure is too long. If the questionnaire form is long and laborious, respondents may deliberately cut responses short, rush them and therefore make mistakes, or respond inaccurately through boredom. It is also not really known how many days of assessed activity are necessary to obtain a reliable estimate of habitual physical activity. Simons-Morton et al., (1990) assessed children's frequency of participation in moderate to vigorous physical activities and took 3 days activity information as representative of patterns of participation in physical activity. Recent work conducted by Durant et al., (1993), on the reliability and variability of heart rate monitoring in children reports that just over four days of recording are necessary to achieve a reliability of 0.8 in the physical activity measure. Likewise, it is not known how activity differs from weekday to weekend, or from season to season, and error may result if seasonal variation and weekend versus weekday variation is not accounted for. Baranowski (1988) states "we do not know how such sources of variability affect the estimates of physical activity."

While the problems highlighted here are common to both adults and children completing self-report measures, they seem to be magnified and more prevalent in children. To summarise, the major errors associated with self-report in children stem from problems with definition, cognition (including memory decay, failure to encode/report necessary information, time perception), inadequate length of assessment and failure to account for weekday versus weekend and seasonal variations in physical activity. Of course, the extent to which the measures are affected by such problems will vary and will depend on the type of self-report measure and on the characteristics of the population (the age and developmental level of the children) to which the measure is been applied.

2.13 Recommendations and New Directions from the Literature for The Future Methodological Study of Children's Self-Report

Having identified the major problems and potential sources of error in children's self-report, it should be possible to eliminate or at least minimise some degree of error in future attempts to measure children's physical activity. A number of researchers have highlighted the need for more research in the area . Sallis et al., (1993), for example, claim that "because there is a growing demand for information on children's physical activity, there is a need for instruments of adequate reliability and validity." Similarly LaPorte et al., (1983) and Sopko et al., (1992) acknowledge the need for questionnaires for the assessment of physical activity *in children and* Paffenbarger et al., (1993) recommend that future research on physical activity and health should include work on developing a questionnaire for the assessment of physical activity in children. Baranowski et al., (1984), also recommend that efforts "be made to develop valid and reliable measures of self-reported aerobic activity among children." They state that "working on the assumption that a form can be created which maximises the ability of the child to accurately report aerobic activity, alternative forms need to be designed and tested for their validity." Concern has been expressed that in the past measurement development has been a secondary research endeavour and that few investigators have pursued a systematic line of inquiry in the area (Sallis, 1991). Sallis (1991) recommends therefore, that physical activity self-reports should be developed and evaluated as rigorously as any psychological or behavioural assessment instrument.

The previous section highlighted human cognition as a major source of error. Evidently, the cognitive skills necessary to accurately self-report physical activity need to be identified and the knowledge of the best means of eliciting accurate information by questionnaire or interview needs to be gained. Sallis (1991) recommends that further research should identify and develop reporting formats appropriate for the child's cognitive development and identify limitations of children's ability to report and recall so that they are not asked to perform cognitive tasks which they are unable to do. Baranowski (1988) has made a number of useful recommendations which may help researchers to do just this in the development of future self-report measures. His suggestions relate to the improvement of the 7-Day Recall in particular, though most of the recommendations are applicable and relevant to all self-report measures. He notes how the prescribed procedure in a number of self-report measures in the past has been to briefly define what moderate, hard and very hard activities are and then ask respondents to recall only those types of activities. According to Baranowski (1988) however, this method does not seem to elicit accurate information as many hard and moderate activities are likely to be missed. Rather, respondents are likely to remember more if they are asked to remember sequentially over the day what they did and report a "stream of activity." Sequencing the report in this way should impose a logical ordering, or cueing, over time of the activities, thus enabling respondents to remember more.

Reporting a stream of activity may also help to overcome other common problems associated with self-report measures. Existing self-report methods often leave to the respondent's discretion which activities to select and report as moderate, hard and very hard. If employing an interview method, a stream of activity report will avoid the problem of respondents reporting activities at their discretion, with the subsequent danger of omitting particular activities, and will avoid the danger of respondents misclassifying activities. Instead, the interviewer can record during recall, any activity which has the potential for being hard, moderate or very hard. They can then query these and any other unmentioned events further by asking more probing questions. In this way the interviewer facilitates recall gaining information which otherwise may be lost.

The segmented day method of recall used by Baranowski et al., (1984) represents another possible way of reducing error. The procedure for recalling activities before school, at school, after school and after dinner has proven to elicit more accurate information with children (Baranowski et al., 1984). This method capitalises on the possible memory-enhancing effect of considering the context within which the day's activities might have been performed (Mandler, 1980). It is believed that it requires the individual to identify other time related cues during the day, which in turn cues memory for activity more accurately. The previous section (2.12) suggested that 7-Day Recalls may not be the best way of obtaining accurate activity information from children as they require them to recall their events of the past week. Verbrugge (1980) notes how it is usual to assume that daily self-monitoring data are more accurate since they overcome many problems in memory. This may be an issue worth serious consideration in developing self-report.

Another critical variable in children's self-report in particular is duration of physical activity. Sallis et al., (1993) recognise the problem of reporting duration and the need for research on children's accuracy in reporting this variable. They ask: "How does ability to estimate and report time develop, and how can reporting of exercise duration be improved through training or different response formats?" Some ideas as to how to overcome and/or minimise the problem have been presented by Baranowski et al., (1984). Baranowski et al., (1984) conducted a study which employed three different types of response format: an exact minutes format, a dichotomous format (no activity or activity of less than 20 minutes versus activity of more than 20 minutes), and a trichotomous format (no activity, less than 20 minutes, more than 20 minutes of activity). Increased accuracy of time estimation was obtained with the trichotomous format.

Another way of enhancing the integrity of day-to-day information of activity may be to identify habitual events such as the habitual activities a person performs on specific days of the week, the habitual TV programmes watched as well as unusual events which may have occurred in the past week. Baranowski (1988) claims that by identifying such "habit" patterns and unusual events, a more accurate report may be gained. He concludes that such suggestions "pose promising leads for the application of cognitive psychology ideas for improving the accuracy of recall of activity."

While improving recall is of obvious importance, making improvements to it alone will not overcome other errors and biases in the measures. With regards to the definitional problem, investigators have recommended that the task is defined clearly for the child prior to the assessment and that it is appropriate for the developmental level of the child. Baranowski, (1988) stressed the need for the establishment of a clear definition of the variables to be estimated.

Careful consideration also needs to be made with respect to the length of activity assessment. This needs to be appropriate for the age, developmental level and attention span of the children for which the measure is designed. The number of days of activity to be assessed also needs to be established. The literature seems to suggest that between 3-4 days of activity information are necessary to obtain a representative activity profile (Simons-Morton et al., 1990; Durant et al., 1993). Furthermore, given that the likely influences of weekday versus weekend and season to season on activity levels are not known (Baranowski, 1988), these variables should also be taken into account.

Finally, attention should be paid towards developing standard training and administration procedures for self-report measures. Sallis (1991) states that further research should address the effects of instruction and training in self-reports and Baranowski (1988) recommends the development of detailed protocols for implementing self-report methods. Protocols, he advises, must pay attention to interviewer training, definition of variables and concepts, procedures for handling both usual responses and exceptions, and procedures for monitoring and correcting quality control of data collection.

Evidently a number of changes could be made to improve self-report measures of physical activity. This final part of this section of the review has attempted to present possible solutions to at least some of the problems identified earlier. The review has certainly provided ample scope and direction for future work in the area. A number of recommendations for improving self-report have been made, many of which are implemented in the design of the self-report measure for the purpose of this research. The recommendations may also give guidance to other researchers interested in pursuing this line of enquiry.

Table 2.1 Characteristics, Reliability, and Validity of Self-Report Measures of Physical Activity for Children

CITATION	CHARACTERISTICS OF MEASURE	RELIABILITY	VALIDITY
Seliger et al., (1974)	Personal activity records over a 24 hour period. Activities classified into 7 categories ranging from sleep to heavy intensity activity.		Different intensities of activity were reflected in changes in heart rate response.
Shephard et al., (1980)	An *activity diary (completed spring and autumn)*, and a brief daily physical activity questionnaire. The diary involved a report of activity every half hour. The retrospective report covered journey to school, weekly walking distance, sports participation, *chores, sedentary activities* and sleep.	*Correlation coefficients for* the diary record between spring and autumn were low (r=-0.03 to 0.27).	*Coefficients of correlation* between the prospective diary records and retrospective records were 0.44 for hours of sleep and 0.53 for hours of T.V. watching.
Thorland & Gilliam (1981)	*Five day diary* record. The duration of participation in different categories of activities recorded and a profile of typical participation derived.		Greater exposure to moderate to very highly intense activities was associated with lower triglycerides and higher HDL cholesterol.
Bouchard et al., (1983)	Three day activity record. Every 15 minute period qualified on a 1-9 scale of *energy* expenditure (METS).	Intraclass correlation of 0.96 *for mean* kcal of energy expenditure over 3 days.	Mean energy expenditure was significantly correlated with physical working capacity (r=0.31) and negatively related to body fat (r=-0.08).

Linder et al., (1983)	Interview questionnaire. Information sought included daily number of hours spent watching T.V., hours spent reading/studying, team sports played, sports/activities performed at least 3 days a week, days spent jogging, days spent cycling.	Test-retest correlation coefficient for items was r=0.70 (range 0.49-0.99).	
Baranowski et al., (1984) Study 1	Two self-report forms, a daily self-report and a weekly retrospective report. Both recorded the amount of aerobic activity performed.		Analyses covering the overlapping time period revealed differences in mean minutes engaged in activity. No relationships found between the two sets of data.
Study 2	Self-report aerobic activity measure comprising 6 different forms varied along 2 dimensions (whole versus segmented day and exact minutes, dichotomous and trichotomous response format).		Percentage agreement between observation and self-report across all forms was 73.4%. Increased accuracy obtained with the segmented forms.
Godin & Shephard (1984)	Leisure-Time Exercise Questionnaire (self administered). Weekly activity score derived based on frequency of exercise at 3 intensity levels:strenuous, moderate and mild.	Two week test-retest reliability coefficient was r=0.84.	Significant difference between activity scores reported by swimming competitors and scores reported by general child population.

Linder et al., (1983)	Interview questionnaire. Information sought included daily number of hours spent watching T.V., hours spent reading/studying, team sports played, sports/activities performed at least 3 days a week, days spent jogging, days spent cycling.	Test-retest correlation coefficient for items was $r=0.70$ (range 0.49-0.99).	
Baranowski et al., (1984) Study 1	Two self-report forms, a daily *self-report* and a weekly *retrospective report*. Both recorded the amount of aerobic activity performed.		Analyses covering the overlapping time period revealed differences in mean minutes engaged in activity. No relationships found between the two sets of data.
Study 2	Self-report *aerobic activity* measure comprising *6 different forms varied along 2 dimensions* (whole versus segmented day and exact minutes, dichotomous and trichotomous response format).		Percentage agreement between observation and self-report across all forms was 73.4%. Increased accuracy obtained with the segmented forms.
Godin & Shephard (1984)	Leisure-Time Exercise Questionnaire (self administered). Weekly activity score derived based on frequency of exercise at 3 intensity levels:strenuous, moderate and mild.	Two week test-retest reliability coefficient was $r=0.84$.	Significant difference between activity scores reported by swimming competitors and scores reported by general child population.

Sallis et al., (1988)	Interviewer administered 7-Day Recall and a simple one-item self rating of activity level. Self rating involved reporting activity status compared with others on a 5 point scale from "much less active" to "much more active."	Same day test-retest reliability with different interviewers (r=0.78).	Activity rating was significantly correlated with heart rate and body mass index in boys and blood pressure, heart rate and HDL/LDL in girls. Significant correlations ranged from +/-0.15-0.28. Energy expenditure from the 7-day recall correlated with HDL/LDL in girls only
Tell & Vellar (1988)	Self-report questionnaire. Form asked about frequency of being out of breath and sweating for at least half an hour.		Fitness level was significantly related to physical activity in boys (r=0.11) and girls (r=0.12)..
Murphy et al., (1990)	Self-report activity poster. Children selected one of 3 posters to reflect their typical daily activities. Posters displayed sedentary, moderate and vigorous activities.		Active children had significantly greater oxygen uptake than sedentary children. Correlation of r=0.21 between VO_2 max and child's poster selection.
Noland et al., (1990)	Parental reports, teacher reports and child interview. Parental and teacher report was a 6-item questionnaire on a 5-point rating scale. Interview determined activity preferences from pictures.		No correlations between parent or teacher ratings and activity observed during 20 minute free-play or 6 hours home observation, but significant correlations between children's activity preferences and physical activity performed.

Simons-Morton et al., 1990)	Moderate to vigorous physical activity (MVPA) recall. Form comprised 10 aerobic activity category choices, with 3 response categories: none, less than, or more than 10 mins for 2 time periods: during school, and before or after school.		Percentage agreement between reported and observed number of MVPA's of greater than 10 minutes was 86.3%.
Klesges et al., (1990)	Parental reports. Four reports, the hyperactivity score on the SNAP checklist, the general activity factor on the Dimension of Temperament Survey, the competitiveness factor on the Matthews Youth Test of Health and the *Energy Balance* Questionnaire of the Studies of Children's Activity and Nutrition.		No consistent relationship found between the physical activity factors and cardiovascular risk factors of weight and blood pressure. Individual physical activity measures failed to correlate with children's physical activity.
Biddle et al., (1991)	Three types of self-report, an interviewer administered 7-Day Recall, a *self administered* 7-Day Recall Questionnaire and the Godin & Shephard Leisure-Time Exercise Questionnaire (described earlier).		A significant relationship found between time children spent with heart rates above 159 bpm and the self-administered recall of hours spent in moderate (r=0.3) and vigorous (r=0.34) activity. No correlations between time spent with heart rates above 139 bpm and any of the recall methods.

Sallis, Buono, Roby, Micale & Nelson (1993)	Three measures, the interviewer administered 7-day recall, the Godin Shephard Questionnaire and a one-item rating scale (see Sallis et al., 1988).	Test-retest reliabilities were r=0.77 for the 7-day recall, r=0.81 for the Godin Shephard and r=0.93 for the one item rating.	A correlation of 0.53 for the total group was obtained between the 7-day recall of very hard activities and heart rate records.
Sallis et al., (1993)	Four measures: the Yesterday Activity Checklist, the Weekly Activity Sum, the Weekly Activity Checklist and the 7-Day Tally. Forms 1, 2 & 3 comprised a list of 20 activities. The frequency of each activity reported was multiplied by a MET score and MET scores were summed. The tally recorded activity hard enough to make the child tired, breathe hard or sweat.	Intraclass reliabilities were r=0.60 for the Yesterday Activity Checklist, r=0.51 for the Weekly Activity Sum, r=0.74 for the Weekly Activity Checklist and r=0.68 for the 7-Day Tally.	Significant correlations found on two occasions between the Yesterday Activity Checklist and Caltrac activity counts (r=0.33 and r=0.22), and between the Weekly Activity Checklist and the Caltrac (r=0.34 and 0.26).

CHAPTER 3

DESIGNING THE SELF-REPORT MEASURE AND PRELIMINARY STUDIES

3.1 Introduction

Following the review of literature on the methodology of monitoring physical activity, this chapter outlines the procedures which were followed and the considerations which were made in designing the self-report measure of physical activity. The proposed characteristics of the measure are established early in the chapter following recommendations made in the literature. In the latter part of the chapter, a series of preliminary studies are described which were conducted in order to determine the content and assess the feasibility of the measure.

3.2 Designing the Self-Report Measure (Questionnaire)

In fulfilling the aim of developing a self-report measure of physical activity designed specifically for use with children, a number of considerations and decisions with regard to the design of the measure had to be made. These were made with close reference to the self-report measures and recommendations reviewed in the literature. Firstly, however, the age range for which the measure was to be designed had to be established. Given the problems which have been encountered using self-report measures with young children (Shephard et al., 1980; Baranowski et al., 1984; Noland et al., 1990), it was decided that the measure would be designed for secondary aged children (11 years and upwards). It was felt that by 11 years of age, children would be able to provide realistic recalls of their physical activity. Indeed, just recently Sallis, Buono, Roby, Micale & Nelson (1993) have noted how the capacity of children and adolescents to accurately report physical activity is age related and how both reliability and validity in self-report improves with age. Furthermore, the researchers own interests and experiences in education are in the secondary sector therefore gaining access to children of this age would be easier.

The nature of activity to be measured by the questionnaire was also a major consideration. It was decided that the measure would encompass the following dimensions of physical activity;

physical activity at work, i.e., at school (excluding sport), sport at school, physical activity during leisure-time and sport during leisure-time. These dimensions are similar to those recognised by Baecke, et al., (1982) in their adult questionnaire. Given the definition of physical activity which has been adopted in this research, that physical activity is "any bodily movement produced by skeletal muscles that results in caloric expenditure" (Caspersen et al., 1985), all activities "sport related" or not and "school based" or not would be included in the measure. It was felt that if questions asked only about sport type activities, as some questionnaires have done in the past, true physical activity would not measured and vital activity information may be lost. For example, a child may be highly active, yet may not be active in sport. Instead, he/she may have a physically demanding job or may be very active helping out at home with the gardening or housework.

A similar important consideration in the design was the amount and type of activity information the questionnaire would elicit. For example, should the emphasis be on number of activities engaged in, frequency of participation in activities, duration, or intensity? To improve upon existing activity questionnaires was of paramount importance, not only in terms of the amount of information which could be gained from the measure, but also in terms of the accuracy of the information gained. The literature review (see chapter 2, 2.12) revealed how the physical activity stimulus has not yet been clearly defined to achieve health related outcomes (Haskell, 1985) and how the health issues of appropriate physical activity are still being explored (Paffenbarger et al., 1993). In other words, what kind and how much physical activity will prevent cardiovascular disease or promote health has not clearly been established. Past measures have tended to measure either aerobic activity of specific durations, intensities and frequencies per week, or have calculated total energy expenditure as a measure of physical activity. Because there is still controversy over what constitutes appropriate physical activity, if either one of these methods of measuring physical activity were selected at the expense of the other, important information may be gained in one respect but vitally important information may be lost in another. It was therefore decided to measure both aspects, i.e., energy expenditure and aerobic activity. These measures it was felt, would provide a more detailed, comprehensive and accurate activity profile, and thereby improve upon a number of existing measures. This decision is also in keeping with the recommendations which have since been made by Davey Smith & Morris (1992), that the two principal dimensions of physical activity should be captured in physical activity assessment: total physical activity (energy output) and aerobic activity.

Furthermore, it seemed more appropriate to assess both aspects following concerns in the literature about the nature of children's activity. Children have been reported to be active but only for short spurts rather than the longer stretches that might be expected to have an aerobic training effect (Baranowski et al., 1988) and their activity has been reported to be sporadic and change frequently (Puhl, Greaves, Hoyt & Baranowski, 1990). More recently, Armstrong & Bray (1991), have also recognised how "sustained periods of activity are not features of children's habitual physical activity." In view of these findings, the questionnaire would not only deal with aerobic activities of particular intensities or durations, but would records all activity in order to calculate total energy expenditure. Researchers have acknowledged the need to further investigate the effects of short periods (five minutes) of physical activity on children's cardiopulmonary systems (Armstrong & Bray, 1991), but until such information is available it seems more appropriate to monitor physical activity in as global a sense as possible.

The questionnaire therefore, proposes to elicit activity information with respect to the following:

1) Average daily energy expenditure
2) The amount of time spent in moderate activity
3) The amount of time spent in hard and very hard activity
4) The number of bouts of activity of an intensity that causes a child to "huff and puff," i.e., to breathe hard, harder than normal. It is associated with activities that make the child's heart beat faster and make him/her hot and/or sweaty.

The amount of time spent in hard/very hard activity and the number of bouts of "huff and puff" activity (3 & 4) would give some indication as to the amount of aerobic activity the children were engaging in which was likely to result in aerobic conditioning. As was noted earlier, activities of an intensity of more than 6 METS are believed to be of sufficient intensity to condition the cardiovascular system (Taylor et al., 1978). This is because they are assumed to be heavy enough to demand greater than 50% of maximal oxygen intake. Activities of 6 METS or more constitute hard or very hard activities in this self-report measure (see scoring procedure outlined in chapter four).

To calculate energy expenditure a scoring system similar to those which have been used in the past, in the Tecumseh study and in the Minnesota Leisure-Time Physical Activity Questionnaire with adults, and in the 7-Day Recall Questionnaire with both adults and children (Wallace et al., 1985) would be adopted. Such scoring systems were reviewed earlier in chapter two (2.10.). The scoring procedure developed for the purpose of this research is explained in detail in chapter 4.

The questionnaire would determine the physical activity levels of children by gathering information from the previous day's activities. Verbrugge (1980) noted how daily self monitoring data are presumably more accurate since they overcome many problems in memory and two studies have since been conducted which support this view. A study by Wallace et al., (1985) showed how children were able to recall activity of the previous day reasonably accurately, but how they have had great difficulty with days further back in time and a study by Sallis et al., (1993) found a one day recall, the "Yesterday Activity Checklist" to be superior to two different 7-day recall measures. It was further felt that if more than one day's activity information was requested, the questionnaire would have to be that much longer and motivation would be lost while completing it, thus leading to more inaccuracies.

However, details of 1 day's activity can hardly be said to be representative of a child's habitual activity pattern and it was therefore decided that 4 days of activity information should be collected for each child. Four days was selected based on reports from previous studies. Alderson & Yasin (1967) for example, collected 2 days of information four times over a year, Simons-Morton et al., (1990) took 3 days of activity information as representative of patterns of participation in physical activity while Durant et al., (1993), have reported that just over 4 days of recording are necessary to achieve a reliability of 0.8 in the physical activity measure. Indeed, Dickenson 's (1987) results revealed consistency in activity levels for each day of the week, suggesting that a 1-day measure would provide a representative indication of a child's activity level.

It was established that 4 days activity information would be collected for 2 different days in the week and 2 weekend days (a Saturday and a Sunday). Two separate questionnaire forms would thus need to be devised, one concerned with the types of activities children engage in on either a Saturday or a Sunday (a weekend form), and a second concerned with the children's school day activities (a school day form). The school day form would be administered on a Tuesday, Wednesday, Thursday or a Friday, while the weekend form would be completed on the Monday following the weekend. Each questionnaire would be administered twice in the year, in order to account for possible seasonal variations. Ross, Dotson & Gilbert (1985) acknowledge how it is year-round participation in appropriate physical activity which is important in terms of continuing health benefits.

To enhance recall, the forms would be divided into segments of the day. This follows Baranowski's recommendations (1988). The school day form would be segmented into before school, at school and after school, and the weekend form into morning, afternoon and evening. Given the nature of the information required by the self-report measure it will be necessary to ask children to recall varying lengths of time in minutes. They will be required to report exactly how many minutes (to the nearest 5 minutes) they have been active and engaged in a particular activity for. The difficulty of doing this accurately has been acknowledged (Baranowski et al., 1984). However, Baranowski et al., (1984) addressed this issue and interestingly found that reporting of exact minutes produced much higher agreement when a segmented format was used than reporting time by other methods (see chapter 2, 2.11). It is also known that the ability to accurately perceive time improves with age (Richards, 1964) and that the capacity of children and adolescents to accurately report physical activity is age related (Sallis, Buono, Roby, Micale & Nelson, 1993). As the subjects in this study were to be 11 years and older, it was anticipated that their ability to perceive time would be superior to the ability of the younger children who have been the subjects of previous studies, for example, in the studies conducted by Baranowski et al., (1984).

For ease of administration children would be provided with a checklist of activities. The form would furthermore include all activities children may engage in and not just physical activities. In this way, it is hoped to conceal the intent of the questionnaire as much as possible and thereby reduce the risk of children giving desirable rather than truthful responses. It was also felt that if only physical activities were included in the questionnaire, then the less active children, having nothing or very little to report, may feel excluded from the study.

Finally, to increase the chances of gaining the full co-operation, attention and accurate information from children completing the questionnaire, it was felt that the school environment would be the most appropriate setting for the administration of the measure. The decision was made therefore, that the questionnaire forms would be administered during the school day.

Table 3.1 Summary of the Proposed Characteristics of the Self-Report

The Questionnaire proposes to...

1) measure four dimensions of physical activity: a) physical activity at school (excluding sport) b) sport at school c) physical Activity during leisure-time d) sport during leisure-time.
2) measure physical activity in terms of: a) average daily energy Expenditure (METS) b) time spent in moderate activity c) time spent in hard and very hard activity (6 METS or more) d) number of bouts of "huff and puff" activity.
3) have an objective scoring system.
4) record the previous day's activity only.
5) gather 4 days of activity information.
6) consist of two separate forms -a school day and a weekend form.
7) segment the day into parts.
8) contain checklists of activities.

3.3 Preliminary Studies

Decisions made in designing the self-report measure led to a need for preliminary studies, prior to making drafts of the forms. It was established for instance, that the measure would comprise checklists of activities from which children would select which activities they had done the previous day. It was therefore necessary in devising the checklists, that appropriate activities were included in the lists, appropriate in terms of reflecting the developmental level and culture of the children for whom the forms were being designed. As the literature review revealed, a number of questionnaires which have been used in the past have demanded too much of children in terms of their ability to remember events, for instance in the 7-Day Recall used by Wallace et al., (1985) and Sallis et al., (1988) and in the Leisure-Time Exercise Questionnaire

(Godin & Shephard, 1984). Others meanwhile, have either being designed with younger children in mind (Murphy et al., 1990; Noland et al., 1990) or are not culturally suitable for British children (Baranowski et al., 1984; Simons-Morton et al., 1990; Sallis et al., 1993). The activities for inclusion in the questionnaire were established based on a short preliminary study, the details of which are outlined in study one.

Furthermore, and as a result of the concerns in the literature with regard to children's inability to accurately perceive time, a further two studies were initiated to try to determine the extent to which time perception may be a problem in the final forms. Time estimations would be required from the children in order to calculate energy expenditure. If however, a preliminary study was to reveal that children of 11 years of age were clearly unable to make satisfactory time estimations, then it may be that the design of the forms needed to be re-assessed at this early stage. Two time perception studies are outlined in studies two and three.

Finally, prior to any firm decisions being made with respect to the design of the final version of the measure, a preliminary pilot study (study four) of the drafts of the forms was conducted. The draft forms were drawn up following the decisions over the characteristics of the measure and following the findings from preliminary studies one, two and three.

3.4 Study One

Method

Following a review of the literature and the proposed design and format of the self-report measure, the types of activities to be included in the forms' checklists needed to be established. The activities were selected on the basis of the results from a short self administered questionnaire. Initially, a study of a number of established activity questionnaires (The Canadian Fitness Survey Questionnaire, 1981, The Health Related Behaviour Questionnaire; The Northern Ireland Health and Fitness Survey Questionnaire, 1989; and Baranowski 's forms, Baranowski et al., 1984) was made in order to provide a number of potential activities for inclusion in the questionnaire checklist. A combined sample of activities was drawn up from the existing questionnaires to produce a list of 64 activities.

The list of activities was used to devise a short two part questionnaire (see appendix A). Part one consisted of a page for reporting activities undertaken the day before, i.e., the children responded to the question, "What did you do yesterday.... a) in the morning before school?, b) at break time?, c) at lunch time? and d) in the evening?" and part two consisted of a two page checklist of a number of different activities. The children were required to tick those activities they did or sometimes did, and cross any activities they did not do or would never think of doing.

The questionnaire was administered to a sample of school children from a local high school. Two classes (n=58) completed the questionnaire during school time under the supervision of their teacher. One class comprised year 7 pupils (11-12 year olds) and one class year 9 (13-14 year olds) pupils.

Results

The responses to the questionnaire proved to be very similar across the sample. A number of the activities on the list were not found to be popular and were reported to be of no interest to the pupils. For the purpose of including or excluding activities from the forms, it was decided that if 75% of the pupils did not engage in a particular activity, and furthermore declared that they would never think of engaging in it, then it would be omitted from the final checklists.

There is a slight danger in omitting activities from the forms, however, because important and relevant information may be lost. It was therefore decided that an "any other activity" category should be included in the final forms to account for the less popular activities or activities which children may tend to engage in only occasionally. While it was important to keep the checklists relatively short, alternatively they had not to be too short otherwise the purpose behind the questionnaire may become too apparent to the children. It was felt it was important to include a number and range of activities in the forms to try to convince children that it was not only sporting activities which were of interest, but all activities. Hence, a number of light activities were retained and included in the final checklists irrespective of their popularity.

3.5 Time Perception Studies

Background

An important process involved in self-reporting of physical activity is the estimation of time spent in activity. Given that the questionnaire was to ask children to report for how long they had engaged in different activities, and given the concerns over children's ability to accurately estimate time (Eisler, 1975; Friedman, 1982, Baranowski et al., 1984; Sallis, 1991; Sallis et al., 1993), it was decided to administer two further studies to determine the accuracy with which children are able to report and make judgements about time. Subsequently the degree of error which may be expected in responses to the questionnaire could be estimated. If considered to be too high, the design of the questionnaire forms may have needed to be re-assessed.

The limited literature in the area of time perception reveals that little is known about the mechanisms by which individuals perceive time (Richards, 1964). Information with regard to children and time perception is even more scarce. Four main methods of studying time perception are recognised however, namely: verbal estimation, production, comparison and reproduction. After reviewing the literature it became evident that, for the purpose of this investigation, the former two methods were the most relevant.

Verbal estimation and production involve the measurement of a personal time scale as related to an objective time scale (Richards, 1964). Verbal estimation requires the subject to make a verbal estimate in seconds or minutes of the duration of a given interval. Production requires the subject to respond to a requested time interval. According to Clausen (1950), it is such personal scales that can be easily distorted by the environment or a subject's activity. It appears therefore, that it is these aspects of time perception which are relevant and which should be of concern to us when dealing with and studying children's activities and their ability to estimate time.

Method

Two studies were devised using both verbal estimation and production as measures of time perception. For ease of organising and administering the experiments it was decided to conduct the studies within the school environment. A local high school granted permission for the studies to be conducted on a sample of year 7 (11-12 year olds) and year 9 pupils (13-14 year olds). One measurement of the pupil's ability to perceive time was taken during a lunch time and a second measurement during a physical education lesson. Different procedures were adopted for the lunch time and P.E. studies and each study is outlined separately.

3.6 Study Two-The Verbal Production Lunch time Study

The decision to conduct the first study during a lunch time was based on a number of factors. Firstly, most lunch times at school are an hour in duration giving sufficient time in which to conduct the study. The environment was furthermore suitable as the pupils' movements were restricted by the school boundaries. This had the advantage that throughout the study the children were always at hand. Finally, the lunch time is a period of the day when a variety of activities may be engaged in. The situation however, did not easily lend itself to any form of time perception other than verbal production. Children tend to spend their lunch times engaging in a whole variety of activities and do not stay in any one place for any period of time. It would therefore have been extremely difficult to have monitored the pupils closely and requested verbal estimates from them during their lunch time without creating too false an environment.

Method

Subjects were randomly selected from a year 7 and year 9 register. Prior to the study an explanation as to what the study was about was given to the pupils. Full instructions were also given with regard to what they would be required to do. The pupils were informed that the purpose of the study was to see how well they could make judgements about time. They were instructed not to try to count or to use aids in making judgements about time but to merely make an "intuitive" judgement. The pupils were each given a numbered envelope containing a slip of paper on which was a written instruction. They were told to "report back" after a specified interval of time. They were instructed not to confer with any of their peers or reveal their time to anyone else and they were unaware of whether others had been given the same or different times from themselves. Once the pupils had read the instructions and it was clear that each understood what they were being asked to do, the stopwatch was started and timing began. The times at which the pupils returned were recorded to the nearest 15 second interval.

Results

Verbal production results were obtained for 27 pupils in total. Fifteen year 7 and 12 year 9 pupils completed the study. Unfortunately numbers were not as high as had been planned as a few subjects were absent on the days of testing and a few failed to meet on the required day at the time of starting the study.

Absolute error scores and percentage error scores were calculated for each time interval respectively. In addition, error scores were calculated for each pupil separately. The results are summarised in tables 3.2, 3.3 and 3.4. The full set of results are presented in Appendix B. The results revealed error in the times produced by the pupils. Absolute error ranged from 1 minute 26.66 seconds for the 20 minute time production interval to 3 minutes 13.33 seconds for the 30 minute time production interval. In percentage error terms, the 10 minute time interval proved to be the least accurate production time with 21.38% error in the times produced. The most accurate production time was the 20 minute time interval (7.22%). The 30 minute time production interval was slightly less accurate than the 20 minute interval with 10.74% error obtained in responses. The average percentage error score obtained across all ages and time intervals was found to be 12.74%. Differences in the absolute error and percentage error scores were evident between the year 7 and year 9 pupils. The year 9 pupils were more accurate in terms of time production (14.36% versus 11.11% respectively).

Table 3.2 Summary of Verbal Production Results for Year 7 and Year 9 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	128.33 2 mins 8.33 secs	21.38%
20	86.66 secs 1 min 26.66 secs	7.22%
30	193.33 secs 3 mins 13.33 secs	10.74%
AVERAGE PERCENTAGE ERROR=12.74%		

Table 3.3 Summary of Verbal Production Results for Year 7 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	153 secs 2 mins 33 secs	25.5%
20	96 secs 1 min 36 secs	8%
30	174 secs 2 mins 54 secs	9.6%
AVERAGE PERCENTAGE ERROR=14.36%		

Table 3.4 Summary of Verbal Production Results for Year 9 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	90 secs 1 min 30 secs	15%
20	75 secs 1 min 15 secs	6.25%
30	217.5 secs 3 mins 37.5 secs	12.08%
AVERAGE PERCENTAGE ERROR=11.11%		

Discussion

The conclusions drawn from this preliminary time perception study were that, as expected, pupils did make errors in their judgements of time, although the amount of error made varied considerably amongst individuals. Some pupils managed to make very accurate time perceptions, while others evidently found the task much more difficult (see Appendix B). The lowest individual percentage error score obtained for example, was 0%, while the highest percentage error score was 40%. As expected, and given that an individual's concept of time is reported to develop with age (Richards, 1964), the older pupils were found to be more accurate in the time estimations they made.

Of course, it may have been good luck rather than accurate judgements of time which were responsible for the results and there is no way of establishing whether this was the case. The mechanism by which the pupils judged the time they were given is not known and is beyond the scope of this preliminary investigation to find out. Nevertheless, if these pupils were representative of the general child population of this age, it does appear from this initial study that children can make reasonable estimations of time.

3.7 Study Three-The Verbal Estimation Physical Education Lesson Study

Despite the verbal production method used in the lunch time study being a useful measure and initial indicator of children's ability to perceive time, it did however have its limitations. The method is limited in terms of its appropriateness to the self-report measure of physical activity to be used in this research, in that in study two pupils had to be informed prior to the experiment that they would be required to perceive time. In completing the self-report measure of physical activity however, the children will be asked to make their best recall judgement and estimate how long they were active for following the event. Evidently, this is a rather different task. In essence, this estimate requires a verbal estimation. In an attempt to produce a situation more in keeping with the task of completing the self-report measure therefore, a second time perception study was devised in which the pupils were required to make verbal estimations of varying lengths of time.

Method

The environment selected in which to conduct this second time perception study was a Physical Education lesson. The lesson represented an environment in which all pupils could be closely monitored for the duration of the study. Furthermore, the P.E. environment represented an ideal "active" environment. As with the verbal production study, the subjects were year 7 and year 9 pupils drawn from the same local high school. A total of 160 pupils, (95 year 7 and 65 year 9 pupils), were involved in the study. Pupils were randomly selected and permission was sought from them to be involved. In this instance the only information the pupils were given regarding the nature of the experiment was that they would be called over at some stage during the lesson and would be asked a question about the lesson. They were informed that their answer would be confidential and would involve a "best guess." They were assured that it did not matter if they got the answer wrong but they were encouraged to try to give as accurate an answer as possible.

Having instructed the pupils of what was to be required from them, the stopwatch was started and timing began. Pupils were called over to make time estimations after either a 10, 20 or 30 minute time interval. On being called over they were required to give a time estimation as to how long had passed from the beginning of the lesson's activity, to the point of being called upon. The pupils were asked "How long do you think you have been doing this activity for?"

Results

As in study one, absolute error scores and percentage error scores were calculated for each time interval and a percentage error score was calculated for each individual child's time estimation. A summary of the results is presented in tables 3.5, 3.6 and 3.7 and the full set of results can be seen in Appendix B.

Again error was found in the time estimations made by the pupils. Total absolute error scores across age groups ranged from 3 minutes 19 seconds for the 10 minute time interval, to 7 minutes 6 seconds for the 30 minute time interval. Percentage error ranged from 23.66% to 33.15%. The average percentage error obtained across all pupils and all time intervals was calculated to be 29.59%. No consistent pattern emerged between the year 7 and year 9 pupils' results in this study. What became particularly evident in this study though, (as was evident though to a lesser extent in the verbal production study), were the large differences in error found between individuals. Individual error scores ranged from 0% to 125%. Thirty five pupils achieved 0% error scores. Certain pupils then, were able to make accurate time estimations, while others were not.

Table 3.5 Summary of Verbal Estimation Results for Year 7 and Year 9 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins 19 secs	33.15%
20	6 mins 2.4 secs	32.00%
30	7 mins 6 secs	23.66%
AVERAGE PERCENTAGE ERROR=29.59%		

Table 3.6 Summary of Verbal Estimation Results for Year 7 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins 38 secs	36.30%
20	6 mins 51 secs	34.25%
30	7 mins 3.4 secs	23.54%
AVERAGE PERCENTAGE ERROR=31.36%		

Table 3.7 Summary of Verbal Estimation Results for Year 9 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins	30%
20	5 mins 57 secs	29.75%
30	7 mins 8.4 secs	23.78%
AVERAGE PERCENTAGE ERROR=27.84%		

In addition, when error was made in the times reported by the pupils, the direction as well as the amount of error was noted and the number of over estimations and under estimations of time were calculated. In total, 55 under estimations and 70 over estimations of time were recorded. When the year 7 and year 9 pupils were considered separately, it became apparent that the year 9 pupils made considerably more over estimations of time.

Discussion

Evidently then, error increased greatly in this study which relied on verbal estimation as the method of time perception. The average percentage error across all ages and time intervals calculated for the verbal production study was only 12.74%. This study revealed the percentage error to be 29.59%, 16.85% higher than in the initial study. This suggests that the majority of pupils found it difficult to make accurate verbal estimates of time while engaged in activity during a physical education lesson. However, worthy of mention here are the large individual differences in error. A number of pupils made perfect time estimations, obtaining 0% error scores. Clearly, some children are able to accurately perceive time while others are not.

Implications

As was expected then, children do seem to make error in making time estimations. We must therefore expect there to be error in the time estimations made by children completing the self-report measure. However, the estimations made, in the researchers opinion, were not ridiculously inaccurate. Indeed, on the positive side, many of the pupils were surprisingly accurate. It must be realised in considering the results from the self-report measure though, that while some individuals are likely to be accurate, others are not, and it should be accepted that on average approximately 30% error may exist in the time estimations made in completing the forms.

The influence that 30% error could have on the overall activity results obtained from the self-report measure in real terms was considered. To determine the influence of such error on the energy expenditure values obtained for subjects, hypothetical examples were calculated in which 30% error in the time estimations of all activities was made. Examples included both hypothetical active and inactive subjects and time estimations were either all overestimated or all underestimated. While the error did influence the energy expenditure calculations and activity scores obtained, the differences were insufficient to make any major difference to the overall activity scores. In other words, the hypothetical very inactive subjects remained very inactive, the inactive subjects remained inactive and the active subjects remained active. This is probably due to the fact that activity represents proportionately only a small part of the day (even for active children), and therefore most children are required to make only a few time estimations accounting for relatively little time. Because most energy is expended in sleep, very light and light activities, which have MET values of only 1, 1.5 or 2.5 respectively, and because very light activity does not require time estimates to be made (see scoring procedure), yet constitutes a good deal of time for most people (Blair, 1984), the activity scores were only marginally affected by the error.

Furthermore, the hypothetical calculations which were made assumed that the subjects always either overestimated or underestimated time. It may be, of course, that in reality subjects make both over and under estimations of time in their activity reports and as such the error made may be cancelled out to some extent. As a result of the hypothetical calculations, the researcher concluded that the activity scores derived from the self-report measure would not be severely affected by the error in most cases and that the error was therefore acceptable.

3.8 Study Four-Piloting the Self-Report Measure

The proposed characteristics of the questionnaire established earlier in this chapter (see 3.2) were implemented in the design of a self administered measure of physical activity. A pilot study of two self administered forms (a weekend and a school day form) was conducted on two classes of pupils. More than 60 pupils (30 year 7 pupils and 32 year 9 pupils) completed the forms during their tutor time at school under the supervision of their teacher. Each form was reported to take between 5 and 10 minutes to complete.

Although the self administered forms were time and cost effective, problems were experienced with them. Despite careful instructions and wording of questions, there was evidence of misinterpretation of the forms by some of the pupils. Many questions were left unanswered or answered incompletely, and evidently some pupils were far more motivated to complete the forms carefully and correctly than others. This made analysis of some of the forms very difficult. Because the priority in this research is to design a measure of physical activity which addresses as many of the problems associated with existing measures as possible, the feasibility of administering self administered forms to children was re-considered. It was decided that although the forms could be self-administered, with such a young population as this measure was designed for, the most appropriate means of gathering accurate information would be to adapt the self administered forms to interviewer administered forms.

Despite rejecting the self administered version of the forms, however, piloting the forms in this way proved very useful. On the basis of the responses from the forms, for example, changes were made to the checklist of activities included in the final version of the interviewer forms. A number of the activities in the checklists were not found to be popular among the pupils sampled, despite the results of the short self administered questionnaire in study one suggesting otherwise. To shorten the length of the checklist and consequently minimise the total time it would take to administer the questionnaire, a number of additional activities were omitted from the lists. These included aerobics, bowling, cricket, horse riding, fishing, darts, pool/snooker, skateboarding, ice/roller skating and going to the cinema. If any of these activities were reported by subjects during the interview questionnaire, they could be recorded in the "any other activity" category.

CHAPTER 4

FINAL PREPARATIONS IN DESIGNING THE SELF-REPORT MEASURE

4.1 Introduction

In this chapter, details of the final preparations which were made in designing the self-report measure are provided. Details of the scoring procedure, the final format and lay-out of the interview questionnaire and the procedure for piloting of the forms are all outlined. Finally, the development and administration of the training procedure for interviewers is described.

4.2 Scoring Procedure

The questionnaire proposed to use an objective scoring system. Raw data from the questionnaires was to be used to calculate an estimate of average daily energy expenditure for each child. An appropriate scoring procedure therefore had to be developed. The first task in preparing the scoring system involved an analysis of the metabolic costs of the activities included in the questionnaire checklists. The metabolic costs adopted for use in this questionnaire were expressed in the form of METS and were derived from the best available published data. Energy costs recorded by Durnin & Passmore (1967); Katch & McArdle (1977); Bouchard et al., (1983), The Tecumseh Questionnaire (Reiff et al., 1967) and The Minnesota Leisure-Time Physical Activity Questionnaire (Taylor et al., 1978) were studied carefully and, based on the best representation from these published lists, a MET value was assigned to each activity checklisted in the questionnaire.

The energy costs of activities reported by the different authors did not differ markedly, suggesting that relatively good estimates could be made. As was noted earlier (see chapter 2, 2.10), only limited research on measured energy expenditure in children during physical activity is available. Where energy expenditure values were available for children, then these values were used rather than the adult equivalents. Generally though, and for the purpose of scoring this questionnaire, activities were taken to be the same intensity for children as they were for adults. Where energy expenditure values were not available for particular activities, personal judgements about the intensity, based on activities they were comparable to had to be made.

Data on the energy costs of activities such as playing tag/chasing games or playing other ball games in the playground was lacking for example, therefore estimates were made for these activities based on the energy costs of similar known activities. This practice is in keeping with the practices and recommendations of other researchers (Taylor et al., 1978; Ainsworth et al., 1993). Just recently, and since the development of the energy costs for this study, Ainsworth et al., (1993) have produced a compendium of physical activity energy costs. The procedure they employed to establish their compendium was the same procedure as was adopted to establish the energy costs in this study. Indeed, it is encouraging to note that the established energy costs from this study and from the compendium presented by Ainsworth et al., (1993) compare very favourably.

Once the energy costs of the activities had been established, the activities were categorised into five categories: very light, light, moderate, hard or very hard. A similar scoring method to the 7-Day Recall described by Blair (1984) was used in deriving the energy expenditure measures from the raw data in this study. The exception was the inclusion of an extra "very light" category of intensity. It was felt that more accurate estimates of energy expenditure could be made by the inclusion of an additional category. Blair (1984), in the 7-Day Recall, identified light activities to include any activities involving sitting as well as any light sports, light housework or office work. Clearly activities which involve translocation and slow movement, such as shopping, light household chores and walking, expend more energy than activities in which there is little or no movement, such as watching television and reading. Indeed, this is evident from the values quoted in the literature (Bouchard et al., 1983; Torun, 1983; The Tecumseh Community Health metabolic costs). The energy cost of activities involving some movement tend to be in the range of 2.3-2.8 METS (Torun, 1983; Bouchard et al., 1983). These values are a good deal higher than the 1.5 MET value assigned for all light activities in the 7-Day Recall. It was therefore decided that for the purpose of this research, all activities involving translocation and not merely sitting would be included in a separate activity category and assigned a MET value of 2.5. These activities would be referred to as "light" activities, while the more stationary activities would be referred to as "very light." Ainsworth et al., (1993) have since confirmed more strongly than ever the researchers decision to assign such activities to a new MET category in their compendium of energy cost values. They quote for example, a 2.5 MET value for home activities including carpet sweeping, cooking, serving food, setting the table, putting away groceries etc., and a 2.3 MET value for other light activities such as shopping, ironing etc. Examples of the kinds of activities which have been assigned to the different intensity categories and the average MET value for each category are shown in table 4.1. A full list of the activities as categorised can be seen in Appendix C. Table 4.2 describes the procedure for making the energy expenditure calculations in $Kcal \cdot Kg^{-1} \cdot day^{-1}$.

Table 4.1 The Intensity Categories of Selected Activities

INTENSITY	ASSIGNED MET VALUE	EXAMPLES
Very Light	1.5	watching television/videos, using a computer/playing computer games, homework, reading for pleasure
Light	2.5	walking, shopping, light household chores, going to a youthclub/disco, bowling, cricket
Moderate	4.0	cleaning/moving furniture, brisk walking, swimming, tennis, gymnastics
Hard	6.0	disco dancing, basketball, rugby
Very Hard	10.0	running, athletics, football

Table 4.2 Making the Energy Cost Calculations

The Calculations In making the daily energy cost calculations in $Kcal \cdot Kg^{-1} \cdot day^{-1}$, the hours spent in an activity category must be multiplied by the average MET value for that category. This must be calculated for sleep, light, moderate and hard activities. It is not necessary to determine how many hours each subject was involved in very light activities as this is determined by calculating the difference in 24 hours from all other reported activity.

A few discrepancies arose in categorising the intensity of certain activities and in such instances personal judgements had to be made. Where two activities were found to be markedly different in the literature, to the extent that the activities were categorised differently, the lower MET value was generally chosen as it was felt that in most cases a certain level of skill would be required to expend the higher level of energy in the given activity. Many children's skill level in sports is limited (certainly when compared to adults). In some instances therefore, it was felt that where activities were identified as light by some authors and as moderate by others, as was the case in table tennis, or as moderate by some and as hard by others, as was the case in badminton, the former category would be the most appropriate.

Another reason for choosing to place activities in the lower of the two categories was as a result of the re-classification option offered within the scoring system offered. In contrast to the 7-Day Recall and other previous procedures, it was decided to add more flexibility to the scoring system in this measure. Following the concern over categorising activities strictly as light, moderate, hard or very hard, it was decided that there should be scope for the interviewers in this questionnaire to re-classify activities as and when they felt necessary. The intensity (purpose) with which an activity was engaged in was therefore to be taken into account. A child who reports playing an organised football game with his/her local team, for instance, is likely to expend more energy than a child just kicking a ball around with his/her younger brother or sister in the garden. Similarly, a person swimming for recreational purposes is not likely to expend as much energy as a club swimmer participating in a training session. Ainsworth et al., (1993), in their compendium of energy costs similarly recognise the importance of the intensity in which physical activity is engaged and have assigned different energy costs to the same activities depending on their purpose. Under previous procedures of calculating energy expenditure, the same activities would be categorised as having the same MET value, despite the very differing circumstances in which these activities might have been undertaken. To try to minimise the effects of this problem, and thereby improve upon existing and similar measures, it was decided that distinctions would be made between "how" certain activities were engaged in. Probing questions were therefore devised in an attempt to make such distinctions in intensity. Interviewers were instructed to ask the following probing questions for all sporting activities requiring time estimations:

1) Did you do/play the activity...

a) with an organised club/a regular team, or

b) on your own or with family/friends?

(It was felt that if a subject played an activity or sport for an organised club/regular team, then he/she would have been more likely to expend more energy than if just doing the activity with friends).

2) If subject answers a) to question 1, How long have you been doing the activity for,

a) more than 6 months, or

b) less than 6 months?

(It is assumed that the longer a subject had been doing an activity for, the more skilful he/she would likely to be, and therefore the more likely he/she would be to expend more energy as a result of the increased skill level).

3) Did you do the activity for...

a) training purposes, i.e., for fitness training or competition, or

b) for pleasure/for fun?

4) Did you do the activity...

a) fairly continuously and/or vigorously? or

b) fairly lightly, not very strenuously?

The following instructions were also given to the interviewers:

If a child answers a) to two or more of the questions, then it is suggested that the activity should be re-classified and included one activity category higher up in intensity. For example, table 4.1 classifies swimming as a moderate activity. However, if a child reported that he/she was a club swimmer who trained seriously and/or fairly continuously, and/or had been doing so for more than 6 months, it would seem far more appropriate and accurate to record the activity as hard, or even very hard, i.e., one or two categories higher than it would normally be placed.

Alternatively, if on questioning a child it becomes apparent that an activity was engaged in only very lightly, the activity may be classified into a category lower. For example, athletics constitutes very hard activity, regardless of the event. On probing, if it is revealed that the activity consisted of perhaps only a few throws of the javelin in an hours athletics session, then clearly the activity does not warrant classification as a very hard activity and assigned a value of 10 METS for one hour. The final decision as to which category to place activities in is at the discretion of the interviewer and demands adequate questioning to arrive at a decision. It should be realised however, that a re-classification of activities should not be restricted to sports club or team members only. An individual may engage in an activity independently and yet take it very seriously, perhaps training very hard for personal fitness, and/or doing the activity vigorously and/or sustaining it for quite some time. Further probing questions with a possible need for a re-classification of activities are also required if a child reports they walked or cycled to and/or home from school on the school day form, or engaged in a part time job on both the school day and weekend forms.

The full set of interviewer instructions are presented in the protocols in Appendices G and H.

Limitations of Scoring Procedure

The applicability of energy expenditure values to children was questioned earlier in the review (see chapter 2, 2.10). Some of the activities in this procedure were categorised according to values obtained from studies conducted with children (Durnin & Passmore, 1967), though the majority were not. Despite concerns expressed by Torun (1983), other researchers have found the error in doing this to be minimal, particularly after the age of 9-11 (Taylor et al., 1948; Bedale, 1923; Cullumbine, 1950; Legun & Moltschanowa, 1935). The problem does not, therefore, appear to be so significant in the age of the children for which this measure was designed. Another limitation in the energy costs is that the values for some of the activities listed in the questionnaire were not available and have not been derived from actual measurements of oxygen consumption. Instead they were estimated from the energy cost of activities having similar movement patterns. However, this is the recommended procedure in such an instance (Taylor et al., 1978; Ainsworth et al., 1993).

While the scoring procedure improves upon previous methods in that it adds flexibility to the scoring system, it is still limited by the fact that it relies on children reporting the intensity in which they were engaging in an activity accurately. For example, one child may rate his/her walking pace as brisk while another child may classify the same pace as slow. The interviewer must make a decision based only on the information the child gives to the questions asked. Further, the procedure cannot account for individual differences in movement efficiency. Another point which may be highly significant, particularly in the sample used in this study, is the question of the reliability of calculated energy expenditure when there is frequent change in activity. With such changes the steady state values for energy expenditure as given by the tables may not actually be reached. This may be particularly applicable to children who seldom sustain any one activity for long.

On the positive side however, the recent publication of the Compendium of Physical activities by Ainsworth et al., (1993), acknowledging the importance of flexibility within scoring systems, reinforces the value of the scoring procedure this research has developed. The compendium, (which has been developed by very well known and established authorities in the area of physical activity) compares very favourably with the energy cost classifications established in this study. Of course, what is really needed though, is more information on the energy cost of children's activities, but until such measures are conducted and such values become available, the present values must suffice.

4.3 The Format of the Interview Questionnaire

The characteristics of the questionnaire (outlined in section 3.2) and the scoring system (see 4.2) determined the final format and lay-out of both forms, i.e., the weekend and school day forms (see Appendices D and E). The activities listed in the forms were decided upon based on the results of preliminary study one and the pilot test of the self administered version of the questionnaire (preliminary study four). However, given that the segmented day format was adopted in structuring the forms, it was not appropriate to include all activities in all parts of the questionnaire. Each activity selected for inclusion in the forms was placed into various segments of the day according to the feasibility of pursuing the activity at the particular time of day. The short questionnaire completed by the pupils in preliminary study one was again useful here because it identified the activities that were commonly reported at particular times of the day and these were included at the corresponding time of day in the final forms.

Once organised into the appropriate segments of the day, the activities were grouped according to intensity. They were divided into three categories: a very light category, a light category and a moderate, hard or very hard category. Depending on the intensity of the activities, certain additional information was required in administering the forms and selected questions needed to be asked. If children reported to have done any light, moderate, hard or very hard activities, time estimations needed to be made for these activities. The "aerobic rating" question, i.e., whether the activity made the child "huff and puff," only needed to be asked for activities of moderate, hard or very hard intensity, as it was assumed that subjects would only "huff and puff" if engaging in activities of at least moderate intensity.

In addition to the weekend and school day questionnaires, summary sheets were prepared for both forms in which a summary of all relevant raw data collected was made by the interviewer following each interview (see appendix F). The summary sheets were coded and were designed to record the subject's number, school, age, sex, time of year (winter/summer), hours sleep, and activities engaged in of each intensity type, i.e., total time spent in light, moderate, hard and very hard activity. Each activity listed in the questionnaire was allocated a different code (see Appendix C) and these too had to be recorded in the relevant intensity category on the summary sheets.

Detailed protocol and instruction booklets for interviewers were also devised (see Appendices G and H). This follows Baranowski 's (1988) recommendation to standardise and develop detailed protocols for implementing self-report methods. The protocol and instruction booklets provided all the necessary details for interviewers administering the questionnaires, from the initial meeting of the subject to the final completion of the summary sheets. They gave details of how to introduce the questionnaire, how to administer the forms, what questions to ask in certain situations and how to complete the summary sheets.

4.4 Piloting the interviewer administered forms

Following the decision to make the self-report measure an interviewer conducted questionnaire, adaptations were made to the original forms. To assess the feasibility of the new interviewer forms and protocol and instruction booklets they were piloted on a sample of year 7 and year 9 pupils. In total, 40 pupils were interviewed over four school days. The protocol was closely adhered to throughout. The weekend form was piloted on two consecutive Monday mornings, and the school day form on two consecutive Tuesday mornings. As a result of the pilot, minor changes were made to the protocol to clarify the administration procedure and answer some of the discrepancies that had arisen during some of the interviews. Very minor changes were also made to the questionnaire forms.

4.5 Interviewer Training

The final stage in the preparations of the interview questionnaire involved the planning of an appropriate training procedure for interviewers and the training of a sample of interviewers in the administration of the questionnaire. For the measure to be considered a useful and practical tool it was vital that it could be administered by different interviewers. The training procedure followed a similar structure to the procedure outlined by Gross et al., (1990) for the 7-Day Recall. Two structured training sessions were planned and a training pack was prepared for trainee interviewers. The pack comprised background information to the questionnaire (see Appendix I) , two protocol and instruction booklets(Appendices G and H), a separate one for the weekend and school day form, and both questionnaire forms with summary sheets (see Appendices D, E and F).

Four interviewers were trained to administer the questionnaires, all of whom were former or current physical education students or physical education professionals who had a good understanding of physical activity. The details of the training procedure were as follows:

The first training session outlined in detail the background to the questionnaire and the major characteristics in the design of the forms. The exact information required from the questionnaires was made very clear to the interviewers before they were taken through both forms. The protocol and scoring procedure was also explained fully. Following the first session, interviewers were required to study and familiarise themselves with the forms and protocol individually and practise administering the forms with children. Any queries that arose as a result of their practice trials were to be noted for discussion and clarification at the second training session. In the meantime interviewers were also requested to read literature on interviewing technique.

In session two interviewers gave feedback about their experiences and practice trials. Problems which had arisen in administering the forms were tackled and any questions were answered. Interviewers were also reminded and given general tips about interviewing technique as well as tips specific to administering the particular forms to be used in this research. Finally, the interviewers practised the administration procedure on each other in role-play situations. Following each practice the interviewee gave the interviewer corrective feedback on their performance.

CHAPTER 5

EVALUATING THE SELF-REPORT MEASURE

5.1 Introduction

Every effort was made in designing the self-report, to address as many of the problems associated with the current measures as possible, and thereby to design an instrument which improved upon existing measures. Sallis (1991) states that physical activity self-reports should be developed and evaluated rigorously and that their development should follow a systematic line of inquiry. In view of this, the development of the measure entailed a detailed review of existing self-report measures of physical activity, an investigation of the reliability, validity and the major problems associated with such measures, followed by a review of the recommendations for their future development. Beyond the review, the development procedure entailed an implementation of a number of the recommendations made in the review and a series of preliminary investigations which determined the content of the forms (preliminary study one), the feasibility of collecting the information required by the forms (preliminary studies two and three) and the feasibility of the administration procedure (study four). In this respect, the researcher is confident that a vigorous and systematic line of enquiry was followed in designing, piloting and refining the self-report measure.

Furthermore, it has been stated that the "minimal requirements of an instrument for the recall assessment of physical activity necessitate that it provide reliable and valid measurements, that it's administration is feasible, and that it will not alter habitual physical activity" (Dishman & Steinhardt, 1988). The pilot study (preliminary study four) revealed that the administration of the interview questionnaire was feasible, and given that it was designed as a 1-day recall which gave subjects no prior warning that they were to be interviewed, it clearly would not alter or influence habitual physical activity in any way. In order to evaluate the interview questionnaire rigorously though, (in keeping with the recommendation made by Sallis, 1991), and in order to assess whether it provided reliable and valid measurements (a minimal requirement according to Dishman & Steinhardt, 1988), further studies needed to be conducted which would address such issues. Firstly, the validity and reliability of the measure and how it compared with other physical activity measures needed to be investigated and secondly the reliability of the interviewers trained to administer the questionnaire needed to be determined. The first part of this chapter deals with the validation of the instrument and the second part with the reliability of both the instrument and the interviewers.

5.2 Choice of Validation Methods

In the case of validity there are no gold standard measures of physical activity against which to validate an instrument. Baecke et al., (1982) and LaPorte et al., (1985) state that problems of validity (and reliability) arise because the most appropriate way to assess validity (and reliability) is not really known and there is no accepted criterion method of assessing physical activity. As a result, it was decided to validate the questionnaire using two different methods in this study. The methods used included heart rate monitoring and observation. The details and justification for choosing each method are outlined in this section.

Heart Rate Monitoring

Heart rate monitoring was selected as one method of validating the interview questionnaire as it represents an objective measure of physical activity. The self-contained, computerised telemetry system (Sport Tester 3000) was selected to record the continuous minute-by-minute heart rates of pupils. This instrument has been widely used by Armstrong & colleagues (Armstrong, 1989; Armstrong et al., 1990; Armstrong et al., 1990a; 1990b; Armstrong & Bray, 1991; Armstrong et al., 1991). The Sport Tester 3000 was reviewed earlier (see chapter 2, 2.3), but to briefly recall, it consists of a lightweight transmitter which is fixed to the chest with electrodes, and a receiver and micro computer that is worn as a wrist watch.

The device is capable of recording and storing minute-by-minute heart rates for up to 16 hours, therefore one day's activity information derived from the Sport Tester could be compared with one day's activity information derived from the interview questionnaire relatively easily. While heart rate monitoring does not directly measure physical activity, and while factors other than physical activity can influence heart rate, the technique still remains one of the best and most practical alternatives available for measuring daily energy expenditure in children (Saris, 1986). Freedson (1989) and Freedson (1991) has also recommended heart rate as a valid and practical measure of children's physical activity and Durant et al., (1993) suggest that this is based on the assumption that children who spend longer periods of time in higher heart rate ranges are generally more active than children whose heart rates are in lower ranges. Furthermore, the Sport Tester has been reported to be a reliable and valid means of recording heart rate with children (Tsankas, et al., 1986) which permits almost total freedom of motion (Leger & Thivierge, 1988). All things considered therefore, it was felt that heart rate monitoring via the use of the Sport Tester would be a suitable method for validating the interview questionnaire.

Observation

As a second method of validating the questionnaire pupils would be discretely observed. Observation was selected as a means of validation following the claim that it may provide one candidate for a gold standard means of validation (Baranowski, 1988). The observational method which was chosen was the same as that employed in the study by Wallace et al., (1985). The method requires that activities be discretely observed and documented (i.e., without subjects being aware that they are being observed) every 15 minutes throughout the day, recording the mode, duration and intensity of activities observed in each period.

The decision to observe the pupils in this way rather than by means of some of the more popular observational techniques reviewed earlier, such as the FATS (Klesges et al., 1984) or the Children's Physical Activity Form (CPAF) (O'Hara et al., 1989), was made based on the concern expressed by some researchers that observation may sensitise subjects to their activity level resulting in better recall. Klesges et al., (1990) state that "It has been argued that if subjects are aware that their (diet and) exercise patterns are being monitored, they are likely to be sensitised to the process and likely to provide more accurate information than otherwise may be the case." In other words, an observational method may artificially increase the accuracy of the self-report measure. It was felt, however, that if a discrete observational procedure was used, (such as the method adopted by Wallace et al., 1985), the risk of pupils becoming more aware of their activity and therefore better able to recall it would be minimised. The scoring procedure for the observational method also complimented the scoring procedure for the interview questionnaire very well. Activities were classified as light, moderate, hard or very hard in the observation and energy expenditure was calculated based on the activities recorded.

5.3 The Validation Study

Having identified the methods and the reasons why such methods were chosen for the validation study, the details and procedure of the study are now outlined.

Initial Preparations

Following recommendations made by Sallis (1991), that the "validity and reliability of the instrument should be evaluated in a group of children similar to the target population," the study was conducted on year 7 (11-12 year olds) and year 9 pupils (12-13 year olds) from a local high school. Due to the nature of the study and the fact that a good deal of co-operation would be required from both subjects and parents alike, the subjects recruited for the study were volunteers. An initial visit was made to the school and the procedure of the study was briefly explained to a class of year 7 and a class of year 9 pupils. The exact purpose and details of the study however, were withheld from the pupils. Rather, they were informed that the study was about how young peoples' heart rates responded during a typical day either at school or on a weekend and that it would involve them wearing a heart rate monitor for a day and being interviewed the following day. They were not informed that they were to be observed, nor were they given any details as to what the interview would be about. Following this meeting, pupils who expressed an interest in the study were given letters to take home requesting for their parents permission and co-operation in the study (see appendix J). The full details of the study were outlined in the letter to parents though they were requested not to disclose the full details to their children as it was explained that this may influence the results. In all, 20 pupils were recruited for the study (10 year 7 pupils and 10 year 9 pupils, with equal numbers of boys and girls in the sample).

Prior to the validation study, further visits were made to the school to familiarise the pupils with the Sport Testers. All pupils who were to be involved in the study were fitted with and wore the Sport Tester for a morning or afternoon session at school approximately one week prior to being monitored. It was hoped that a session of this nature would not only familiarise the pupils with the device, such that they knew how it was fitted and how it worked, but that it would reduce the likelihood of any reactive behaviour resulting from wearing the device during the actual study. It was also hoped that the pupils would feel more at ease during the study if they got to know the researcher beforehand and became accustomed to her presence.

Method

The procedure took two days per subject to complete. On day one, the pupils' heart rates were monitored and they were discretely observed, and on day two the pupils completed the interview questionnaire. For the validation of the school day forms the entire procedure was conducted at school, while for the weekend forms pupils who had their heart rates monitored and were observed on a Saturday completed the interview questionnaire at home on the Sunday and those who had their heart rates monitored and were observed on a Sunday completed the questionnaire at school on the Monday. Half of the pupils had their heart rates monitored and were observed during a school day and half at a weekend on a Saturday or a Sunday. In this way both interview forms, i.e., the school day and the weekend forms were validated.

To monitor heart rate during the school day, pupils were each fitted with the Sport Tester as soon as they arrived at school in the morning (at approximately 8.30 a.m.) and were instructed to wear the device until they went to bed or until 9.00 p.m. At this time parents helped their children to stop the watch recording and remove the transmitter. Clear instructions of how to do this were sent home to parents with the pupils (see Appendix K). The pupils returned the Sport Tester to the researcher at school the following day, at which time they also completed the interview questionnaire. Throughout the time the pupils were at school the researcher was always at hand to ensure that the device was working correctly and to adjust it if necessary. In this way it was possible to discretely observe the pupils at the same time. For the weekend validation, the researcher visited the children in their home environment first thing in the morning to fit the Sport Tester and they then wore the monitor all day until 9.00 p.m. or until they went to bed. The researcher was again always at hand in the event of any problems and discretely observed the children while their heart rates were being monitored.

The observations were carried out from the time of fitting the pupils with the Sport Testers to the time the pupils went home from school (in the case of the school day procedure), or until the Sport Tester was removed (in the case of the weekend procedure). The mode, duration and intensity of the activities the pupils engaged in were recorded on pre-prepared observation record sheets (see Appendix L). *To coincide with the interview questionnaire however, only* those activities which were sustained for at least 5 minutes during the period of the observation were recorded. The researcher managed to discretely carry out the observations by informing pupils that she was only present to attend to the Sport Tester if necessary. The researcher thus remained in the background as much as possible throughout the day. As problems were often encountered with the device, it seemed very feasible for the researcher to be present and the pupils seemed unaware that they were being observed.

5.4 Treatment of the Data

The extent to which the interview questionnaire (the pupil's recall of activity of the previous day) corresponded with the heart rate data and observational measure of the same day (i.e., the previous day) needed to be established.

<u>Interview Questionnaire and Heart Rate</u>

The amount of time (in minutes) pupils reported to spend in moderate, hard and very hard activity was calculated for the interview questionnaire and was correlated with the amount of time (in minutes) pupils spent with the heart rate above 139 beats per minute. In addition, the time spent in activity was correlated with the time spent with the heart rate above 159 beats per minute. This method of analysis was similar to the method adopted by Biddle et al., (1991) (see chapter 2, 2.11).

Interview Questionnaire and Observation

Energy expenditure calculations were made for the interview questionnaire following the scoring procedure outlined in chapter four (see 4.1). For the observational method, the time spent in light, moderate, hard and very hard activity types was derived from the completed observational record sheets and used to calculate energy expenditure in the same way. Following the procedure adopted by Wallace et al., (1985), a t test was employed to determine whether there were any differences between the two sets of energy expenditure values (activity scores). A correlation was also conducted to determine the extent of the relationship between the two sets of scores. Furthermore, and again in keeping with the comparisons made by Wallace et al., (1985), the activities reported by the pupils were compared with the activities observed in terms of the total number, mode and intensity. Percent accuracy for mode of activity was determined by dividing the number of activities accurately recalled by the pupils by the total number of activities recorded by the researcher, and the percent accuracy for intensity was calculated by dividing the number of activities matched by mode and matched by intensity by the total number of activities matched by mode.

(Note- Comparisons of the information derived from the measures were made for the overlapping time periods only. In the case of comparing the information from the interview questionnaire with the heart rate data, the comparisons were made from approximately 8.30 a.m. (when pupils were fitted with the Sport Tester), to the time at which the device was removed. Similarly, in comparing the information from the questionnaire with the information from the observational record, comparisons were made from approximately 8.30 a.m. until 3.30 p.m. (for the school day measure) and until the time the Sport Tester was removed (for the weekend measure). It was felt however, that in all of these cases the time periods allowed for sufficient comparisons of physical activity information to be made.

5.5 Results

Note- Raw data for the evaluation studies are presented in Appendix M.

Interview Questionnaire and Heart Rate

A significant relationship ($r=0.61$) ($p < 0.01$) was obtained between the time pupils reported to spend in moderate, hard and very hard activity in the interview questionnaire and the time they spent with the heart rate above 139 beats per minute. The time pupils reported to spend in activity was not significantly correlated with the time spent with the heart rate above 159 beats per minute however ($r=0.39$).

Interview Questionnaire and Observation

No significant difference was found between the daily energy expenditure values (activity scores) for the interview questionnaires and the observational records ($t=0.72$). Furthermore, the activity scores obtained from the questionnaire were significantly correlated with the scores obtained from the observational records ($r=0.79$) ($p < 0.01$). The pupils reported a total of 32 activities between them whereas the researcher reported a total of 37, and the pupils were able to match 86.49% of the activities by mode and 88.89% by intensity.

5.6 Discussion

Interview Questionnaire and Heart Rate

The results revealed that there was a relationship between the time spent in activity reported by pupils in the interview questionnaire and the time pupils spent with the heart rate above 139 beats per minute. The relationship between the time spent in activity and the time spent with the heart rate above 159 beats per minute was not statistically significant however. The correlation obtained between the questionnaire and the heart rate data for >139 beats per minute in this study is higher than the correlations obtained in other similar studies (for example the studies conducted by Sallis et al., 1988; Biddle et al., 1991 and Sallis, Buono, Roby, Micale & Nelson, 1993). In the study conducted by Sallis et al., (1988) heart rate was significantly (but poorly) correlated with a simple one item self activity rating ($r=-0.15$) and was not significantly correlated with the energy expenditure derived from the 7-Day Recall ($r=-0.02$ for boys and

-0.12 for girls). Biddle et al., (1991) reported rather more encouraging findings but the correlations were still lower than the correlation which has been achieved in this study. Biddle et al., (1991) reported correlations between the time spent with the heart rate above 159 beats per minute and self administered recall estimates of the time spent in moderate and vigorous activities of 0.30 and 0.34 respectively. No significant correlations were found between the time spent with heart rates above 139 beats per minute and any of the recall measures however. The recall measures compared in their study included the 7-Day Recall Interview, the 7-Day self administered questionnaire and the Godin & Shephard's (1985) Leisure-Time Exercise Questionnaire. More recently, Sallis, Buono, Roby, Micale & Nelson (1993) found an overall correlation of 0.53 between heart rate and recalls of very hard activities from the 7-Day Recall. Sallis and colleagues claimed that this correlation supported the validity of the reports and concluded that the 7-Day Recall was of adequate validity to use in research on physical activity in children.

Although the correlation obtained for this study (r=0.61) was higher than has been reported by some previous researchers, the study did however have a number of limitations. The problem of conducting validity studies generally was highlighted earlier (see chapter 2, 2.9 and 5.2). Lamb & Brodie (1990) acknowledge how throughout history validity has been one of the fundamental aspects of physical activity self-reports but how it has always been difficult to fully establish. While heart rate has been recommended as a valid and practical measure of children's physical activity (Freedson, 1989; Freedson, 1991), it does not represent a gold standard method. Physical activity is not directly measured by heart rate monitoring and heart rate is known to be affected by other factors including emotional state, the climatic condition and the specific muscle group that perform an activity (Anderson et al., 1981; Armstrong & Bray, 1991). Whether the heart rate data had more error or the recalls from the interview questionnaire had more error in this study is not therefore really known.

Furthermore, in the study, despite a correlation of r=0.61 indicating a relationship between the interview questionnaire and the heart rate measures, some marked disparities were nonetheless found between the raw interview data and the heart rate data. More minutes of activity were generally reported by the pupils during the interview questionnaire than were reflected in their heart rate response. Comparisons of the raw data revealed definite increases in heart rate at the approximate time that pupils reported to have engaged in some form of moderate activity, but not always to the extent that was anticipated. On a number of occasions even though pupils had reported to have engaged in moderate activity and their heart rate increased beyond a resting level, it did not always reach > 139 beats per minute, or of it did, it was not always sustained above this threshold for the entire duration of the activity. Thus, a 10 minute period of moderate activity reported by the pupils in the interview questionnaire may have resulted in a corresponding 5 minutes with the heart rate above 139 beats per minute. For the other 5 minutes the heart rate may have been at or just below 139 beats per minute and consequently was not recorded.

The findings described above are partly in keeping with the findings of the study conducted by Seliger et al., (1974) who found different intensities of activity (as reported in personal activity records) to be reflected in changes in heart rate response. When the actual heart rate values obtained in their study were considered however, it was discovered that moderate intensity activity and medium intensity activity elicited mean heart rates of only 112 and 118 beats per minute respectively. The findings of both the study by Seliger et al., (1974) and this study may be explained by the observation made by Durnin (1990) who noted how there are "problems about relating heart rate to the intensity of activity, especially at the level of or below moderately strenuously activity." Biddle et al., (1991) similarly acknowledge how the heart rate response to low levels of activity is more variable and difficult to evaluate. Given that the pupils in this study reported to engage in light and moderate activity, but in very little hard or very hard activity (only one of the 20 pupils reported to have engaged in any hard/very hard activity), some degree of inaccuracy in the results could have been expected using this method of validation. This would also explain the non significant correlation obtained between the questionnaire and the time spent with the heart rate > 159 beats per minute. Clearly, the pupils in this study performed insufficient hard and very hard activity for a relationship to be found between general activity and activity eliciting heart rates of >159 beats per minute. Indeed, Sallis, Buono, Roby, Micale & Nelson (1993) acknowledged this as a problem in their study of the 7-Day Recall. They claimed that their study was hampered by the low rates of participation in vigorous activities and suggested that methods other than heart rate monitoring need to be used to validate activities of lower intensity.

Another possible limitation in the findings of the study relates to the treatment and analysis of the raw interview and heart rate data. Because the pupils' activity levels were so low and intermittent in the study, the only feasible means of comparing the questionnaire and heart rate data was by comparing minutes spent in activity (moderate, hard and very hard) with the minutes spent with the heart rate above a specific threshold (i.e., above 139 beats per minute). In the study conducted by Sallis, Buono, Roby, Micale & Nelson (1993) activity intervals of heart rate elevations of above 140 and 160 beats per minute were considered, with intervals consisting of at least 10 minutes of relatively continuous heart rate elevations, while in part of the study conducted by Biddle et al., (1991), 10 minute periods with the heart rate sustained above 139 beats per minute and 159 beats per minute were considered. In contrast, the method of comparison adopted in this study assumed quite simply that children who spent more time in moderate, hard and very hard activity were more active than children who spent less time in moderate, hard and very hard activity and children who spent longer periods of time in higher heart rate ranges were more active than children whose heart rates were in the lower ranges.

Comparing the measures in this way provided a correlation between the most active pupils (according to the interview data) with the most active pupils (according to the heart rate data). It did not however, provide a direct comparison of the overlapping time periods of activity. It may have been the case, for example, that those pupils who reported to spend more time in moderate, hard and very hard activity in the recall, also spent more time with their heart rates above 139 beats per minute, thus resulting in the significant correlation, but the moderate, hard and very hard activity reported by the pupils may not have been the same activity which elicited the elevated heart rates. However, an analysis of the times at which pupils' heart rates were elevated during the study and the approximate times at which they reported and were observed to have engaged in activity revealed the time periods to correspond quite closely. In this study therefore, the results were probably little affected by treating the data in this way. It should be realised though, that such a method could influence the results of other and future studies.

A final limitation in the study arose from a slight technical problem which was encountered with the Sport Tester. Difficulty was experienced in fitting the pupils with the device such that the transmitter remained in position and registered their heart rates for the duration of the study. A number of measures were taken to secure the device. The transmitter was fitted to the chest with electrodes and tape was used to hold the electrodes and the transmitter in place. In addition, and as added precaution, adjustable elastic (velcro fastening) belts were made for the pupils to wear around the chest. Despite such measures being taken however, the devices still shifted on occasions and consequently heart rates were not registered for the full day for some pupils. The fact that the watches were not registering and recording the heart rate sometimes went unnoticed for quite some time and some of the heart rate data was therefore flawed by a series of zero readings. A close analysis of the heart rate data and the observational records for the corresponding time periods revealed that the zeros sometimes occurred when physical activity was being undertaken. This may further help to explain to some extent the issue which was raised earlier as to why more minutes in activity were reported by the pupils than were detected in their heart rate response.

Despite some limitations and problems encountered with the method, the results of the heart rate validation are nonetheless encouraging. The correlation obtained between the questionnaire and the heart rate measure is higher than has been obtained in previous studies ($r=0.61$). Of course, the findings here have only been compared with the studies which have adopted the same method of validation as it is very difficult to make comparisons between studies which have adopted different methods. Based on the findings however, it seems reasonable to declare the self-report measure to be a valid measure of physical activity for children.

Interview Questionnaire and Observation

The results for the observational validation method appear to be even more encouraging. The t test revealed no difference between the daily energy expenditure values derived from the questionnaire and the values obtained for the observational record and the correlation indicated a strong relationship between the two measures (r=0.79). Furthermore, a high percentage of the activities were matched by mode and intensity (86.49% and 88.89% respectively). Given that observation has been suggested to be one possible gold standard method of validating self-report measures (Baranowski, 1988), these results may be considered all the more encouraging.

As with the heart rate validation, the findings can be compared to the findings of other studies which have adopted the same validation method. Wallace et al., (1985) similarly found no significant differences between observed and recalled energy expenditure for the 7-Day Recall but were found to match only 46% of the activities recalled by mode and 75% by intensity. On the basis of their findings Wallace et al., (1985) concluded that " the 7-Day recall appears to measure the child's ability to recall his general physical activity during the previous week accurately," and furthermore claimed that the tool quantified average daily energy expenditure very well. The percentage agreements for mode and intensity in this study (86.49% and 88.89%) are higher than those obtained by Wallace and colleagues and are also higher than those reported by Baranowski et al., (1984), who reported that boys and girls could only remember 55 to 65% of their activities when recalled on a daily basis. Baranowski et al., (1984) reported a percentage agreement of 73.4% between observation and different types of self-report forms. The study by Simons-Morton et al., (1990) reported very similar findings to those obtained in this study, revealing a percentage agreement between reported and observed number of moderate to vigorous physical activities of 86.3%. The self-report measure used in their study was similar to one of the forms used by Baranowski et al., (1984).

It should be realised though, that while these results are very encouraging and while they appear to compare very favourably with other studies, they too may be limited in some respect.

The high percentage agreement which was obtained for intensity for example (88.89%), is slightly flawed by the method which was employed to calculate the result. In making the calculations, if activities failed to be matched by mode they were not included in the intensity calculations. Furthermore, the protocol for the interview questionnaire demands that the interviewer makes the final decision as to how to categorise the intensity of activities, i.e., whether to classify them as light, moderate, hard or very hard and not the pupils. While the pupils are required to describe the intensity of their activities during the interview, the final decision as to how they are recorded is the interviewers. The researcher who carried out the observations in this study also conducted the interviews and may therefore have sub consciously made independent decisions about the intensity of activities based on her prior knowledge and experience of them.

Another limitation may stem from the low activity levels of the pupils involved in the study. The pupils were not found to be particularly active and therefore when it came to completing the interview questionnaire, they did not have very much activity to recall. This issue of course also relates to the heart rate validation method, but the extent of the pupil's inactivity became particularly apparent during the observations. Had the sample been very active and had they engaged in a number and variety of activities throughout the day, the pupil's recall of activities may not have been so accurate. Because however, activity seemed to be quite a rare event in the day for many pupils, they may have been better able to recall it. This may explain to some extent why the percentage agreement results obtained for mode and intensity by Wallace et al., (1985) for the 7-Day Recall are not as high as were obtained for this study. The 7-Day Recall may have presented problems for the children because it required them to recall activities over a week (it was reported in chapter two (see 2.12) how the children were able to recall activity of the previous day reasonably accurately but had difficulty with days further back in time), but in addition the recall of activities may have been hindered further by the children's unusually high activity levels. The boys involved in the study were at a "fitness and trim down camp" for overweight boys and were each assigned a specific programme of activities. Thus, they will have had many more events to recall during the interview than the pupils involved in this study.

The interview questionnaire was, however, validated with the population for which it was designed, i.e., secondary aged school children. Sallis (1991) highlights the importance of evaluating the validity (and reliability) of an instrument in a group of children similar to the target population. It may be that the majority of British children are inactive, and as such, the measure may represent a valid and appropriate tool for measuring the physical activity levels of typical British children. Indeed, the majority of the pupils involved in the pilot study (preliminary study four) were also found to be inactive. Taking this into account therefore, it seems that it was very appropriate to validate the questionnaire with such a group. Nonetheless, it would be interesting to know how valid and reliable the measure is among more active subjects as presumably some active children will be found in administering the questionnaire on a larger sample?

This brings us to a possible final limitation which relates to both the observational and heart rate validation methods. The validation study was very time intensive (taking 2 days per subject to complete), and due to time and organisational constraints was conducted on a relatively small sample (n=20). To draw any firm conclusions with regard to the validity of the interview questionnaire therefore, the study may need to be replicated on more subjects. Having said this however, the study did have larger or approximately the same size sample as a number of the validation studies reviewed in chapter two (see 2.12), such as those conducted by Seliger et al., 1974; Baranowski et al., 1984; Wallace et al., 1985 and Noland et al., 1990 for example. Indeed, the heart rate validation study by Seliger et al., (1974) and the observational validation study by Wallace et al., (1985) was conducted on just 11 subjects.

All things considered, the findings for the observational validation method are nonetheless positive and reinforce the validity of the self-report measure for children. The interview questionnaire certainly compares favourably with other self-report measures which have been validated by similar means.

Summary of the Validation Study

In summary, it seems from this initial evaluation of the interview questionnaire, that the measure is capable of accurately measuring physical activity in children (i.e., in the population for which it has been designed). The questionnaire correlated well with the heart rate measure and very well with the observational measure of physical activity, thus providing support for it's validity. It seems that providing accurate activity information for one day is well within the capabilities of most children of this age.

5.7 The Reliability of the Interview Questionnaire

Method

While reliability has been found difficult to establish in self-report measures, a test-retest procedure is traditionally the optimal method (Lamb & Brodie, 1990) and was therefore the method adopted to examine the reliability of the interview questionnaire in this study. A small sample of pupils (n=12) from the same local high school agreed to participate in the study. Pupils were again volunteers but were drawn from different classes from the pupils who were involved in the validation study.

To assess the reliability of the measure the pupils completed the four questionnaires (the two school day and two weekend forms) twice over a period of 4 weeks. Each pupil was therefore interviewed a total of eight times during the month to obtain two activity scores. The interviews were conducted on the same day at the weekend and the same day in the week on each occasion. All weekend measures were administered on a Monday (for a recall of a Sunday), and all school day measures were administered on a Wednesday (for a recall of a Tuesday).

The interview days were deliberately kept the same throughout the study to try to minimise the extent to which the stability of the subject's physical activity habits may have influenced the results. One of the major problems with test-retests on questionnaires, and particularly on questionnaires of this kind, is that they may be affected by the stability of the subject's physical activity habits (Lamb & Brodie, 1990). Jacobs et al., (1993) note how for questionnaires with a short time frame, re-administration after a month measures a combination of short term stability of physical activity behaviour in addition to questionnaire reliability, and they state that this applies even more strongly for longer gaps between administrations. Many studies have failed to account for such factors in their reliability methods (Lamb & Brodie, 1990). It was felt that in this study, the pupils' habits would be more likely to be more stable on the same days of the week, and thus by conducting the interviews on the same school days and the same weekend days each time, the likelihood of the study assessing the reliability of the interview questionnaire rather than the pupils' activity habits would be increased. It was also hoped that by conducting the interviews within the space of a month, the chances of the pupils changing their activity habits dramatically within such a short space of time would be reduced. Of course, the shortest space of time possible in which to complete the study was 1 month because pupils were required to complete the questionnaires on the same days of the week four times.

Results

Two average energy expenditure values (test and retest activity scores) were calculated for each pupil following the usual scoring procedure (see chapter 4, 4.2). The first test activity score (derived from information collected in the first 2 weeks) was correlated with the retest activity score (derived from information collected in the second two weeks). A significant correlation was obtained between the two scores ($r=0.62$, $p < 0.05$).

Discussion

The reliability study revealed a significant correlation between the test and retest activity scores ($r=0.62$). While the reliability estimate obtained in this study does not meet the acceptable standard ($r=0.70$) proposed by Safrit (1990), this finding is nonetheless fair considering the problems associated with reliability studies, and more specifically the problems where this type of self-report measure (which deals with specific activity over a short time frame) is concerned. It was highlighted earlier (see 5.2) how problems with reliability (and validity) arise because the most appropriate way to asses reliability (and validity) is not really known (Baecke et al., 1982; LaPorte et al., 1985). Lamb & Brodie (1990) also recognise the problems of establishing reliability. They recommend a test-retest procedure as the optimal method for reliability studies but they also recognise that one of the major problems with this method is that it may be affected by the stability of the subjects' physical activity habits. While efforts were made in designing the study to try to minimise the extent to which the stability of the subject's physical activity may have influenced the results, it is still likely that the study was influenced by both the pupil's short term stability of physical activity behaviour and the reliability of the questionnaire. Taking this limitation into account therefore, the reliability result obtained in this study may be considered quite reasonable. The result may furthermore seem reasonable considering the comments made by Sallis, Buono, Roby, Micale & Nelson (1993) in their discussion of the test-retest reliability coefficients obtained in their study. They suggested that it may not be appropriate to expect younger children to meet adult standards for recall data. Thus, a lower correlation of 0.62 may be quite acceptable in a younger population.

Previous studies have reported higher reliability coefficients for children's self-reports than were found in this study (*for example the studies conducted by Bouchard et al., 1983; Linder et al.*, 1983 and Godin & Shephard, 1984) but it may be that these findings are more a reflection of the nature of the questionnaires used in the studies and their suitability to a test-retest procedure. It was reported earlier (chapter 2, 2.9) how reliability tended to be higher for questionnaires covering usual patterns of physical activity such as the Paffenbarger Physical Activity Questionnaire and the Minnesota Leisure-Time Physical Activity Questionnaire, as opposed to those which identified specific events in specific time frames.

Indeed, on close scrutiny of the various results from the reliability studies, it can be seen how reliability varies depending on the type of measure being evaluated. The higher reliabilities have generally been obtained for questionnaires which gather usual activity information rather than those which ask about activity on specific days. For example, high test-retest reliabilities were obtained for the Godin & Shephard Leisure-Time Exercise Questionnaire (Godin & Shephard, 1984) (r=0.84) and for the questionnaire used in the study by Linder et al., (1983) (r=0.70) which asked children to recall usual activity patterns. In the study conducted by Sallis, Buono, Micale, Roby & Nelson (1993), the 7-Day Recall, the Godin & Shephard Questionnaire and a simple activity rating were evaluated and higher reliabilities were again reported for the questionnaires which asked for general or usual activity information (r=0.81 for the Godin & Shephard Questionnaire and r=0.93 for the simple activity rating). The 7-Day Recall however, produced a lower correlation (r=0.77). Studies which have produced lower reliability coefficients than the one obtained in this study include those conducted by Telama et al., (1985); Shephard et al., (1980) and Sallis et al., (1993) and interestingly the study which produced the lowest correlations (ranging from just -0.03 to 0.27) used a daily diary record (Shephard et al., 1980).

Perhaps of particular interest and relevance to the results of this study though, are the results obtained by Sallis et al., (1993) who provided reliability information on four self-report measures including information on a 1-day recall, the "Yesterday Activity Checklist." While the subjects in the study were younger than the pupils involved in this study, the ages and the 1-day recall measure in particular were comparable. The reliabilities reported by Sallis et al., (1993) ranged from 0.51 to 0.74 and the reliability of the 1-day recall was reported to be 0.60. On the basis of the results Sallis et al., (1993) declared the reliabilities to be acceptable for 1-day and 1 week recalls.

In conclusion, given the nature of the interview questionnaire used in this study, the results appear to suggest that it is a fairly reliable measure of physical activity. The correlation obtained is higher than has been obtained by some researchers for some other measures (Shephard et al., 1980, Telama et al., 1985) and is higher than has been found for an alternative and comparable 1-day recall measure of physical activity (Sallis et al., 1993).

5.8 Reliability of the Interviewers

The interview questionnaire was designed with detailed protocols and instructions for both the school day and weekend forms such that it may be administered by different interviewers. As explained earlier (see chapter 4, 4.4) a training procedure was prepared for interviewers and four different interviewers were trained to administer the questionnaire through a structured training programme. It was necessary though to ensure that the interviewers scoring skills were reliable and had reached an acceptable level following the training procedure. Two studies were therefore conducted which aimed to evaluate the reliability of the interviewers' scoring skills. The studies involved a measure of inter interviewer reliability and a measure of intra-interviewer reliability, or test-retest reliability and were similar to those conducted by Gross et al., (1990) in their assessment of the reliability of interviewers using the 7-Day Recall.

5.9 The Measure of Inter Interviewer Reliability

Method

A measure of inter interviewer reliability was made to assess how closely the interviewers agreed in their scoring of the questionnaire. In order to do this, the four trained interviewers independently scored the same 12 tape recorded interviews. The interviews were derived from the final pilot stages of the interview questionnaire. The interviewers listened to a random sample of six school day and six weekend interviews and completed the relevant questionnaire forms for each interview. To avoid fatigue, the interviewers were given a 10 minute break between completing the weekend and school day forms. Following the interviews, each interviewer was required to complete the 12 summary sheets independently for each questionnaire before returning them to the researcher.

Results

Energy expenditure values (activity scores) were calculated from the raw data from the summary sheets following the scoring procedure outlined in chapter four (see 4.1) and Pearson correlations were conducted to determine the relationship between each of the interviewers' activity scores. The between interviewer correlations ranged from 0.88 to 0.99 revealing a high inter interviewer reliability of scoring skills (see table 5.1).

Table 5.1 Correlation Matrix Illustrating the Inter Interviewer Reliability

INTERVIEWER	1	2	3	4
1	1			
2	.997	1		
3	.888	.899	1	
4	.965	.962	.882	1

5.10 The measure of Intra-Interviewer Reliability, or Test-Retest Reliability.

Method

The degree of reproducibility of each interviewers' scoring skills was assessed by a measure of intra-interviewer reliability, or test-retest reliability. The interviewers scored the same 12 recorded interviews (six school day and six weekend forms) again 3 weeks later. Exactly the same procedure was followed for the retest as for the first test of inter interviewer reliability (see 5.9). It was felt that a period of 3 weeks between interviews was sufficient time for the interviewers to have forgotten the details of the first test and would thus allow them to score the retest fairly and independently of the first occasion.

A general discussion session followed the retest which briefly addressed the administration procedure and the interview technique which had been employed by the interviewer who had conducted the taped interviews. The aim of the discussion was to try to determine the extent to which the interviewers agreed with the interview procedures on the tape, the questions which had been asked and the responses to the pupils' answers. The feedback given during the discussion was found to be very positive with all interviewers reporting that they would have adopted the same administration procedures and asked similar probing questions on the same occasions.

Results

Correlations across the repeated scorings of the interviews were conducted to determine the test-retest reliability of the interviewers' scoring skills. An overall reliability of r=0.98 was calculated from a correlation of the 48 pairs of combined scores (i.e., four interviewers x 12 pairs of interviews). Correlations conducted for each interviewer separately also revealed high correlations for all interviewers. Correlations of 0.94, 0.96, 0.98 and 1.0 were obtained. These results indicate a good reproducibility of scoring skills over time.

5.11 Discussion of Interviewer Reliability Studies

The findings from the two studies revealed that the interviewers demonstrated high levels of agreement with the other interviewers and high reproducibility of scoring skills. All interviewers performed very well in both studies. The lowest correlation obtained was between two interviewers in the inter interviewer reliability study (r=0.88) and the highest correlation obtained was in the intra-interviewer reliability study, in which one interviewer showed perfect test-retest reliability (r=1.0). The range of correlations obtained were 0.88 to 0.99 for the inter interviewer reliability study and 0.94 to 1.0 for the individual correlations for the intra-interviewer reliability or test-retest study.

These findings reflect the findings of the studies conducted by Gross et al., (1990) and Sallis et al., (1988) for the 7-Day Recall which similarly found favourable interviewer reliability results. Gross et al., (1990) found close agreement between interviewers and across interviewers in studies similar to the ones conducted here. They concluded that the demonstrated success of the interviewers provided reason for the confidence in the use of the 7-Day Recall when similar training procedures are used. Such a conclusion is favourable as far as this study is concerned because the training procedure adopted in this study was modelled closely with the training procedure outlined by Gross et al., (1990). Sallis et al., (1988) also reported the interview procedure for the 7-Day Recall to be acceptable following re-interviews of subjects the same day by different interviewers. In their study, Sallis et al., (1988) found a combined reliability of energy expenditure of 0.78.

The method of re-interviewing by different interviewers adopted by Sallis et al., (1988) was also employed in a third study conducted by Gross et al., (1990) and could similarly have been adopted in this study. However, while this method has the advantage of assessing the reliability of the scoring skills and the entire interview procedure (i.e., the administration and questioning procedure as well), the method does have one major disadvantage. Given that the subjects must be interviewed twice, the first interview may affect the responses given by the subjects on the second interview. It was felt that in this study, even if the pupils were informed to answer independently for both interviews, their first answers may still have interfered with and affected the responses given in the second interview. The extent to which this procedure is a measure of the performance and recall abilities of the pupils rather than a measure of the performance of the interviewers must therefore be considered.

The discussion which took place at the end of the retest in the intra-interviewer reliability study provided some indication as to the degree to which interviewers agreed in the interview procedure. The feedback from the interviewers suggested that they would all have followed the same interview procedure and would have asked similar questions and probed the same answers. The interviewers should, if this was the case, have been able to elicit the same or very similar information from the pupils as the interviewer who conducted the taped interviews. It was thus felt that the two studies which were selected for the assessment of the reliability of the interviewers, and the discussion of the interview procedure which followed the second study would give a good indication as to the overall reliability of the interviewers.

The findings obtained from these studies reveal quite clearly that following the training procedure, the interviewers had acquired the scoring skills necessary for the reliable administration of the interview questionnaire. The reliability of the interviewer's performance was high in both studies providing further confidence and support for the self-report measure.

5.12 Conclusions and Chapter Summary

A major aim of this research (outlined in chapter 1, 1.3) was to design a self-report measure designed specifically for use with children and which addressed as many of the problems associated with current measures as possible. In addressing such problems, the intention was to improve upon existing measures. The series of studies described in this chapter have aimed to evaluate the interview questionnaire and establish whether and to what extent it is an improvement on existing measures. The studies have included a validation study (which involved a comparison of the questionnaire with heart rate and an observational measure of physical activity), a test-retest reliability study and a measure of the inter interviewer reliability and intra-interviewer reliability of the interviewers trained in the administration of the questionnaire.

In conclusion, the findings from these studies are very encouraging. The validation study revealed a relationship between the interview questionnaire and heart rate monitoring (r=0.61) and an even stronger relationship between the questionnaire and the observational method (r=0.79). In terms of the validity of the measure therefore, it seems reasonable to conclude that the measure is capable of accurately measuring physical activity in the population for which it has been designed. The reliability of the instrument was also found to be acceptable. Though the reliability coefficient was not as high as has been reported in some other studies, given the problems encountered with test-retest reliability studies where measures of this kind are concerned, the instrument can be considered to be of adequate reliability. Considering both validity and reliability, therefore, it seems that the self-report measure is capable of attaining reliable and valid activity reports from children of 11 years and upwards.

The final issues to be addressed in the evaluation of the self-report measure related to the reliability of the interviewers. The results obtained here are just as important as the results obtained for the reliability and validity of the instrument itself, as for any measure to be useful and practical it must be able to be administered by different interviewers. The interviewer reliability studies revealed high levels of agreement both between interviewers and with themselves over time. All correlations were high indicating that all interviewers had acquired the necessary scoring skills for the reliable administration of the interview questionnaire. Thus, it seems that by following a brief training procedure, interviewers can be trained to reliably administer the interview questionnaire.

The results of the evaluation studies are encouraging throughout. These studies, in conjunction with the systematic and rigorous design of the interview questionnaire (outlined in chapters three and four) provide a good deal of confidence in and justification for the use of the self-report measure for monitoring physical activity in children. The design incorporated a number of the recommendations made in the literature for the improvement of self-report, the preliminary pilot studies found the administration of the measure to be feasible, and the evaluation studies outlined in this chapter have now shown that the measure is capable of accurately measuring physical activity in children. Furthermore, the interview questionnaire was designed specifically for British children, and to the researcher's knowledge it is the first of its kind to be developed and evaluated for this population in this way. In this respect, the self-report measure developed in part one of this thesis must be an improvement upon existing measures. Its subsequent use to gather activity information on a sample of British children in part two of this thesis can thus be well justified.

PART TWO

CHAPTER 6

THE ASSESSMENT OF CHILDREN'S PHYSICAL ACTIVITY LEVELS

6.1 Introduction

Having designed and evaluated a self-report measure of physical activity for children in part one, and having concluded that its use could be justified to gather activity information from a sample of British children, this part of the thesis now deals with the use of the measure in the assessment of the activity levels of a large sample of secondary aged school children. The chapter begins with a detailed review of children's activity levels and the formulation of hypotheses based on the findings in the review. It then goes onto describe the details of the study including the initial selection of the sample and the administration of the questionnaire.

6.2 Review of Children's Physical Activity Levels

The review of literature in chapter two addressed the methodological issues of monitoring physical activity which were subsequently taken into consideration in the design and evaluation of the self-report measure of physical activity in chapters three, four and five. This review now moves away from these methodological considerations to examine the evidence which currently exists on the activity levels of children. Following the concerns of a number of researchers that the physical activity levels of children have declined during past decades (Gortmaker et al., 1987; Ross et al., 1987), there is a need to determine just how active or inactive young people of today are. This chapter, therefore, provides a comprehensive review of a number of both international and British studies which have measured and reported the physical activity levels of children. The review aims to give an overview of the information which is available, the different types of methods which have been employed to gather such information and the dimensions of physical activity which have been assessed in the different studies. Because the assessment of physical activity levels in British children is the focus and main concern of this research from now on, the British studies which have been conducted in the area of children's activity are dealt with separately.

6.3 International Studies of Children's Physical Activity Levels

As early as 1967, Huenemann, Shapiro, Hampton & Mitchell studied the activity levels of a sample of American children. A self-report method was used to collect activity information from 16-17 year old teenagers. The teenagers completed activity diaries over four separate, 7 day periods. Each individual discussed their diary for the previous day with a trained interviewer. The time spent at levels of activity of different intensities was then totalled for the week. The results from this study showed teenagers to be relatively inactive. For the mean of the 4 weekly periods, the girls spent more than 95% and the boys over 90% of their time in sleep, very light or light activity. These findings are particularly interesting as they suggest that teenagers were already inactive 20 years ago.

In another early study, (Seliger, Trefny, Bartunkova & Pauer, 1974) heart rate counters were used to identify the physical activity patterns of 11-12 year old boys. The subjects were also interviewed personally. Results showed that only 3% of the boy's time was spent in activities of a moderate or medium intensity and that at no time did the boys engage in "heavy intensity" activity. Seliger et al., concluded that "all of the subjects in this sample exhibited a sedentary lifestyle."

In 1978, Hovell, Bursick, Sharkey & Mclure conducted an observational study to establish elementary student's habitual level of activity during recess. In their study about 300 third to sixth grade students (8-11 year olds) were observed. Every 5 seconds their activity levels were rated as no activity, moderate activity, or vigorous activity. In addition the observers recorded the general type of activity and any unusual events which may effect the activity record, such as a child fighting, for example. Results revealed that students engaged in little exercise during recess periods, engaging in physical activity for only about 60% of their recess time. Observers reported that most children spent much of their time waiting their turn to run races, waiting to bat in kickball, or casually moving about talking with friends. Only rarely did they report a child engaged in sustained vigorous activity.

In addition, an attempt was made to measure some of the children's extra-recess activity and activity providing some aerobic exercise. A small sample of the children were therefore rated while walking to school. However, the students walking to school were found to be no more active than the children during recess. Such results suggest that even during activities outside recess, little aerobic activity was performed voluntarily.

An extensive study of physical activity was carried out by Shephard et al., (1980) in Quebec. Children were asked to complete a 24 hour activity diary twice during the year, (March and September), for a typical Wednesday and a typical Saturday. Children were also asked to complete a brief daily activity questionnaire for a week. The results showed that the children spent an average of 2.15 hours a day in light to moderate activity and 0.44 hours a day in vigorous activity outside of school. It was furthermore reported that Quebec children spent more time in very light to light activity and less time in light to moderate and vigorous activity than their European counterparts. Both the activity history and the diary showed a difference of 0.3 hours per day between the boys and girls.

A group of researchers in the Netherlands, Saris, Binkhorst, Cramwinckel, Waesberghe & Veen-Hezemans (1980) used heart rate monitors to collect comprehensive activity information from 171 kindergarten children (4-6 year olds) and 54 elementary school children (8-12 year olds). Twenty four hour heart rate data were recorded during a school day. Saris et al., chose a heart rate of 176 bpm beats per minute (bpm) to indicate appropriate activity intensity. Results revealed activity levels to be low. The most active 4-6 year olds experienced heart rates greater than 176 bpm for only 15 minutes per day, with the corresponding figure for 8-12 year olds being 6 minutes per day. The least active children experienced heart rates greater than 176 bpm for only 4 minutes per day in both age groups.

A major national survey conducted in Canada, The Canada Fitness Survey (1981) (Hebbelinck & Shephard, 1986), provided a detailed portrait of the physical recreation habits, physical fitness and health status of the Canadian population. More than 23,000 persons age 7 and older participated in the survey. In terms of the physical activity data gathered from the younger population involved in the study, children were classified as active, moderately active or sedentary according to the amount of activity they did. They were classified as active if they did an average of 3 or more hours per week of physical activity for 9 months of the year or more. The results showed approximately 75% of young Canadian children to be sufficiently active. However, the results did not take into account the intensity of the activity the children did. This drawback was acknowledged by the researchers, who then re-classified activity using classifications of activity intensity. This made a considerable difference to the overall activity pattern. The revised figures for the 10 to 12 year age group revealed that only 3.5% of children could now be classified as active, while 91% of males and 88% of females were now classified as sedentary.

Gilliam, Freedson, Greenen & Shahraray (1981) and MacConnie, Gilliam, Greenan & Pels (1982) conducted two well known studies which involved monitoring the heart rate of 6-7 year old children in the United States. In the initial study, heart rate data were recorded over a 12 hour period (8 a.m. to 8 p.m.) during a summer day. A heart rate of 160 bpm was chosen to indicate an intensity of activity appropriate for promoting health. Boys were found to have heart rates of more than 160 bpm for 7.8% of the time and girls for 4% of the time. In the subsequent study, 59 children (aged 7), were reported to spend 6.9% of their time with heart rates above 140 bpm. The conclusions drawn were that young children seldom undergo physical activity of an intensity high enough to promote cardiovascular health.

Similar findings were evidenced in a study of the physical activities of 9-10 year old boys living in Tokyo (Miyashita, Atomi & Iwaoka, 1983). In this study heart rates were monitored for 24 hours. It was declared that "the duration of daily exercise of the ordinary boys living in Tokyo is too short to develop cardiopulmonary functions at their utmost."

In 1985, a National Health and Fitness Survey was carried out in Australia (The Australian Health and Fitness Survey, 1985). A questionnaire was administered to determine how much physical activity children had done in the previous week, both in and out of school. The survey revealed low levels of physical activity in children, especially activity of an intensity necessary to promote cardiovascular health. Approximately 30% of all students under the age of 12 were found to have engaged in no school sport in the week preceding testing. This percentage increased to about 40% at 12 years and to 49% for boys and 51.5% for girls at 15 years. Furthermore, more than one in five boys and one in four girls had not done any activity at all outside of school in the previous week. In addition, the survey attempted to establish an "aerobic rating" score for each child. Children were asked, "In most weeks do you get exercise or activity three to four times which makes you "huff and puff" and lasts at least thirty minutes each time?" Fifty percent of the boys and 61% of the girls said they did not.

In the same year the World Health Organisation (WHO) conducted a cross national study which considered habitual physical activity and social influences in 11 European countries including England (Wold & Aarø, 1985). A questionnaire was administered to children aged 11 to 16. Children were asked how many times and how many hours a week they usually exercised to the extent that they got out of breath or sweat. Findings from the study suggested that there were some significant differences in physical activity and sports participation by country, age and sex. Although differences between activity levels by country were found, they were not systematic and it was not possible to place any one country far ahead of the others in terms of physical activity. With respect to age, however, the proportion of children reporting that they were not physically active was larger in the higher age groups, with those children in the highest age group (approximately 15 years) being less involved in sports. Boys were generally reported to be more physically active than girls with respect to both the number of hours and number of times of exercise per week. Boys also participated more frequently in competitive activities.

In an extension of earlier work, Saris (1985) conducted a study which this time collected 24 hour heart rate data, together with activity information gathered from a questionnaire. Longitudinal data was obtained on children from the age of 6 through to 12. Changes were found to occur in the physical activity levels of the boys and girls over the 6 year period. In the case of the girls, the percentage of total energy expenditure which was spent in activities requiring more than 50% of VO_2 max over the 24 hours, dropped from 15.8% to 9.3% over the period of the study. The boys energy expenditure showed a decrease from 18.9% to 10.7%. The mean heart rate for the period dropped from 96.7 bpm to 84.6 bpm in girls and from 98.4 bpm to 87.7 bpm in boys. Physical activity scores obtained from the questionnaires also showed similar trends, with scores declining by about 10% in the boys and 18% in the girls.

In a study conducted in Finland, relatively high levels of physical activity were found amongst 3 and 6 year old and 9 to 18 year old children (Telama et al., 1985). Levels of leisure-time activity were assessed by means of a questionnaire. For the 3 and 6 year old children the questionnaire was designed to be completed by the parents. Children were also asked to categorise their leisure-time physical activity into one of three intensity categories: not out of breath, no sweating; moderately out of breath and sweating; or strongly out of breath and sweating. More than half of the children were found to engage in physical activity at least twice per week, and a third of the girls and more than half of the boys said that they were active for the majority of their leisure-time. The percentage of exercise time spent at the "moderately out of breath and sweating" level was relatively high. The results led the researchers to conclude that "a large proportion of Finnish children and adolescents are physically active."

Verschuur & Kemper (1985) investigated the habitual physical activity and health of 13 and 14 year old Dutch teenagers. Measurements were taken over 4 successive years using three methods: a questionnaire and interview, which aimed to record activities with a minimum energy expenditure equivalent to a running speed of 5 km per hour; a heart rate integrator; and a pedometer, (sensitised to include only those activities with a movement intensity comparable to a running speed of 6 km per hour or more). All methods were applied to the teenagers over 3 months during the winter (January to March). Activity patterns were assessed by means of energy expenditure per kilogram of body weight, the amount of time heart rate was above 150 bpm (in minutes per week), the amount of time spent in "heavy activities" (in minutes per week), and the total activity time spent at all three levels (in minutes per week).

The authors used the former A.C.S.M. (1978) recommendations to define "appropriate activity." (see table 6.3). It was found that a median of 480 minutes per week in boys and 421 minutes in girls were spent engaged in activities of an intensity greater than 5 km per hour. The results showed a marked difference between the activity levels of boys and girls. For girls, "light activities" accounted for 53% of the total time between the ages of 12-13 years and 77% of time between 17-18 years. For boys the corresponding figures were 43% and 64% respectively. Indeed, girls spent very little time engaged in "heavy activities" at any age while boys spent 24% of their time at 12-13 years and 15% at 17-18 years. The results also showed a steady decrease in daily physical activity from 12-18 years. This trend was common to both boys and girls. Verschuur and Kemper concluded from their results that from 12 to 18 years of age, the daily physical activity patterns of the boys were healthier than those of the girls. They felt that until 15 or 16, boys and girls spent enough time doing "appropriate" physical activity to keep a reasonable level of fitness.

A second Japanese study determined the physical activity levels of eleven 9-10 year old boys with reference to aerobic power or lactate threshold (Atomi, Iwaoka, Hatta, Miyashita & Yamamoto, 1986). The subjects' heart rates were monitored for 12 hours on three occasions. It was reported that boys spent on average only 4.7% of their time at heart rates equivalent to 60% of maximal aerobic power.

Engstrom (1986) conducted a major study to investigate the participation in, and socialisation into physical activities of 2,000 young people in Sweden. The subjects were interviewed between 1968 and 1983 and were required to complete mailed questionnaires at the ages of 15, 20, 25 and 30. Physical activity was classified into three progressive categories or levels. Ninety per cent of the population of both sexes throughout the age range reported that they took part in level I activity (light activity comparable to walking). Fewer people reported to take part in the level II (representing jogging or similar activities) and level III (high level exertion) activities. Fifty per cent of males and 40% of females engaged in level II activities and only 18 per cent of males and 3 per cent of females engaged in level III activities. A significant decline in activity was evident with age, with virtually the entire decline occurring by the age of 20.

In 1986, Kannas, Tynjala, Aarø & Wold collected data on the activity levels of children from four countries (Austria, England, Finland and Norway) using self completion questionnaires. The target groups for the study were children of 11.5, 13.5 and 15.5 years of age. The first set of data was collected in 1983/4 and a follow up study was carried out in 1986. The study was concerned only with leisure-time physical activity, thus any exercise children experienced during the school day was excluded. The results were analysed based on the criteria that 20-30 minutes of exercise, three to four times per week, is the minimum level of activity necessary for health. The results showed that overall 61% of the 11 year olds and 50% of the 15 year olds took part in leisure-time physical activity one to six times per week. Furthermore, approximately every fifth child was found to participate in daily physical activity.

The findings from a survey of Italian girls (aged 14-18), were not however, so encouraging (Marella, Colli & Faina, 1986). It was revealed that 60 to 70% of the girls did no physical activity in their leisure-time at all. A further 20 to 30% reported that they occasionally went for a walk or into the town centre for non specified activities, while the remaining 6 to 10% reported to take part either in sport or cycling regularly. In the study, television emerged as the most important use of leisure-time. On the basis of such findings it was concluded that the girls were "tragically sedentary."

The National Children and Youth Fitness Study, (McGinnis, 1987) represents another major national survey which has been carried out on young people, this time in the United States. In this study a self-report method on a large sample of 10-17 year olds was employed which gathered details of all activity the children took part in. Recognising that it is year round participation in appropriate physical activity that is important for an individual to reap its continuing health benefits and to avoid becoming out of condition, seasonal variations were also taken into account. Based on the American College of Sports Medicine's recommendations as to what constitutes "appropriate" exercise, (see table 6.3), the results from the survey showed that at least half of the youth did not perform the weekly requirement of vigorous activity needed to maintain an effectively functioning cardiorespiratory system. Exercise patterns were also found to vary greatly from season to season, with the lowest activity figures being obtained in the winter.

In 1987, Sunnegardh & Bratteby assessed the physical activity levels of a sample of 155 children aged 8 or 13 via interview questionnaires. Activity scores based on type and duration of the most common leisure-time activities pursued were calculated for each child. In addition, physical activity was studied in 116 children by the actometry method over a 24 hour recording period. The results showed that the boys of both ages had significantly higher daily activity scores than the girls of the same age, and the younger children of both sexes had significantly higher scores than the older ones. Details are not given as to how the activity score was actually derived and it is therefore impossible to interpret the score in terms of how active the sample was on the whole.

In a study of primary school children in the United States, Baranowski et al., (1987) recorded the number of "aerobic" events undertaken by children over 2 consecutive days. Data was collected using a self-report questionnaire and in addition, trained observers followed 24 children for up to 12 hours each day. Initially an "aerobic event" was defined as 20 minutes in which rapid trunk movement through space was maintained without stopping. However, in a total of 48 days of observation, no such events were found to occur. As a result, less stringent criteria were devised. These included: 20 or more minutes of continuous trunk movement (slow or fast), through space without stopping; 20 or more minutes of continuous trunk movement through space, with only one stop of a maximum of 2 minutes; 14 or more minutes of continuous trunk movement through space without stopping; or 14 or more minutes of continuous trunk movement through space, with only one stop of a maximum of 2 minutes. Using the strictest of these new criteria, only six aerobic events occurred in 48 full days of observation. It was concluded from these observations that children are active, but only for short spurts rather than for the longer stretches that might be expected to have an aerobic training effect and subsequent health benefits.

Klesges & Klesges (1987) assessed the physical activity levels of 30 pre-school children in their natural environment using an accelerometer and an observational technique. The children were observed in non-structured activity for approximately 9 hours while wearing the accelerometer. The observer recorded the children's activity using the Fargo Activity Timesampling Survey (FATS) observation system. The technique is a two-dimensional rating system in which the behaviour that is engaged in is recorded, followed by the intensity of that behaviour, defined as minimal, moderate, or extreme intensity. The observations were made once during spring or summer, from breakfast until an hour after the children's evening meal. The results reported the percentage mean time spent in various behaviour categories. It was revealed that 66.79 % of time was spent engaged in minimal intensity activity, 32.9% of the time was spent in moderate intensity exercise and only 0.31% was spent engaged in extreme intensity activity.

In 1988, Sallis, Patterson, McKenzie & Nader conducted a study of the physical activity levels of young children (3 to 5 year olds) using the same observational technique (FATS). Thirty three children were observed during 30 minute unstructured free play sessions over 2 consecutive days. The observations showed that the children spent 60% of their free play time in sedentary activities and only 11% in vigorous activities. Sallis et al., felt that their results were particularly pertinent because observations were conducted when the children were free to choose their own activity level. They concluded that their results suggested that either "young children are not 'naturally' active, or that they have been socialised to choose low levels of activity."

A longitudinal follow-up of the 1981 Canada Fitness Survey, known as The Campbell's Survey on Well-Being in Canada, was conducted in 1988 (Stephens & Craig, 1990). Approximately one fifth of the 1981 sample was contacted to participate in the follow-up study and data has been published based on 4,000 individuals. Subjects responded to a list of activities and reported which activities they had engaged in the past 12 months. They were also required to indicate how many times they had participated in each particular activity during this time and the average amount of time spent on each occasion. An estimate of average total leisure-time activity (in kilocalories expended per kilogram of body weight per day over 12 months) was calculated from the energy costs of the activities the subjects reported. On the basis of these calculations individuals were classified as active if they expended 3+ kcals per kg body weight per day, moderately active if they expended between 1.5-2.9 kcals per kg body weight per day, or inactive if they expended between 0-1.4 kcals per kg body weight per day. Using these definitions, 72% of boys and 49% of girls between the ages of 10 to 14 were reported to be active. However, activity levels did decrease with age. Between the ages of 15-19 years 69% of boys and 39% of girls were reported to be active. Fifteen percent of boys were found to be inactive in both age groups, while in girls inactivity increased from 23% between 10-14 years to 30% in the 15-19 year age group.

In the Oslo Youth Study, Tell & Vellar (1988) examined the physical fitness, physical activity levels and cardiovascular disease risk factors in 785 adolescents. Measurements including indirect maximal oxygen uptake, blood pressure, pulse rate, skinfold thickness, serum total cholesterol and high-density lipoprotein cholesterol levels were taken and all subjects were required to complete a physical activity questionnaire. Information with regard to the frequency and intensity of physical activity was obtained by asking "How often do you exercise in your leisure-time (for at least half an hour) so that you get out of breath and sweat?" The response alternatives were daily, two to three times a week, once per week, two to three times per month or not that often. The activity levels recorded were generally low, with 16% of the boys and 22% of the girls reporting to exercise less than two to three times a month.

Fuchs et al., (1988) conducted a longitudinal study (The Berlin-Bremen Study of Health Behaviour in Childhood and Adolescence) which was designed to investigate a number of health behaviours, including physical activity. Patterns of leisure-time physical activity among 932 West German boys and girls were examined over a 2 year period. Participants completed self administered questionnaires at six month intervals. Frequency and duration of activity were determined. Overall findings were that most students were active, with about 95% spending 2 hours or more per week, on a yearly average, in physical activity. Time spent in activity decreased by about 10% during the 2 year period, with the relative decline being in vigorous rather than moderate activity. The median level of total activity time was, on average, about 3 hours per week higher among boys than girls. Boys devoted twice as much time to vigorous activity as girls, although gender differences for the time spent engaged in moderate activities were less obvious.

A study conducted in Belgium measured the habitual physical activity levels of children by means of a standardised questionnaire (Weymans & Reybrouck, 1989). The primary purpose of the study was to investigate the relationship between the habitual level of physical activity and the cardiorespiratory endurance capacity of children. Habitual level of activity was assessed in 257 healthy children (140 boys and 117 girls) from schools in the region of *Leuven*. Ages ranged from 5.7 years to 18.5 years. Children were asked whether they participated in physical education classes at school and whether they took part in sports during the holidays or at weekends. They were also asked about their hobbies, whether they belonged to a sports team or a youth movement, how much television they watched and about their journey to and from school. In contrast to the findings from other studies, Weymans & Reybrouck found activity levels to increase gradually with age. The results revealed that in both boys and girls, the habitual level of physical activity was lowest in the younger children. The children were least active between the ages of 5 and 6, with the next least active group being the 7-8 year olds. However, physical activity in girls increased only until the age of 12.

More recently, Simons-Morton et al., (1990) conducted a study to assess the type and frequency of participation in moderate to vigorous physical activity (MVPA) of third to fourth grade children (8-9 year olds) in four Texas City elementary schools. Eight hundred and seventy pupils completed a self-report questionnaire form which assessed the children's frequency of daily MVPA. The forms, which were constructed based on the work of Baranowski et al., (1984), were administered over 5 consecutive weekdays during school time. The researchers considered children who reported either none or less than one session of moderate to vigorous daily physical activity to be less active than recommended. The results revealed that only 33.1% of boys and 35.2% obtained an adequate number of activity sessions. On the basis of the results, it was concluded that many children may not be getting adequate amounts of physical activity.

6.4 British Studies of Children's Physical Activity Levels

One of the earliest studies to monitor British children's activity levels involved the completion of activity diaries (Durnin, 1967). Activity levels were assessed in 13-15 year olds from 1 week's diary information. All reported activity was categorised as being of moderate, heavy or very heavy intensity. Light activity was deliberately excluded as it was felt that such exercise would not produce any measurable physical benefits. Low levels of activity amongst children, particularly girls were reported. Boys were found to spend 29 minutes per day in heavy physical activity and 12 minutes a day in very heavy activity. The corresponding figures for girls were 10 minutes in heavy activity and 3 minutes in very heavy activity.

In 1971, Bradfield, Chan, Bradfield & Payne conducted a study to measure the energy expenditure and physical activity patterns of 54 English primary school children. Heart rate was recorded using an older model telemetry device (the Socially Accepted Monitoring Instrument or SAMI) over 3 school days during the winter term. The results revealed the level of participation throughout the study to be higher than had been anticipated.

In Scotland an 18 month investigation carried out in 1975 revealed low levels of activity in a group of 15-16 year old teenagers (Hendry, 1978). The sample comprised just over 3,000 pupils from 15 comprehensive schools in central Scotland. Data were collected by questionnaires and inventories, teacher ratings and assessments, and by direct observations and recordings. More than half of the boys and two thirds of the girls were classified as non-participants, that is, they were found to have no voluntary extra-curricular involvement in school sports or physical activities.

Another Scottish study investigated the involvement of 15 to 19 year olds in sport and physical activity in Stirling (McKusker, 1985). Two hundred young people were interviewed over a 3 month period. Results showed that more than 90% of boys and girls took part in "recreational sport," suggesting that activity levels in youngsters were relatively high. No information concerning the frequency, duration and intensity of the activities reported was available, however, and no clear cut definition of the term "recreational sport" was applied or clarified in the study.

A study by The Sports Council for Wales (1986), entitled "Participation in and attitudes towards sport by eleven to sixteen year olds," similarly indicated that there were high levels of participation in sports, especially "sport for fun." Ninety percent of the sample claimed that they were actively involved in recreational activities outside of school. There was a gradual and progressive lessening of interest in activity with increasing age and activity levels decreased in schools from the first (year 7) to fifth (year 11) forms, though the overall recorded participation remained high. However, there was no categorisation in this study of the sorts of activities included under the heading "sport for fun" and no indication was given of the duration, frequency or intensity of the sports the children reported they were doing.

Dickenson (1987), collected activity data on 311 English children aged between 11 and 16 from six large comprehensive schools in the West Midlands. All children were asked to complete a daily questionnaire for a week and 100 of the original sample were also interviewed. Over the study week, between 80 and 85% of the children were found to have done less than 5 minutes vigorous activity on any day. The questionnaire results were verified by the interviews which classified 83.1% of the sample as inactive during the week and 82% as inactive at weekends. Inactivity increased with age, and generally boys did more vigorous exercise than girls.

In a second study conducted by The Sports Council for Wales (1987), insufficient levels of physical activity this time became evident. The sample comprised more than 6,500 children aged 11-16 from over 80 secondary schools. Subjects were asked to complete a questionnaire reporting the amount of time they spent in activities which made them breathless or sweaty. The amount of activity considered to confer health benefits was taken to be 20 minutes of vigorous activity three times a week. Teenage boys were found to be the most active members of the Welsh population, but it was revealed that less than half of them participated in "sufficient" vigorous exercise. Again there was a marked difference between the activity levels of boys and girls, with girls being less active than boys. Only 19% of 12-17 year old girls were classified as very active, or as performing sufficient amounts of "appropriate" activity. For both sexes there was also a significant decrease in activity levels with age.

Williams (1988), examined the physical activity levels of a large sample of English adolescents (outside of school hours). Over 900 young people (aged 14 -15), from six different schools completed a questionnaire. The results showed that just over half of the sample (52%), claimed to take part in some form of physical activity outside school. Of these, 26% claimed to take part more than once a week and 26% claimed to take part once a week or once a fortnight. In accordance with the results of previous studies, it was found that more boys than girls participated in physical activity outside school and boys tended to be more frequent participants than girls. Williams concluded that in terms of outside school activity, the majority of pupils do not exercise frequently enough to contribute to the maintenance or enhancement of health.

The Northern Ireland Fitness Survey (1989) represents one of the largest studies which has been conducted on British youth. The survey measured the fitness, physical activity levels, attitudes and lifestyles of 3,211 post-primary school children from a total of 16 schools from different regions of the country. Physical activity levels were measured by means of a lifestyle questionnaire. To summarise the results, approximately 33% of boys and 34% of girls reported that they had done no exercise outside of school during the preceding 7 days and approximately 8% of boys and 12% of girls had not done any exercise at all during the preceding 7 days. Exercise was defined as any activity that caused a degree of breathlessness. At all ages, boys were more active than girls and there was a marked decline in activity levels after the age of 13-14 years. The rate of decline was similar in both sexes but the decline in vigorous activity was greater in girls than in boys. Indeed, it was found that by the age of 17-18 years, the vigorous exercise of the boys was similar to the total exercise of the girls.

Perhaps the largest study yet to have been conducted on British youth though, is the survey which was conducted in 1989 by the Health Education Authority. The survey presents insights into the health related factors affecting lifestyles of young people including alcohol, drugs, smoking and exercise. Over 10,000 children aged between 9 and 15 from 475 schools in England participated in the survey. Two separate self completion questionnaires were devised and used in the survey, one for 9-10 year old pupils and one for 11-15 year olds. The survey comprised numerous questions, three of which related to exercise. The three questions asked about time spent in physical education lessons per week, time spent on sports and exercise outside of school per week and pupils self-perception of fitness. The report which was published following the survey, entitled "Tomorrow's Young Adults," revealed that children were getting an average of 4.7 hours exercise both in and out of school per week. These figures assumed that a P.E. lesson lasted for up to 45 minutes. Boys were reported to do more exercise than girls (5.2 hours versus 4.2 hours) and both boys and girls showed an increase in the amount of weekly exercise they did until the age of 12 or 13, after which there was a decline.

In 1989, a study on the fitness and activity levels of English school children was produced as part of the Coronary Prevention in Children Project (Armstrong, 1989). The Project determined the cardiorespiratory fitness and physical activity levels of over 200 children aged 11-15. Armstrong used heart rate measures to estimate the physical activity levels of the children. The instrument used to record heart rate was a self-contained, computerised telemetry system (Sport Tester 3000). Children were monitored for a minimum of 3 weekdays and a Saturday. The threshold for appropriate exercise chosen by Armstrong was as recommended in a review by Simons-Morton et al., (1988). Armstrong's results similarly showed children to be inactive.

Fewer than 15% of the girls and 30% of the boys achieved a single 20 minute session with their heart rates over 139 bpm over the 3 days. Fifty percent of the girls and over 25% of the boys did not even manage a single 10 minute period of appropriate activity. Boys were again found to be significantly more active than the girls. Armstrong concluded from his results that children have surprisingly low levels of physical activity. He stated "many children seldom experience the intensity and duration of physical activity associated with a low CHD in adults."

Armstrong, Balding, Gentle, Williams & Kirby (1990) conducted a study to investigate whether children and adolescents regularly experience the levels of exercise associated with the improvement of peak VO_2 and studied the relationship between 11 to 16 year old students' directly determined VO_2 and their physical activity patterns. Peak VO_2 and habitual physical activity was determined in 111 girls and 85 boys. Volume of habitual physical activity (frequency, intensity, and duration) was estimated from minute-by-minute heart rate monitoring over three 12 hour periods during normal school days. As in Armstrong's previous study, the device used to measure heart rate was the Sport Tester 3000. Results again revealed that the "vast majority of children and adolescents rarely experience sustained periods of physical activity of sufficient intensity and duration to overload the cardiopulmonary system." Over half of the girls and a third of the boys failed to sustain a single 10 minute period with their heart rate at or above 140 bpm. Only one boy sustained a daily 20 minute period with a heart rate at or above 160 bpm.

Armstrong, Balding, Gentle & Kirby (1990a) conducted a study on a larger sample of children. The objective of this study was to examine the patterns of physical activity among British school children and to assess whether the children experienced the intensity and duration of physical activity believed to stress the cardiopulmonary system appropriately. Two hundred and sixty six children (aged 11-16), from two communities in Devon were randomly selected to participate in the study. Physical activity was estimated from continuous monitoring of heart rate over 3 weekdays and a Saturday. Similarly, it was found that British children had surprisingly low levels of habitual physical activity and many seldom undertook the volume of physical activity believed to benefit the cardiopulmonary system. The boys were more active than the girls, displaying heart rates greater than 139 bpm for a significantly higher percentage of time during the weekday (6.2% in boys versus 4.3% in girls), and on the Saturday (5.6% versus 2.6%).

Armstrong, Balding, Gentle & Kirby (1990b) conducted a further study providing still more information on children's activity levels. This research was primarily concerned with the prevalence of coronary risk factor variables in British children. Physical activity therefore, represented just one aspect of the study. Heart rate data was obtained over 12 hours on 32 boys and 44 girls from two large community colleges. Results revealed that the girls maintained their heart rates above 159 bpm for 1.5 % of the time, while the boys maintained their heart rates at this intensity for 2.6% of the time.

The physical activity patterns of British primary school children were studied in a survey conducted by the Happy Heart Project (Sleap & Warburton, 1990). This survey was carried out on primary school children aged 5 to 11 years from different regions of England. The bulk of the data was obtained using a general evaluation which involved parents filling in a detailed activity diary including all the activity their child(ren) did outside of school. In addition, an intense minute by minute observation was carried out on a small sample of the children using a method based on an American observation procedure. The observation involved studying the children's activity during break times, lunch times, P.E. lessons and outside of school hours. The major finding of this survey was that primary aged children did very little vigorous physical activity. The qualification of vigorous activity was any activity that made a child sweaty and/or out of breath. During the period of the investigation, half of the children took part in no vigorous activity, and the longest period of continuous vigorous physical activity recorded by any child was only 8 minutes.

In 1991, Armstrong & Bray investigated the physical activity patterns of 132 British primary school children. The heart rates of 67 boys and 65 girls (mean age 10.7 years) were monitored continuously for three 12 hour periods during normal school days. Thirty nine children also had their heart rates monitored during a 12 hour period on a Saturday. The results revealed that few children experienced the volume of physical activity associated with an improvement in cardiopulmonary fitness. However, when the number of children who had sustained 5 minute and 10 minute periods with heart rates above 139 bpm and 159 bpm were analysed, it was found that shorter (5 minute) periods of "appropriate" activity were quite common. No difference was found between the boys and girls in terms of moderate amounts of activity, but the boys displayed more 5 minute periods of intense activity than the girls. On the basis of the findings from the study, it was declared that sustained periods of activity are not features of children's physical activity. Rather, the claim was made that "the physical activity patterns of primary school children consist of relatively short periods of physical activity." It was suggested that this may be as a result of their limited attention span.

A more recent study by Armstrong, Williams, Balding, Gentle & Kirby (1991) investigated the cardiopulmonary fitness, physical activity patterns and selected coronary risk factor variables in 11 to 16 year old children. The heart rates of 199 boys and 164 girls were monitored for 3 weekdays. In analysing the physical activity data, low levels of activity were again evident. Results showed that 35.9% of the boys and 47.8% of the girls did not manage a single 10 minute period of activity with their heart rates above 139 bpm. The girls maintained their heart rates above 159 bpm for only 1.26% of the time and the boys for 2.67% of the time.

Sleap & Warburton (1992) conducted a study of 56 preadolescent children's activity levels from four regions of England. Continuous observation of the childrens' activities were made during break times, lunch times and physical education lessons, as well as during the children's free time. Of the total time observed, the children were found to spend 32.4% of it engaged in moderate to vigorous physical activity (MVPA). However, only 14% of the children were observed to participate in MVPA for sustained periods of 20 minutes or longer. The children were found to be most active during school breaks and least active during free time at home. Sleap & Warburton (1992) concluded from their results that although the children in the sample engaged in a reasonable amount of MVPA, it may not have been sustained for periods of sufficient length to produce a cardiovascular training response.

A recent study conducted by Thirlaway & Benton (1993) estimated the physical activity of 684 West Glamorgan school children aged between 10 and 16. The children were drawn from four secondary schools (years 7, 9, & 11) and six feeder primary schools (year 6). The children completed an activity diary for 4 school days and a weekend. An estimated score per minute for each activity was calculated using energy expenditure values (in kilojoules per minute) for all occupational, recreational and sporting activities reported. The scores for each activity were then added together to give a total activity score for each child. The study found boys to be more active than girls and the younger children (year 6) to be more active than the secondary school children. Based on the A.C.S.M. (1988) adult recommendations of appropriate activity, (see table 6.3), activity levels of the children were revealed to be low. This was particularly worrying given that the study took into account the two periods of physical education the children had a week. Thirlaway & Benton concluded that their study supports the claim made by Armstrong and colleagues (1990a) that "British children have surprisingly low levels of habitual physical activity."

6.5 Summary and Discussion of Findings of the Studies

It is clear from this review that there are certain common trends which are consistent across both the International and British studies. The majority of the studies reviewed reveal that children are not very active. While some researchers report to the contrary and find children to be active, such findings are very much in the minority. Indeed, just 3 of the 18 studies reviewed suggest that children are active participants in recreational sports and activities (McKusker, 85; The Sports Council for Wales, 86; The Health Education Authority, 1989). The majority of the studies report activity levels in children to be low and a number of studies report how many children may not be taking sufficient exercise to enhance their health status. It is repeatedly reported that levels are insufficient to develop the cardiovascular system and promote cardiovascular health (Gilliam et al., 1981; 1982; Miyashita et al., 1983; The National Children and Youth Fitness Study, 1987; Williams, 1988; Armstrong, 1989; Armstrong et al., 1990; Armstrong et al., 1990a; Armstrong & Bray, 1991). A summary of the studies, the methods used and a brief outline of the major findings are presented in tables 6.1 and 6.2.

Other consistent findings to emerge across a number of the studies include the differences in activity levels between boys and girls and between younger and older children. Low activity levels are clearly most marked in girls and in older children. A number of studies report boys to be more active than girls (Gilliam et al., 1981; Wold & Aarø, 1985; Vershuur & Kemper, 1985; Sunnegardh & Bratteby, 1987; Durnin, 1967; The Sports Council for Wales, 1987; Dickenson, 1987; Williams, 1988; The Northern Ireland Fitness Survey, 1989; The Health Education Authority Survey, 1989; Armstrong, 1989; Armstrong et al., 1990; 1990a; 1990b; 1991; Thirlaway & Benton, 1993), and/or report that activity levels decrease with age (Wold & Aarø, 1985; Saris, 1985; Verschuur & Kemper, 1985; Engstrom, 1986; Dickenson, 1987; The Sports Council for Wales, 1987; The Northern Ireland Fitness Survey, 1989; Thirlaway & Benton, 1993).

Given the knowledge that physical activity has many physiological and possible psychological effects that influence the health of children (Gilliam & MacConnie, 1984; Shephard, 1984; Montoye, 1985; Pate & Blair, 1978; Rowland, 1990), the findings presented here are worrying and highlight a serious cause for concern. Chapter one highlighted relationships between physical activity in children and CHD risk factors including blood pressure (Fraser et al., 1983; Fripp et al., 1985; Strazullo et al., 1988), serum lipoproteins (Durant et al., 1983; Gilliam & Burke, 1978; Thorland & Gilliam, 1981) and obesity (Clark & Blair, 1988; Walberg & Ward, 1985). These associations are furthermore of particular significance because CHD is known to have its origins in childhood (Lauer et al., 1975; Newman et al., 1986) and because CHD risk factors are known to track over time (Freedman et al., 1985; Lauer et al., 1989).

While the findings across studies do tend to be consistent, it should be realised that the studies from which the evidence is drawn are clearly limited and far from comprehensive. What becomes evident from this review in particular, is the dearth of information which exists on the activity levels of British children. The United States, Canada and Australia have all conducted large scale national fitness and activity surveys to assess how active their child populations are (The National Children and Youth Fitness Study, 1987; The Canada Fitness Survey, 1981; The Australian Health and Fitness Survey, 1985). As yet we have no activity data on such a large scale. The Health Education Survey represents the largest scale survey conducted on British children to date, but the activity information it provides is vague and is deduced from only three exercise related questions. The survey covers a whole range of health related behaviours and therefore lacks the detail necessary to draw any firm conclusions from the activity information obtained.

A limitation with the findings from a number of the studies lies in the inability to interpret and compare them to the findings of other studies. Because the studies have used a diverse range of methods of monitoring physical activity, the findings across studies are difficult to compare, thus making any generalisations of the findings very difficult. Furthermore, methodological problems and problems with reliability and validity are inherent in the various methods of monitoring physical activity used. These were highlighted earlier in the review in chapter two. Clearly a number of the studies reviewed here use unknown or non-validated instruments which may not be appropriate for use with child populations. Such methodological flaws need to be taken into account when considering the findings.

In addition, a number of the studies have adopted different criteria as to what constitutes "appropriate" physical activity. Table 6.3 highlights some of the different definitions of "appropriate" physical activity. Evidently, what is deemed as appropriate activity in some studies is clearly not appropriate in others and children who are therefore classified as active in one study, may be categorised as inactive by another researchers' standards. This too makes any comparisons between studies difficult. Indeed, Goodman, Baker, Powell & Sayre (1988), in a survey of physical activity patterns among adults, acknowledged the importance of both the definition and cut-off point adopted when assessing the prevalence of physical activity. They noted how estimates of physical activity vary as a function of both the rigour of the definition and of the cut-off point chosen to define "active" persons. Their survey revealed the prevalence of active persons to vary from 77% when activity was defined only as participation in the preceding 30 days to 24% when defined as the energy expenditure of > 4 kcal/kg/day. As a result, Goodman et al., (1988) urge caution when interpreting prevalence estimates of physical activity levels in populations.

A final point to perhaps raise, is that while all of the studies outlined in this review are concerned with children's activity, a number of them are concerned primarily with aspects other than activity patterns. For example, the primary purpose of the study conducted by Weymans & Reybrouck (1989) was to investigate the relationship between the habitual level of physical activity and the cardiorespiratory endurance capacity of children. The study by Atomi et al., (1986) aimed to investigate daily physical activity levels in preadolescent boys with reference to lactate threshold, while Shephard et al., (1980) aimed to evaluate the effects of sex, milieu, season and required activity on physical activity. As a result of the differing aims of such studies, it has often been difficult to interpret the results in terms of just how active the children in the population sample actually are.

In summary then, variations in the methodologies used, the definitions adopted and the different forms of analyses and aims of the studies presented in this review have contributed to making any clear interpretation from the results very difficult. Nonetheless, three consistent findings emerge from the results. Firstly, that children are not very active; secondly, that boys are more active than girls; and thirdly, that younger children are more active than older children. Evidently though, what is required, is more information on the physical activity levels of young people, but information which has been gathered in a systematic way by a method which is appropriate for use with child populations. Only then will any real conclusions be able to be drawn as to how active young people of today actually are.

6.6 Hypotheses

Despite the limited number of studies of children's physical activity, and despite limitations in the methodologies used in some cases, consistent findings did emerge from the literature review. In keeping with the findings of other researchers, it is expected that the majority of children in this study will be found to be inactive. More specifically though, the findings from the review lead to the formulation of the following hypotheses:

Hypothesis 1)

Boys will be more active than girls;

In null form (H_O)

Boys will be no more active than girls

Hypothesis 2)

Younger children will be more active than older children.

In null form (H_O)

Younger children will be no more active than older children.

Note-The hypotheses predict the direction in which the differences are expected to lie.

6.7 Sampling Procedure

Loughborough is centrally situated in England and, as such, it was possible to draw children from three separate counties: Nottinghamshire, Derbyshire and Leicestershire to participate in the study. Schools in Nottinghamshire, Derbyshire and Leicestershire were drawn from the Education Year Book, 1991. A stratified random sampling procedure was adopted to select the sample of schools from each of the three counties. Stratification factors/categories included type of school, (i.e., high school, upper school, secondary comprehensive, independent) and size of school (< 600 pupils, 600-900 pupils and > 900 pupils). Once stratified, the schools were randomly selected. This procedure ensured that high schools (11-14), upper schools (14-18), secondary comprehensive schools (11-18) and independent schools of varying student numbers were all represented in the final sample. (Proportionately one independent school should have been drawn for inclusion in the sample but two schools were selected as all independent schools listed were boys or girls only schools. It was therefore decided to include two schools, to sample both boys and girls, but to administer the questionnaire to just half the number of pupils from each school).

A total of 15 schools, 13 comprehensive and 2 independent schools were selected. Given the time constraints of data collection, in that the weekend form could only be administered on a Monday and the winter and summer months both provided only 12 weeks (10 excluding school holidays) in which to collect the winter and summer activity information, the researcher felt that 15 schools was the maximum number which could be visited in the time available. Letters were sent to headteachers from each school formally requesting permission for their school to participate in the study (see Appendix N).

6.8 Data Collection

Of the 15 headteachers contacted, 13 granted permission for their school to be involved in the study. Further contact was then made with each consenting headteacher by telephone to arrange convenient times for the visits to the schools. Dates and times were arranged which were also confirmed in writing. Each school was visited on four separate occasions (to collect the four days of activity information for each child). Two visits were made in the winter between December and February, with the final visits being made in the summer between May and July. The weekend measures of physical activity were collected every Monday and the school day measures on one other day of the week during this period. For the weekend measure, activity information was collected for both a Saturday and a Sunday and, where possible, different school days were selected from the winter to the summer visit.

The pupils interviewed were randomly selected by the schools themselves, though the classes from which the pupils were drawn tended to be selected based on convenience and class availability. This was something beyond the control of the interviewers as some teachers clearly did not want to release pupils from some classes. Prior to visiting each school, 10 year 7 pupils (11-12 year olds) and 10 year 9 pupils (13-14 year olds) were selected to participate in the study by the teacher co-ordinating the visits. Pupils received letters to take home to parents explaining the study and parents were requested to complete a reply slip if they granted permission for their child to participate in the study (see Appendix O). Few pupils failed to return the slips by the required date indicating that most were very happy to be involved.

Table. 6.1 A Summary of the Major Findings of the International Studies

STUDY	METHOD	SAMPLE	FINDINGS
Huenemann et al., (67)	Activity diary	American children	Teenagers were found to be inactive. Over 4 weekly periods, girls spent more than 95% and boys over 90% of time in sleep, very light or light activity.
Seliger et al., (74)	heart rate and interview	11-12 year old Belgium children	Only 3% of the boys time was spent in activities of a moderate or medium intensity. At no time did the boys engage in heavy intensity activity.
Hovell et al., (78)	Observation	8-11 year old American children	Students were found to engage in little exercise during recess.
Shephard et al., (80)	Activity diary and questionnaire	10-12 year old Canadian children	Vigorous activities accounted for only 0.44 hours per day for Quebec children.
Saris et al., (80)	Heart rate	4-6 year old and 8-12 year olds Dutch children.	The most active children experienced activity of the appropriate intensity for only 15 mins for 4-6 years and for only 6 mins for 8-12 year olds.
The Canada Fitness Survey (81)	Questionnaire	Canadian children aged 7 and upwards	Results showed 75% of young children to be sufficiently active. However, revised figures for 10-12 year olds revealed only 3.5% of children to be active.
Gilliam et al., (81; 82)	Heart rate	6-7 year old American children	Young children found to seldom undergo physical activity of high enough intensity to promote cardiovascular health.
Miyashita et al., (83)	Heart rate	9-10 year old boys in Tokyo	The duration of daily exercise of Tokyo boys was found to be too short to develop cardiopulmonary functions.
The Australian Health and Fitness Survey (85)	Survey questionnaire	Australian children	More than 1 in 5 boys and 1 in 4 girls had not done any activity at all outside of school in the previous week.
Wold & Aarø (85)	Questionnaire	children aged 11-16 from 11 European countries	Findings varied by age, sex and country. The older children were found to be less active and boys reported to be more active than girls.
Saris (85)	Heart rate and questionnaire	6-12 year old Dutch children	Boys found to be more active than girls.
Telama et al., (85)	Questionnaire	3-6 year old and 9-18 year old Finnish children	A large proportion of Finnish children were found to be physically active.
Verschuur & Kemper (85)	heart rate, pedometer and interview	13-14 year old Dutch children	A median of 480 mins per week for boys and 421 mins for girls were spent doing activities of an intensity greater than 5km per hour.

Atomi et al., (86)	Heart rate	9-10 year old Japanese boys	Boys spent on average 4.7% of their time at heart rates equivalent to 60% of maximal aerobic power.
Engstrom (86)	Questionnaire and interview	Swedish youth	90% of the population took part in light activity, (comparable to walking), but fewer in higher intensity exercise.
Kannas et al., (86)	Questionnaire	Austrian, English, Finnish and Norwegian children	Results showed approximately every fifth child to be participating in daily physical activity.
Marella et al., (86)	Questionnaire	Italian girls aged 14-18	60-70% of teenagers were found to do no physical activity in their leisure time.
The National Children and Youth Fitness Study (87)	Survey questionnaire	10-17 year old American children	Results revealed that probably half of American children did not perform the weekly requirement of vigorous activity.
Sunnegardh & Bratteby (87)	Interview questionnaire	Swedish children	Younger children were found to be more active than older ones and boys were more active than girls.
Baranowski et al., (87)	Questionnaire and observation	American primary school children	Children were found to be active, but only for short spurts rather than for the longer stretches that might be expected to have a training effect and subsequent health benefits.
Klesges & Klesges (87)	Accelerometer and observation	American pre-school children	66.79% of time was spent in minimal intensity activity, 32.9% of time in moderate and only 0.31% of time in extreme intensity activity.
Sallis et al., (88)	Observation	3-5 year old American children	60% of children's free time spent in sedentary activities, 11% in vigorous activities.
The Campbell's Survey on Well-Being in Canada (88)	Survey questionnaire	Canadians aged 7 and upwards	Between 10-14 years, 72% of boys and 49% of girls were reported to be active, and between 15-19 years, 69% of boys and 39% of girls were active.
Tell & Vellar	Questionnaire	785 adolescents from Norway	Activity levels were low. 16% of the boys and 22% of the girls reported to take exercise less than 2-3 times a month.
Fuchs et al., (88)	Questionnaire	German boys and girls	Most students were found to be active. 95% spent 2 or more hours per week on average in physical activity.
Weymans & Reybrouck (89)	Questionnaire	Belgium children	The lowest activity levels were found in younger children. Boys were found to be more active than girls.
Simons-Morton et al., (1990)	Questionnaire	8-9 year old American children	35.6% of boys and girls obtained less activity than recommended.

Table 6.2 A Summary of the Major Findings of the British Studies

STUDY	METHOD	SAMPLE	FINDINGS
Durnin (67)	Diaries	13-15 year old British children	Results revealed that boys spent 29 mins a day in heavy physical activity and 12 mins in very heavy activity. Girls spent 10 mins in heavy and 3 mins in very heavy activity.
Hendry (78)	Self-report questionnaire	15-16 year old Scottish children	More than 50% of boys and 66% of girls were classified as non-participants.
McKusker (85)	interview questionnaires	15-19 year olds in Stirling, Scotland	More than 90% of boys and girls were found to take part in recreational sport.
The Sports Council for Wales (86)	Survey questionnaire	11-16 year old Welsh children	90% claimed they were actively involved in recreational activities outside of school.
Dickenson (87)	Interviews and questionnaires	11-16 year old English children	Between 80 and 85% of children did less than 5 mins of vigorous activity over the study week. 38.16% of boys and 62.16% of girls were found to be totally inactive during the week.
The Sports Council for Wales (87)	Survey questionnaire	Welsh teenagers	Less than half of the males and only 19% of the females participated in sufficient amounts of appropriate activity
Williams (88)	Questionnaire	English adolescents	Only 52% of the sample reported to take part in physical activity outside of school
The Northern Ireland Fitness Survey (89)	Survey questionnaire	N. Irish post-primary school children	32.9% of boys and 34.4% of girls reported they had done no exercise outside of school during the preceding 7 days.
HEA Survey (89)	Survey questionnaire	English children aged 9-15	Children were found to get an average of 4.7 hours of exercise per week. Boys did more exercise than girls (5.2 *versus* 4.2). Activity decreased after the age of 12 or 13.
Armstrong (89)	Heart rate	English children aged 11-15	Results showed children to be inactive. Over 4 days, 50% of girls and more than 25% of boys did not manage a single 10 min period of appropriate activity.
Armstrong et al., (90)	Heart rate	English children aged 11-16	Results revealed that few children have periods of physical activity of sufficient intensity and duration to stress the cardiopulmonary system.
Armstrong et al., (90a)	Heart rate	11-16 year old children from Devon	British children had surprisingly low levels of physical activity. Many children were found to seldom experience the intensity and duration of physical activity believed to stress the cardiopulmonary system appropriately.
Armstrong et al., (90b)	Heart rate	Second year children from 2 Community Colleges	Over 12 hours testing, girls maintained their heart rates above 159 bpm for 1.5% of the time. Boys managed 2.6% of the time.
Sleap & Warburton (90)	Activity diaries and observation	English primary school children	Primary children were found to do very little vigorous physical activity

Armstrong & Bray (91)	Heart rate	English primary school children (mean age 10.7)	Few children were found to experience the volume of physical activity associated with an improvement in cardiopulmonary fitness.
Armstrong et al., (91)	Heart rate	11-16 year old English children from 2 communities in S. England	35.9% of the boys and 47.8% of the girls did not manage a single 10 min period of activity with their heart rates above 139 bpm.
Sleap & Warburton (1992)	Observation	preadolescent children from 4 regions of England	Children engaged in a reasonable amount of moderate to vigorous physical activity but it may not have been sustained long enough to produce a CV training response.
Thirlaway & Benton (1993)	Activity diaries	West Glamorgan school children aged 10-16	Based on A.C.S.M guidelines, activity levels were low. Boys were found to be more active than girls and younger children more active than older children.

Table 6.3 Definitions of "Appropriate" Physical Activity

STUDY	DEFINITION OF APPROPRIATE ACTIVITY
Durnin (1967)	activity of moderate, heavy or very heavy intensity
Saris, (1980)	Heart rate of 176 beats per minute
The Canada Fitness Survey (1981)	average of 3 or more hours of physical activity per week for 9 months of the year or more
Gilliam et al., (1981; 1982)	Heart rate of 160 beats per minute
Verschuur & Kemper (1985)	the former (1978) A.C.S.M. recommendation*
The Australian Health and Fitness Survey (1985)	activity 3-4 times a week which makes the child 'huff and puff' and lasts for 30 minutes
Atomi et al., (1986)	Heart rate corresponding to 60% of VO_2 max believed to contribute to increased aerobic power.
Kannas et al., (1986)	20-30 minutes of exercise, 3-4 times a week
The Sports Council for Wales (1987)	20 minutes of vigorous activity 3 times a week
The National Children and Youth Fitness Study, McGinnis (1987)	the A.C.S.M. recommendation
The Northern Ireland FitnessSurvey (1989)	exercise versus no exercise, defined as any activity that causes a degree of breathlessness
Armstrong (1989); Armstrong et al,.1990a;1990b)	As recommended in a review by Simons-Morton et al., (1988), activity involving large muscle groups in dynamic movement, for a period of 20 minutes or longer, 3 or more times a week, at an intensity producing a heart rate of at least 140 beats per minute
Simons-Morton et al., (1990)	More than 10 mins of moderate to vigorous physical activity (LMVPA)
Sleap & Warburton (1990)	Refer to vigorous activities, i.e., those activities making a child sweaty and/or out of breath.
Thirlaway & Benton (1993)	Based on the A.C.S.M (1988) adult recommendations that between 6300-8400 kilojoules per week should be spent participating in exercise.

* The American College of Sports Medicine (1978) recommend that for exercise to develop and maintain fitness, it should involve using large muscle groups for a period of between 20-45 minutes, for a minimum of three times a week, at an intensity of 50-60% of maximum capacity.

CHAPTER 7

RESULTS OF THE ASSESSMENT OF CHILDREN'S ACTIVITY LEVELS

7.1 Introduction

The results of the assessment of children's physical activity levels are presented in this chapter. The chapter outlines the procedures undertaken in treating and analysing the data and describes the results in some detail. Information with respect to the pupils' activity scores, time spent in moderate activity, time spent in hard/very hard activity and number of bouts of "huff and puff" activity are dealt with under separate sections within the chapter.

7.2 Treatment of the Data

Prior to data analysis, the four sets of data from the four separate interview questionnaires were merged to create one large data file. The statistical programme spss-x was employed to analyse the data. Using this programme a series of compute commands were made to determine the following activity information:

1) The average daily activity score for each subject, i.e., average daily energy expenditure in $kcal \cdot kg^{-1} \cdot day^{-1}$.

2) The total amount of time spent in moderate activity over the four days.

3) The average daily time spent in moderate activity.

4) The total amount of time spent in hard and very hard activity over the four days.

5) The average daily time spent in hard and very hard activity.

6) The total number of bouts of activity each subject had engaged in which had made them "huff and puff" i.e., breathe hard/harder than normal over the 4 days (concerned with activities of a moderate, hard or very hard intensity).

7) The number of bouts of activity which had made pupils "huff and puff" and which had lasted for more than 10 minutes over the 4 days.

8) The number of bouts of activity which had made pupils "huff and puff" and which had lasted for more than 20 minutes over the 4 days.

In addition, the time spent in sleep and in very light and light activities was calculated in order to compare time spent in more sedentary activities with time spent in more physical activities.

On the basis of the activity scores (energy expenditure values) obtained, students were classified as very inactive, inactive, moderately active or active. These classifications were set according to the average values quoted for the 7-Day Recall by Blair (1984). The values were based on random samples of more than 2,000 men and women from four California towns. However, Blair (1984) identified only three categories of activity level (very inactive, inactive and active). Blair stated that individuals who have relatively active lifestyles have energy expenditures of 40 kcal· kg^{-1}· day^{-1} or more, while persons with values in the mid to high 30s are inactive and those with scores in the low 30's are very inactive. In considering these classifications, however, it became apparent that the categories were rather stringent. An analysis of the raw data from the pilot study (chapter 4, 4.4) revealed that subjects who were classified as inactive under Blair's criteria, were clearly not entirely inactive. They had all engaged in regular (i.e., daily) activity of at least a moderate intensity. It was therefore decided to employ a less stringent classification system for the purpose of this research (see discussion in chapter 8). The classification system adopted in this study was as follows:

A score of less than 33 =VERY INACTIVE
A score between 33 and 36.99=INACTIVE
A score between 37 and 39.99=MODERATELY ACTIVE
A score of 40 or greater=ACTIVE

7.3 Data Analysis

One-tailed t tests for independent samples were employed to determine whether there were significant differences between the activity levels (i.e., activity scores) of the boys and girls (hypothesis 1), and between younger (year 7) and older (year 9) pupils (hypothesis 2). Due to the lack of information available on the nature of British children's activity levels, only two hypotheses were made. The remaining activity information and statistics derived from the study are therefore presented descriptively.

7.4 The Final Sample

Of the 240 pupils interviewed, 199 successfully completed the study. The remaining subjects were absent from school on one or more of the interview days and therefore failed to be interviewed the required four times. For the purpose of data analysis, only those subjects who completed all of interviews were included in the results. The final sample comprised 96 boys (48.2%) and 103 girls (51.8%). Of these 104 were year 7 pupils (11-12 year olds) and 95 year 9 pupils (13-14 year olds), constituting 52.3% and 47.7% respectively.

7.5 Activity Scores (Energy Expenditure in $kcal \cdot kg^{-1} \cdot day^{-1}$)

In terms of energy expenditure, the mean daily energy expenditure or activity score was 36.74 ($kcal \cdot kg^{-1} \cdot day^{-1}$) (SD=4.07). The minimum activity score obtained by any individual was 30.84 and the maximum was 57.26. When pupils were classified into the appropriate activity categories (outlined in 7.2), it became clear that, as anticipated, the majority of pupils in the study were inactive. The results revealed only 14.1% (n=28) of the sample to be active and 21.1% (n=42) to be moderately active. The remaining pupils were found to be inactive (54.7%, n=109) or very inactive (10.1%, n=20). Put another way, only 35.2% or approximately one third of the sample were classified as either moderately active or active, while 64.8% or approximately two thirds were classified as inactive or very inactive. The activity status of the sample as a whole is shown in table 7.2 and in figure 7.1.

Hypothesis 1

The activity scores for the boys and girls were then analysed separately. The mean activity score for the boys was 38.19 (SD=4.48) and for the girls 35.37 (SD=3.09) (see figure 7.2). Hypothesis 1 made in chapter six (6.6), stated that:

Boys will be more active than girls,

In null form (H_0)

Boys will be no more active than girls.

A one-tailed t test for independent samples revealed a significant difference between the activity scores of the boys and girls ($t=5.14$, $P<0.005$). Boys were found to be more active than girls and consequently the null hypothesis was rejected (see table 7.1).

The proportion of active, moderately active, inactive and very inactive boys and girls in the sample was then determined. It was revealed that the majority of the 14.1% (n=28) of active pupils in the total sample were boys, with 23 out of the 28 active pupils being boys (24%), compared with just 5 or 4.9% of the girls. When the moderately active and active categories were combined, half (50%, n=48) of the boys and approximately one fifth (21.4%, n=22) of the girls were classified as either moderately active or active. In other words, half of the boys and almost 80% of the girls (78.6%, n=81) were classified as inactive or very inactive. Also worthy of mention is the large proportion of very inactive girls found in the sample. Approximately 15% (n=16) of the girls were found to be very inactive compared with 4.2% (n=4) of the boys. The differences between the activity status of the boys and girls can be seen in tables 7.2 and 7.3, and in figures 7.3, 7.4 and 7.5.

Hypothesis 2

The activity scores were also analysed by age. The mean activity score for the year 7 pupils was 36.39 (SD=3.79), while the mean score for the year 9 pupils was 37.11 (SD=4.34) (see figure 7.6).

Table 7.1 t test for Independent Samples (Boys, Girls)

Group 1=Boys

Group 2=Girls

Activity Score	No' of Cases	Mean	Standard Deviation	Standard Error	t Value	Degrees of Freedom	1-tailed Prob
Group 1 Boys	96	38.19	4.48	0.46	5.14	167.54	0.000
Group 2 Girls	103	35.37	3.09	0.30			

Figure 7.1 Activity Status of the Total Sample

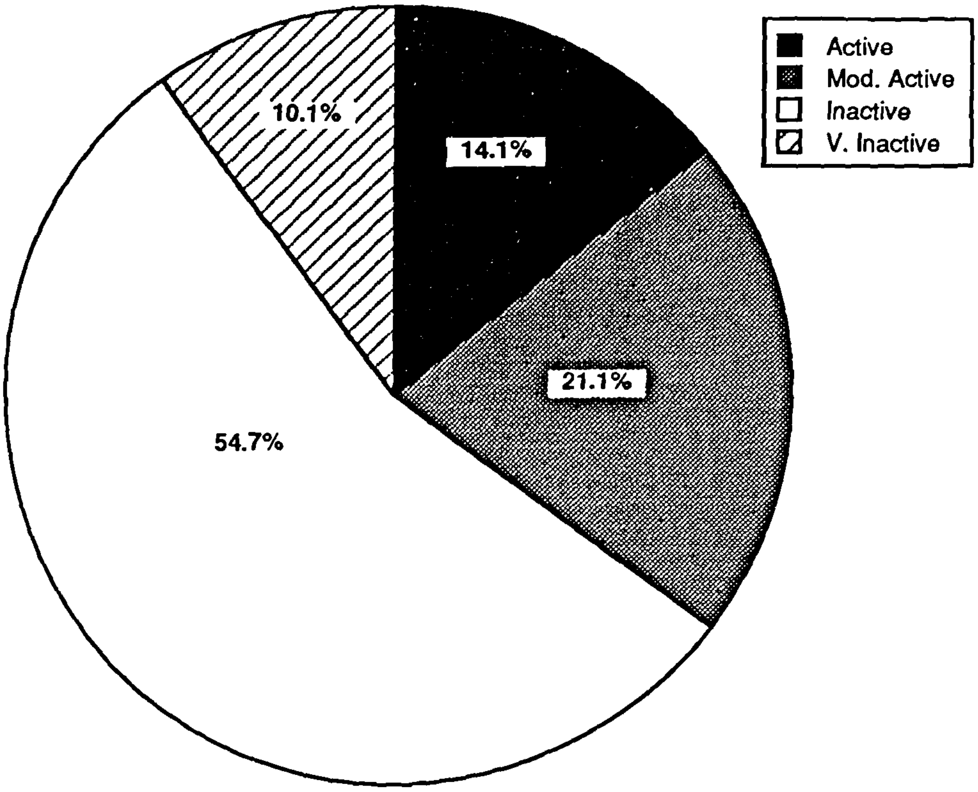


Figure 7.2 Mean Activity Scores-Total, Boys and Girls

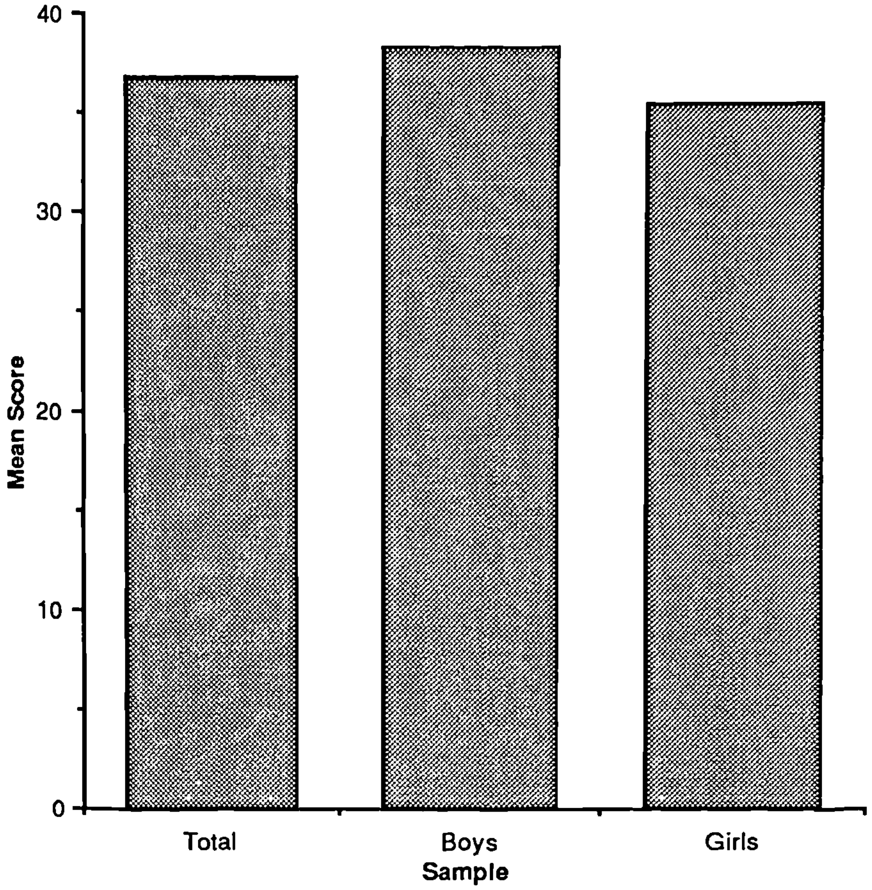


Figure 7.3 Activity Status of the Boys

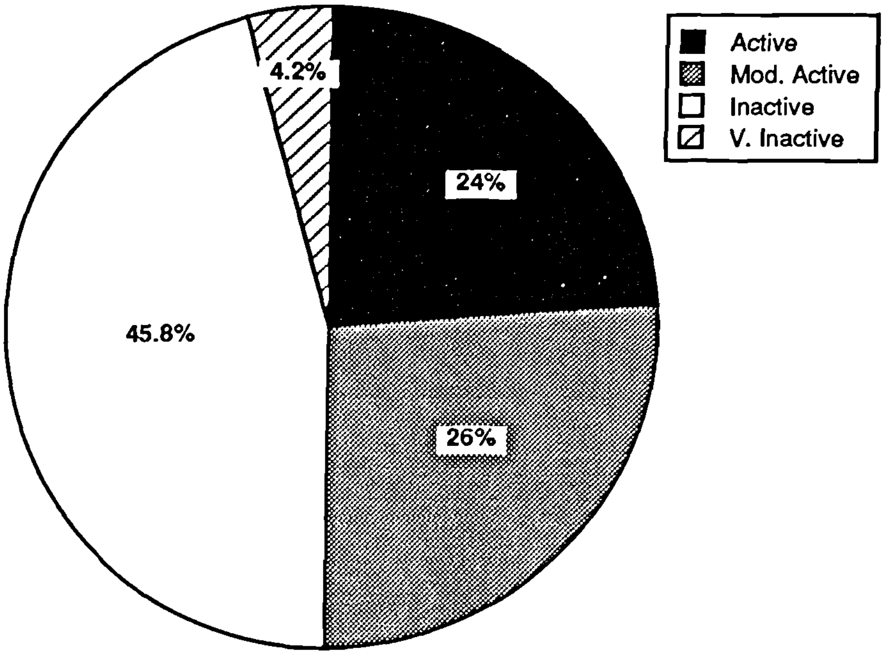


Figure 7.4 Activity Status of the Girls

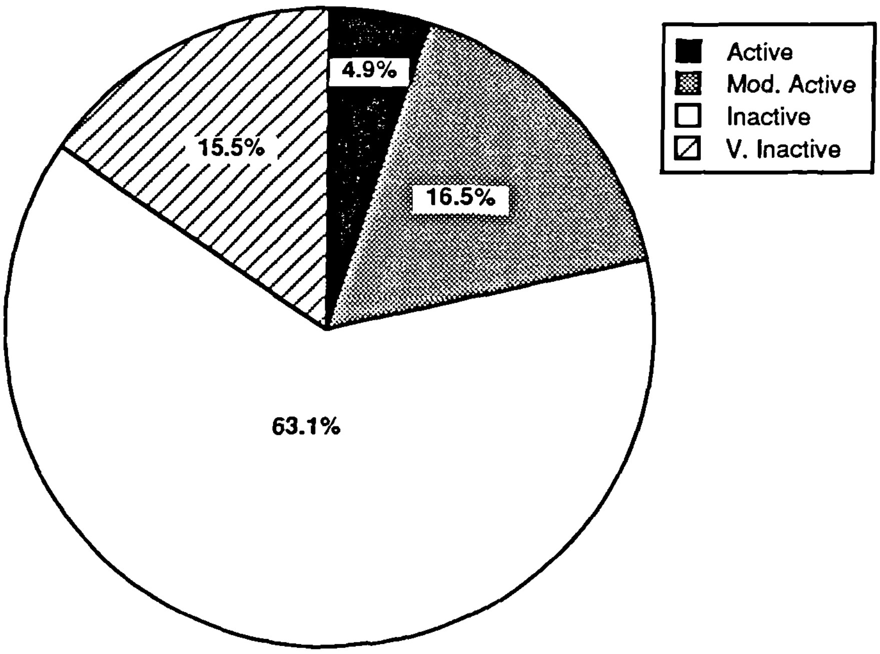


Figure 7.5 Activity Status of the Boys and Girls

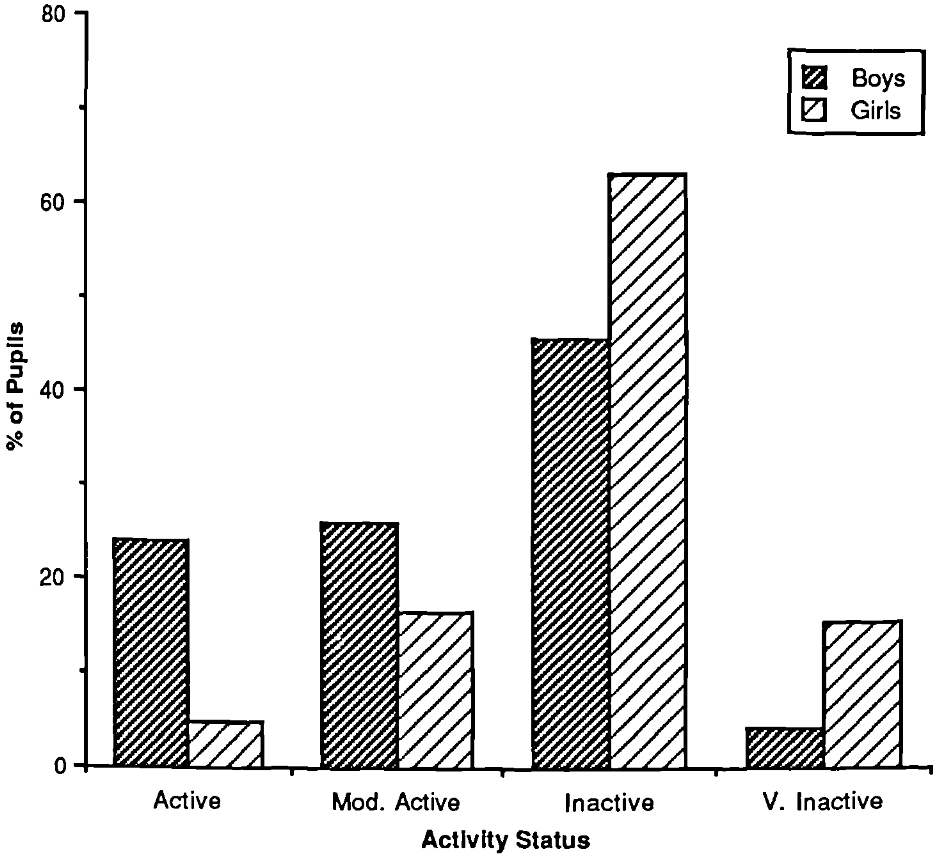


Figure 7.6 Mean Activity Scores-Total, Year 7 and Year 9 Pupils

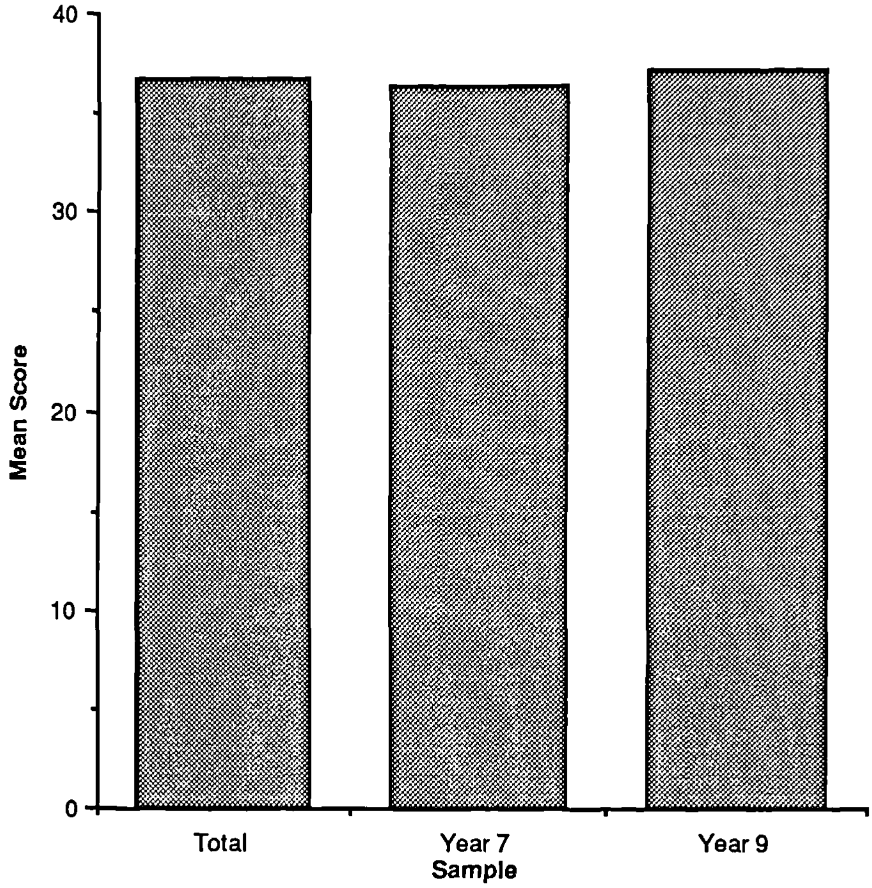


Table 7.2 Activity Status of Boys and Girls in Relation to the Total Sample

ACTIVITY STATUS	Total (n=199)	Boys (n=96)	Girls (n=103)
ACTIVE	14.1%	24%	4.9%
MODERATELY ACTIVE	21.1%	26%	16.5%
INACTIVE	54.7%	45.8%	63.1%
VERY INACTIVE	10.1%	4.2%	15.5%

Table 7.3 Summary of Activity Status of Boys and Girls in Relation to the Total Sample

ACTIVITY STATUS	Total (n=199)	Boys (n=96)	Girls (n=103)
MODERATELY ACTIVE/ ACTIVE	35.2%	50%	21.4%
INACTIVE/VERY INACTIVE	64.8%	50%	78.6

Hypothesis 2 stated that:

Younger children will be more active than older children,

In null form (H_0)

Younger children will be no more active than older children.

A one-tailed t test this time revealed no significant difference between the activity levels of the younger (year 7) and older (year 9) pupils ($t=-1.23$, $p<0.05$). The null hypothesis in this case was accepted and it was concluded that younger children were no more active than older children (see table 7.4).

When the activity status of the year 7 and year 9 pupils was compared, more year 9 pupils in the sample were found to be active or moderately active than year 7 pupils. For year 9 pupils, 15.8% (n=15) were classified as active and 23.1% (n=22) moderately active, compared to

Table 7.4 t test for Independent Samples (Year 7, Year 9)

Group 1=Year 7 pupils (11=12 year olds)

Group 2=Year 9 pupils (13-14 year olds)

Activity Score	No' of Cases	Mean	Standard Deviation	Standard Error	t Value	Degrees of Freedom	1-tailed Prob
Group 1 Year 7	104	36.39	3.79	0.37	-1.24	187.69	0.220
Group 2 Year 9	95	37.10	4.34	0.45			

12.5% (n=13) active and 19.2% (n=20) moderately active for year 7 pupils. It should be realised however, that these differences are only relatively small. At the other extreme, more year 7 pupils were categorised as very inactive (14.4%, n=15) than year 9 pupils (5.3%, n=5). The activity status of the sample by age is illustrated in tables 7.5 and 7.6 and in figures 7.7, 7.8 and 7.9.

Table 7.5 Activity Status of Year 7 and 9 Pupils in Relation to the Total Sample

ACTIVITY STATUS	Total (n=199)	Year 7 (n=104)	Year 9 (n=95)
ACTIVE	14.1%	12.5%	15.8%
MODERATELY ACTIVE	21.1%	19.2%	23.1%
INACTIVE	54.7%	53.9%	55.8%
VERY INACTIVE	10.1%	14.4%	5.3%

Table 7.6 Summary of Activity Status of Year 7 and 9 Pupils in Relation to the Total Sample

ACTIVITY STATUS	Total (n=199)	Year 7 (n=104)	Year 9 (n=95)
MODERATELY ACTIVE/ ACTIVE	35.2%	31.7%	38.9%
INACTIVE/VERY INACTIVE	64.8%	68.3%	61.1%

Some interesting findings emerged when both the age and sex of the pupils was taken into account in the analysis of the results. The activity scores and the activity status of the year 7 boys, year 9 boys, year 7 girls and year 9 girls were compared. The mean activity scores obtained for each group were 38.09 for year 7 boys, 38.30 for year 9 boys, 34.87 for year 7 girls and 35.94 for year 9 girls and are shown in figure 7.10. The year 7 and year 9 boys' results were found to be very similar. The year 9 boys achieved a marginally higher mean activity score and in

Figure 7.7 Activity Status of the Year 7 Pupils

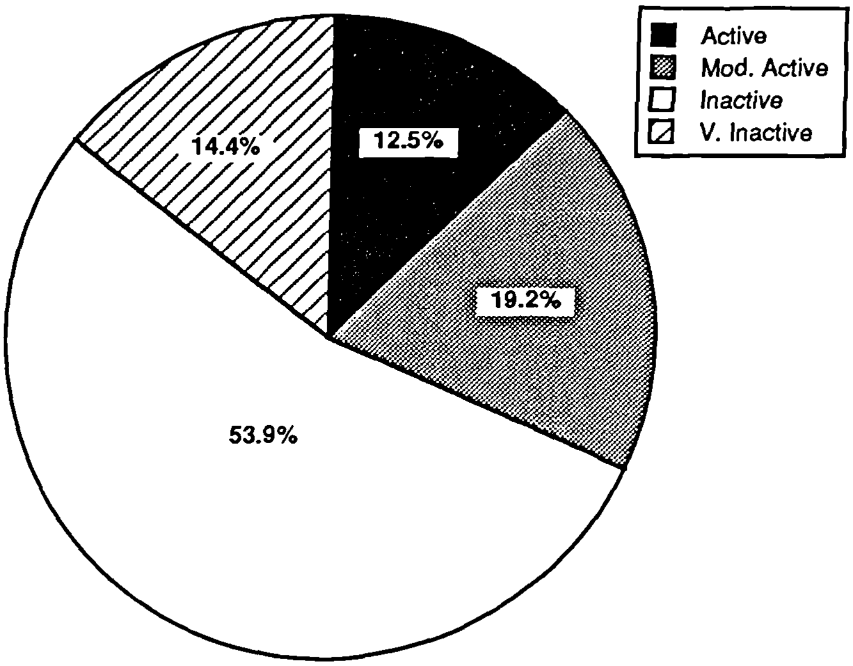


Figure 7.8 Activity Status of the Year 9 Pupils

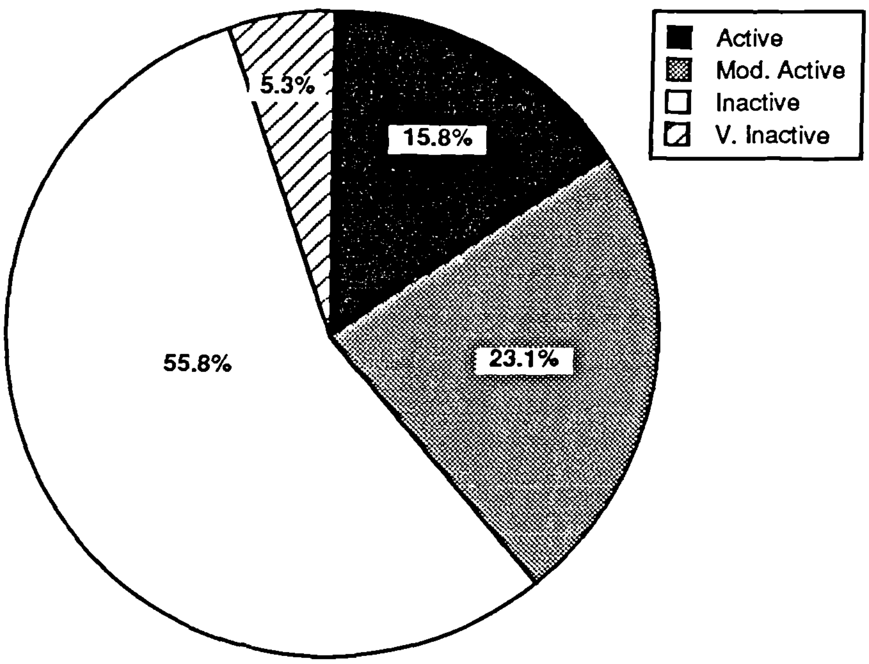
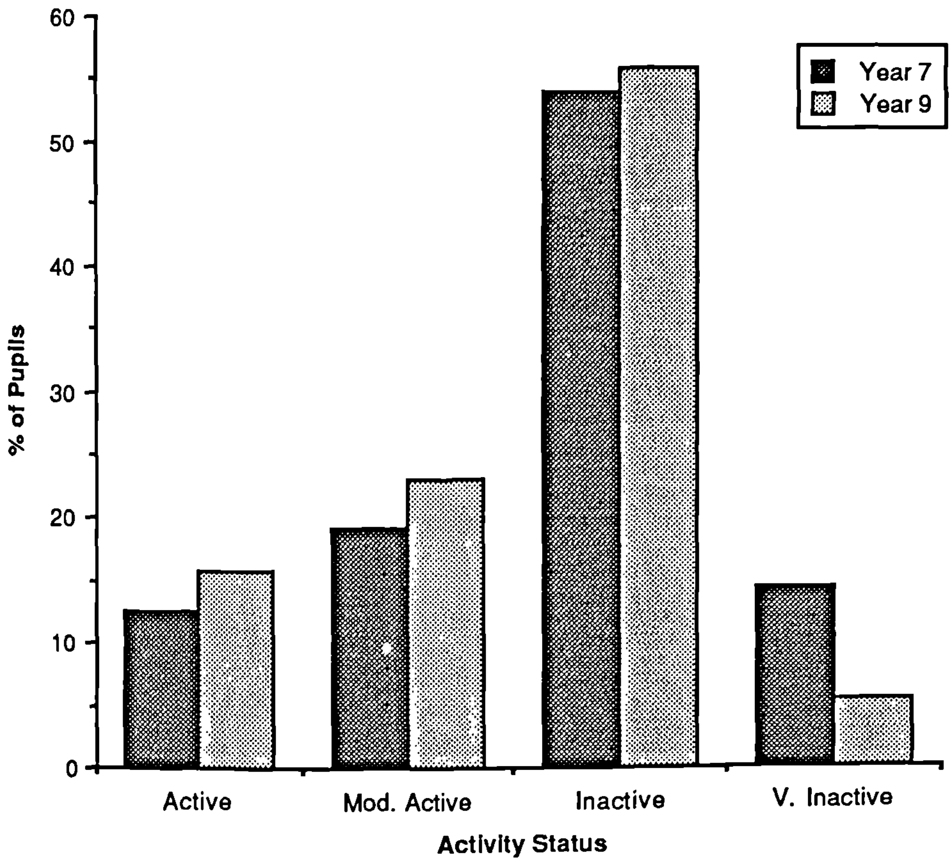


Figure 7.9 Activity Status of the Year 7 and Year 9 Pupils



terms of activity status, more year 9 boys (53.2%, n=25) were classified as moderately active or active than year 7 boys (46.9%, n=23). Year 7 boys had the highest percentage of active pupils however (24.5%). The least active group were the year 7 girls, having the lowest mean activity score of any group and the lowest percentage of active pupils. Indeed, only one year 7 girl (1.8%) was classified as active. Even when categories were combined, only 18.2% (n=10) of the year 7 girls were found to be moderately active or active. In terms of inactivity, few boys were found to be very inactive. Just 8.2% (n=4) of the year 7 boys and none of the year 9 boys were classified as very inactive. In contrast, 20% (n=11) of the year 7 girls and 10.4% (n=5) of the year 9 girls were found to be very inactive. Tables 7.7 and 7.8 summarise the activity status of the four groups and the results are illustrated in figures 7.11, 7.12, 7.13, 7.14 and 7.15.

Table 7.7 Activity Status of the Sample by Age and Sex

ACTIVITY STATUS	Year 7 Boys (n=49)	Year 9 Boys (n=47)	Year 7 Girls (n=55)	Year 9 Girls (n=48)
ACTIVE	24.5%	23.4%	1.8%	8.3%
MODERATELY ACTIVE	22.4%	29.8%	16.4%	16.7%
INACTIVE	44.9%	46.8%	61.8%	64.6%
VERY INACTIVE	8.2%	0%	20%	10.4%

Table 7.8 Summary of Activity Status of the Sample by Age and Sex

ACTIVITY STATUS	Year 7 Boys (n=49)	Year 9 Boys (n=47)	Year 7 Girls (n=55)	Year 9 Girls (n=48)
MODERATELY ACTIVE/ ACTIVE	46.9%	53.2%	18.2%	25%
INACTIVE/ VERY INACTIVE	53.1%	46.8%	81.8%	75%

The activity scores were also investigated for each school involved in the study. The mean scores for each school are presented in table 7.9 and figure 7.16. The proportion of active, moderately active, inactive and very inactive pupils from each school was determined and these results are presented in table 7.10 and figure 7.17. Although the mean activity scores for each

Figure 7.10 Mean Activity Scores-Age and Sex

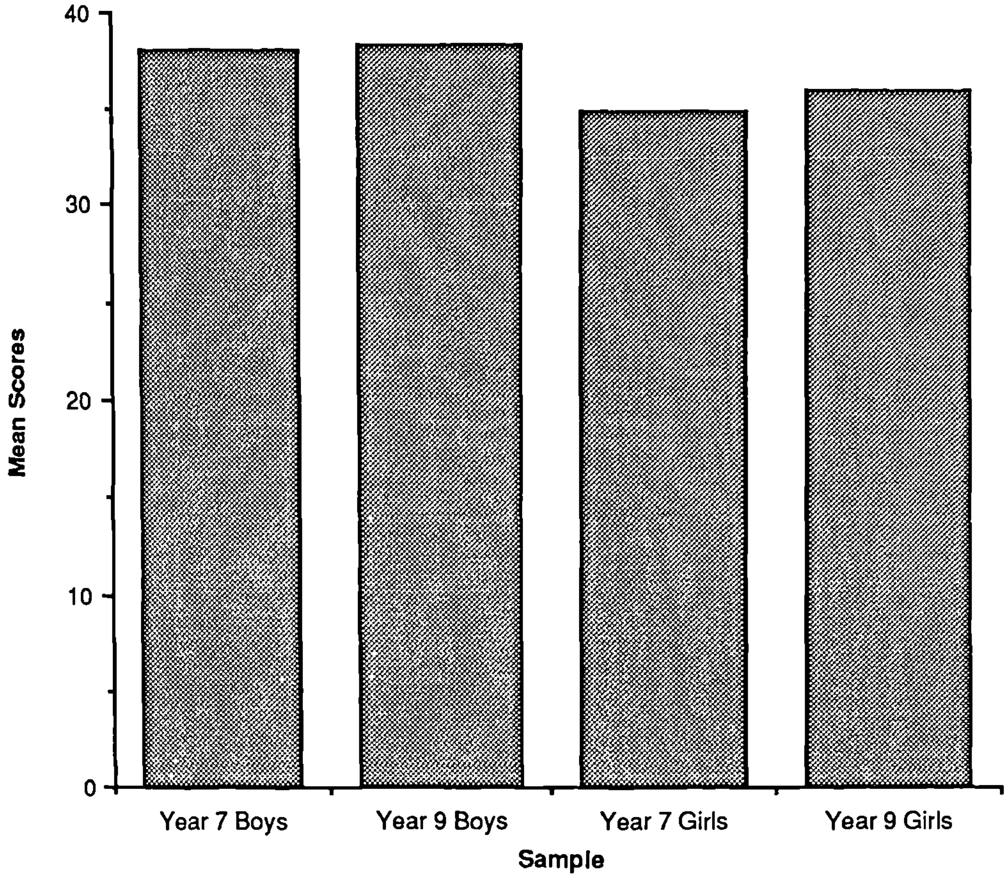


Figure 7.11 Activity Status of the Year 7 Boys

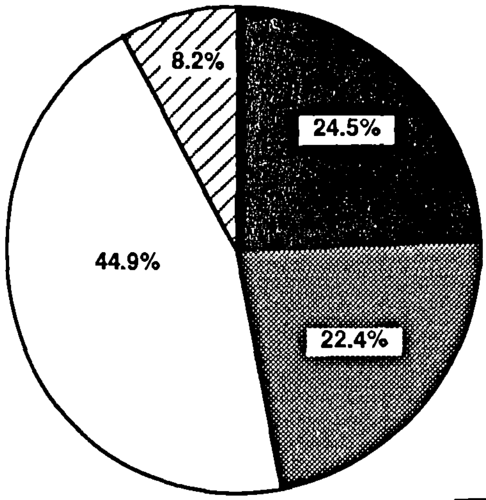
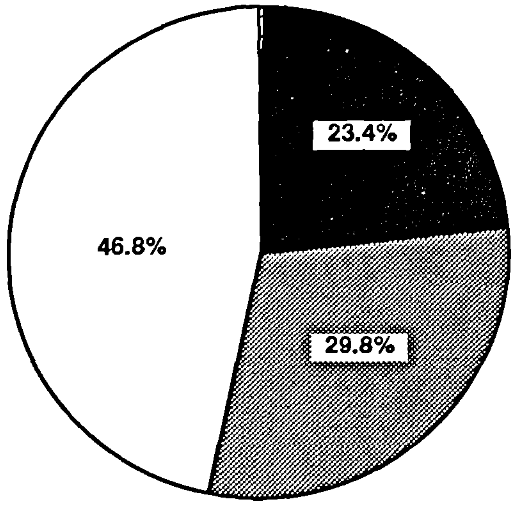


Figure 7.12 Activity Status of the Year 9 Boys



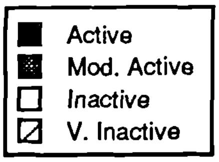


Figure 7.13 Activity Status of the Year 7 Girls

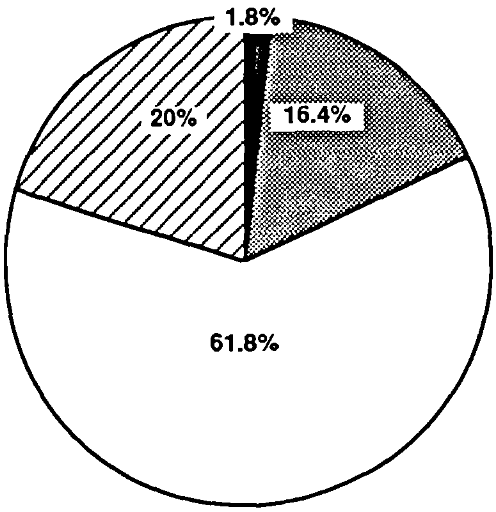


Figure 7.14 Activity Status of the Year 9 Girls

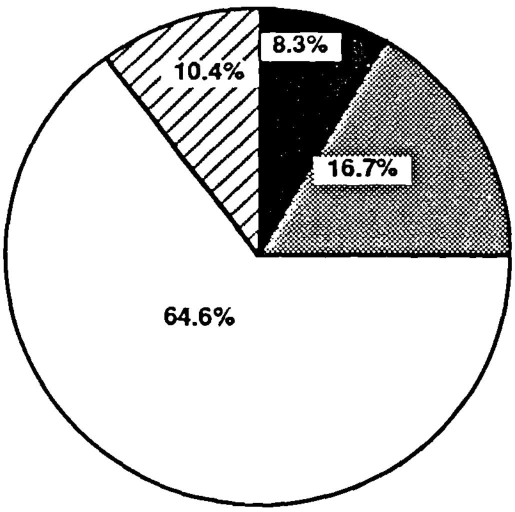


Figure 7.15 Activity Status of the Sample by Age and Sex

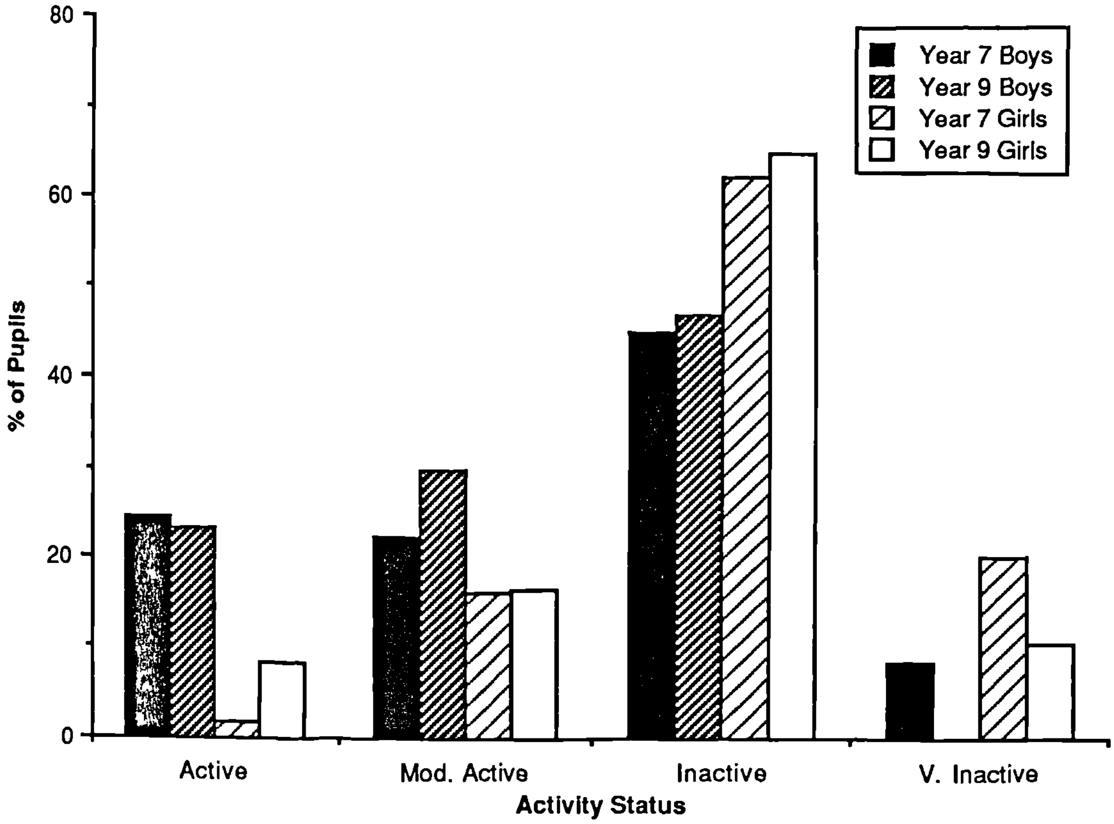


Table 7.9 The Mean, Minimum and Maximum Activity Scores for each School

School	Cases	Mean	SD	Min	Max
1	17	36.68	4.07	33.05	49.96
2	16	35.91	2.77	30.84	42.00
3	15	37.07	4.40	32.27	47.61
4	12	37.81	4.16	32.71	48.07
5	20	37.32	5.74	31.80	57.26
6	19	37.16	3.55	32.15	45.74
7	14	35.89	2.59	32.53	41.09
8	17	35.02	2.02	32.68	39.89
9	17	37.75	3.26	32.19	44.18
10	19	37.99	6.39	31.61	53.28
11	14	35.52	3.86	31.71	47.72
12	10	36.92	3.69	32.83	44.53
13	9	35.76	2.21	33.03	38.78
Total	199	36.73	4.07	30.84	57.26

school were all relatively comparable, as illustrated in figure 7.16, large differences were found between the number of active pupils and the number of inactive pupils within the various schools (see figure 7.17). The school with the highest proportion of active pupils was school no' 10, with 26.34%. However, a number of other schools also had 20% or more pupils who were active (schools 4, 5, 6, 9 and 12). Two schools were found to have no active pupils (schools 8 and 13). In fact, school number 8 was found to have no active pupils and only 11% (n=2) moderately active pupils. The remaining pupils were classified inactive (82.3%, n=14) or very inactive (5.9%, n=1). Virtually all schools (with one exception), had predominantly more inactive or very inactive pupils than active or moderately active. The exception was school no' 4, in which 60.35% of the pupils sampled were moderately active or active and 41.65% inactive or very inactive.

Figure 7.16 Mean Activity Scores by School

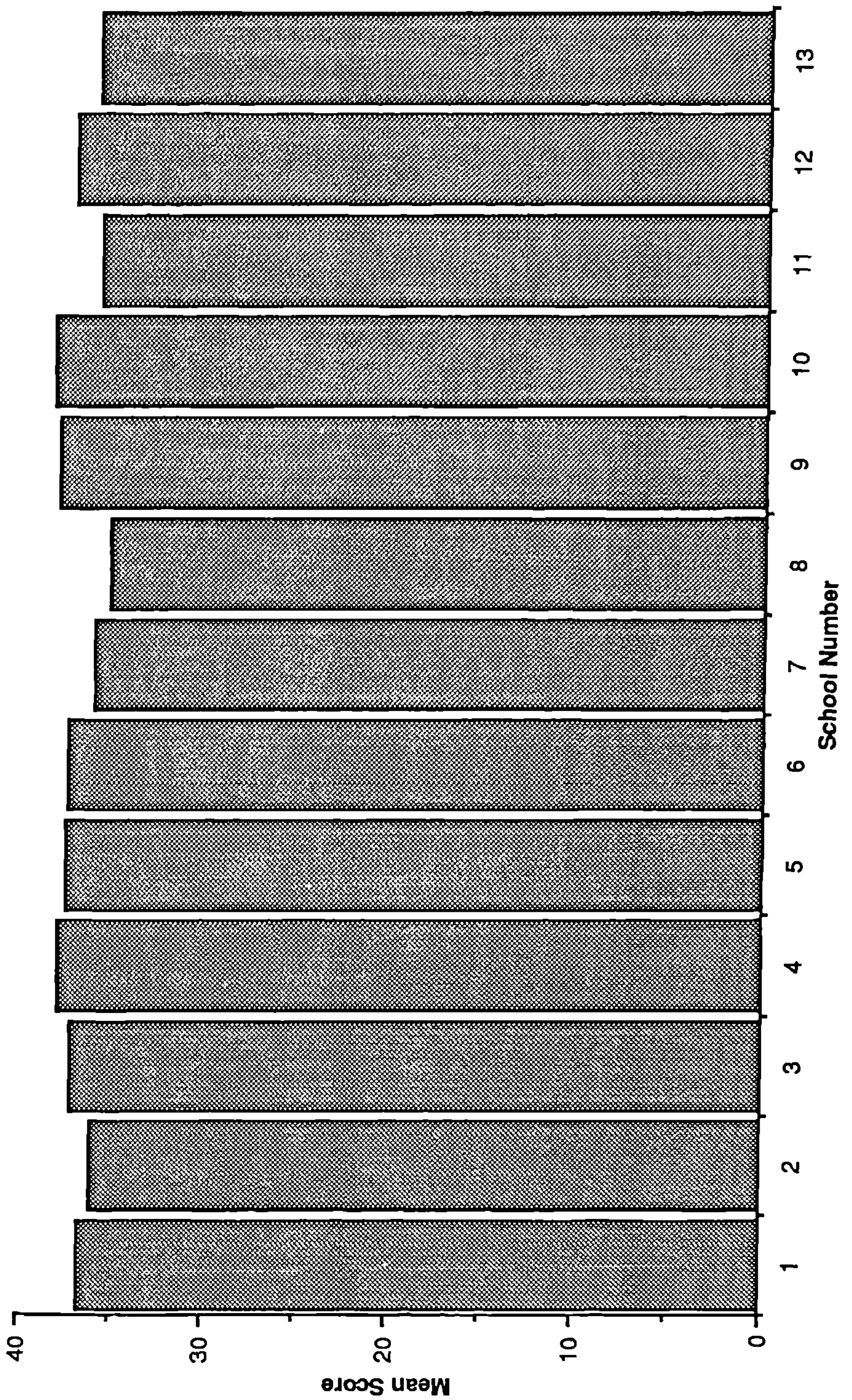


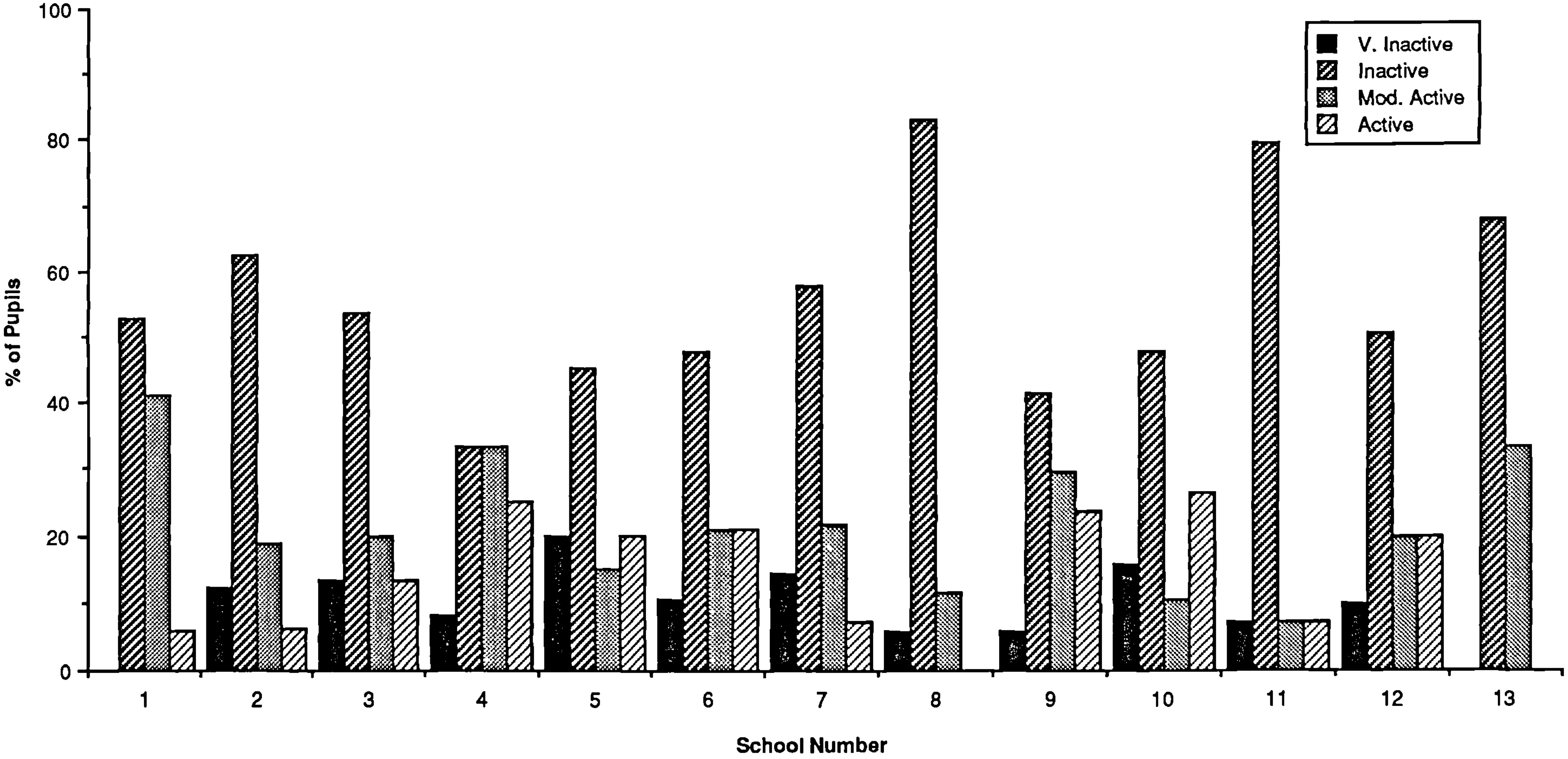
Table 7.10a Activity Status of the Sample by Schools (%)

	School Number												
Activity Status%	1	2	3	4	5	6	7	8	9	10	11	12	13
Active%	5.91	6.31	13.3	25	20	21.05	7.1	0	23.5	26.3	7.15	20	0
Moderately Active%	41.2	18.7	20	33.35	15	21.05	21.5	11.8	29.4	10.5	7.15	20	33.33
Inactive%	52.9	62.5	53.4	33.35	45	47.4	57.1	82.3	41.2	47.4	78.55	50	66.67
Very Inactive%	0	12.5	13.3	8.3	20	10.5	14.3	5.9	5.9	15.8	7.15	10	0

Table 7.10b Activity Status of the Sample by Schools (Number)

	School Number												
Activity Status NO'	1 n=17	2 n=16	3 n=15	4 n=12	5 n=20	6 n=19	7 n=14	8 n=17	9 n=17	10 n=19	11 n=14	12 n=10	13 n=9
Active	1	1	2	3	4	4	1	0	4	5	1	2	0
Moderately Active	7	3	3	4	3	4	3	2	5	2	1	2	3
Inactive	9	10	8	4	9	9	8	14	7	9	11	5	6
Very Inactive	0	2	2	1	4	2	2	1	1	3	1	1	0

Figure 7.17 Activity Status of the Sample by School



Note-While it is interesting to analyse the results by school, this was not an intended aim of the research therefore no further results for individual schools will be described in this chapter. A summary of the main findings for each school is presented in the appendix (Appendix P). It should be realised when considering these results however, that the generalisability of the findings within individual schools is limited given the limited sample size drawn from each of the schools.

Finally, summer and winter activity scores were investigated separately. The mean activity scores were 36.37 (SD=4.93) for the winter measure and 37.10 (SD=4.58) for the summer measure. A t test was employed to determine whether the difference between the two means was significant. The results of the test, however, revealed no significant difference between the winter and summer activity scores ($t=-2.11$, $p<0.05$) (see table 7.11).

7.6 Time Spent in Moderate Activity

The total time and the average daily time pupils spent in moderate activity was next calculated. The mean time spent in moderate activity over the 4 days was found to be 250.55 minutes (4 hours 10.55 minutes) (SD=167.42). The minimum amount of time spent in moderate activity over the 4 days was 0 minutes and the maximum amount of time was 1,030 minutes (17 hours 9.96 minutes). The average daily time spent in moderate activity was 62.64 minutes (SD=41.86), with a minimum daily average of 0 minutes and a maximum of 257.5 minutes (4 hours 17.46 minutes). A summary of the means and standard deviations for the total sample is shown in table 7.12.

As is evident from the large standard deviations and maximum and minimum values obtained, there were large individual differences in the amount of time pupils spent in moderate activity. It was found however, that most pupils had engaged in at least some moderate activity over the 4 days, albeit for only a short period of time in some cases. Indeed, 97.5% of the sample had engaged in some moderate activity over the 4 days. Over 90% (91.5%) had engaged in at least one hour of moderate activity over the 4 days, a daily average of 15 minutes per day, and a

Table 7.11 t test for Paired Samples

Group 1=Winter

Group 2=Summer

Activity Score	No' of Cases	Mean	Standard Deviation	Standard Error	t Value	Degrees of Freedom	2-tailed Prob
Group 1 Winter	199	36.37	4.93	0.35	-2.11	198	0.036
Group 2 Summer		37.10	4.58	0.33			

considerable number were found to have engaged in excess of this. The percentage of pupils spending daily averages of between 0-19 minutes, 20-29 minutes, 30-59 minutes, up to a maximum of 180 minutes or more was then considered. It was revealed that only 14.1% of the sample had spent less than a daily average of 20 minutes in moderate activity. Almost 80% (78.4%) of the sample had engaged in a daily average of 30 minutes or more, and 47.2% had engaged in a daily average of an hour or more of moderate activity. Figure 7.18 shows the relative proportions of time the pupils spent in daily moderate activity.

The boys were found to spend more time in moderate activity than the girls over the 4 days. The mean time spent in moderate activity by the boys was reported to be 313.95 minutes (5 hours 13.95 minutes) (SD=168.34), compared to 191.46 (3 hours 11.46 minutes) (SD=143.9) by the girls. The daily averages were 78.48 minutes (SD=42.09) for the boys and 47.99 minutes (SD=35.98) for the girls respectively. The means and standard deviations for time spent in moderate activity are provided in table 7.12 and figure 7.19 illustrates the difference between the total sample and the boys and girls. All of the boys in the sample were found to have engaged in some moderate activity over the 4 days. The minimum amount of time recorded by any boy was 75 minutes, a daily average of 18.75 minutes. Just 1% of boys had engaged in less than a daily average of 20 minutes of moderate activity. More than 90% had engaged in a daily average of 30 minutes or more and 63.5% had engaged in a daily average of 60 minutes or more. In contrast, 4.9% of the girls were reported to have done no moderate activity at all over the 4 days and 26.2% had spent a daily average of less than 20 minutes. The proportion of girls spending a daily average of 30 minutes or more and 60 minutes or more in moderate activity was considerably lower than the boys. Sixty five percent of girls spent 30 minutes or more (compared to more than 90% of the boys) and just 32% spent an average of an hour or more in daily moderate activity (compared to 63.5% of boys) (see figure 7.20).

Table 7.12 Mean Time Spent In Moderate Activity-Boys and Girls

MODERATE ACTIVITY	Total (n=199)	Boys (n=96)	Girls (n=103)
TOTAL TIME (4 DAYS) IN MINUTES	250.55 SD=167.41	313.95 SD=168.34	191.46 SD=143.9
AVERAGE DAILY TIME IN MINUTES	62.64 SD=41.86	78.48 SD=42.09	47.87 SD=35.98

TOTAL SAMPLE

TOTAL ACTIVITY	MAXIMUM=1030 MINIMUM=0		
DAILY ACTIVITY	MAXIMUM=257.5 MINIMUM=0		
BOYS		GIRLS	
TOTAL ACTIVITY	MAXIMUM=1030 MINIMUM=75	TOTAL ACTIVITY	MAXIMUM=745 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=257.5 MINIMUM=18.75	DAILY ACTIVITY	MAXIMUM=186.25 MINIMUM=0

The differences in time spent in moderate activity were not so obvious between the year 7 and year 9 pupils. Year 7 pupils reported to spend more time in moderate activity than year 9 pupils. Year 7 pupils spent 265.01 minutes (4 hours 25.01 minutes) (SD=174.77) and year 9 pupils 234.73 minutes (3 hours 54.73 minutes) (SD=158.39) in moderate activity over the 4 days, a daily average of 66.25 minutes (SD=43.69) and 58.68 minutes (SD=39.59) respectively (table 7.13 and figure 7.21). The differences in the relative proportions of time spent in moderate activity by age were also not so obvious. Just 1% of year 7 pupils and 4.2% of year 9 pupils had engaged in no moderate activity over the 4 days and 12.5% and 15.8% had engaged in a daily average of less than 20 minutes respectively. Approximately 80% of year 7 pupils and 75% of year 9 pupils spent a daily average of 30 minutes or more in moderate activity, while the corresponding figures for an hour or more of daily moderate activity were 47.1% (year 7) and 47.4% (year 9). Figure 7.22 illustrates these findings.

Figure 7.18 Proportions of Time Spent in Moderate Activity (Daily)

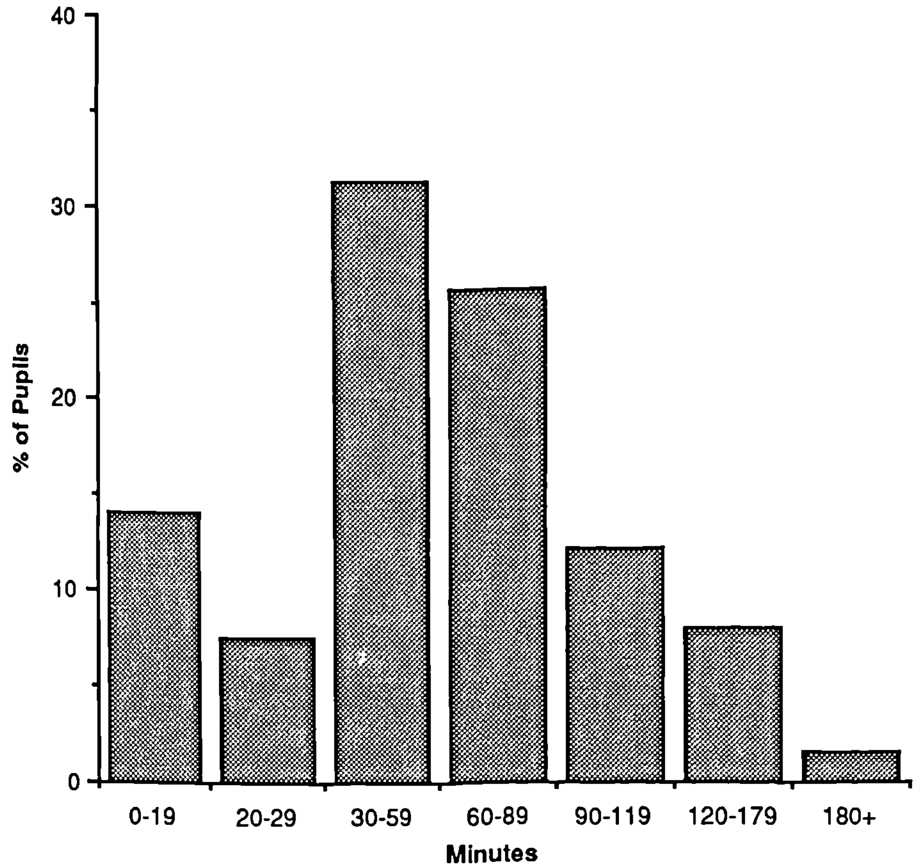


Figure 7.19 Average Daily Time Spent in Moderate Activity -Total, Boys and Girls

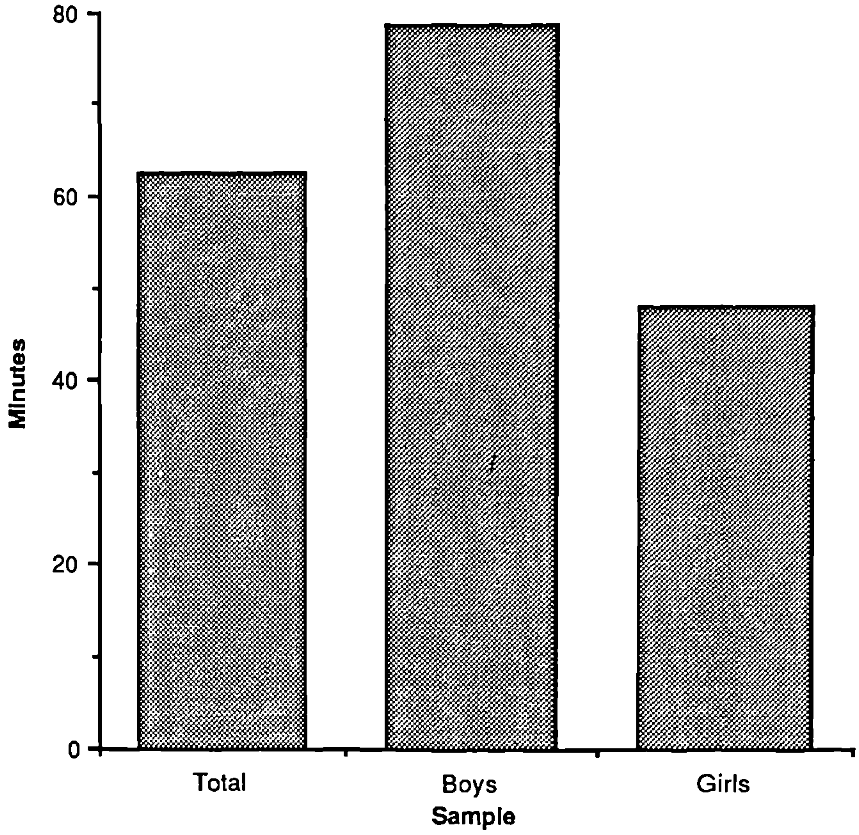


Figure 7.20 Proportions of Time Spent by Boys and Girls in Moderate Activity (Daily)

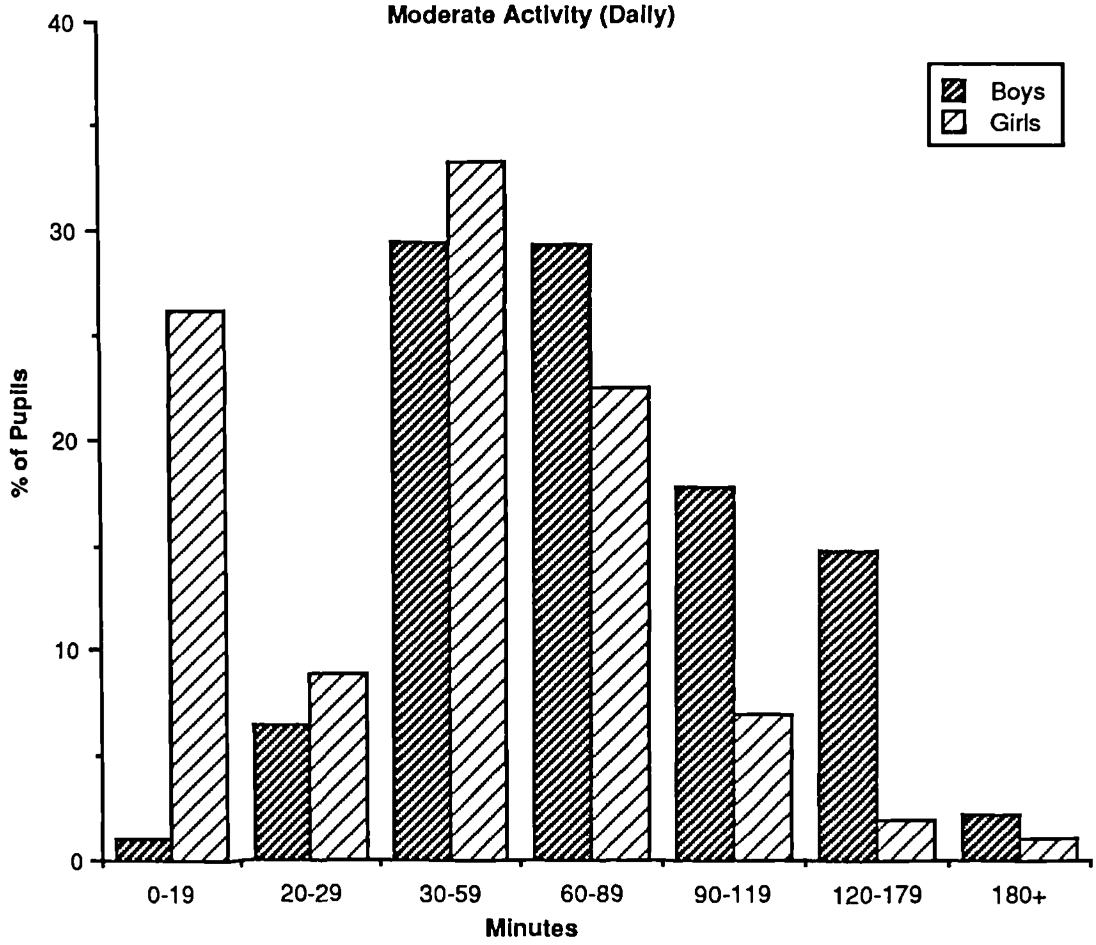


Figure 7.21 Average Daily Time Spent in Moderate Activity -Total, Year 7 and Year 9 Pupils

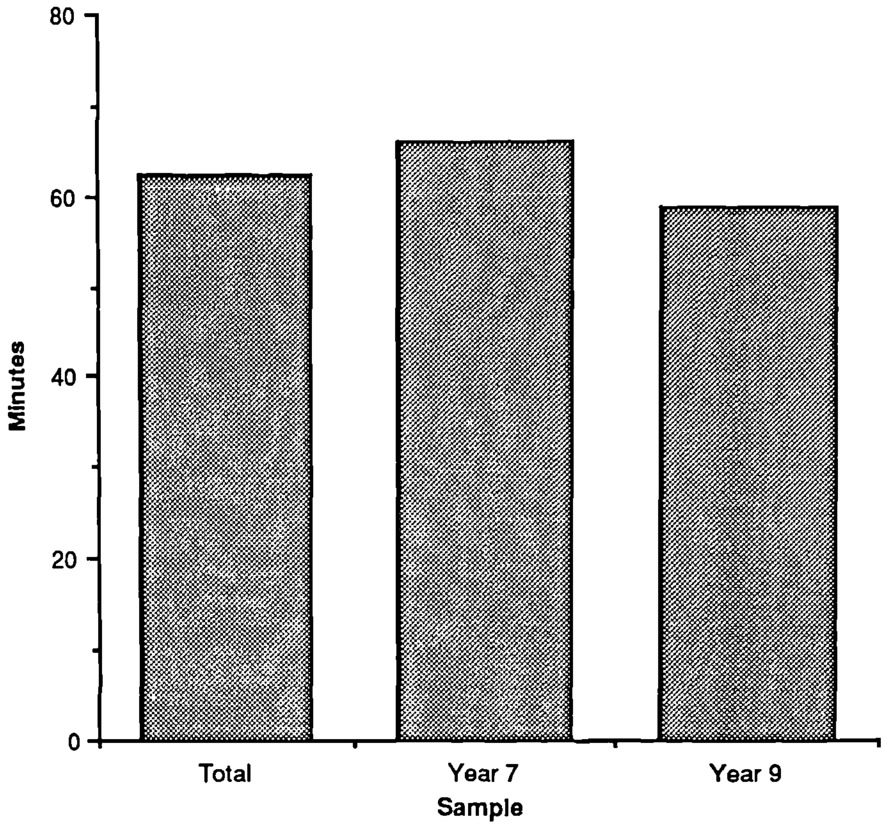


Figure 7.22 Proportions of Time Spent by Year 7 and Year 9 Pupils in Moderate Activity (Daily)

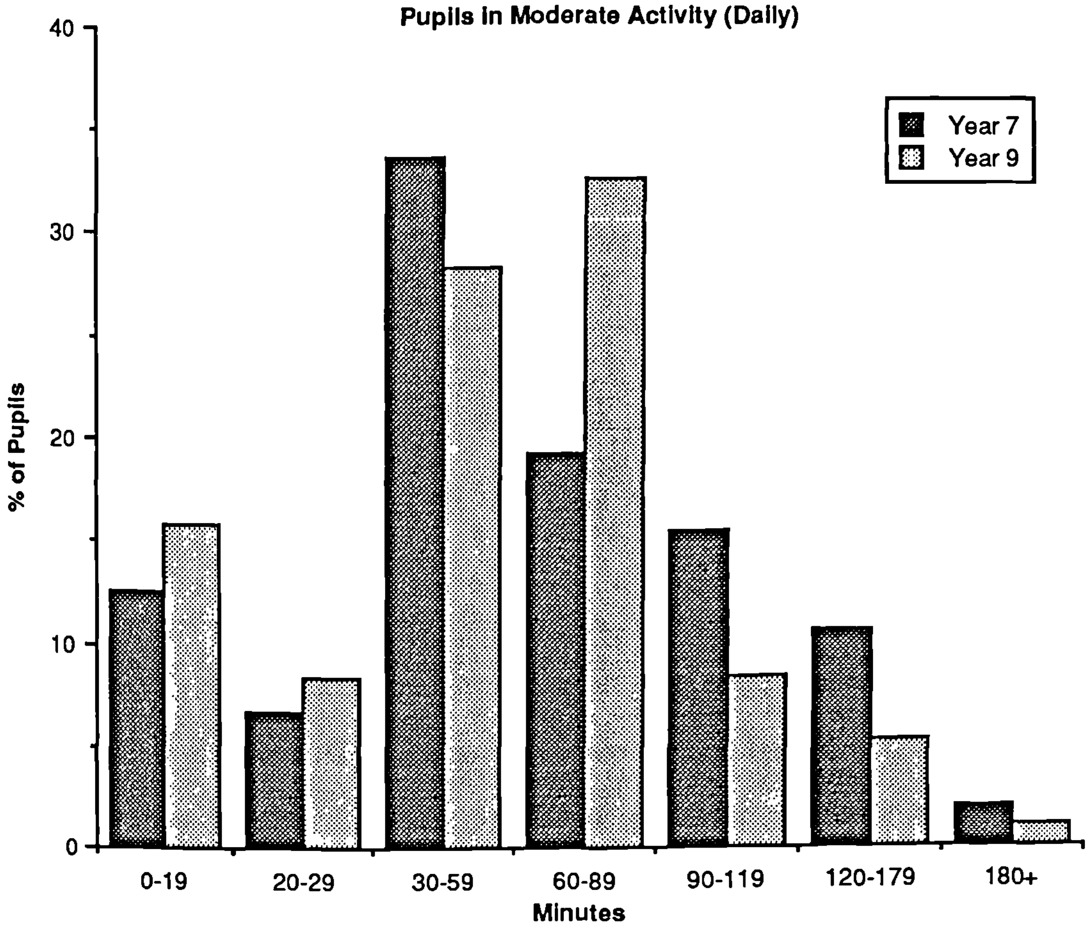


Table 7.13 Mean Time Spent In Moderate Activity-Year 7 and Year 9 Pupils

MODERATE ACTIVITY	Total (n=199)	Year 7 (n=104)	Year 9 (n=95)
TOTAL TIME (4 DAYS) IN MINUTES	250.55 SD=167.41	265.01 SD=174.77	234.73 SD=158.39
AVERAGE DAILY TIME IN MINUTES	62.64 SD=41.86	66.25 SD=43.69	58.68 SD=39.59

YEAR 7		YEAR 9	
TOTAL ACTIVITY	MAXIMUM=745 MINIMUM=0	TOTAL ACTIVITY	MAXIMUM=1030 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=186.25 MINIMUM=0	DAILY ACTIVITY	MAXIMUM=257.5 MINIMUM=0

Finally, time spent in moderate activity was analysed by age and sex. The means of the four groups are shown in figure 7.23 and the means and standard deviations are presented in table 7.14. As can be seen from the figure in particular, year 7 boys spent the most amount of time in moderate activity, spending a daily average of 81.51 minutes (SD=44.63), while year 9 girls spent the least amount of time (42.37 minutes) (SD=32.56). Indeed, it can be seen that the year 7 boys spent almost twice the amount of time in moderate activity than the year 9 girls. The next most active group in terms of moderate activity were the year 9 boys followed by the year 7 girls.

In terms of the proportions of time spent in moderate activity by the different groups, year 7 boys and year 9 boys again came out the most favourable. The minimum time spent in moderate activity by any year 7 boy was 75 minutes over the 4 days and 91.8% of this age group spent a daily average of 30 minutes or more in moderate activity. The percentage of year 7 boys spending an hour or more in moderate activity was also found to be relatively high (57.1%). The minimum time spent in moderate activity by year 9 boys was 90 minutes and 93.6% had spent a daily average of 30 minutes or more and 70.2% an average of an hour or more in moderate activity. When moderate activity in year 7 girls was considered, 70.9% had engaged in a daily average of 30 minutes or more but only 38.2% in an average of an hour or more. The results for the year 9 girls were lower still. A number of girls of this age (8.3%) reported to take no moderate activity at all over the 4 days, 58.3% took a daily average of 30 minutes or more and only 25% took an average of an hour or more. These results are presented in figure 7.24.

Table 7.14 Mean Time Spent In Moderate Activity-Age and Sex

MODERATE ACTIVITY	Year 7 Boys (n=49)	Year 9 Boys (n=47)	Year 7 Girls (n=55)	Year 9 Girls (n=48)
TOTAL TIME (4 DAYS) IN MINUTES	326.02 SD=178.52	301.36 SD=157.97	210.66 SD=153.44	169.48 SD=130.24
AVERAGE DAILY TIME IN MINUTES	81.51 SD=44.63	75.34 SD=39.49	52.66 38.36	42.37 SD=32.56

YEAR 7 BOYS		YEAR 7 GIRLS	
TOTAL ACTIVITY	MAXIMUM=735 MINIMUM=75	TOTAL ACTIVITY	MAXIMUM=745 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=183.75 MINIMUM=18.75	DAILY ACTIVITY	MAXIMUM=186.25 MINIMUM=0
YEAR 9 BOYS		YEAR 9 GIRLS	
TOTAL ACTIVITY	MAXIMUM=1030 MINIMUM=90	TOTAL ACTIVITY	MAXIMUM=670 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=257.5 MINIMUM=22.5	DAILY ACTIVITY	MAXIMUM=167.5 MINIMUM=0

7.7 Time Spent In Hard/Very Hard Activity

The time pupils spent in hard activity and in very hard activity were added together to give a combined total time in hard/very hard activity and a combined daily average time in hard/very hard activity. The results for time spent in hard/very hard activity were then analysed in the same way as they were for time spent in moderate activity. The mean time spent in hard/very hard activity over the 4 days was 67.39 minutes (SD=107.39). The minimum amount of time spent in this category of activity was 0 minutes and the maximum amount of time was 645 minutes (10 hours 45 minutes). The average daily time spent in hard/very hard activity was thus 16.85 minutes (SD=26.91), with minimum and maximum daily values of 0 minutes and 161.25 minutes (2 hours 41.25 minutes) respectively.

Figure 7.23 Average daily Time Spent in Moderate Activity -Age and Sex

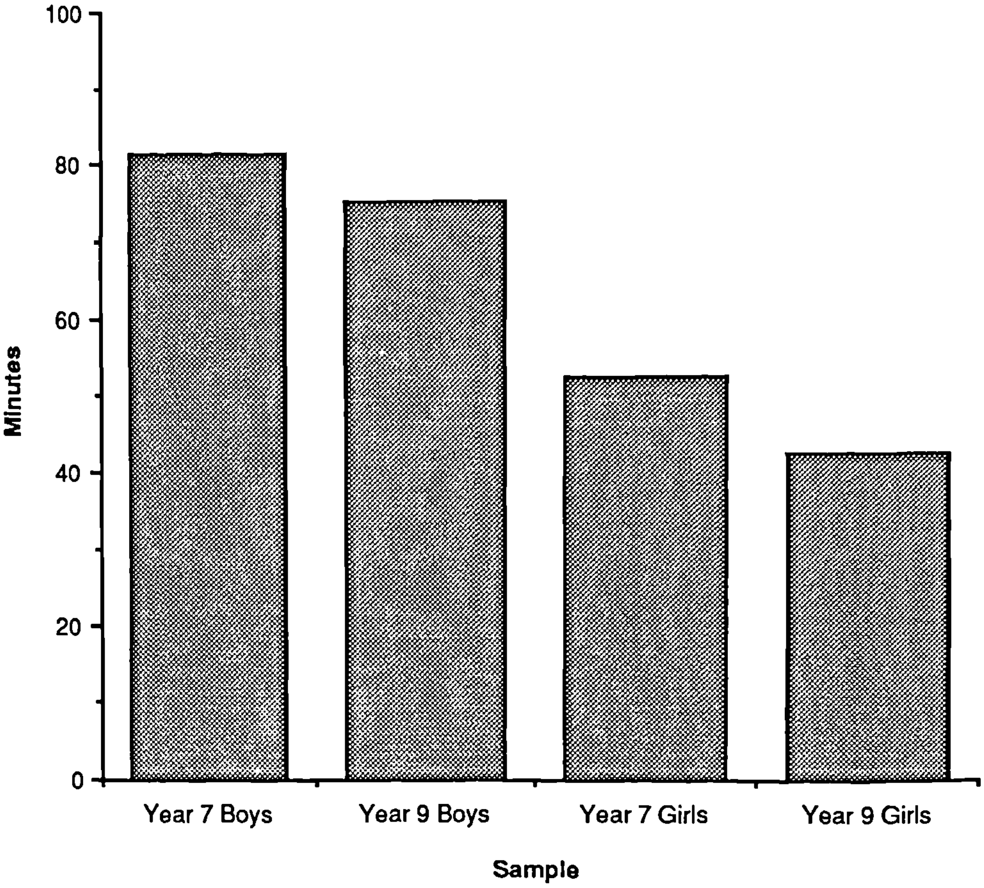
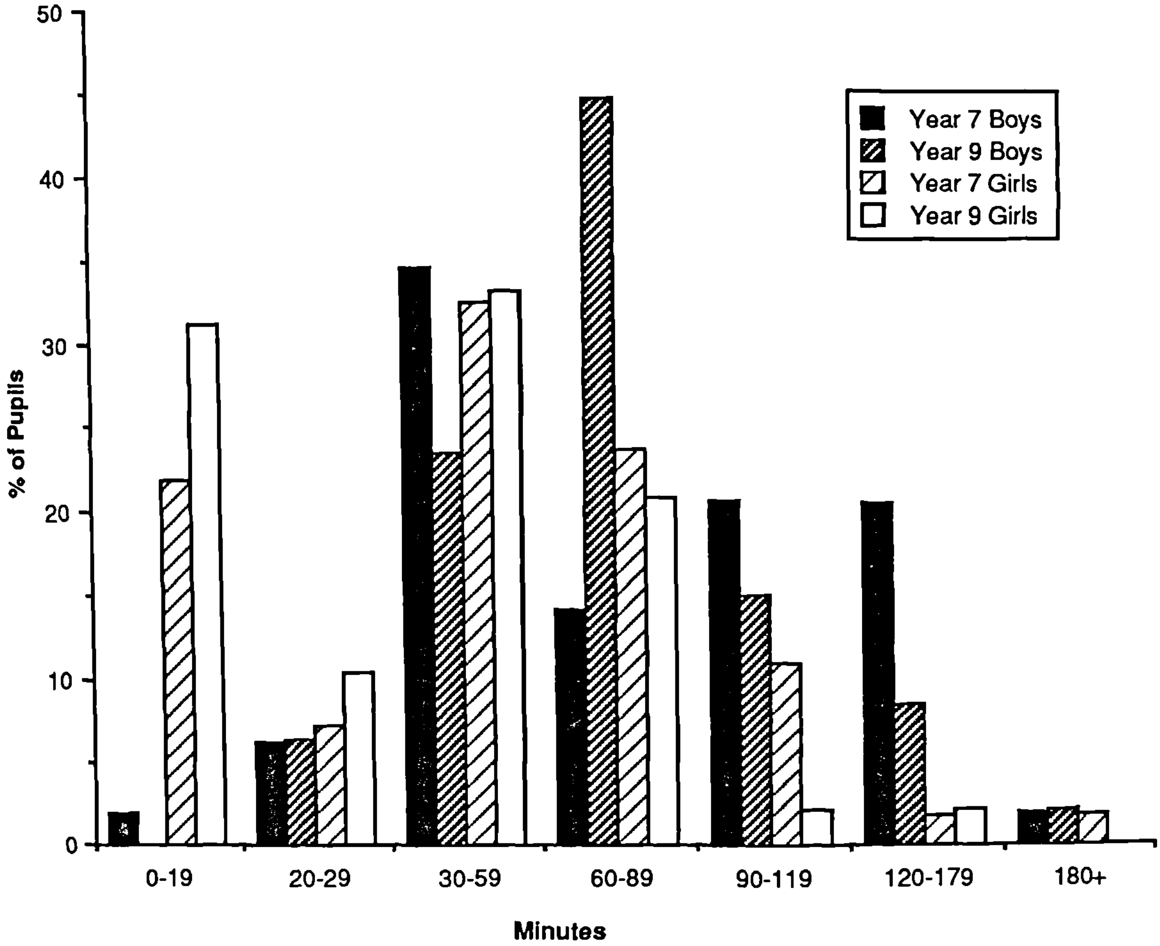


Figure 7.24 Proportions of Time Spent by Age and Sex in Moderate Activity



As with moderate activity, large differences were found in the amount of time spent by pupils in hard/very hard activity. In contrast to the findings for moderate activity, however, in which most pupils had been found to have engaged in at least some such activity over the 4 days, a large proportion of the pupils were found to have engaged in no hard/very hard activity. Indeed, 38.7% of the sample reported to have engaged in no such activity over the 4 days. Furthermore, of those who reported that they had engaged in some hard/very hard activity, more than 60% of them had engaged in less than 1 hour over the 4 day period. When the percentage of pupils engaging in daily averages of specific time intervals was considered, virtually all of the pupils were now categorised in the lower three time intervals (i.e., 0-19 minutes, 20-29 minutes and 30-59 minutes) (figure 7.25). Approximately 70% (70.4%) of the sample had engaged in a daily average of less than 20 minutes of hard/very hard activity. Less than one fifth (19.6%) of the sample had engaged in 30 minutes or more and only 6.5% in 1 hour or more of hard/very hard activity.

In analysing the time spent in hard/very hard activity by the boys and girls separately, the boys were found to have spent more than twice the amount of time in hard/very hard activity than the girls. Boys recorded an average of 95.44 minutes in hard/very hard activity (SD=123.701) over the 4 days, compared to 41.24 minutes (SD=82.49) by the girls. The daily averages were 23.86 minutes for the boys (SD=30.93) and 10.31 minutes for the girls (SD=20.62). The total time and daily average time spent by boys and girls in hard/very hard activities is shown in Table 7.15 and the daily average time is shown in figure 7.26.

Interesting differences also emerged in terms of the proportions of time the boys and girls spent in hard/very hard activity. In the case of the boys, 31.3% were found to have engaged in no hard/very hard activity over the 4 days and 56.3% revealed to have engaged in less than a daily average of 20 minutes. Approximately 30% (29.2%) were found to have taken 30 minutes or more and 11.5% to have taken 1 hour or more of hard/very hard activity. The percentage of girls reported to have engaged in no hard/very hard activity was higher than in the boys. In the girls, 45.6% had engaged in no hard/very hard activity over the 4 days and 83.5% had engaged in a daily average of less than 20 minutes hard/very hard activity. Only 16.5% therefore, had engaged in a daily average of 20 minutes or more, while just 10.7% and 1.9% had spent 30 minutes or more or 1 hour or more respectively in hard/very hard activity (see figure 7.27).

When it came to differences in hard/very hard activity by age, surprisingly the year 9 pupils reported to spend more time in hard/very hard activity than the year 7 pupils. This finding is contrary to the finding for moderate activity. Year 7 pupils spent an average of 56.73 minutes (SD=92.27) and year 9 pupils 79.05 minutes (SD=121.05) in hard/very hard activity over the 4 days. The daily averages were thus 14.18 minutes (SD=23.07) and 19.76 minutes (SD=30.43) for year 7 and year 9 pupils respectively. The means and standard deviations for time spent in hard/very hard activity by the year 7 and year 9 pupils are presented in table 7.16. Figure 7.28 illustrates the average daily time spent in hard/very hard activity by the year 7 and year 9 pupils. Similar proportions of year 7 and year 9 pupils were found to have engaged in no hard/very hard activity. The figures for no activity were 38.5% for year 7 and 38.9% for year 9 pupils. Similar daily averages of 20 minutes, 30 minutes and 1 hour or more of hard/very hard activity were also evidenced. Seventy five percent of year 7 pupils and 65.3% of year 9 pupils had engaged in less than a daily average of 20 minutes of moderate activity. In other words, only a quarter of year 7 pupils and 34% of year 9 pupils had engaged in 20 minutes or more of hard/very hard activity, while 14.4% and 25.3% had engaged in 30 minutes or more and only 6.7% and 6.3% of year 7 and year 9 pupils respectively had engaged in 1 hour or more. These results are presented in figure 7.29.

Table 7.15 Mean Time Spent in Hard/Very Hard Activity-Boys and Girls

HARD/VERY HARD ACTIVITY	Total (n=199)	Boys (n=96)	Girls (n=103)
TOTAL TIME (4 DAYS) IN MINUTES	67.39 SD=107.63	95.44 SD=123.70	41.24 SD=82.49
AVERAGE DAILY TIME IN MINUTES	16.85 SD=26.91	23.86 SD=30.93	10.31 SD=20.62

TOTAL SAMPLE

TOTAL ACTIVITY	MAXIMUM=645	MINIMUM=0
DAILY ACTIVITY	MAXIMUM=161.25	MINIMUM=0

BOYS

TOTAL ACTIVITY	MAXIMUM=645	MINIMUM=0
DAILY ACTIVITY	MAXIMUM=161.25	MINIMUM=0

GIRLS

TOTAL ACTIVITY	MAXIMUM=620	MINIMUM=0
DAILY ACTIVITY	MAXIMUM=155.0	MINIMUM=0

Table 7.16 Mean Time Spent in Hard/Very Hard Activity-Year 7 and 9 Pupils

MODERATE ACTIVITY	Total (n=199)	Year 7 (n=104)	Year 9 (n=95)
TOTAL TIME (4 DAYS) IN MINUTES	67.39 SD=107.63	56.73 SD=92.27	79.05 SD=121.70
AVERAGE DAILY TIME IN MINUTES	16.85 SD=26.91	14.81 SD=23.07	19.76 SD=30.43

YEAR 7

TOTAL ACTIVITY	MAXIMUM=510	MINIMUM=0
DAILY ACTIVITY	MAXIMUM=127.5	MINIMUM=0

YEAR 9

TOTAL ACTIVITY	MAXIMUM=645	MINIMUM=0
DAILY ACTIVITY	MAXIMUM=161.25	MINIMUM=0

Finally, the results for hard/very hard activity were analysed by age and sex. Table 7.17 and figure 7.30 not only illustrates very clearly the large difference in time spent in hard/very hard

Figure 7.25 Proportions of Time Spent in Hard/Very Hard Activity (Daily)

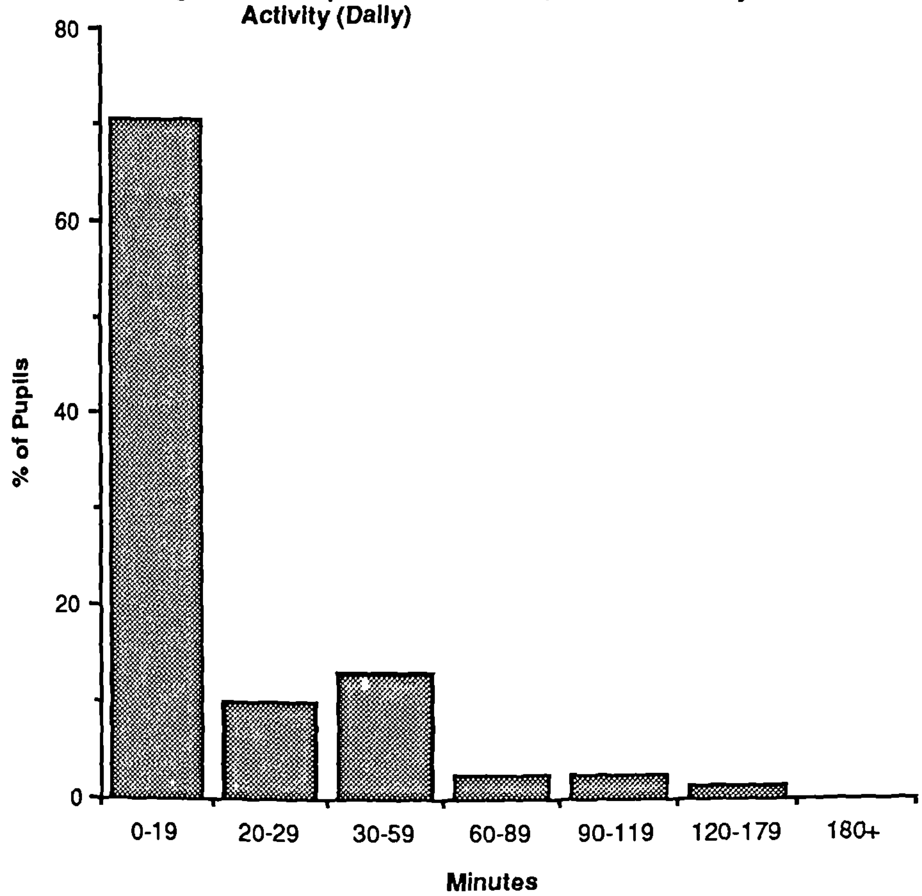


Figure 7.26 Average Daily Time Spent In Hard/Very Hard -Total, Boys and Girls

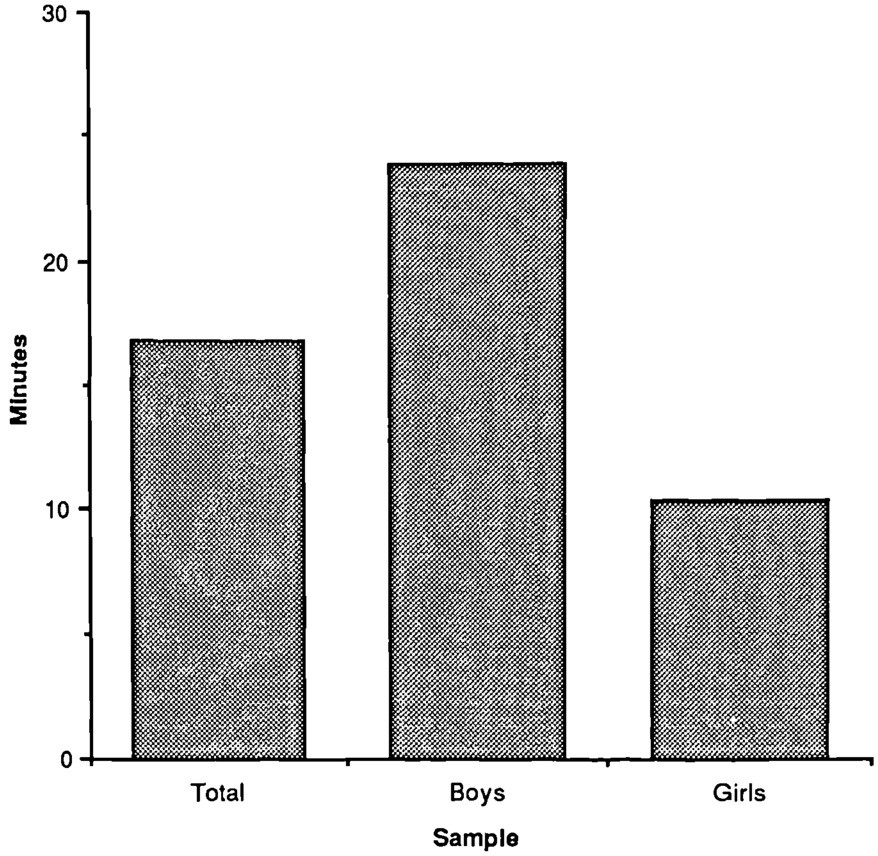


Figure 7.27 Proportions of Time Spent by Boys and Girls in Hard/Very Hard Activity (Daily)

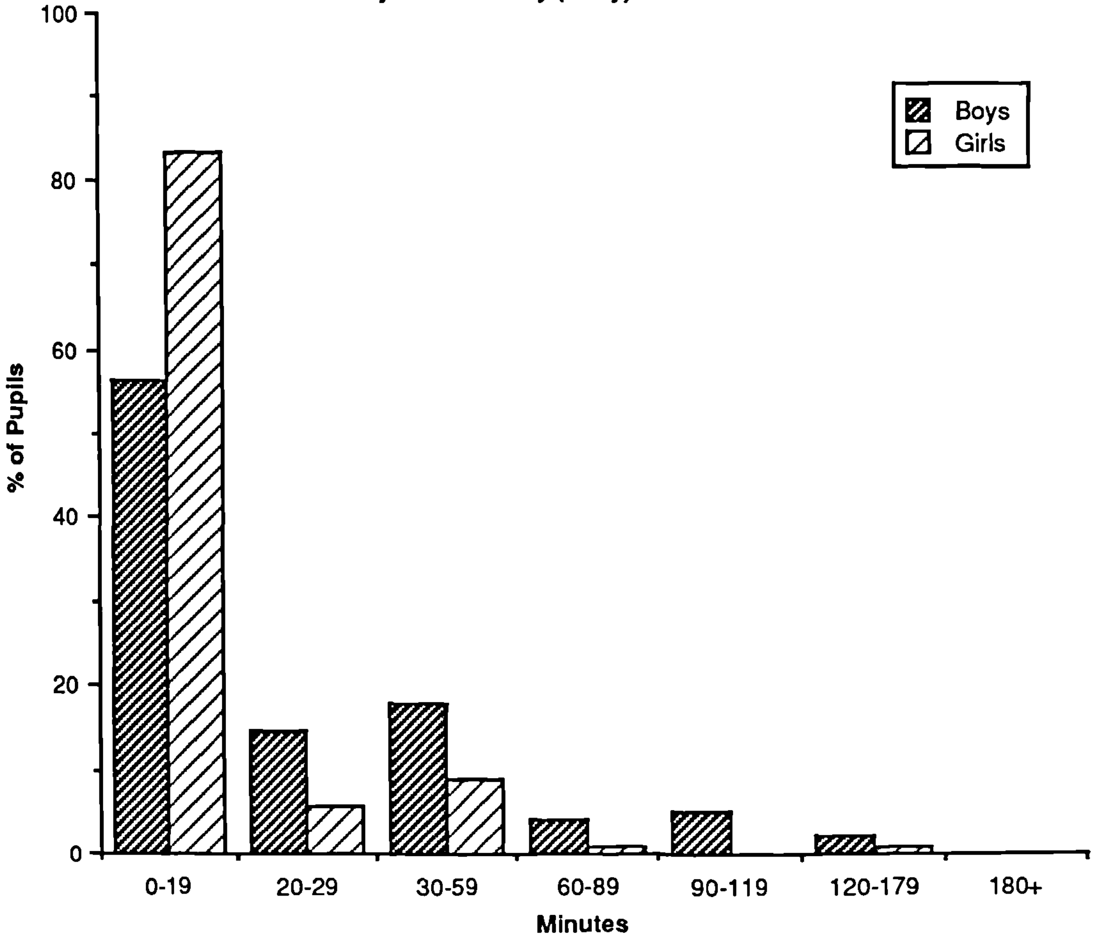


Figure 7.28 Average Daily Time Spent In Hard/Very Hard Activity-Total, Year 7 and Year 9 Pupils

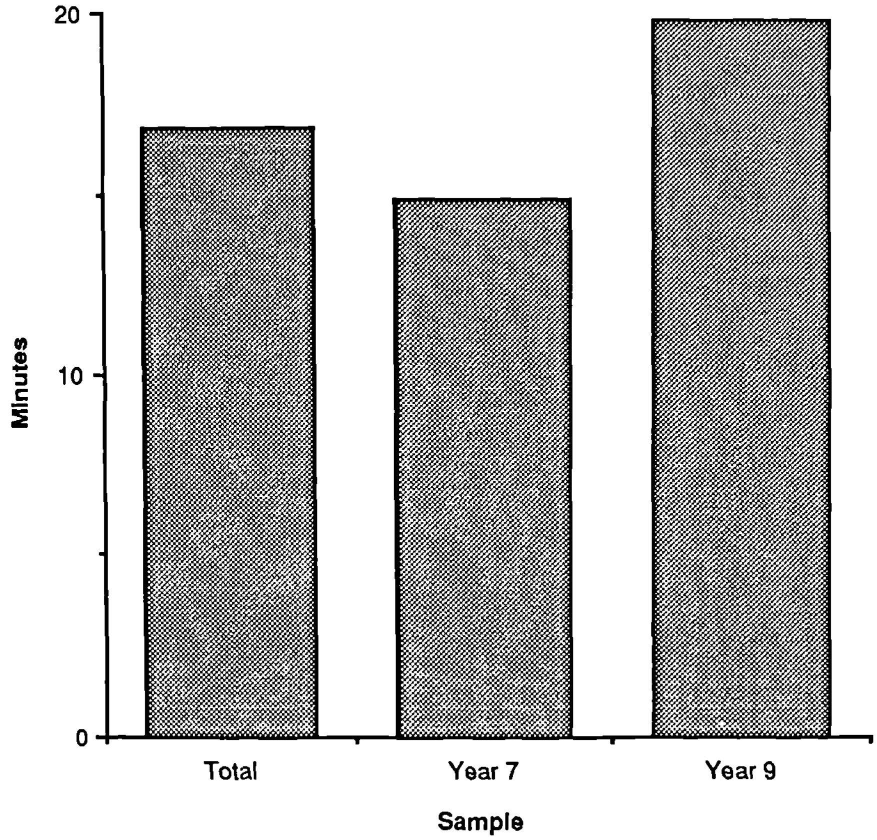
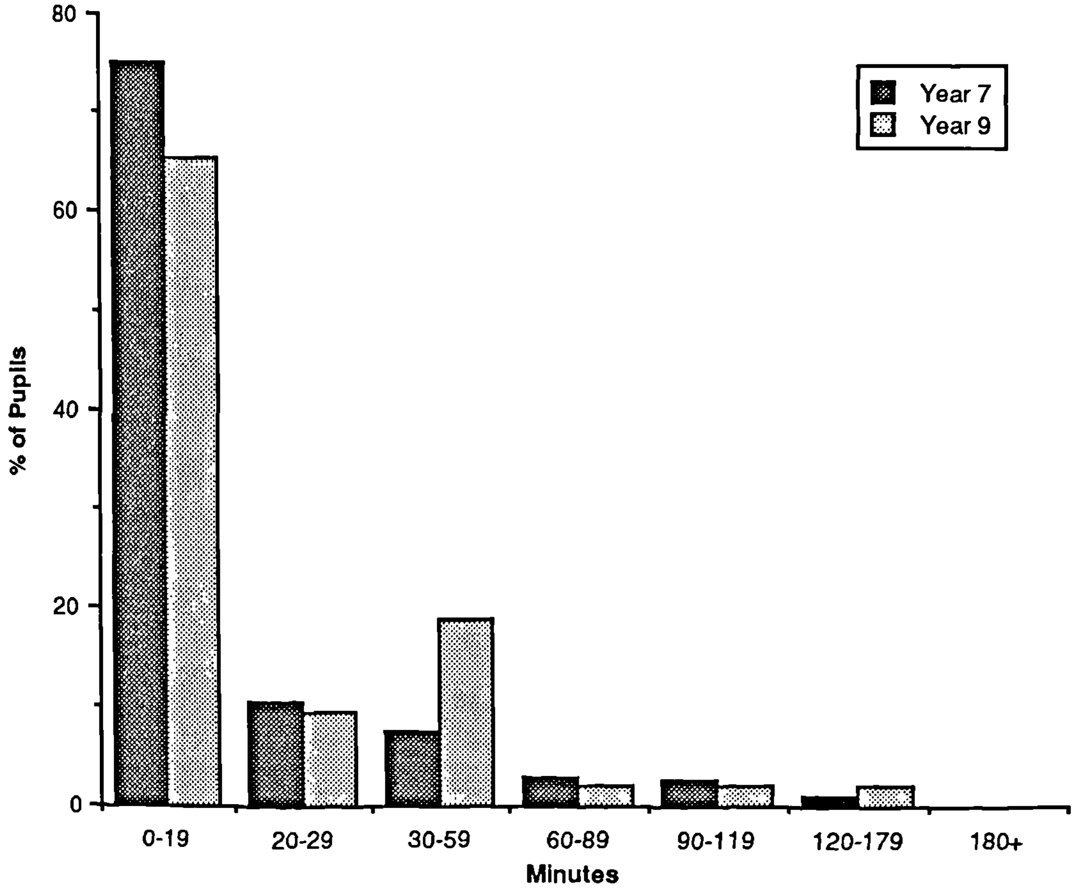


Figure 7.29 Proportions of Time Spent by Year 7 and Year 9 Pupils in Hard/Very Hard Activity (Daily)



activity between boys and girls (highlighted earlier), but more particularly the large difference between the time spent in hard/very hard activity by the year 7 girls and the other groups. The year 7 girls reported to spend a daily average of only 5.9 minutes (SD=5.90) in hard/very hard activity. In fact, the year 7 and year 9 boys engaged in approximately four times and the year 9 girls more than two and a half times as much hard/very hard activity as the year 7 girls. The highest proportion of non-participants in hard/very hard activity were found amongst the year 9 girls (52.1%) followed by the year 7 girls (40%). The lowest number of non-participants were found in the sample of year 9 boys, but still a quarter (25%) reported to have spent no time in hard/very hard activity over the 4 days. The percentage of year 7 girls who had engaged in hard/very hard activity for any length of time was also low. More than 90% had engaged in a daily average of less than a 20 minutes, just 1.8% had engaged in exactly 30 minutes and none had engaged in daily hard/very hard activity for longer than this (figure 7.31).

Table 7.17 Mean Time Spent In Hard/Very Hard Activity-Age and Sex

MODERATE ACTIVITY	Year 7 Boys (n=49)	Year 9 Boys (n=47)	Year 7 Girls (n=55)	Year 9 Girls (n=48)
TOTAL TIME (4 DAYS) IN MINUTES	93.92 SD=120.49	97.02 SD=128.25	23.60 SD=30.97	61.46 SD=113.52
AVERAGE DAILY TIME IN MINUTES	23.48 SD=30.12	24.26 SD=32.06	5.90 SD=7.74	15.37 SD=28.38

<u>YEAR 7 BOYS</u>

TOTAL ACTIVITY	MAXIMUM=510 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=127 MINIMUM=0

<u>YEAR 7 GIRLS</u>

TOTAL ACTIVITY	MAXIMUM=120 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=30 MINIMUM=0

<u>YEAR 9 BOYS</u>

TOTAL ACTIVITY	MAXIMUM=645 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=161.25 MINIMUM=0

<u>YEAR 9 GIRLS</u>

TOTAL ACTIVITY	MAXIMUM=620 MINIMUM=0
DAILY ACTIVITY	MAXIMUM=155 MINIMUM=0

Figure 7.30 Average Daily Time Spent In Hard/Very Hard Activity
-Age and Sex

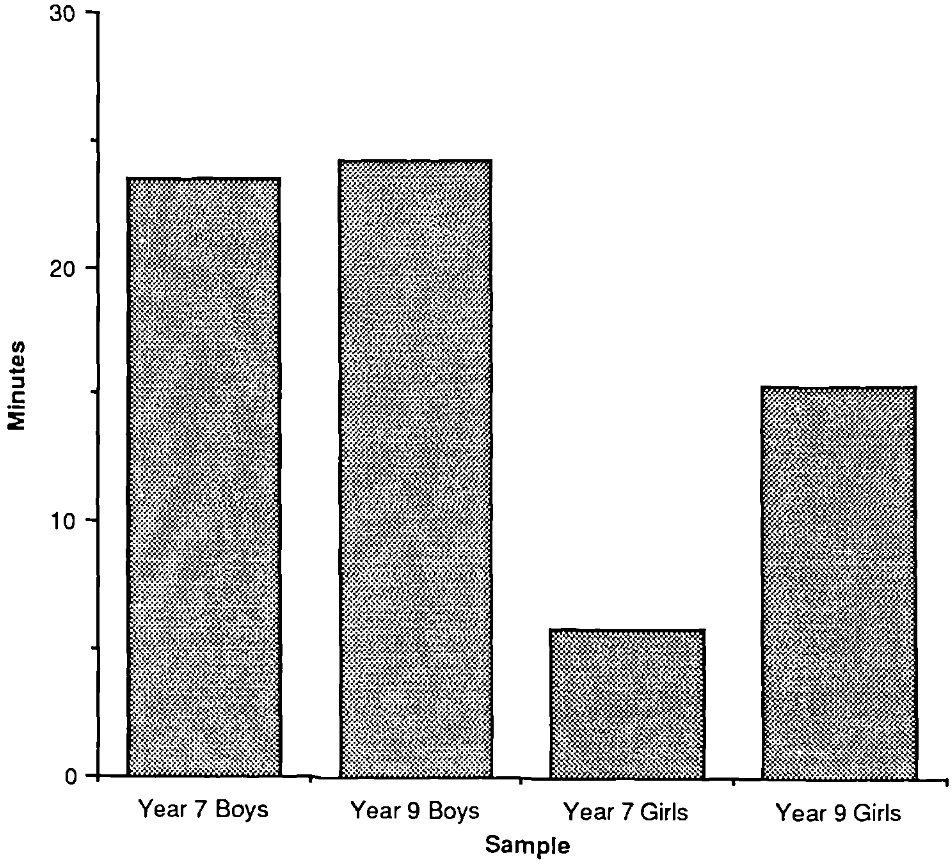
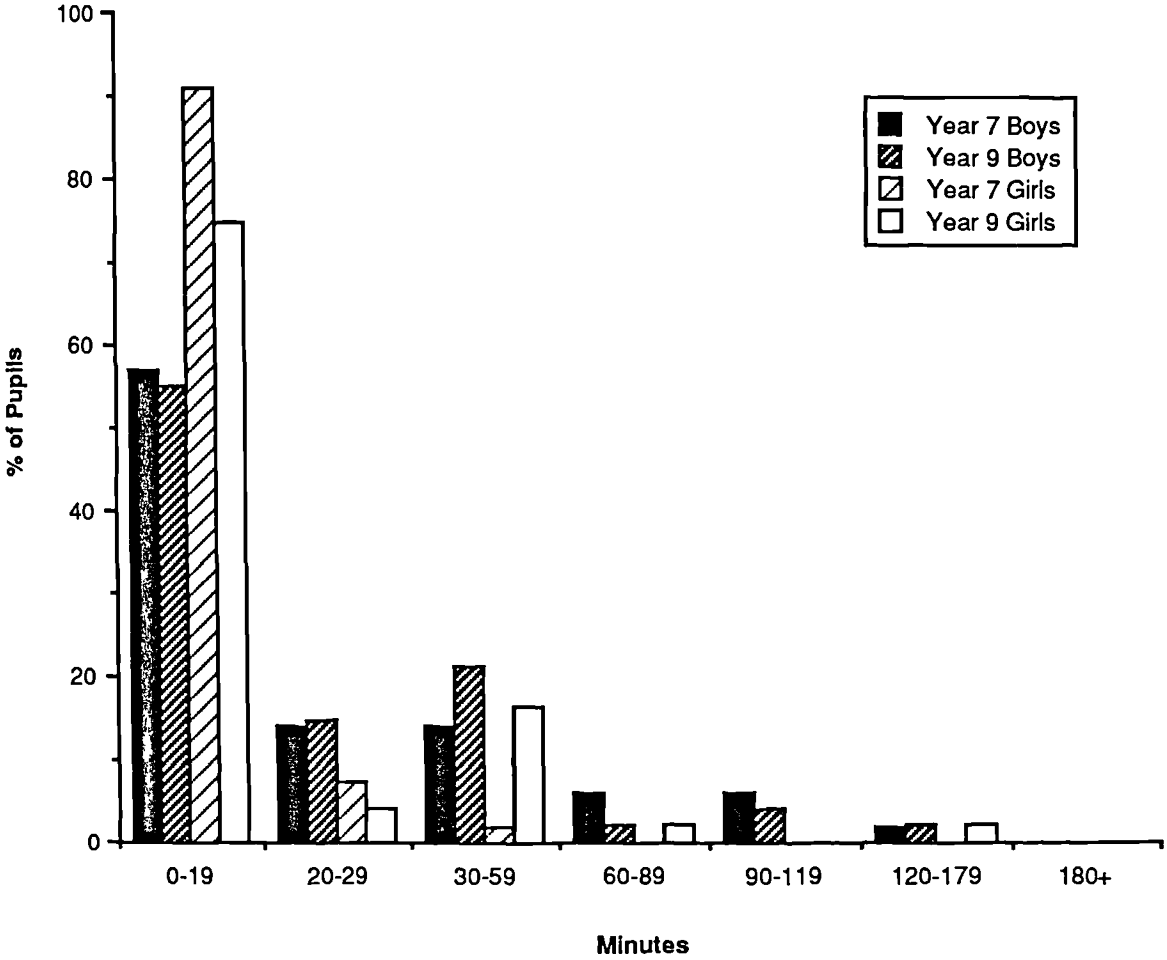


Figure 7.31 Proportions of Time Spent by Age and Sex in Hard/Very Hard Activity



7.8 Time Spent In Sleep, Very Light and Light Activity

Additional information was sought from the raw data with regard to the amount of time pupils spent in the remaining activity categories, namely the amount of time they spent in sleep and in very light and light activity. The percentage of time pupils spent daily in sleep, very light and light activity in relation to the time they spent in moderate and hard/very hard activity is shown in figure 7.32. Figures 7.33, 7.34 and 7.35 show the time spent in different activity types by boys and girls, year 7 and year 9 pupils and by age and sex.

To briefly summarise the findings, pupils were found to spend the majority of their time in very light activity (figure 7.32). The mean daily time spent in very light activity was 686.2 minutes (11 hours 26.2 minutes) (SD=65.67). Pupils also spent a good deal of time in sleep, spending an average of 597 minutes (9 hours 57.53 minutes) (SD=47.39) a day. Of surprise was the limited amount of time pupils spent in light activity (76.78 minutes, SD=44.16). Indeed, pupils spent almost as much time in moderate activity as they did in light activity and boys in fact spent more time in moderate activity than they did in light activity (figure 7.33). Girls on the other hand were found to spend more time in light activity than in moderate activity and were found to spend more time in sleep and in very light and light activity than the boys. Year 7 pupils spent more time in sleep than year 9 pupils, while year 9 pupils were found to spend more time in very light and light activity than year 7 pupils (figure 7.34). The results by age and sex on the whole showed similar trends. Both year 7 groups (boys and girls) reported to spend more time in sleep than the year 9 groups and the year 9 groups reported to spend more time in very light activity than the year 7 groups. Year 7 girls spent more time in very light activity than the year 7 boys, though year 9 girls and year 9 boys spent approximately the same amount of time in very light activity. In terms of light activity, year 9 girls spent the most time and the boys' groups the least time in light activity (figure 7.35).

Figure 7.32 Percentage of Daily Time In Different Activity Types

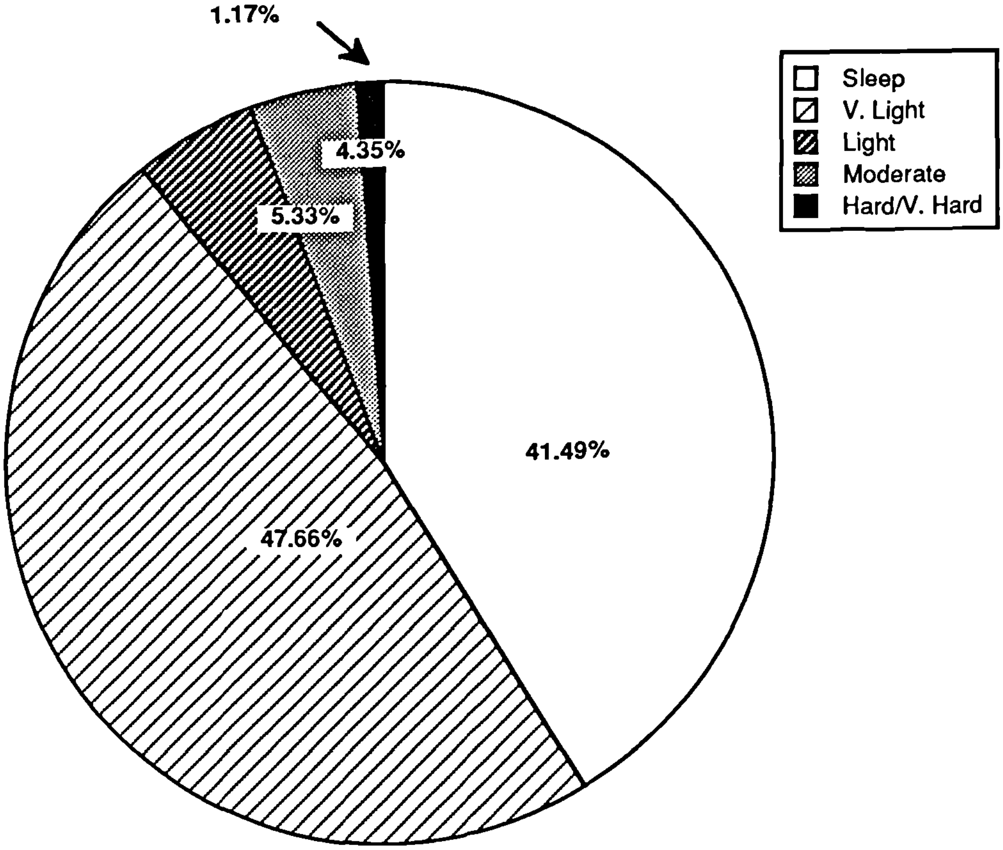


Figure 7.33 Average Daily Time Spent in Different Types of Activity-Total, Boys and Girls

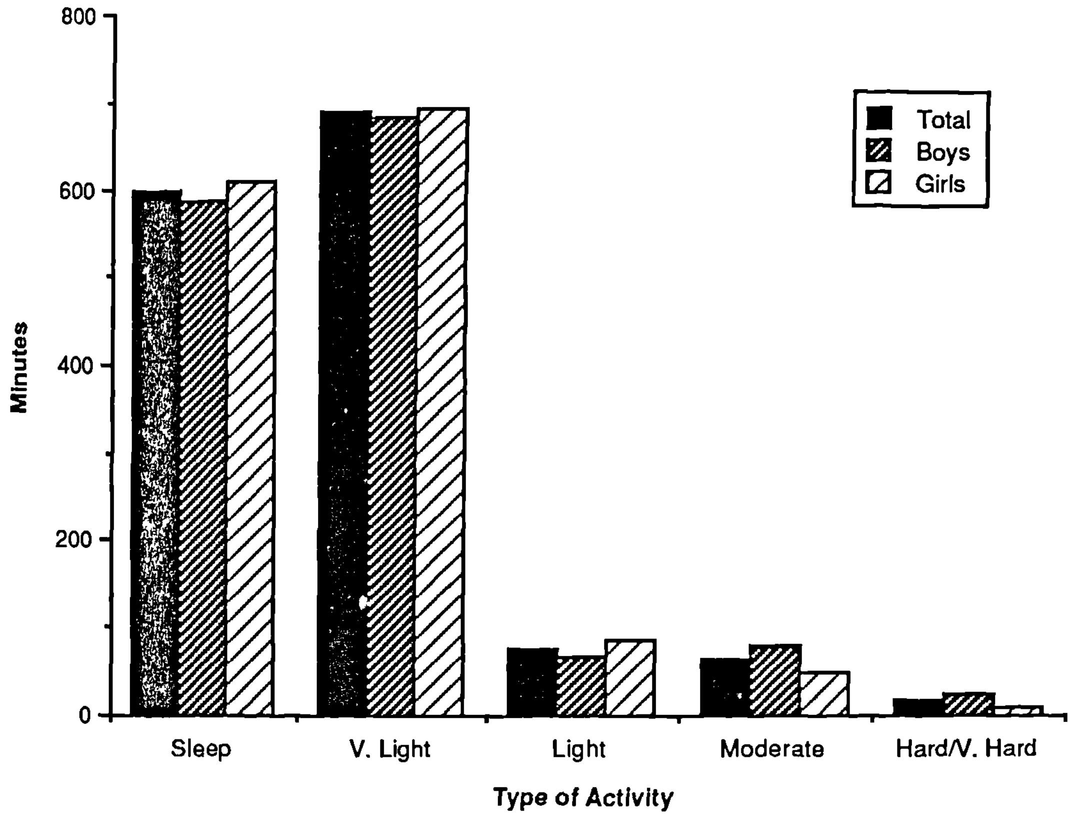


Figure 7.34 Average Daily Time Spent in Different Types of Activity-Total, Year 7 and Year 9 Pupils

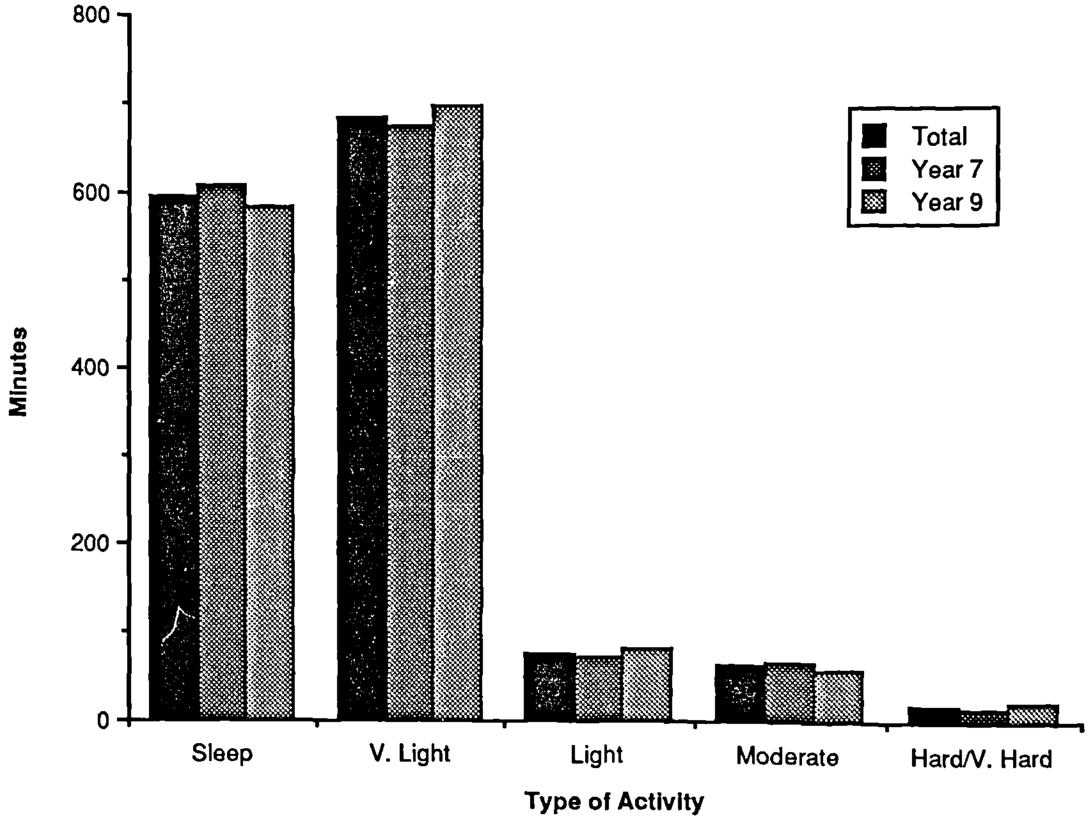
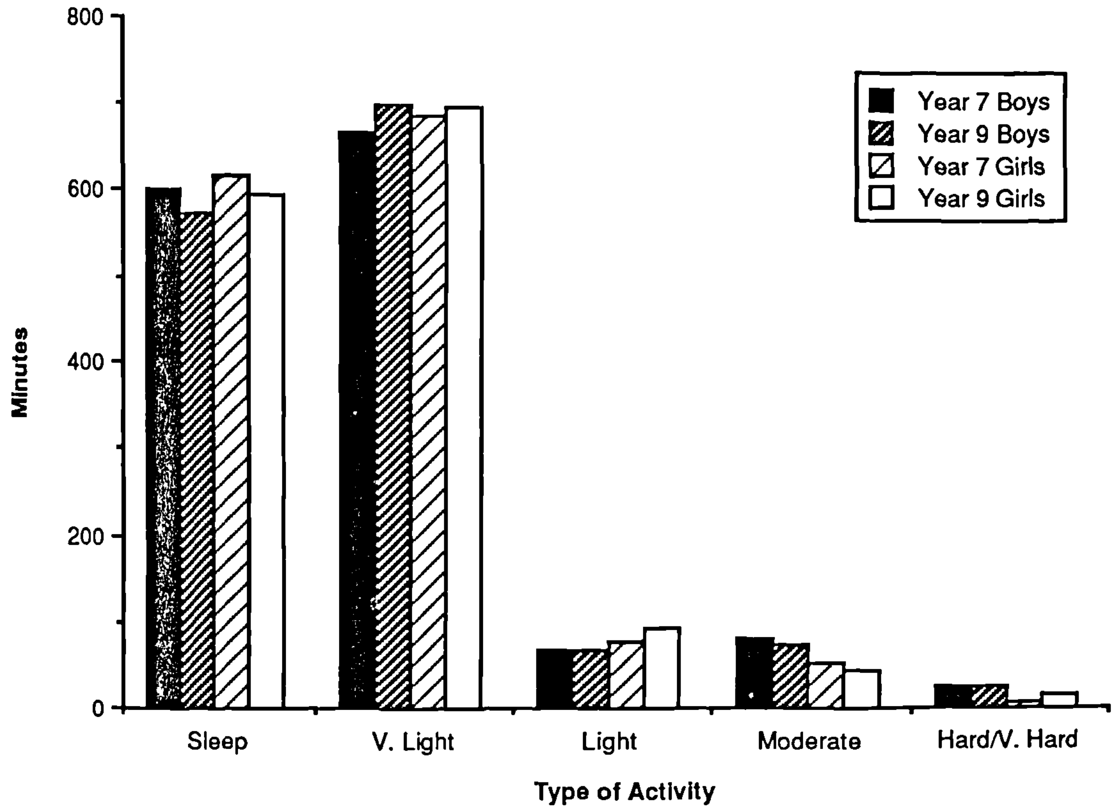


Figure 7.35 Average Daily Time Spent In Different Types of Activity-Age and Sex



7.9 Bouts of "Huff and Puff" Activity

The final activity information derived from the study related to the number of bouts of "huff and puff" activity children had engaged in over the 4 day period. The total number of bouts of "huff and puff" activity, the number of bouts lasting for more than 10 minutes and the number of bouts lasting for more than 20 minutes were calculated. The mean total number of bouts of "huff and puff" activity was 4.19 (SD=3.37). The maximum number of bouts any child had engaged in over the 4 days was 19 and the minimum number 0. Indeed, 12.1% of the sample were found to have engaged in no bouts and 23.6% were found to have engaged in only 1 bout over the 4 days. Approximately 50% (47.7%) had engaged in less than 4 bouts of activity over the 4 days, i.e., they had not experienced the equivalent of a bout of "huff and puff" activity a day. Table 7.18 and Figure 7.36 illustrate the mean number of bouts of "huff and puff" activity for the total sample and figure 7.37 the relative number of bouts of activity engaged in by the sample.

The total number of bouts of "huff and puff" activity gave no indication however, as to the duration of each bout of activity. The amount of time spent in "huff and puff" activity lasting for more than 10 minutes and more than 20 minutes was therefore considered. The mean number of bouts for the >10 minute period was 3.59 (SD=3.02) (table 7.18, figure 7.36). In considering bouts of activity lasting for more than 10 minutes, it was found that 12.6% of the sample had engaged in no bouts at all and the number of pupils who had experienced less than 4 bouts rose to 56.8% (see figure 7.38). However, these values were not too different from the values obtained for the total number of bouts of activity. Thus, it seemed that if children engaged in "huff and puff" activity, the majority tended to sustain the activity for more than 10 minutes (see discussion in chapter 8). However, when it came to considering the number of bouts of activity lasting for more than 20 minutes, the results were found to be quite different. The mean number of bouts of "huff and puff" activity lasting for more than 20 minutes fell to 2.76 (SD=2.45) (table 7.18, figure 7.36), while the percentage of children reporting no such bouts of activity rose to 17.6%. The majority of the sample (68.8%) were now found to have engaged in less than 4 bouts of "huff and puff" activity over the 4 days (figure 7.39).

Figure 7.36 Mean Number of Bouts of "Huff and Puff" Activity -Total Sample

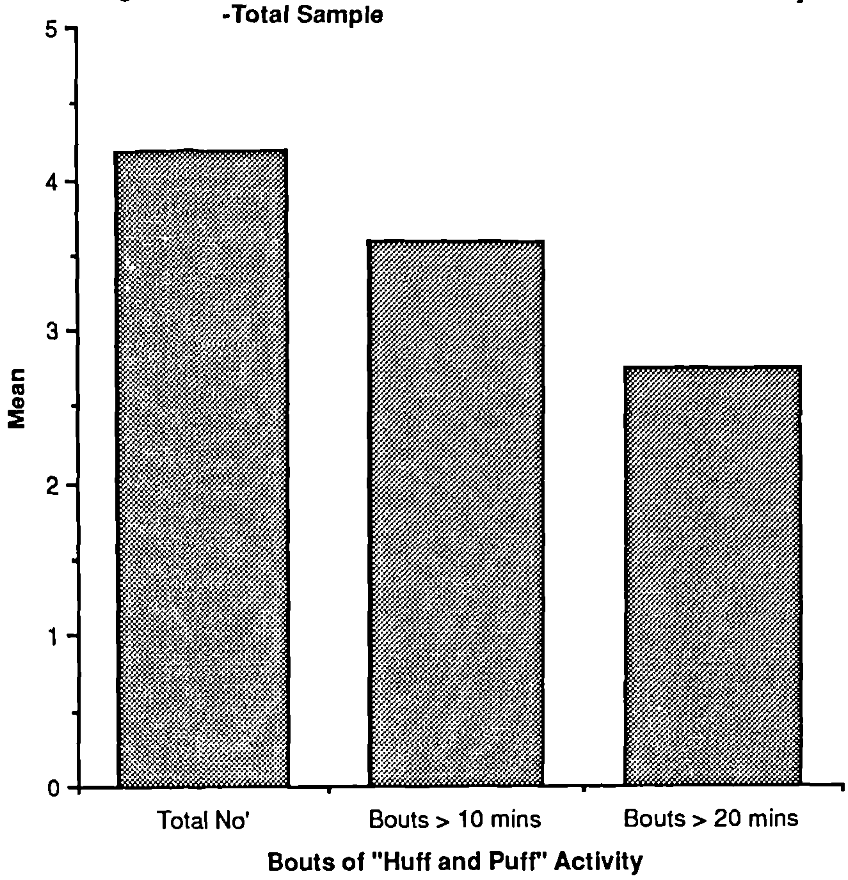


Figure 7.37 Number of Bouts of "Huff and Puff" Activity engaged in by the Total Sample

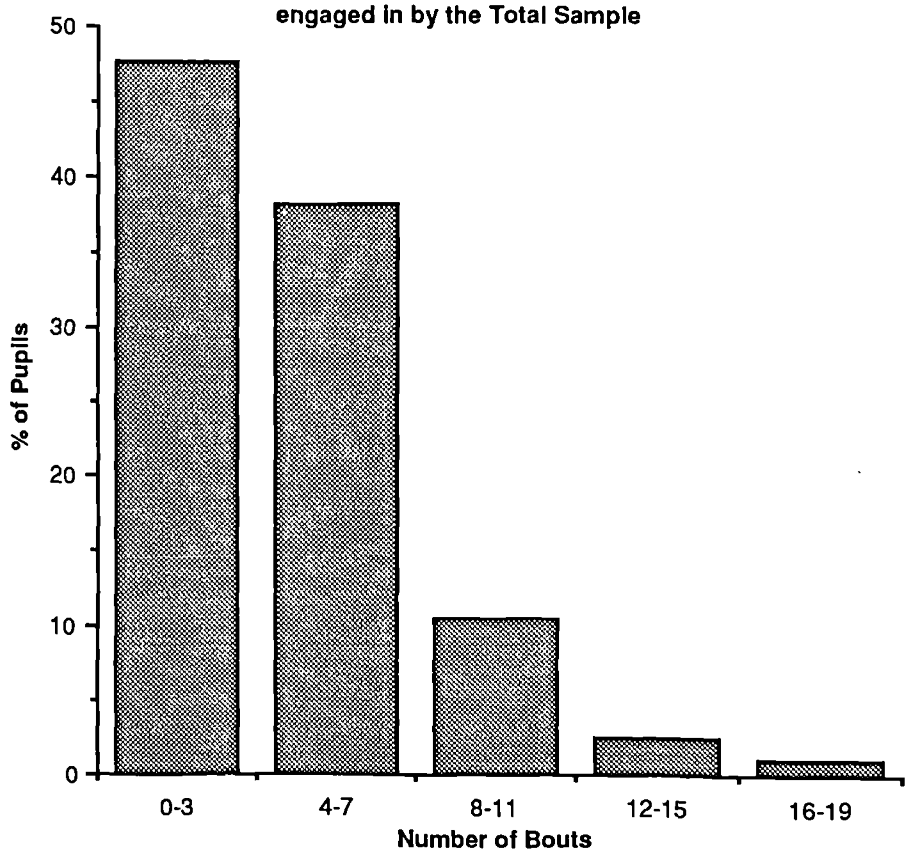


Figure 7.38 Number of Bouts of "Huff and Puff Activity Lasting > 10 Minutes-Total Sample

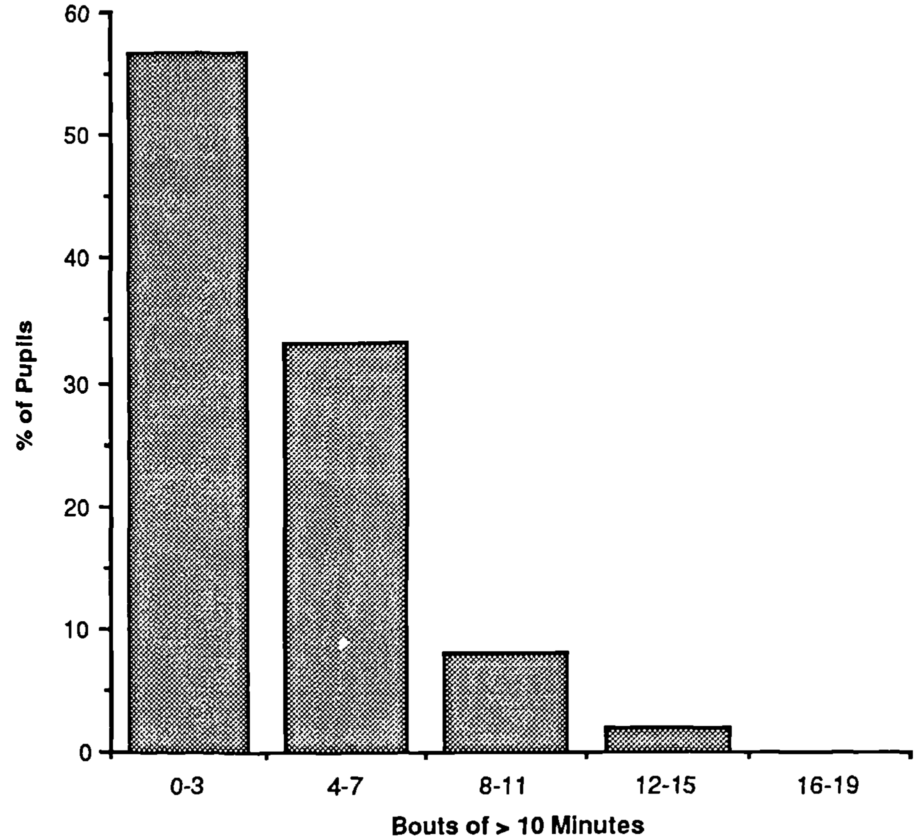
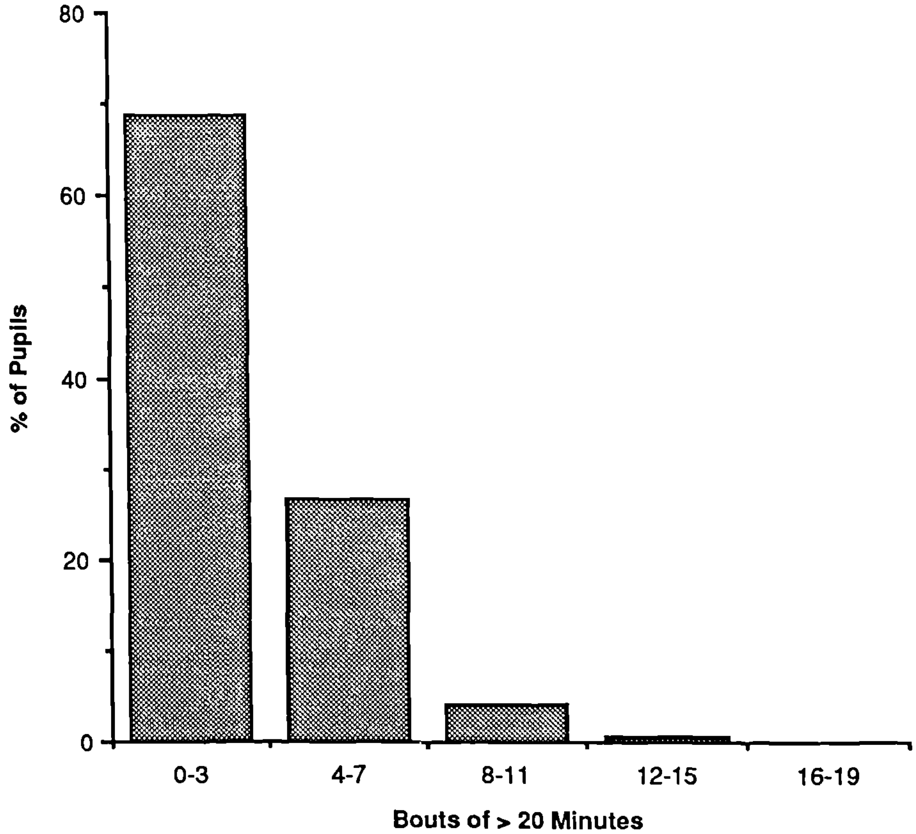


Figure 7.39 Number of Bouts of "Huff and Puff" Activity Lasting > 20 Minutes-Total Sample



In keeping with the other activity information derived from the study, the boys results were again found to be considerably more favourable than the girls. The mean number of bouts of "huff and puff" activity for the boys was 5.67 (SD=3.76), compared to 2.88 (SD=2.31) for the girls (table 7.18, figure 7.40). Most boys (94.8%) had also engaged in some "huff and puff" activity over the 4 days. In the case of the girls, 18.4% had engaged in no such activity. Furthermore, nearly twice the number of girls (62.1%) than boys (32.3%) had engaged in less than 4 bouts of "huff and puff" activity. These differences are shown in figure 7.41. Slight decreases were seen between total "huff and puff" activity and "huff and puff" activity lasting for more than 10 minutes, though again the differences were not marked (figure 7.42). However, more marked differences were observed when bouts of activity lasting for more than 20 minutes were considered, particularly in the girls. The mean number of bouts dropped to 3.72 (SD=2.7) for the boys and to 1.86 (SD=1.77) for the girls. The percentage of pupils who had engaged in no bouts of activity rose from 5.2% (for total bouts) to 6.3% (for bouts > 20 minutes) in the boys, and from 18.4% to 28.2% in the girls. The percentage of pupils who had engaged in less than 4 bouts of "huff and puff" activity also rose to 53.1% and 83.5% respectively (figure 7.43)

Table 7.18 Mean Number of Bouts of "Huff and Puff" Activity-Boys and Girls

BOUTS OF ACTIVITY	Total	Boys	Girls
TOTAL NO' OF BOUTS	4.19 SD=3.39	5.67 SD=3.76	2.83 SD=2.31
BOUTS > 10 MINUTES	3.59 SD=3.02	4.85 SD=3.32	2.41 SD=2.13
BOUTS > 20 MINUTES	2.76 SD=2.45	3.72 SD=2.71	1.86 SD=1.77

The mean number of bouts of "huff and puff" activity were found to be marginally higher in the year 7 pupils. The mean number of bouts was 4.43 (SD=3.59) for the year 7 pupils and 3.94 (SD=3.18) for the year 9 pupils (table 7.19, figure 7.44). The percentage of year 7 and year 9 pupils reporting to have engaged in no "huff and puff" activity over the 4 days was similar

Figure 7.40 Mean Number of Bouts of "Huff and Puff" Activity -Boys and Girls

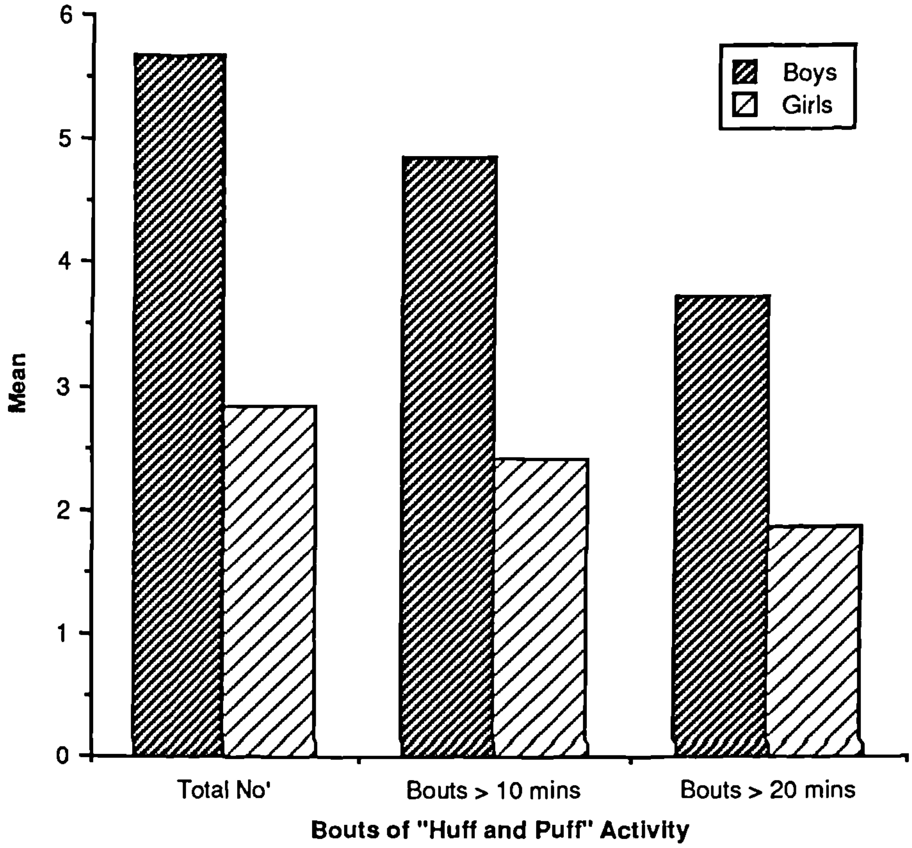


Figure 7.41 Number of Bouts of "Huff and Puff" Activity engaged in by Boys and Girls

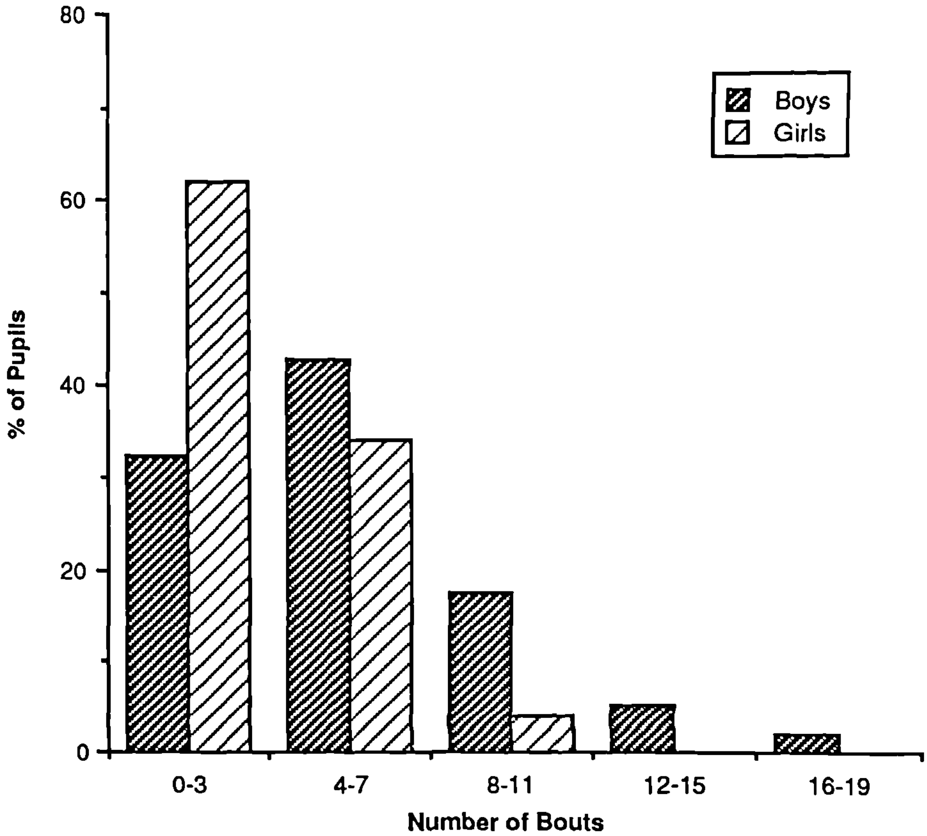


Figure 7.42 Number of Bouts of "Huff and Puff" Activity Lasting > 10 Minutes-Boys and Girls

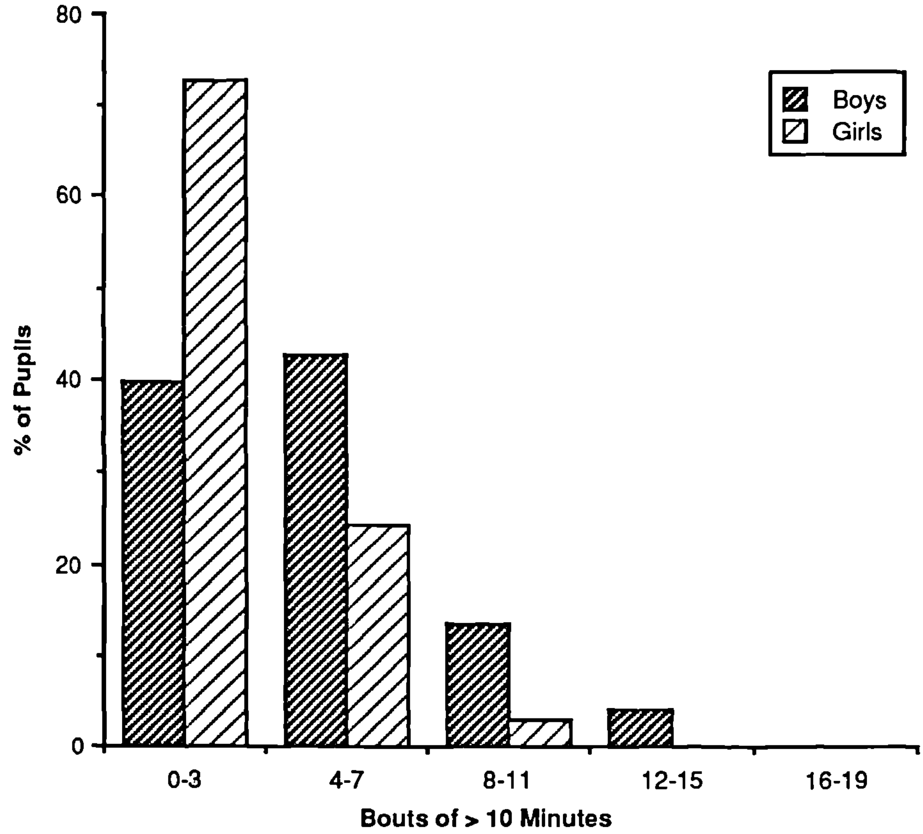
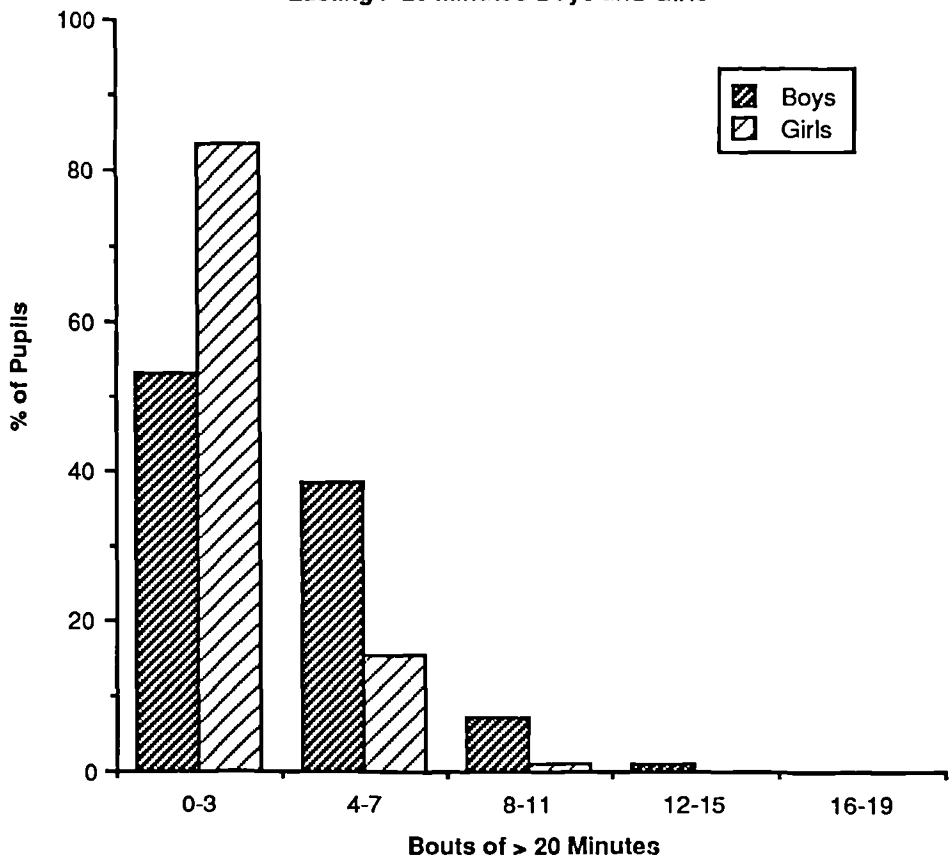


Figure 7.43 Number of Bouts of "Huff and Puff" Activity Lasting > 20 Minutes-Boys and Girls



(12.5% for year 7 pupils and 11.6% for year 9 pupils) and the percentage reporting to have engaged in less than 4 bouts over the 4 days was also found to be similar (43.3% for year 7 and 52.6% for year 9). As was the case in the total and boys and girls samples, the results for bouts of "huff and puff" activity lasting for more than 10 minutes were comparable to the total number, but changes were evident in the number of bouts of activity lasting for more than 20 minutes. Little difference was again found between the results of the year 7 and year 9 pupils, however. The means were 2.75 (SD=2.62) and 2.77 (SD=2.26) respectively, with 18.3% and 16.8% of year 7 and year 9 pupils reporting no bouts of activity respectively. Furthermore, 70.2% of year 7 pupils and 67.4% of year 9 pupils reported to have engaged in fewer than 4 bouts of "huff and puff" activity over the 4 days. Figures 7.45, 7.46 and 7.47 illustrate these findings.

Table 7.19 Mean Number of Bouts of "Huff and Puff" Activity-Year 7 and 9 Pupils

BOUTS OF ACTIVITY	Total	Year 7	Year 9
TOTAL NO' OF BOUTS	4.19 SD=3.39	4.43 SD=3.59	3.94 SD=3.18
BOUTS > 10 MINUTES	3.59 SD=3.02	3.67 SD=3.21	3.49 SD=2.81
BOUTS > 20 MINUTES	2.76 SD=2.45	2.75 SD=2.62	2.77 SD=2.26

When the results were analysed by age and sex, further interesting findings emerged. The mean number of bouts of "huff and puff" activity was highest amongst the year 7 boys and lowest amongst the year 9 girls (table 7.20, figure 7.48). Also in year 7 boys, only 4.1% had engaged in no "huff and puff" activity over the 4 days compared with 6.4% of year 9 boys, 20% of year 7 girls and 16.7% of year 9 girls. The percentage of pupils engaging in fewer than 4 bouts of "huff and puff" activity was also lowest in the year 7 boys and highest in the year 9 girls (figure 7.49). These trends remained fairly consistent when bouts of activity lasting for more than 10 and 20 minutes were considered (see figures 7.50 and 7.51). Year 7 boys again had the highest means for number of bouts of activity lasting for more than 10 and 20 minutes (table 7.20) and the lowest percentage of pupils reporting to have engaged in no bouts of "huff and puff" activity (6.1% for bouts of > 20 minutes). The corresponding figures were 6.4% for year 9 boys, 27.1% for year 7 girls and 29.1% for year 9 girls. The percentage of pupils reporting to have engaged in less than 4 bouts of "huff and puff" activity lasting for more than 20 minutes over the 4 days was particularly high in the year 7 and year 9 girls (85.5% and 81.3% respectively).

Table 7.20. Mean Number of Bouts of "Huff and Puff" Activity-Age and Sex

BOUTS OF ACTIVITY	Year 7 Boys (n=49)	Year 9 Boys (n=47)	Year 7 Girls (n=55)	Year 9 Girls (n=48)
TOTAL NO' OF BOUTS	6.12 SD=4.04	5.19 SD=3.42	2.93 SD=2.27	2.71 SD=2.38
BOUTS > 10 MINUTES	5.16 SD=3.66	4.53 SD=2.92	2.35 SD=1.97	2.48 SD=2.32
BOUTS > 20 MINUTES	3.88 SD=3.05	3.55 SD=2.32	1.75 SD=1.62	2.00 SD=1.92

7.10 Was the Activity Information Typical?

To determine the extent to which the 4 days of activity information collected was "typical" and therefore "typical" or representative of the pupils' general activity levels, pupils were asked at the end of each interview "Was yesterday or Saturday/Sunday a typical day for you?," to which they responded "yes" or "no." If the response was no, the subjects were asked to explain why the day had not been typical.

Out of a total of 796 responses to the question (4 interviews x 199 pupils), just 134 no responses were recorded (16%). The interview days in question had been typical on all four occasions for 53.3% of the pupils, and typical on three out of the four occasions for a further 27.1%. The days were thus typical, or typical on all but one occasion for 80.4% of the pupils. If pupils claimed that the day was not typical, the reasons they gave were varied and were

Figure 7.44 Mean Number of Bouts of "Huff and Puff" Activity -Year 7 and Year 9 Pupils

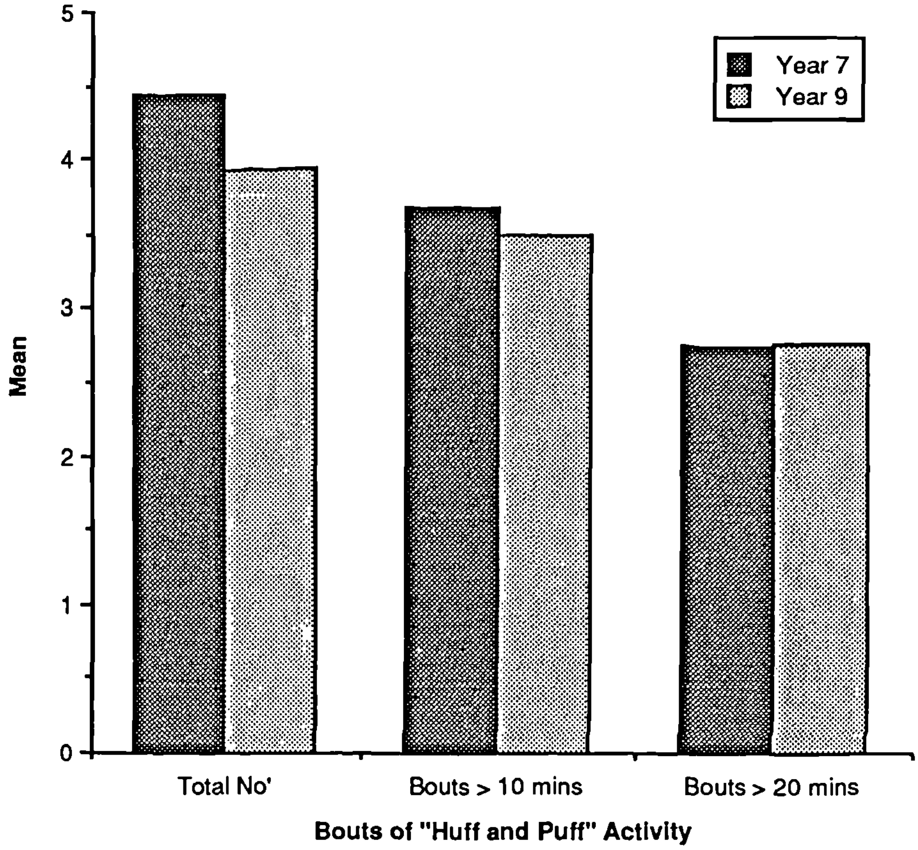


Figure 7.45 Number of Bouts of "Huff and Puff" Activity engaged in by Year 7 and Year 9 Pupils

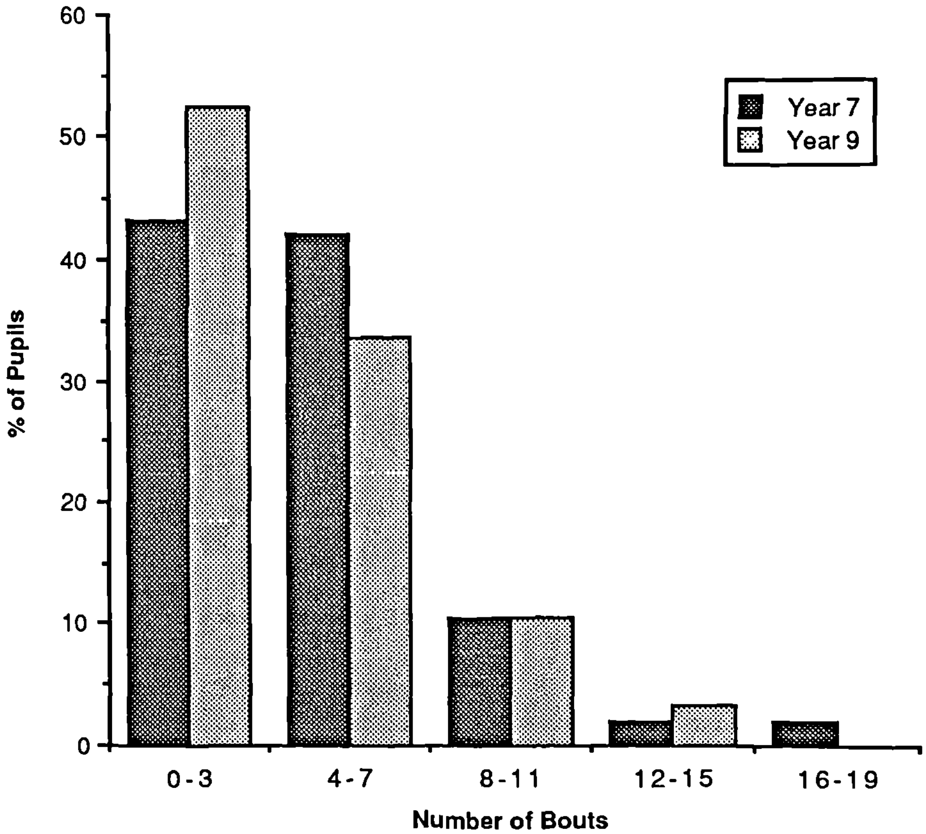


Figure 7.46 Number of Bouts of "Huff and Puff" Activity Lasting > 10 Minutes-Year 7 and Year 9 Pupils

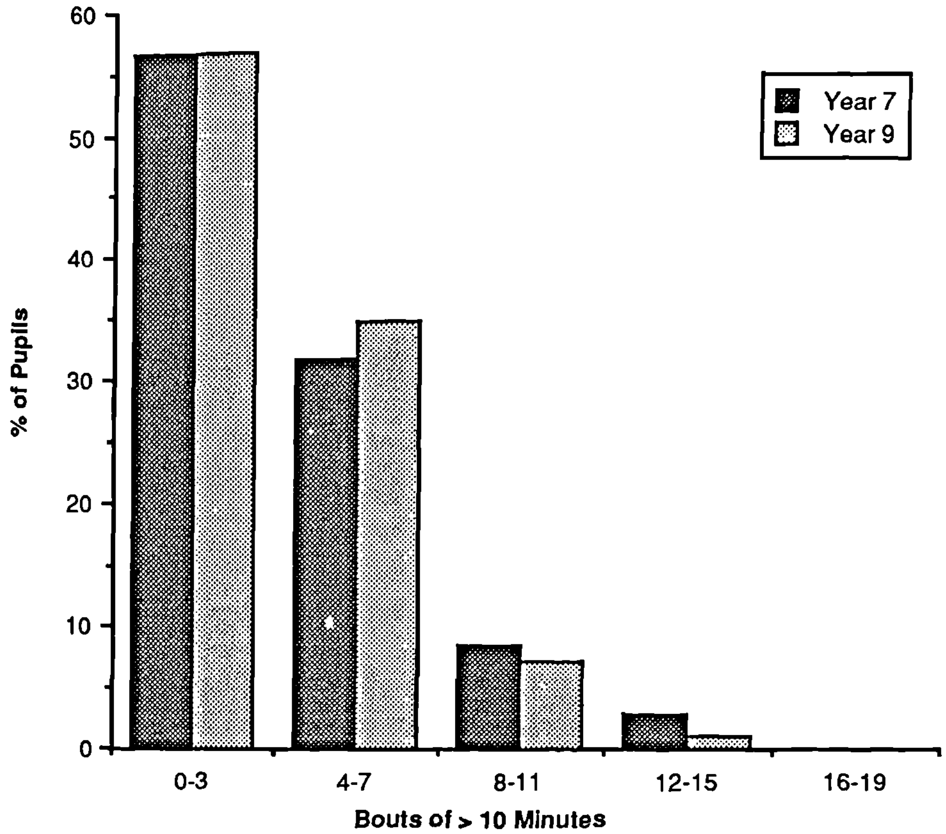


Figure 7.47 Number of Bouts of "Huff and Puff" Activity Lasting > 20 Minutes-Year 7 and Year 9 Pupils

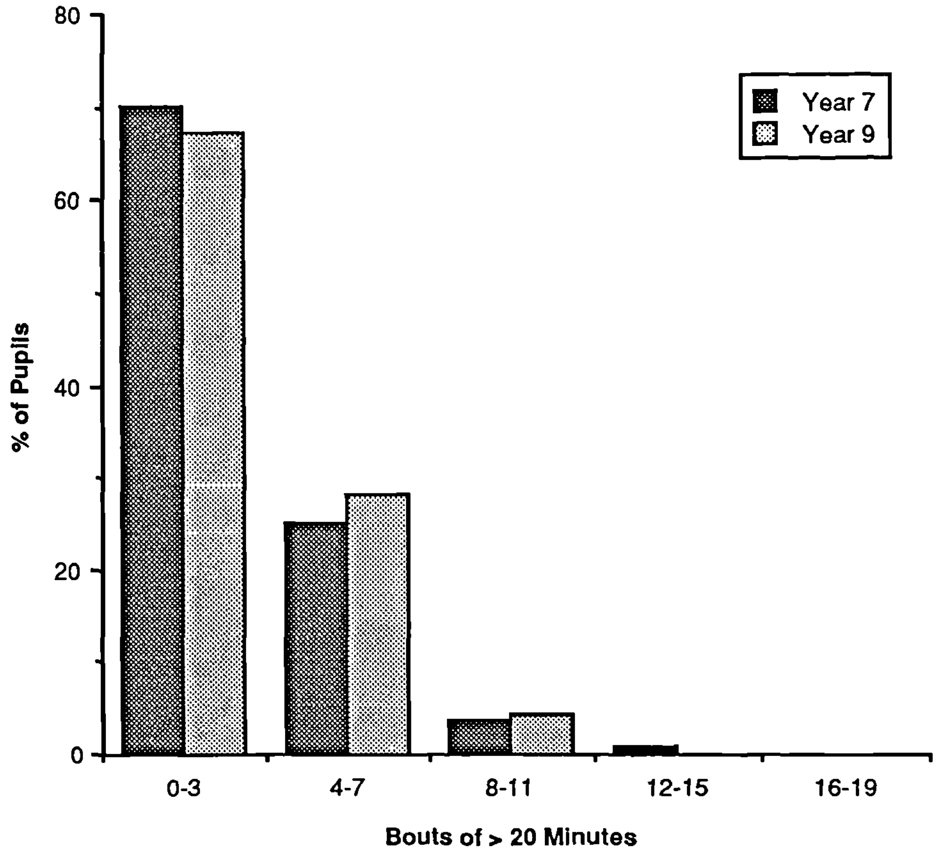


Figure 7.48 Mean Number of Bouts of "Huff and Puff" Activity -Age and Sex

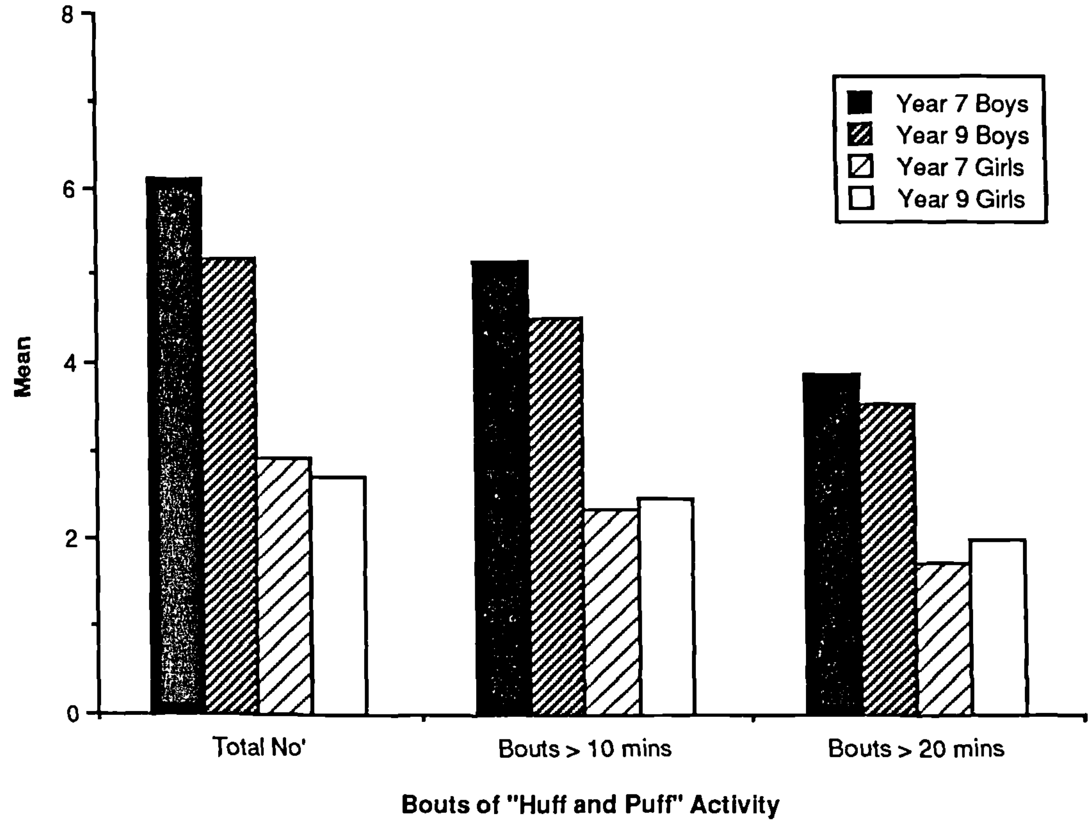


Figure 7.49 Number of Bouts of "Huff and Puff" Activity engaged in by Year 7 and 9 Boys and Year 7 and 9 Girls

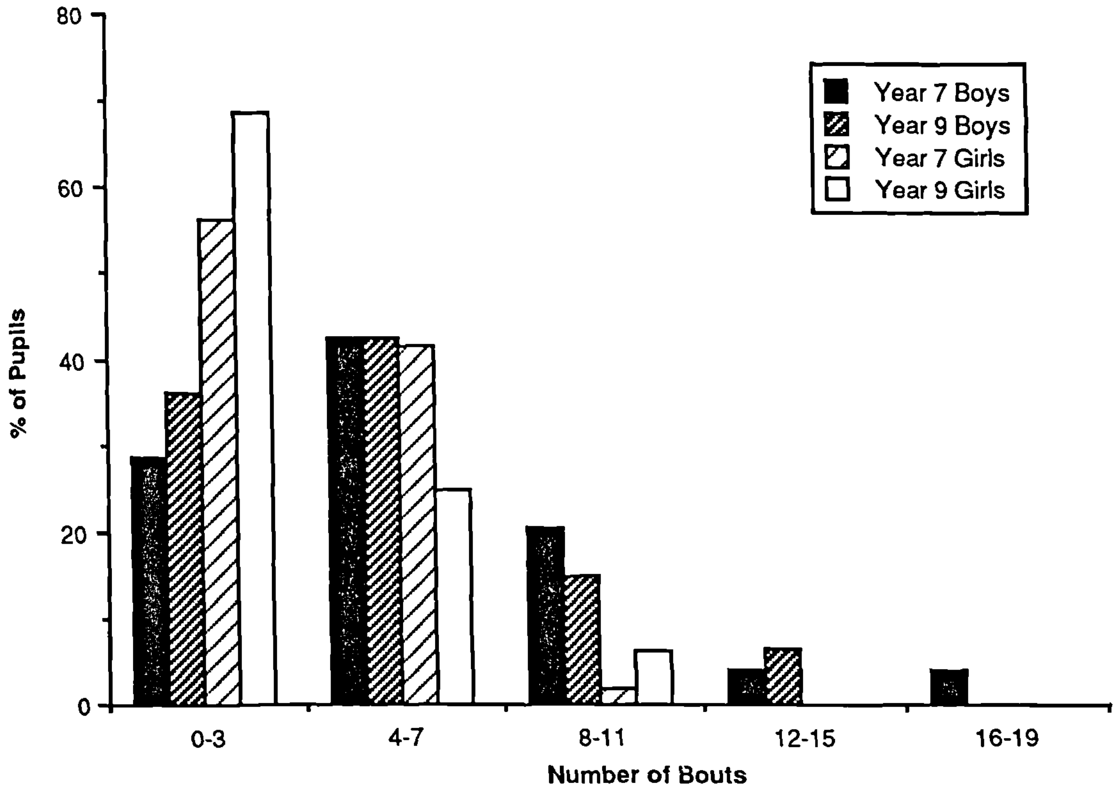


Figure 7.50 Number of Bouts of "Huff and Puff" Activity Lasting > 10 Minutes-Age and Sex

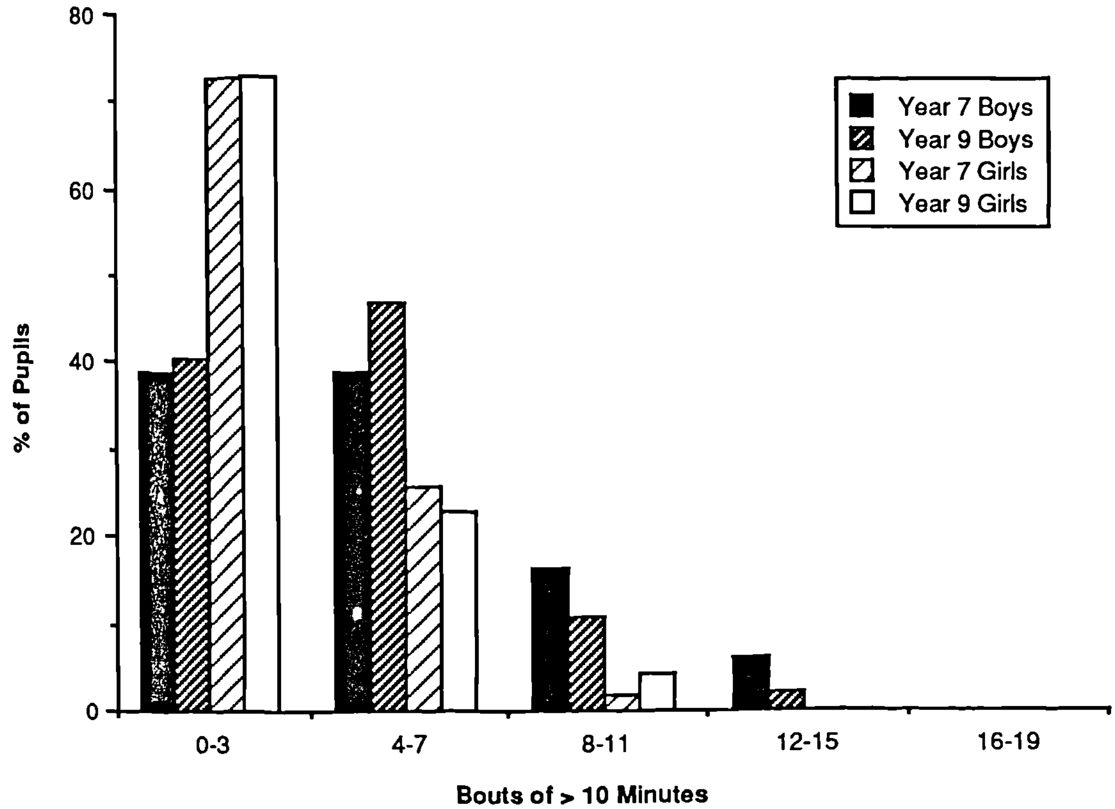
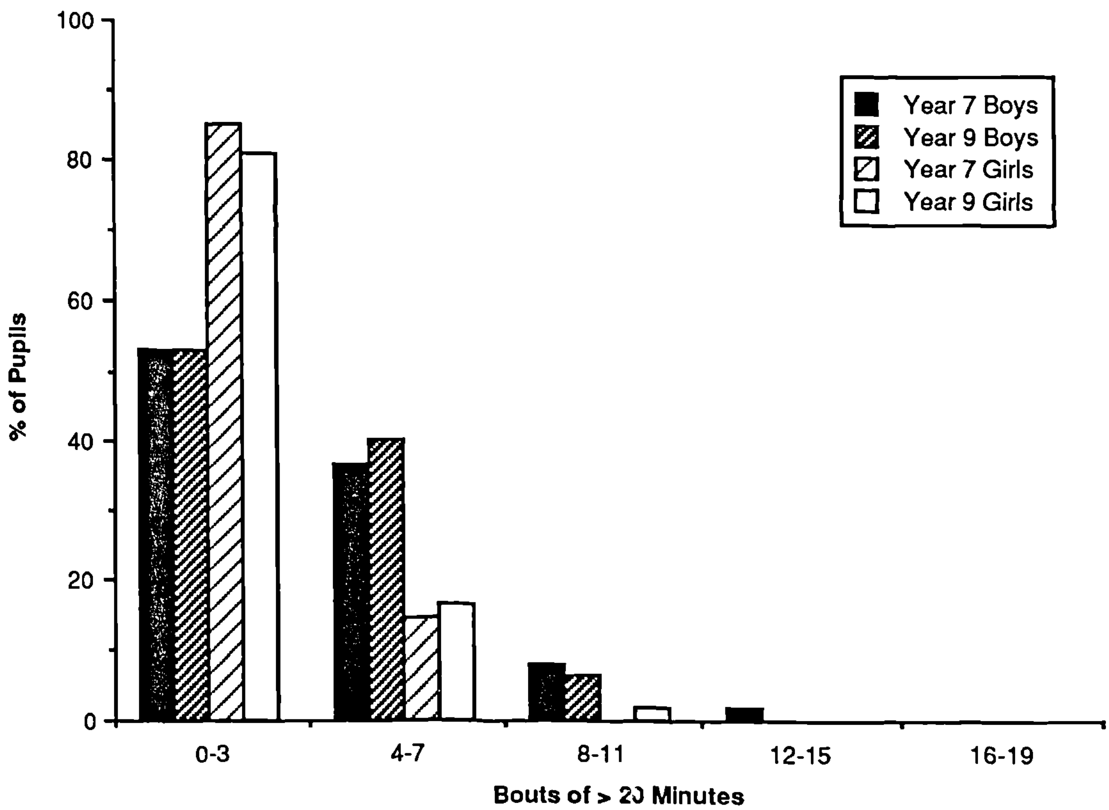


Figure 7.51 Number of Bouts of "Huff and Puff" Activity Lasting > 20 Minutes-Age and Sex



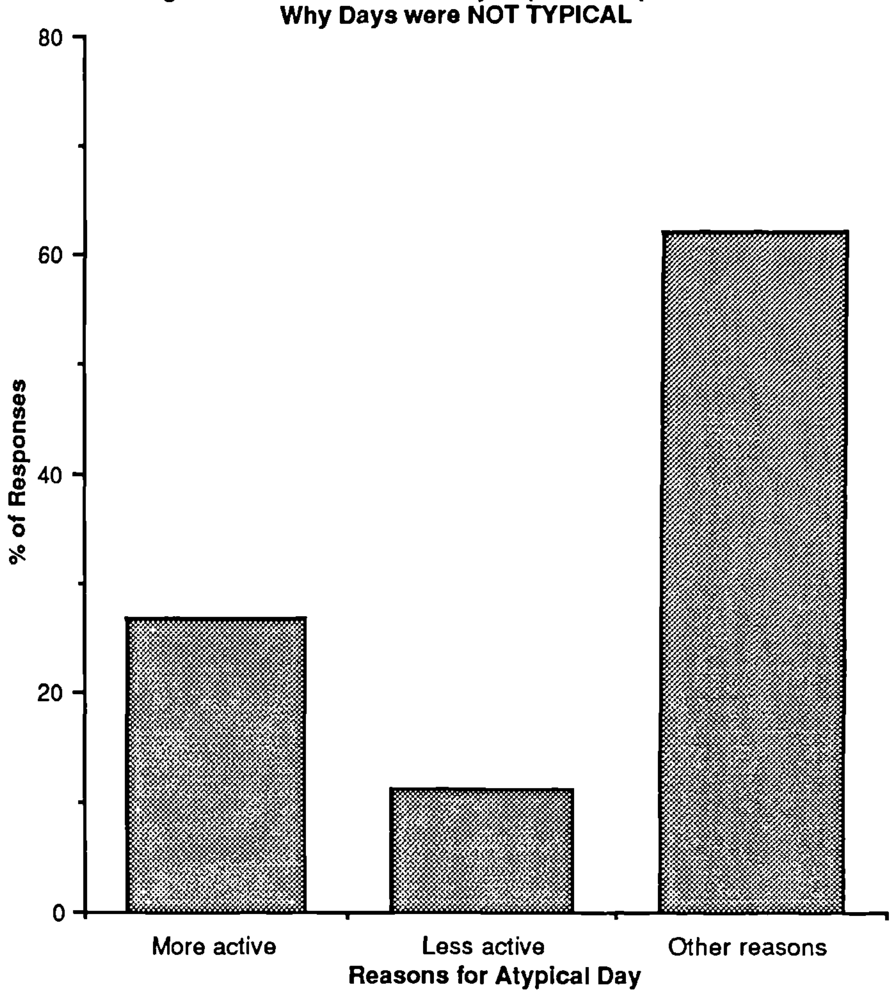
categorised into one of nine categories listed in table 7.21. The frequency and percentage of times each reason was given over the 4 days is also presented in table 7.21 and is summarised in figure 7.52. As can be seen from the table and from the figure in particular, 26.86% of the reasons given to explain why the day had not been typical related to doing more activity than usual and 11.19% to doing less activity than usual. The remaining 61.95% of reasons given were unrelated to physical activity. These findings are encouraging and suggest that for the vast majority of the pupils, the days in question provided a typical representation of their usual activity level (see discussion in chapter 8).

Table. 7.21 Reasons given by Pupils to explain why the day was NOT TYPICAL

Reasons for Atypical Day	Responses	
	No	%
1. "normally more active/do more"	36	26.86%
2. "normally less active/do less"	15	11.19%
3. "stayed up late/later than usual'	9	6.71%
4. "friends/relatives visited or visited friends"	6	4.48%
5. "visited doctors/dentist/hospital"	8	5.97%
6. "was ill/injured"	4	2.99%
7. "special occasion-birthday/other celebration"	9	6.27%
8. "an unusual event occurred"	27	20.15%
9. "any other reason"	20	14.93%

TOTAL =134 RESPONSES

Figure 7.52 Reasons Given by Pupils to Explain Why Days were NOT TYPICAL



More active=Normally more active/do more
Less active=Normally Less active/do less

7.11 Summary of Results

The major findings from the study are summarised below. Only the more pertinent findings and those which will provide in the main, the basis for the discussion are highlighted again in this section.

Activity Scores (Energy Expenditure in $kcal \cdot kg^{-1} \cdot day^{-1}$)

1) The majority of pupils in the study were inactive. Approximately one third of the sample (35.2%) were classified as moderately active or active, while approximately two thirds (64.8%) were classified as inactive or very inactive. The exact percentages were: 14.1% active, 21.1% moderately active, 54.7% inactive and 10.1% very inactive.

2) There was a significant difference between the boys' and girls' activity scores. Boys were found to be more active than girls. The mean activity scores were 38.19 for the boys and 35.37 for the girls. Half of the boys but only approximately one fifth (21.4%) of the girls were classified as moderately active or active.

3) No significant difference was found between the activity levels of the year 7 (younger) and year 9 (older) pupils and younger pupils were found to be no more active than older pupils. The mean activity scores were 36.39 for the year 7 pupils and 37.11 for the year 9 pupils. However, more year 9 pupils were found to be moderately active and active than year 7 pupils (38.9% versus 31.7%) and fewer very inactive (5.3% for year 9 versus 14.4% for year 7).

4) In all, year 7 boys had the highest number of active subjects (24.5%) and year 7 girls the least number (1.8%).

5) No significant difference was found between winter and summer activity levels. The mean activity score for the winter was 36.37 and for the summer 37.10.

Time Spent in Moderate Activity

1) Pupils reported to spend a daily average of approximately 1 hour (62.64 minutes) in moderate activity, though large individual differences were found in the amount of time spent in moderate activity (daily range of 0-257.5 minutes or 4 hours 17.5 minutes)

2) Most pupils (97.5%) had engaged in some moderate activity over the 4 days. Almost 80% (78.4%) had engaged in a daily average of 30 minutes or more and almost half (47.2%) in a daily average of 1 hour or more.

3) Boys spent more time in moderate activity than the girls, spending daily averages of 78.48 minutes and 47.99 minutes respectively. All of the boys in the sample were found to have engaged in some moderate activity but l4.9% of the girls were found to have engaged in no moderate activity over the 4 days.

4) Year 7 pupils were found to spend more time in moderate activity than year 9 pupils, spending daily averages of 66.25 minutes and 58.68 minutes respectively. Year 7 boys engaged in the most moderate activity of any group (81.5 minutes) and year 9 girls in the least (42.37 minutes).

5) The highest percentage of non-participants in moderate activity were the year 9 girls (8.3%).

Time Spent in Hard/Very Hard Activity

1) Pupils were found to spend considerably less time in hard/very hard activity, spending a daily average of only 16.85 minutes.

2) Approximately 40% of the pupils (38.7%) reported to have engaged in no hard/very hard activity over the 4 days. Approximately 70% (70.4%) were found to have engaged in a daily average of less 20 minutes of hard/very hard activity. Less than one fifth had engaged in 30 minutes or more and only 6.5% in 1 hour or more of hard/very hard activity.

3) Boys were found to spend more than twice the amount of time in hard/very hard activity than girls, spending a daily average of 23.86 minutes compared with 10.31 minutes by the girls. Approximately 30% of boys and 45% of girls had engaged in no hard/very hard activity over the 4 days and 56.3% of boys and 83.5% of girls had engaged in a daily average of less than 20 minutes. More than 70% of boys and almost 90% of girls reported to have engaged in less than a daily average of 30 minutes.

4) Year 9 pupils reported to spend more time in hard/very hard activity than year 7 pupils Year 9 pupils reported to spend a daily average of 19.76 minutes and year 7 pupils 14.18 minutes.

5) Year 7 girls engaged in considerably less hard/very hard activity than any of the other groups, engaging in less than four times the amount of the year 7 and year 9 boys and approximately two and a half times the amount of the year 9 girls.

6) The highest percentage of non-participants in hard/very hard activity were the year 9 girls (52.1%), followed by the year 7 girls (40%).

Bouts of "Huff and Puff" Activity

1) The mean number of bouts of "huff and puff" activity was 4.19. Over 12% of the sample had engaged in no bouts of "huff and puff" activity and approximately 50% (47.7%) had engaged in less than 4 bouts of activity over the 4 days, i.e., less than the equivalent of a bout of "huff and puff" activity a day.

2) Findings for bouts of "huff and puff" activity lasting for more than 10 minutes were similar to the total number of bouts (see 1 above), but differences were found between the total bouts and bouts lasting for more than 20 minutes.

3) The mean number of bouts of "huff and puff" activity lasting for more than 20 minutes was 2.76. Now 17.6% of the sample reported to have engaged in no > 20 minute bouts and 68.8% reported to have engaged in fewer than 4 bouts of activity.

4) Boys engaged in more bouts of "huff and puff" activity than the girls. They engaged in more total bouts, more bouts lasting for more than 10 minutes and more bouts lasting for more than 20 minutes than the girls. The mean number of bouts were 5.67 versus 2.88 for boys and girls respectively for total bouts, 4.85 versus 2.41 for > 10 minute bouts and 3.72 versus 1.86 for > 20 minute bouts.

5) Most boys (94.8%) had engaged in some "huff and puff" activity over the 4 days but 18.4% of the girls had engaged in no such activity over the 4 days. For bouts lasting for more than 20 minutes, 6.2% of boys and 28.2% of girls had engaged in no bouts respectively.

6) Little difference was found between the year 7 and year 9 pupils' results, though year 7 pupils reported to have engaged in more total bouts of "huff and puff" activity and more bouts lasting for more than 10 minutes (4.43 versus 3.94 for total bouts and 3.67 versus 3.49 for > 10 minute bouts) than year 9 pupils. However, year 7 pupils engaged in fewer bouts lasting for more than 20 minutes (2.75 versus 2.77).

7) Year 7 boys reported to have engaged in more total bouts of "huff and puff" activity, more bouts lasting for more than 10 minutes and more lasting for more than 20 minutes than any other group, recording means of 6.12, 5.16 and 3.88 bouts respectively. They also recorded the lowest percentage of no bouts of "huff and puff" activity on all occasions (4.1% for total bouts, 4.1% for > 10 minute bouts and 6.1% for > 20 minute bouts).

CHAPTER 8

DISCUSSION OF THE RESULTS OF THE ASSESSMENT OF CHILDREN'S ACTIVITY LEVELS

8.1 Introduction

This study aimed to provide much needed information on the activity levels of a sample of British children. It has provided comprehensive activity information on 199 pupils from three separate counties in central England, assessing physical activity in terms of both energy expenditure and aerobic activity. The information derived focuses on:

i) average daily energy expenditure in $kcal \cdot kg^{-1} \cdot day^{-1}$;

ii) time spent in moderate activity;

iii) time spent in hard/very hard activity;

iv) the number of bouts of "huff and puff" activity.

The decision to assess physical activity in this way was made in light of the fact that the physical activity stimulus has not yet been defined to achieve health related outcomes (Haskell, 1985). Since undertaking this study, the researcher's decision has been confirmed and reinforced by Paffenbarger et al., (1993), who have similarly stressed how the health issues of appropriate physical activity are stillbeingexplored, and by Davey Smith & Morris (1992) who have recently recommended that two principal dimensions should be assessed in physical activity, total physical activity (energy output) and aerobic activity (see chapter 2, 2.12).

The results presented in the previous chapter revealed some very interesting findings which pose many leads for discussion. The results outlined in the summary to chapter seven (see chapter 7, 7.11) form the basis of and provide the structure for the most part of this discussion. The results are discussed under the same headings as in chapter seven, dealing with each dimension of activity in turn and where appropriate explanations are offered to account for the findings. It should be realised however, that in this discussion, the explanations presented are merely speculative and there is yet no concrete evidence to support them. Evidently further research is required in the area to investigate the real reasons as to why such results have been obtained (see chapter 9, 9.7 recommendations).

A further limiting factor in discussing the results lies in the fact that the physical activity stimulus to achieve health related outcomes has not yet been defined (Haskell, 1985) and that the health issues of appropriate physical activity are still being explored (Paffenbarger et al., 1993). This issue is raised consistently throughout the chapter and limits the interpretation of many of the findings.

General Discussion

8.2 Activity Scores

As expected, the majority of pupils in this study were not found to be active. The mean activity score for the pupils as a whole was 36.74. When the activity status of the sample was considered and pupils were classified as active, moderately active, inactive or very inactive on the basis of their activity scores, approximately one third of the sample were classified as moderately active or active (14.1% active and 21.1% moderately active), while two thirds were classified as inactive or very inactive (54.7% inactive and 10.1% very inactive). This finding is in keeping with the findings from the majority of other studies (reviewed in chapter 6, 6.3 & 6.4) which similarly highlighted the low levels of activity prevalent among young people. Perhaps the most relevant studies to this research are the more recent British studies conducted on secondary school children by Williams (1988); The Northern Ireland Fitness Survey, (1989); Armstrong, (1989); Armstrong et al., (1990); Armstrong et al., (1990a); Armstrong et al., (1990b); Armstrong et al., (1991) and Thirlaway & Benton (1993). The precise conclusions drawn from these studies are presented in table 6.2 but all essentially declare that activity levels are low amongst children and young people. A number of significant researchers believe total energy expenditure is most important in terms of children's health because it may help to reduce health risks, improve physical fitness, optimise growth and encourage future participation in physical activity (Bar-Or, 1983; Gilliam & MacConnie, 1984; Shephard, 1984;

Saris, 1985). If this is the case, these findings are very worrying and present a real cause of concern for the future health of our young people.[1]

It should be mentioned at this stage though, that while it is feasible to compare the general findings of this study, to the conclusions of other studies which have gone before, it is impossible to compare the precise quantitative results. This is due to the different methodologies and definitions of physical activity which have been adopted by the various studies and which have invariably influenced the results and conclusions. The study by Williams (1988) for example, assessed physical activity in terms of the number of times of participation in a week, the Northern Ireland Fitness Survey (1989) was concerned with exercise that caused a degree of breathlessness, while the studies by Armstrong (1989) and Armstrong et al., (1990; 1990a; 1990b, 1991) monitored heart rates and investigated activity for periods of 10 or 20 minutes which elicited heart rates above 139 beats per minute.

The hypotheses which were made in the study were tested based on the activity levels of the pupils as determined from the activity scores. This decision was made due to the nature of the definition which was adopted for the purpose of the study, i.e., that physical activity is "any bodily movement produced by skeletal muscles that results in caloric expenditure" (Caspersen et al., 1985). Clearly this relates to total physical activity and the average energy expenditure values (activity scores) obtained by the pupils. The additional activity information which was sought from the questionnaires (discussed later), served to provide additional and yet much needed activity information and, in conjunction with the activity scores, provided a detailed and thorough activity profile of the pupils' physical activity levels.

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1. A reminder that the physical activity stimulus has not yet been clearly defined to achieve health related outcomes (Haskell, 1985) and the health issues of appropriate physical activity are still being explored (Paffenbarger et al., 1993). In other words, it is not known what type and amount of physical activity will incur health benefits.

The first hypothesis, i.e., that boys would be significantly more active than girls was fully supported in the study. The mean activity scores were 38.19 for the boys and 35.37 for the girls. In terms of the activity status of the boys and girls, by far the majority of the active sample in the study were boys. A staggering 23 out of the 28 active subjects identified in the study were boys, while just 5 were girls. Just one fifth of the girls were moderately active or active compared to 50% of the boys. Put another way, two and a half times as many boys were found to be active or moderately active as girls.

Thus, while the sample as a whole were inactive, revealing an inactivity problem generally, it seems that the girls (been highly inactive) had an even more serious problem. This finding is similarly in agreement with the findings of a number of other studies. A whole host of studies have been identified which have revealed boys to be more active than girls (Gilliam et al., 1981; Wold & Aarø, 1985; Vershuur & Kemper, 1985; Sunnegardh & Bratteby, 1987; Durnin, 1967; The Sports Council for Wales, 1987; Dickenson, 1987; Williams, 1988; The Northern Ireland Fitness Survey, 1989; The Health Education Authority Survey, 1989; Armstrong, 1989; 1990; 1990a; 1990b; Thirlaway & Benton, 1993). Not all of these studies have indicated the extent to which the boys were more active than the girls, but those studies which have provided such information have also revealed considerable differences. Armstrong (1989) for example, discovered that more than twice the number of girls than boys failed to sustain a single 10 minute period of physical activity with their heart rate above 140 beats per minute, while Armstrong et al., (1990) found one and a half times the number and Armstrong et al., (1990a) found twice the number to have failed to achieve this criterion. Whilst the criteria which have been used to identify the differences in activity levels are not the same, it is nonetheless interesting to note that the differences which have emerged are comparable to the differences observed in this study (which found two and a half times more boys than girls to be active or moderately active).

The second hypothesis predicted that the year 7 (younger) pupils would be more active than the year 9 (older) pupils. This hypothesis was not supported in the study however, and it was concluded that year 7 pupils were no more active than year 9 pupils. The mean activity scores were 36.39 for the year 7 pupils and 37.11 for the year 9 pupils. This finding was not in agreement with the findings of a number of previous studies. A number of studies conducted in the past have indicated significant differences in activity levels with age and have reported definite decreases in activity levels as children get older (Wold & Aarø, 1985; Saris, 1985; Vershuur & Kemper, 1985; Engstrom, 1986; Dickenson, 1987; The Sports Council for Wales, 1987; The Northern Ireland Fitness Survey, 1989; Thirlaway & Benton, 1993).

The non significant difference obtained in this study however, may be partly explained by the small difference in age between the two groups (year 7 and year 9 pupils). There was just 2 school years between the ages of the pupils and it may be that such a difference was insufficient to display any marked difference in activity levels. Thirlaway & Benton (1993) revealed differences in activity levels with age in West Glamorgan school children but in their study the activity levels of year 6 primary school children were compared with secondary aged school children. The Northern Ireland Fitness Survey (1989) also revealed a difference in activity levels with age but only after the ages of 13 and 14, and Dickenson (1987) found a decrease in activity with age but he assessed the activity levels of children from 11 to 16 years of age. Had this study compared younger children with older children (as in the case of Thirlaway & Benton's study, 1993), or had it investigated children from the age of 11 through to 16, (as in the study by Dickenson, 1987), then differences in activity levels may have emerged.

Alternatively, it may be the case that a 2 year difference may be sufficient, but not between the ages of 11-12 and 13-14. *Two school years between the ages of 11-14 may not have* represented as marked an age difference in developmental or maturational terms as was expected. It may be that nowadays many year 7 pupils, particularly the girls, have already lost interest in physical activity, opting instead for more sedentary pastimes. Many for example, may no longer engage in "play forms" of physical activity (often engaged in at break times and lunch times), formerly thought to be associated with children of this age and yet have developed no interest in alternative forms of activity either. In order to have seen a decline in physical activity levels over a 2 year period therefore, younger primary aged children may have needed to be have been compared with children in the lower years of secondary school (as in the study by Thirlaway & Benton, 1993).

A further explanation as to why a difference may not have been found between the activity levels of the year 7 and year 9 pupils may relate to the extremely low activity levels observed in both groups. As the majority of both year 7 and year 9 pupils were already inactive, it would have been difficult for any group to have been found significantly more inactive due to a flooring effect on the scores. In other words, there would have been a lower limit in the study as to how inactive pupils could be. Many of the year 7 pupils appeared so inactive, resulting in such a low overall mean activity score, that it would have been difficult for even the most inactive group of year 9 pupils to have obtained an even lower mean activity score. It was interesting to note in the study though, that the year 9 pupils' activity scores were marginally higher than the year 7 pupils' scores. Hence, not only was there no significant difference found between the two groups, but the small difference that was evidenced was not in the direction which was predicted. More year 9 pupils in the study were also found to be moderately active or active than year 7 pupils (38.9% for year 9 pupils versus 31.7% for year 7 pupils) and therefore fewer inactive or very inactive (61.1% versus 68.3%).

In terms of age and sex, the least active of any group in the study were the year 7 girls. They had the lowest mean activity score of any group (34.87), the highest percentage of inactive and very inactive pupils (18.2%), and the lowest percentage of active pupils (1.8%). This suggests that even by the age of 11-12, young girls in the study had already opted for more sedentary pastimes and pursuits. This finding may relate to the suggestion made earlier, that some year 7 pupils may no longer engage in "play forms" of physical activity. If this is the case, one explanation to account for this finding may be that year 7 girls may have outgrown these types of activities. An alternative explanation may relate to the social pressures placed on young girls once they reach secondary school. It may not for example, be deemed appropriate or socially desirable for secondary aged girls to engage in such activities. Of interest and in contrast is the finding that the year 7 boys had the most active number of subjects (24.5%) of any group in the study. The explanations given for the year 7 girls thus seem inappropriate or less applicable to the boys. Two explanations for the boys' findings though are firstly, that because boys generally mature later than girls they may still enjoy such "play forms" of activity and secondly, such activities may be more socially acceptable for boys.

A further interesting finding from the activity score results was that no significant difference was observed between the winter and summer activity measures. The mean activity scores were 36.37 for the winter measure and 37.10 for the summer measure. Researchers in the past have reported large seasonal variations in activity levels. Ross, Dotson & Gilbert (1985) for example, noted how exercise patterns vary from season to season and drew attention to the large seasonal differences obtained between the winter and summer activity measures in the National Children and Youth Fitness Survey. Certainly it would seem that the opportunities for children to engage in outdoor physical activities are restricted by the weather and dark evenings during the winter months, and as a result, it would be expected that children wishing to engage in physical activity may, for safety reasons be restricted to more indoor and/or more organised and structured activities. One explanation which may account for the seasonal findings in this study may be that the pupils involved tended not to engage in unstructured activity on their own, the type that would be more restricted in the winter months. Rather, the minority of children who were found to be active or moderately active may have been involved in more organised and structured activity which involved year round participation and which was therefore generally unaffected by seasonal conditions. Of course, it should be noted that the winter and summer measures were really only taken in the study to ensure that as representative an all year round physical activity profile as possible was obtained. The winter and summer data were derived from just 2 days of activity information and may not therefore be truly representative of the pupils' actual seasonal activity levels.[2]

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2. Simons-Morton et al., (1990) took 3 days of activity as representative of patterns of participation in physical activity while Durant et al., (1993) have reported that just over 4 days of recording are necessary to achieve a reliability of 0.80 in the measure.

In considering the activity scores and activity status of the sample, it is important to realise the extent to which the activity categories employed in the study, (depicting children as active, moderately active, inactive and very inactive) have influenced the results. The importance of the definition and the cut-off point chosen to define "active" persons when estimating the prevalence of physical activity was highlighted by Goodman et al., (1988). In their study they found a range in the percentage of "active" subjects from 77% (most) to 24% (least) depending on their definition of "active." They thus urge that caution be taken when interpreting prevalence estimates of physical activity levels.

The classifications adopted in this study, however, were made following careful consideration and every effort was made to ensure that, in the researchers opinion the classifications were realistic for the pupils. As explained earlier, the classifications were made based on those suggested by Blair (1984) for the 7-Day Recall and based on a detailed analysis of the raw data from the pilot study. On close analysis of the activities individuals reported in the pilot study, the classification system adopted and described by Blair (1984) was modified slightly. An additional category, a moderately active category, was added to account for individuals who over the 4 days had clearly engaged in moderate physical activity but who had not spent large amounts of time in hard/very hard activity. In energy expenditure terms the activities engaged in by a number of pupils had not therefore counted for very much, but nonetheless pupils had clearly been regularly active over the 4 days. It thus seemed inappropriate to classify them as "inactive," with the implication that they had done no or very little activity. Hence, pupils who would have been classified as inactive by Blair's criteria may not have been classified as such in this study.

The researcher further felt that the categories needed to be modified in this way for a child population, given the fact that children generally spend more time in sleep than adults. The self completion version of the 7-Day Recall questionnaire for adults makes its calculations based on an average of 8 hours sleep a night for adults. The mean amount of time children spent in sleep in this study was recorded to be 9 hours 57.53 minutes, a difference of almost 2 hours. On average therefore, children have less time in the day in which to be active.

The cut-off points chosen in the classification system may have led to the incorrect classification of some subjects but it was felt that if this was the case, the error would more than likely be in the more lenient direction. In other words, inactive subjects would more likely to have been wrongly classified as moderately active, than moderately active children been wrongly classified as inactive. This it is felt, is partly due to the modified classification system just described, but also partly due to the scoring system which was adopted in the study. In the scoring system, there was more scope for pupils to gain higher energy expenditure scores following the introduction of the very light activity category as well as the light activity category. Rather than all light activities being grouped together and assigned a common MET value of 1.5, as in the case of the 7-Day Recall, in this study very light activity (watching television, watching videos, listening to music, doing homework etc.) was assigned a MET value of 1.5 and light activity (walking, doing household chores, shopping etc.) a value of 2.5.

In considering the results, it should furthermore be realised that the energy expenditure values (activity scores) obtained in this study represent estimations of energy expenditure only and not precise quantitative values. The limitations of the scoring procedure and the problems with establishing energy costs in this way were outlined in detail in chapter two (2.11) and in chapter four (4.1). Taylor et al., (1978) in particular drew attention to a number of problems. To briefly recall, these included the problem of working with a basal-to-work metabolic rate for the calculations (which is not exact since basal metabolism is not consistent at 1 kcal/min as often interpreted), the problem of some activity intensity codes (not having been derived from actual measurements of oxygen consumption), and the problem of some activities having no intensity codes, (making estimations of intensity necessary). A further problem which was identified related to the variation in vigour with which individuals perform activities and the influence such variation could have on the results. However, this latter problem was considered to be of less of a concern in this study following the introduction of probing questions and a re-classification option in the interview protocols.

Of particular relevance to this study though, were the likely inaccuracies that may have arisen in the calculations due to the adoption of adult energy expenditure values for use with children. Limited research on measured energy expenditure in children is available, thus the application of adult values to children has been the common practice. A number of researchers have found the error in doing this to be minimal (Taylor et al., 1948; Bedale, 1923; Cullumbine, 1950; Legun & Moltschanowowa, 1935) and Durnin & Passmore (1967) have revealed that when comparisons are made between activities conducted by adults and children, a number of activities are the same. Thus, it is anticipated that while there are likely to be some inaccuracies in the values obtained in this study and whilst the activity scores represent estimates of energy expenditure only, they are likely to be no more inaccurate than they would be for adults. In fact, given that the scoring procedure adopted in this study took into account the vigour in which the pupils engaged in activity, it is felt that the values obtained may be more accurate than those obtained in previous studies.

A final issue which needs to be addressed is the possible error in the activity scores resulting from inaccuracies in the time estimations made by the pupils. Of course, the error in the time estimations made will not only have influenced the activity scores but will have influenced all of the activity information derived from the study, namely the time spent in moderate activity, hard activity and the number of bouts of "huff and puff" activity of specific durations. Concern has been expressed in the past over children's ability to accurately estimate time and make accurate judgements about time (Eisler, 1975; Friedman, 1982; Baranowski et al., 1984; Sallis, 1991; Sallis et al., 1993). The preliminary studies conducted in chapter three (3.5 and 3.6) highlighted that children do make error in time estimations. Following the studies, it was declared that on average approximately 30% error may be expected in the time estimations made by the pupils and the likely influence such error would have on the final activity scores was considered in hypothetical examples of both active and inactive subjects. On the basis of such hypothetical examples, it was concluded that the activity scores would not be severely affected by the error and that the error was therefore acceptable. Given that the pupils in this study were found to spend the majority of their time in sleep and in very light activity (requiring no time estimations), it is felt that the error made by the pupils in the time estimations, and consequently the error in the activity scores resulting from the time estimations is likely to be minimal and perhaps less than initially anticipated. Many pupils appeared so inactive that they had very few, if any time estimations to make. Indeed, it seemed that some pupils were required only to recall the time they had got up and gone to bed that particular day. Thus on a positive note, it seems that for the majority of the sample, the problems encountered in making time estimations and the error resulting from inaccurate time estimations were less serious than had been feared even from the preliminary studies.

8.3 Time Spent in Moderate Activity

The results for the time spent in moderate activity were also revealing. Pupils reported to spend a daily average of approximately 1 hour (62.44 minutes) in moderate activity and despite the pupil's apparent inactivity, as highlighted from the activity scores, most pupils engaged in some moderate activity over the 4 days. Nearly all, (97.5%) had engaged in some moderate activity over the 4 days, almost 80% (78.4%) had engaged in a daily average of 30 minutes or more and almost half (47.2%) had engaged in a daily average of an hour or more.

These results certainly appear to be more encouraging than the activity score results just discussed. However, these findings may be partly explained by considering the nature of the activities which were classified as moderate in the study. Moderate activities included activities such as playing football, ball games and tag/chasing games in the playground, as well as more conventional activities such as brisk walking, cleaning, gardening, doing a paper round, swimming, cycling and a whole host of other activities. In other words, they included relatively non strenuous activities, the type that most children should be able to engage in and sustain for considerable amounts of time. Indeed, in the 7-Day Recall moderate activity is defined as activity which makes you tired after about an hour. These less strenuous activities may be the types of activities young children would choose if engaging in activity at all, and this certainly seemed to be the case with the pupils in this study. Children perhaps have more ready access to a number of moderate activities. They may have the opportunity to play football, ball games and tag/chasing games in the playground at school each day for example, and it would be fair to say that most children these days own a bicycle. In addition, paper rounds are a popular means of earning money for many young people. Although the percentage of pupils engaging in specific types of activities was not analysed in this study, moderate activities such as playing football, ball games and tag/chasing games in the playground did appear to be particularly popular activities.

Across the sample the findings were similar, with moderate activity proving to be popular amongst all groups. Boys in particular were found to spend a good deal of time in moderate activity. Boys reported to spend a daily average of 78.48 minutes in moderate activity while the girls reported to spend 47.99 minutes. All of the boys in the sample had engaged in some moderate activity over the 4 days and more than 90% had engaged in a daily average of 30 minutes or more. In contrast, some girls had engaged in no moderate activity, though the percentage was not high (14.9%). Indeed, even 65% of the girls had spent a daily average of 30 minutes or more in moderate activity. While moderate activity seemed attractive to most pupils, it seemed particularly attractive to the boys. It has been noted how moderate activities such as playing football/ball games and tag/chasing games in the playground seemed to be popular amongst many pupils and it may be therefore, that these types of activities contributed significantly to the overall time spent by the pupils in moderate activity. If this was the case, it would seem feasible to suppose that such activities may have been more appealing to more of the boys in the study than to the girls. As was suggested earlier, some girls, even by the age of 11-12 may have either outgrown such "play forms" of physical activity, or social pressure may deter them from participating in such activities. Given that boys on the whole mature later than girls and physical activity seems more socially desirable for boys, such factors may explain the differences between the time spent in moderate activity by the boys and the girls.

It was interesting to note that the year 7 pupils engaged in slightly more moderate activity than the year 9 pupils, engaging in daily averages of 66.25 minutes and 58.68 minutes respectively. This finding conflicts with the activity score findings in which the year 9 pupils were found to have a higher mean activity score than the year 7 pupils. The reason for this finding may similarly be related to the attractiveness of the more common types of moderate activities to year 7 and year 9 pupils. If such activities as playing football, ball games and tag/chasing games did contribute considerably to the moderate activity results, then it would seem logical to assume that such activities would be more appealing to the younger rather than older pupils.

Indeed, when the results of the year 7 boys and girls and the year 9 boys and girls are considered, this explanation similarly holds true. As would be expected, the year 7 boys were found to have engaged in the most moderate activity of any group, a daily average of 81.51 minutes, and the year 9 girls in the least amount of moderate activity of any group, a daily average of 42.37 minutes. It is interesting to note that the least active group shifted from the activity score results (see chapter 8, 8.2) to the moderate activity results. The least active group classified in terms of energy expenditure were the year 7 girls, while in terms of the time spent in moderate activity the least active group were the year 9 girls.

While the findings for moderate activity appear to be rather more encouraging than the activity scores, before becoming overly optimistic about such findings, it is worth considering again the kinds of activity moderate activity encompassed in the study. As was mentioned earlier, moderate activity included non strenuous activities. It did not encompass the more vigorous activities and sports such as football, rugby or basketball for example, nor did it encompass the more common types of aerobic activities such as jogging/running or aerobics. These activities constituted hard or very hard activity in the classification system in this study. Only if a child reported to have engaged in a moderate activity particularly strenuously, perhaps for competitive and/or training purposes would the activity have been re-classified and categorised as hard or very hard for the purpose of this research. It is perhaps for this reason that moderate activity is not seen to contribute significantly to the overall energy expenditure (activity scores) of the pupils in making the energy expenditure calculations. In the calculations, 1 hour of moderate activity at 4 METS (4 METS) equates to less than 2 hours of light activity at 2.5 METS (5 METS). In other words, 1 hour of brisk walking (moderate activity) equates to less than 2 hours of leisurely walking (light activity) in energy expenditure terms. This would explain why the majority of pupils in the study were categorised as inactive in terms of their activity scores, (despite most of them having engaged in some moderate activity over the four days and approximately half having engaged in a daily average of an hour or more).

It is believed by some researchers that moderate activity is not of sufficient intensity to increase cardiovascular efficiency and fitness or reduce the risk of coronary heart disease. It has been advocated that conditioning of the cardiovascular system occurs when non athletes work at a rate which is larger than 50% of their maximum oxygen uptake (Karvonen et al., 1957) which, according to Taylor et al., (1978) constitutes activities of approximately 6 METS or more, or heavy intensity activity. Morris et al., (1973) and Epstein et al., (1976) also found that leisure-time activities of 7.5 kcal/min or more were associated with a low incidence of future CHD. In other words, the kind of activities which are likely to incur significant cardiovascular health benefits relate to the hard and very hard activities, assigned MET values of 6 and 10 respectively in this study. Of course, that is not to say that the moderate activity engaged in by the pupils was not and will not be of value to them, as clearly there are a number of benefits, other than cardiovascular benefits, associated with physical activity (see footnote 1). These were highlighted in chapter one. In terms of the moderate activity reported by the pupils though, the amount was clearly not enough to contribute significantly to their overall activity score and it seems it may not, according to some researchers (Karvonen et al., 1957; Taylor et al., 1978; Morris et al., 1973; Epstein et al., 1976) have been of sufficient intensity to contribute to their cardiovascular fitness, improve their functional capacity and/or reduce the risk of CHD.

The moderate activity findings again indicate and reinforce the importance of assessing physical activity in as global a sense as possible and considering more than one dimension of activity. Had this study looked at frequency of participation and time spent in physical activity only, not taking into account the intensity or type of activities reported, then the findings and conclusions drawn from the study may have been very different. A daily average of approximately 1 hour of activity a day initially appears very encouraging. In reality however, and when the type and intensity of this activity is taken into account, it becomes apparent that such activity may have little impact on children's health. This matter was exemplified in the study by Goodman et al., (1988) discussed earlier (see 8.2).

8.4 Time Spent In Hard/Very Hard Activity

The findings for hard/very hard activity were not as encouraging as the moderate activity findings. A dramatic decrease was found between the amount of time pupils spent in moderate activity and the amount of time they spent in hard/very hard activity. Pupils reported to spend a daily average of 16.85 minutes in hard/very hard activity. Of particular concern though were the large individual differences in the amount of time pupils spent in hard/very hard activity. A daily range of between 0 and 161.25 minutes was obtained. Approximately 40% of the sample (38.7%) had engaged in no hard/very hard activity at all over the 4 days, approximately 30% (29.6%) had engaged in a daily average of 20 minutes or more, less than a fifth (19.6%) in 30 minutes or more and only 6.5% in 1 hour or more. Thus, more than 70% (70.4%) had engaged in less than a daily average of 20 minutes of hard/very hard activity and more than 80% in less than 30 minutes.

Given that activity of 6 METS or more is the suggested intensity of activity required for the conditioning of the cardiovascular system (Taylor et al., 1978), and given that activities of an intensity of 7.5 kcal/min or more are required for a low incidence of future CHD (Morris et al., 1973; Epstein et al., 1976), it seems that a large proportion of the pupils in this study did not take sufficient activity of the kind likely to incur cardiovascular health benefits and/or protect them from CHD. Indeed, those pupils who reported to have taken less than an average of 20 and 30 minutes of hard/very hard activity a day engaged in less than the recommended amount of exercise proposed for children by the American College of Sports Medicine (A.C.S.M.) (1988).[3] To recall, the A.C.S.M (1988) gave the following guidance for children:

> *"Until more definitive evidence is available, current recommendations are that children and youth obtain 20-30 minutes of vigorous exercise each day." (A.C.S.M., 1988).*

Thus, more than 70% of the pupils in the study did not achieve the lower 20 minute standard, and more than 80% did not achieve the upper 30 minute standard for children proposed by the A.C.S.M.

The particularly low levels of participation in hard/very hard activity may perhaps be partly understood if the nature of such activity is taken into account. In this study, examples of hard activities included activities such as jogging, basketball and rugby, while examples of very hard activities included running, athletics and football. In the 7-Day Recall hard activity is defined as activity that makes you tired after about 10 minutes. It could be argued that such strenuous activities are not appealing to young people and it seems that this may have been the case for the majority of the pupils in this study. Hard/very hard activity for many children may not represent a very positive and enjoyable experience, particularly if children are unfit and/or unaccustomed to the feelings of discomfort often experienced when engaging in more vigorous types of activities. This would explain why, while perhaps most pupils in the study seemed willing to engage in moderate activity, (as reflected in the moderate activity results), fewer seemed willing to engage in hard/very hard activity.

The difference in activity levels between boys and girls has already been discussed and the difference was again most evident in the time spent in hard/very hard activity. Boys spent more than twice the amount of time in hard/very hard activity than the girls, engaging in daily averages

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3. The A.C.S.M. (1988) guideline will be referred to throughout this section of the discussion (rather than any of the other common guidelines or definitions of appropriate activity) for two main reasons. Firstly, because it relates to children, and secondly because the hard/very hard activity results in this study can be directly compared with the criteria laid down in the guideline.

of 23.86 minutes and 10.31 minutes respectively. These findings are similar to those reported by Durnin (1967) who found that boys spent three times the amount of time in heavy intensity activity than the girls, and to those of Armstrong (1989) and Armstrong et al., (1990; 1990a) who reported boys to spend between one and a half and two times the amount of time in aerobic type activity than girls. In the study approximately 30% of boys and 45% of girls had engaged in no hard/very hard activity, 56.3% of boys and 83.5% of girls had engaged in a daily average of less than 20 minutes and 29.2% of boys and only 10.7% of girls had engaged in a daily average of 30 minutes or more. Thus, in terms of achieving the quantity of vigorous activity proposed by the A.C.S.M. (1988), the majority of both boys and girls had engaged in less than the recommended amount. By the same token therefore, it seems that large numbers of boys and girls may be gaining limited cardiovascular benefit from physical activity.

The large difference between the amount of time spent in hard/very hard activity by boys and girls may be partly explained again by the appeal that hard/very hard activity has to each group. Girls in particular may not wish to participate in activities which they find exhausting. Other possible explanations which may account for the difference may relate to the acceptability of and access girls have to vigorous activities. More boys than girls may have participated in some form of hard/very hard activity in the study due to their involvement in games such as rugby and football. Although the shift is slowly changing and more girls now have the opportunity to play football and other team games both in and out of school, it would be fair to say that such games are still played by and offered predominantly to boys, giving girls limited access. It may be some time before such activities become socially accepted pastimes for girls and before girls are given equal access to them. Although the exact figures are not known, it seemed that a number of boys in the study participated in football in particular and reported to play seriously for schools or local teams, thus engaging in hard/very hard activity of some description. Few girls however, seemed to be interested in football and other such games.

In contrast to the findings from the time spent in moderate activity, year 9 pupils were this time found to spend more time in hard/very hard activity than year 7 pupils. Year 9 pupils spent a daily average of 19.76 minutes and year 7 pupils spent a daily average of 14.8 minutes in hard/very hard activity. In terms of the proportions of time spent by year 7 and year 9 pupils in hard/very hard activity, 75% of year 7 and 65.35% of year 9 pupils had engaged in less than 20 minutes daily, while only 14.4% and 25.3% had engaged in 30 minutes of hard/very hard activity or more. These figures similarly indicate that a large proportion of both year 7 and year 9 pupils had engaged in less than the A.C.S.M.'s recommended amount of vigorous activity for children.

It was interesting to find that the year 9 pupils were more active in terms of hard/very hard activity than the year 7 pupils. Clearly, moderate types of activity were more popular amongst the younger pupils but hard/very hard activities more popular amongst the older pupils. A possible reason to account for such a finding may relate to the suggestion made earlier with regards to the appeal of such activity to certain pupils. Given the definition of hard activity adopted for the 7-Day Recall, that it comprises activity that makes you tired after about 10 minutes, hard/very hard activity may require a certain functional capacity, degree of maturity and determination to sustain for any length of time. It may be therefore, that fewer year 7 than year 9 pupils had the desire and/or the ability to pursue hard/very hard activity for very long. It seemed that if older pupils reported to engage in physical activity at all in the study, a number of them reported to have engaged in hard/very hard activity. It could be argued that by the age of 13-14 children have either selected an active or an inactive lifestyle and, if they have selected the former, then it may be because they enjoy and/or are good at sport. If this is the case, then by the age of 13-14 active children may have acquired the required standard and skill level to enable them to participate in sports vigorously (constituting hard/very hard activity).

Of further interest and particular concern is the limited amount of time year 7 girls reported to spend in hard/very hard activity. Indeed, year 7 girls engaged in on average a quarter of the amount of hard/very hard activity of the year 7 and year 9 boys and a third of the amount of the year 9 girls. It thus seems that the issue raised above (attempting to account for why the younger pupils engaged in less hard/very hard activity than the older pupils) is particularly pertinent to the year 7 girls. Though year 7 boys did engage in less hard/very hard activity than the year 7 girls, they engaged in more than the year 9 girls. However, the highest percentage of non-participants in hard/very hard activity were the year 9 girls. Over half of the girls (52%) had engaged in no hard/very hard activity over the 4 days. It seems that by this age girls had either become interested in physical activity and pursued it seriously, or had lost interest entirely thus engaging in none at all.

Finally, it should be noted how the hard/very hard activity results may largely explain the activity scores (see 8.2) obtained in this study. As was mentioned earlier, moderate activity, having a MET value of 4 does not have the potential to markedly affect the activity scores. However, hard activity, assigned a MET value of 6 METS and very hard activity, assigned a value of 10 METS do. Given that many pupils reported to engage in very little hard/very hard activity it is hardly surprising that the activity scores of many pupils were so low.

8.5 Bouts of "Huff and Puff" Activity

As a final measure of physical activity, the number of bouts of activity pupils engaged in which made them "huff and puff" i.e., breathe hard/harder than normal was calculated. This information served as an additional indicator of the amount of aerobic activity the children were likely to have engaged in over the 4 days. In addition, it provided the interviewer with another means of determining the intensity of activities for the purpose of classifying them as moderate, hard or very hard.

Pupils were found to have engaged in an average of 4.19 bouts of "huff and puff" activity over the 4 days. This equated to an average of approximately 1 bout of "huff and puff" activity a day. Over 12% of the sample had engaged in no bouts of "huff and puff" activity at all and approximately 50% had engaged in less than 4 bouts, i.e., the equivalent of less than a bout of activity a day.

These initial findings were rather limited however as the information gave no indication as to the duration of each bout of activity. The bouts may for example, have lasted for only five minutes.

As a result, bouts of "huff and puff" activity were considered which had lasted for more than 10 minutes and for more than 20 minutes. Interestingly, the findings for the number of bouts of activity lasting for more than 10 minutes were not very different from the findings for the total number of bouts. This suggests that if pupils had engaged in bouts of "huff and puff" activity, then on most occasions the activity tended to last for more than 10 minutes at a time. When it came to bouts of activity lasting for more than 20 minutes however, the results proved to be quite different. The mean number of bouts of activity lasting for more than 20 minutes fell to 2.76, and approximately a fifth (17.6%) of the sample had engaged in no such "huff and puff" activity. Furthermore, 68.8% of the sample had engaged in fewer than 4 bouts of activity lasting for more than 20 minutes over the 4 days.

To try to put these figures into context and compare them with the established recommendations, "huff and puff" activity could roughly be taken to mean "vigorous" activity and compared to the A.C.S.M (1988) guidelines for children (recommending that "children and youth obtain 20-30 minutes of vigorous exercise each day"). In making this comparison it seems that more than two thirds of the pupils did not achieve the equivalent of a daily bout of activity of sufficient "vigour" to cause them to "huff and puff."[4] Out of a total of 835 bouts of "huff and puff" activity recorded by all pupils over the 4 days, 286 or 34.25% of them had lasted for 20 minutes or less. It therefore seemed that if pupils reported to have engaged in "huff and puff" activity, many of the bouts (over 1/3) lasted for between just 10 and 20 minutes.
This finding is in keeping with the findings of the studies conducted by Baranowski et al., (1987) and Armstrong & Bray (1991). Baranowski et al., (1987) concluded from their study on American primary school children that children are active only for short spurts, rather than for longer stretches that might be expected to have an aerobic training effect and subsequent health benefits. Armstrong & Bray (1991) also discovered that shorter periods of activity of the required intensity were quite common in English school children. They concluded that the

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[4] It should be realised that activity of less than a vigorous intensity may have caused some pupils to "huff and puff." The question was asked for activity of a moderate, hard and very hard intensity.

physical activity patterns of school children consist of relatively short periods of physical activity and claimed that this is perhaps as a results of their limited attention span. Further explanations however, may also be offered to account for such findings. It may be that children's short bouts of activity are a reflection of the short periods of time they have available for activity throughout the day. Children's days (particularly school days) tend to be organised for them and may involve few prolonged periods in which physical activity may be sustained. Another possible explanation may be that many young people engage in activity for recreational purposes only (rather than for competition or training/fitness purposes) and therefore do not need to sustain activity for very long. Alternatively, it may be simply that children need physical rest and recovery time during activity which results in shorter, sporadic bouts of activity.

As expected, the boys in the study revealed to have engaged in considerably more bouts of "huff and puff" activity than the girls. The mean number of bouts for the boys was almost twice that of the girls (5.67 for the boys versus 2.88 for the girls). Most boys had also engaged in some "huff and puff" activity over the 4 days whereas 18.4% of the girls had not. Of further interest was the fact that when bouts of "huff and puff' activity lasting for more than 20 minutes were considered, the mean number of bouts dropped in both cases, to 3.72 and 1.86 respectively, but the percentage who had engaged in no bouts of more than 20 minutes remained fairly consistent in the boys, rising by only 1.2%, but rose by 9.8% in the girls. The boys then, not only engaged in more bouts of "huff and puff" activity than the girls but also sustained the bouts for longer. This result is again in keeping with the general trend of results which depict the girls to be far less active than the boys in every dimension of activity.

In terms of differences in age, year 7 pupils were found to have engaged in more total bouts of "huff and puff" activity and more bouts lasting for more than 10 minutes than year 9 pupils (4.43 versus 3.94 for total bouts and 3.67 versus 3.49 for > 10 minute bouts). However, they reported fewer bouts lasting for more than 20 minutes (2.55 versus 2.77). Given the observations made about young children's physical activity by Baranoswki et al., (1987) and Armstrong & Bray (1991), it might have been expected that the younger (year 7) pupils, perhaps having a more limited attention span, would have engaged in more shorter bouts of "huff and puff" activity and fewer longer bouts (i.e., of > 20 minutes) than the year 9 pupils. The children in the studies conducted by Baranoswki et al., (1987) and Armstrong & Bray (1991) were slightly younger than the year 7 pupils in this study, but nonetheless the ages were comparable.

Another possible explanation may relate to the type of activity the year 7 pupils may have engaged in which caused them to "huff and puff." This issue was raised earlier in the discussion of the moderate activity results (see 8.3). As has been noted, year 7 pupils spent more time in moderate activity and it was proposed that this may have reflected the nature of their activity. It was suggested for example, that activities such as playing football, ball games and tag/chasing games in the playground may have appealed more to younger pupils and may have contributed significantly to the year 7 pupils' moderate activity results. If year 7 pupil's "huff and puff' activity tended to be of the kind which commonly took place in the playground, then as already mentioned the duration of these episodes of activity may have been restricted by the length of school break times and lunch times. However, this explanation accounts only for the school day measures and does not hold for the weekend measures of activity. It should be realised though, that while the year 7 and year 9 pupils' results did show the general trends which were expected, the differences between the groups were only relatively small and not as marked as had been anticipated. The reason for this may relate to the explanations offered earlier with regards the non significant difference found between the activity scores of the two groups (see 8.2).

Finally, year 7 boys were found to have engaged in more bouts of "huff and puff" activity than any other group on all occasions, i.e., more total bouts, more bouts lasting for more than 10 minutes and more bouts lasting for more than 20 minutes. They also recorded the lowest percentage of no bouts of "huff and puff" activity. Interestingly these findings conflict with the explanation just offered. Thus, it seems that while year 7 girls did not engage in many longer bouts of physical activity, year 7 boys did. The mean number of bouts of "huff and puff" activity lasting for more than 20 minutes was only 1.75 for the year 7 girls compared to 3.88 for the year 7 boys. It could be argued that the year 7 boys enjoyed activity that much more and therefore were eager to sustain it for longer. Indeed, the findings for "huff and puff" activity for the year 7 boys reflect their other activity findings, in which in every dimension their results are among the most favourable of any group.

On first consideration, and as was the case with the time spent in moderate, the results for bouts of "huff and puff" activity seemed quite encouraging. Most of the pupils in the sample were found to have engaged in some "huff and puff" activity over the 4 days and approximately 50% had engaged in four bouts of activity or more a day. However, in many instances these bouts tended to be only short and when longer bouts of "huff and puff" activity were considered the results were less encouraging. Approximately one fifth of pupils had engaged in no longer bouts of "huff and puff" activity (i.e., bouts of > 20 minutes) and the majority (68.8%) had engaged in less than 4 bouts. This latter information puts the results into perspective rather more clearly. To further clarify the meaning of the results, it is important not to misinterpret this information. The pupils in this study were required to indicate whether the activity in which they had engaged had made them "huff and puff." If they indicated that it had, this did not necessarily mean that the pupils "huffed and puffed" for the whole duration of the activity. In other words, 20 minutes of activity in which the pupils "huffed and puffed" did not equate to 20 minutes of sustained "huff and puff" activity.

The "huff and puff" rating used in this study was adopted from the Australian Fitness Survey's aerobic rating question (The Australian Fitness Survey, 1985) but it clearly has limitations. In the survey, children were asked "In most weeks do you get exercise or activity three or four times which makes you huff and puff and lasts thirty minutes each time?" More recent studies which have relied on similar measures of activity include the Northern Ireland Fitness Survey (1989) and a study conducted by Sleap & Warburton (1990). In the former study, children were asked to recall the amount of exercise they had engaged in which caused a degree of breathlessness and in the latter study, vigorous activity, defined as activity that made a child sweaty and/or out of breath was monitored. In this study and in the researcher's experience, this type of activity information proved to be the most difficult to ascertain from pupils. Some pupils had difficulty in responding to the question "Did the activity make you "huff and puff?" It had been anticipated that the questions requiring estimations of time spent in activity would be the most difficult for the pupils to answer and this was certainly found to be the case in the pilot studies. However, when it came to the main data collection, more problems were encountered with the pupil's ability to recall whether they had "huffed and puffed" during activity or not.

Another problem encountered with the question related to the influence the pupils' fitness levels may have had on the responses to the question. Individuals are all of differing fitness levels and will therefore respond very differently to activity of the same intensity. Unfit individuals for instance, are likely to "huff and puff" more readily than fitter individuals during physical activity. The implication here is that if the pupils in this study were relatively unfit, they are likely to have reported to have "huffed and puffed" during more activities. Of course, the opposite would be true if the pupils in the study were relatively fit. The fitness levels of the pupils in the study were not known however, but suffice is to realise that such a factor may have influenced the results. As explained earlier though, the "huff and puff" question served as additional activity information only, aiming to give some indication as to the amount of aerobic activity the pupils engaged in and to provide additional help to the interviewers in establishing the intensity of particular activities. Nonetheless, the fact that a pupil "huffed and puffed" is important and encouraging information as it indicates that the pupil may have been working at an "appropriate" intensity for them.[5]

A further problem encountered with the question was that in some instances pupils seemed to deny that they had "huffed and puffed" during an activity, despite them reporting to have engaged in the activity very vigorously. For example, a number of pupils reported to have played a serious game of football, constituting very hard activity, or to have engaged in other

5. "Appropriate" meaning in this instance of an intensity which may incur health benefits for the individual.

kinds of hard/very hard activity, yet reported that it had not made them "huff and puff." A few subjects replied with comments such as "No, I'm very fit," or "It didn't make me tired." It seemed that for some pupils, to admit to "huffing and puffing" during activity was to admit to being unfit and was therefore seen as undesirable. A final problem which arose from this question was when asthmatic children were asked whether an activity had made them "huff and puff." A few pupils responded "Yes because I have asthma." This again led to confusion as some pupils were unable to deduce whether it was their asthma which was making them "huff and puff" or the activity.

8.6 Other Points for Discussion

While it was not a major aim of the study to derive information on the very light and light activity pupils engaged in, such information was made available and it did raise some interesting points for discussion. Pupils were found to spend the majority of their time engaged in very light activity, i.e., in activity which involved no translocation such as watching television, watching videos, playing computer games, listening to music, talking with friends, reading and doing homework. Indeed, nearly half of the pupil's day was spent in very light activity (11 hours 26.2 minutes). Of surprise though, and of concern in this study was the small amount of time pupils spent even in light activity. The mean daily time spent in light activity was 76.78 minutes. Indeed, pupils were found to spend almost as much time in moderate activity as they did in light activity and boys were actually found to spend more time in moderate activity than they did in light activity. Given that 2 hours of light activity (at 2.5 METS) expends more energy than 1 hour of moderate activity (at 4 METS), expending 5 METS and 4 METS respectively, the low activity scores obtained for the majority of pupils in this study can now perhaps be even better understood. It seems that many pupils engaged in very little activity of any kind other than very light activity and consequently expended only the lowest levels of energy expenditure (i.e., 1.5 METS).

To recall, light activities comprised walking (leisurely), shopping, doing light household chores, caring for pets as well as light sports such as bowling, pool/snooker and such like, in general all activities which involved some translocation. Considering some of the types of activities which constituted light activity, it is hardly surprising that little time was spent by many pupils in such activities. With recent technological advances and the widespread introduction of labour saving devices in the home for example, it seems that many household chores are now virtually extinct. If pupils did report to help out at home, it seemed that many reported to do only small jobs which took less than 5 minutes to complete, such as laying the table for dinner for example, loading or unloading the dishwasher, or taking the clothes out of the dryer. Many pupils also seemed to be driven to school in the car or to travel to school by bus each day, rather than walking. The nature of many of the light activities may also explain in part why the boys in particular reported to do little light activity and why the year 9 girls reported to do the most. In many homes boys may still not be encouraged and/or expected to help with the household chores to the same extent as girls.

A final, yet vitally important issue to be raised in the discussion is the degree to which the findings obtained were typical and therefore representative of the pupils' typical activity levels. This information was derived from the concluding question to each interview "Was yesterday or Saturday/Sunday a typical day for you?" The results to this question revealed that for the majority of the pupils (53.3%), all 4 days in question had been typical, and for a further 27.1%, 3 out of the 4 days had been typical. If the day had not been typical for pupils the majority of reasons given to account for the atypical day were unrelated to physical activity. Thus, these findings suggest that for the majority of the pupils in the study, the results were obtained for days which reflected their general activity level. It can therefore be concluded that the results give a good representation of the pupils' activity levels.

8.7 Conclusions

In conclusion, the majority of the pupils in this study were found to be inactive. Low activity levels were reflected in the activity scores and in the time spent in hard/very hard activity in particular, with few pupils obtaining sufficient total activity or sufficient hard/very hard activity believed to enhance their health. If total energy expenditure is important in terms of health, as advocated by researchers such as Bar-Or (1983); Gilliam & MacConnie (1984); Shephard (1984); and Saris (1985), the results are clearly very worrying. The pupil's mean energy expenditure was well below Blair's (1984) criteria of "active" and was also below the researcher's "moderately active" criteria set for the purpose of this study. Similarly, if hard/very hard activity of 6 METS or more is important for cardiovascular health, as advocated by Taylor et al., (1978) the results are again worrying and of concern. The vast majority of pupils engaged in insufficient hard/very hard activity, engaging in less than the recommended amount proposed for children by the A.C.S.M. (1988).

While the sample as a whole were inactive, the girls were found to be particularly inactive and presented even more cause for concern. A significant difference was found between the activity levels of the boys and girls in the study. To illustrate the scale of the problem, two and a half times as many boys than girls were found to be active or moderately active, and boys spent more than twice the amount of time in hard/very hard activity than the girls.

On a slightly more positive note, most pupils were found to have engaged in some moderate activity over the period of the study. However, this was clearly insufficient to have any significant impact on total physical activity and the activity scores obtained by the pupils, and it is felt that it may also have been insufficient to have influenced the cardiovascular health of the pupils. This opinion follows the work conducted by Karvonen et al., (1957); Taylor et al., (1978); Morris et al., (1973) and Epstein et al., (1976). "Huff and puff" activity was similarly found to be quite common amongst most pupils, however for many the duration of the bouts of "huff and puff" activity were relatively short. A number of pupils reported no bouts of "huff and puff" activity lasting for more than 20 minutes. There was also no indication given in the study as to how long the pupils sustained the "huffing and puffing" for during the bouts of activity. The implications of these findings will be discussed in the following and final chapter.

CHAPTER 9

SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

9.1 Introduction

This final chapter provides a summary of the research problems and an overview of the studies which have been conducted in both part one and part two of this thesis. In addition, and to conclude the chapter, the implications of the studies are considered and general recommendations are made for further study in the area of monitoring children's physical activity.

9.2 The Research Problems

This thesis has addressed two main research problems. Firstly, the construction of a self-report measure of physical activity designed specifically for use with children and secondly, the use of the measure to provide information on the activity levels of a sample of British children.

The development of an alternative self-report measure for children was tackled in part one of this thesis. The measure aimed to address as many of the problems associated with current self-reports as possible in an attempt to improve upon existing measures. The decision to design an alternative measure stemmed from the concerns expressed by a number of researchers over the accuracy of self-report (Baranowski, 1985; Bernard et al., 1984; McGowan et al., 1984; Powell et al., 1987) and following the conclusions of others that there was a need to improve the assessment of physical activity, particularly among children (LaPorte et al., 1983; Blair, 1984; Montoye & Taylor, 1984; LaPorte et al., 1985; Saris, 1985; Wilson et al., 1986; Klesges & Klesges, 1987). Indeed, since this research problem was initially identified other researchers have also stressed the need for improvements in the area of children's physical activity assessment (Sopko et al., 1992; Sallis et al., 1993; Paffenbarger et al., 1993).

The assessment of the activity levels of a sample of British children was the focus of part two of the thesis. Interest arose in this research problem given the importance of physical activity to children's health and following concerns over children's low activity levels. Furthermore, the literature review revealed limited information available on the activity levels of British youth and it therefore became evident that more information was desperately required to determine how active or inactive young people in this country are, and to determine the extent of the alleged inactivity problem. The self-report measure which was designed and evaluated in part one was subsequently used to gather activity information on a large sample of secondary aged school pupils in part two.

9.3 Overview of the Research-Part One

The development of the measure in part one of this thesis followed a systematic line of inquiry and involved a number of stages. Firstly, a detailed review of existing self-report measures was made including an investigation of the reliability, validity and the major problems and sources of error associated with such measures. The review concluded with an overview of the recommendations from the literature for the future development of self-report. Beyond the review, the development procedure entailed the implementation of a number of the recommendations made in the literature, (particularly those outlined by Baranowski, 1988), to establish the major characteristics of the self-report measure. It was proposed in the early stages of the research that the measure would be designed to measure physical activity at school (excluding sport), sport at school, physical activity during leisure-time and sport during leisure-time, and that it would measure physical activity in terms of average daily energy expenditure in $kcal \cdot kg^{-1} \cdot day^{-1}$, time spent in moderate activity, time spent in hard/very hard activity (6 METS or more), and the number of bouts of "huff and puff" activity (i.e., activity that made a child breathe hard/harder than normal). Other characteristics of the measure were that it would assess the previous day's activity only (a 1-day recall), gather 4 days of activity information for each child and be designed with an objective scoring system. The measure would furthermore comprise two forms, a school day and a weekend form, to take into account both school day and weekend activity information and the forms would be segmented into parts of the day: before school, at school and after school/in the evening for the school day form, and the morning, afternoon and evening for the weekend form. Finally, and for ease of administration the forms would be designed with checklists of activities.

Once the characteristics of the measure were established a series of preliminary studies or investigations were carried out. The investigations were each carried out for a specific purpose and were important to the design process in different respects. Preliminary study one was conducted to determine the types of activities to be included in the checklists for the measure. These were selected based on the results of a short self administered questionnaire administered to 58 pupils aged 11-12 or 13-14 (i.e., year 7 and year 9 pupils) from a local high school. Pupils were required to list the activities they had done at various stages (segments) of the previous day and select from a list of over 60 possible activities which activities they did or sometimes did, and which activities they never did and would never think of doing. The list was compiled from activities already included in established activity questionnaires (The Canadian Fitness Survey, 1981; The Health Related Behaviour Questionnaire, The Northern Ireland Health and Fitness Survey, 1989; and Baranowski's forms, Baranowski et al., 1984). From the responses the pupils made to the questionnaire, the least popular activities were withdrawn from the list and the remaining activities (the more popular activities) formed the checklists for the questionnaire forms.

Preliminary studies two and three stemmed from concern over children's ability to accurately perceive time (Eisler, 1975; Friedman, 1982; Baranowski et al., 1984; Sallis, 1991; Sallis et al., 1993). Given that the estimation of time is an important process involved in self-reporting of physical activity, and given that time estimations had to be made in order to calculate energy expenditure in the proposed questionnaire, two time perception studies were devised to determine the accuracy with which children were able to make judgements about time. In this way, the degree of error which may be expected in responses to the questionnaire could be estimated. The studies used both verbal production and verbal estimation methods of time perception. The verbal production study was conducted at a lunch time on 27 pupils (year 7 and year 9) and the verbal estimation study during a P.E. lesson on 160 pupils of the same ages. Absolute error scores and percentage error scores were calculated for each study. As expected, the findings of both studies revealed that error was made in the time estimations made by the pupils. The average percentage error score for the verbal production study was 12.74% and the average error for the verbal estimation study was 29.59%. While it was found that children do seem to make error in their judgements of time, when the influence such error could have on the overall activity results (energy expenditure) obtained in real terms was considered, (by way of hypothetical examples in which error in the time estimates was made), it was found to make little difference to the overall activity scores (energy expenditure). It was therefore concluded that the activity scores in most cases would not be severely affected by the error made in the time estimations and the error was therefore acceptable.

Having established the characteristics of the questionnaire, the activities to be included in the forms (preliminary study one), and the degree of error that may be expected from the time estimations made in the measure (preliminary studies two & three), the characteristics of the questionnaire were implemented in the design of a self administered measure of physical activity. The self administered forms were piloted on a sample of 62 pupils (year 7 and year 9) in a fourth preliminary study. However, preliminary study four highlighted a number of problems with the use of self administered forms with children. Despite careful instructions and wording of questions in the forms, there was evidence of misinterpretation of the questionnaire by some of the pupils and a number of errors and omissions were made in their completion. Because the priority in this research was to design a measure of physical activity which addressed as many of the problems associated with current measures as possible, the feasibility of administering self administered forms to children of this age was re-considered. It was consequently decided that although the forms could be self administered, the most appropriate means of gathering accurate information would be to adapt the self administered form to an interviewer administered form.

Following the preliminary studies, the scoring procedure for the self-report measure was developed and the format of the new interview questionnaire was established. The scoring procedure was developed based on the procedure used in the 7-Day Recall described by Blair (1984), though a number of changes were made from the 7-Day Recall to this procedure. Raw data from the questionnaire was to be used to calculate an estimate of energy expenditure. The metabolic costs of activities (expressed in METS) included in the questionnaire checklist therefore had to be established from the best available published data (such as the data by Durnin & Passmore, 1967; Katch & McArdle, 1977; Bouchard et al., 1983; The Tecumseh Questionnaire, Reiff et al., 1967; The Minnesota Leisure-Time Physical Activity Questionnaire, Taylor et al., 1978) and once established, the activities had to be categorised into appropriate intensity categories. An additional intensity category was added to the categories used in the 7-Day Recall and activities were classified as very light, light, moderate, hard and very hard. Hitherto, and in the 7-Day Recall activities were classified as light, moderate, hard or very hard. Also in contrast to the 7-Day Recall and previous adult procedures, (such as The Tecumseh Questionnaire; The Minnesota Leisure-Time Physical Activity Questionnaire; The Paffenbarger Physical Activity Questionnaire), more flexibility was added to the scoring system. It was decided that the intensity (purpose) with which an activity was engaged in would be taken into account and distinctions would be made as to "how" activities were engaged in. Thus, the same activities could be categorised differently and assigned different MET values depending on how they were performed, (i.e., whether they were engaged in vigorously and seriously or lightly and for pleasure or fun). Having established the intensity and MET values of activities, the energy expenditure calculations could then be made following the same procedure as for the 7-Day Recall (see chapter 4, table 4.2).

The characteristics of the questionnaire and the scoring procedure determined the final format and lay out of the interview questionnaire forms. Once the format of the questionnaire had been established the forms were piloted on a sample of year 7 and year 9 pupils (n=40). Following the pilot, minor revisions were made to the protocol to clarify the administration procedure and answer some of the discrepancies which had arisen during some of the interviews. The final stage in the preparation of the interview questionnaire was the establishment of a training programme for interviewers and the training of interviewers (n=4) following the prescribed programme. The training procedure was based on the procedure outlined by Gross et al., (1990) for the 7-Day Recall and involved two structured training sessions. The sessions familiarised the interviewers with the background to the questionnaire, the major characteristics of the forms and the protocol and scoring procedure and gave the interviewers the opportunity to practise administering the forms, providing them with feedback on their interviewing performance and technique.

Once the interview questionnaire had been designed and the practicality and feasibility of its administration had been established (through the preliminary and pilot studies), the questionnaire was evaluated. The evaluation of the self-report measure (see chapter 5) involved studies of the validity and the reliability of the measure as well as studies of the reliability of the interviewers trained in the administration of the questionnaire. Evaluating the measure in this way was deemed particularly important considering the recommendations and claims made in the literature that "*physical activity self-reports be developed and evaluated* rigorously..." (Sallis, 1991) and that "the minimal requirements of an instrument for the recall assessment of physical activity necessitate that it provide reliable and valid measurements..." (Dishman & Steinhardt, 1988).

The instrument was validated by two different methods: heart rate monitoring and observation. Twenty pupils were involved in the validation study. The study required pupils to wear a Sport Tester for a day (either a school day or a day at the weekend) and complete the interview questionnaire the following day. In addition, and while the pupils were wearing the Sport Tester, they were discretely observed. The extent to which the information derived from the pupils from the interview questionnaire corresponded with the activity information derived from the heart rate and observational measures was determined as an indication of the validity of the interview questionnaire.

A relationship of r=0.61 was found between the time pupils reported to spend in moderate, hard and very hard activity in the interview questionnaire and the time pupils spent with the heart rate above 139 beats per minute, and a relationship of r=0.79 was found between the energy expenditure values derived from the interview questionnaire and the values derived from the observational measure. Furthermore, there was no significant difference between the energy expenditure values (t=0.72). Pupils were also able to match 86.49% of the activities by mode and 88.89% by intensity with the observer's records. On the basis of this initial validation study, it was declared that the measure was capable of accurately measuring physical activity in children (i.e., in the population for which it was designed) and that providing accurate activity information for one day is well within the capabilities of children of this age.

The reliability of the measure was determined by a test-retest method on a sample of 12 pupils. Pupils completed the questionnaires (two school day and two weekend forms) twice over a period of 4 weeks. A reliability of r=0.62 was obtained between the test and retest activity scores. It was concluded that, given the problems associated with test-retest methods where such types of self-report measures are concerned, the results appeared to suggest that the measure was a fairly reliable measure of physical activity.

The final stage in the evaluation of the interview questionnaire addressed the reliability of the interviewers. Measures of inter interviewer reliability and intra-interviewer reliability or test-retest reliability were made. The measure of inter interviewer reliability aimed to assess how closely interviewers agreed in their scoring. The study involved the four interviewers (trained in part one) scoring 12 tape recorded interviews independently and a comparison of the resulting energy expenditure values calculated from their summary sheets. Pearson correlations between each of the interviewer's scores ranged from 0.88 to 0.99, revealing a high inter interviewer reliability of scoring skills. The measure of intra-interviewer reliability involved the interviewers scoring the same 12 taped interviews again 3 weeks later. Correlations across the repeated scorings revealed an overall reliability of r=0.98. Correlations for individual interviewers ranged from 0.94 to 1.0, indicating good reproducibility of scoring skills. On the basis of the findings from both studies it was declared that following the training procedure, the interviewers had clearly acquired the scoring skills necessary for the reliable administration of the interview questionnaire.

The evaluation studies concluded part one of this research and the first major research problem. In conclusion, it was declared that the results of the reliability and validity studies were encouraging throughout and that these studies, in conjunction with the systematic and rigorous design of the interview questionnaire, provided a good deal of confidence in and justification for the use of the self-report measure in part two of this thesis.

9.4 Overview of the Research-Part Two

As already explained, part two of the research aimed to provide activity information on a sample of British children. The interview questionnaire elicited detailed activity information on a final sample of 199 pupils drawn from 13 schools in three separate counties in central England: Nottinghamshire, Derbyshire and Leicestershire. The questionnaire was administered according to the method and protocols established in part one of the study. Pupils were interviewed on four separate occasions to collect 4 days of activity information (2 school days and 2 weekend days). Two interviews were conducted in the winter months (December to February), to collect information for a school day and a day at the weekend, and two in the summer months (May to July). The four interviewers trained in part one of the study were all involved in data collection, though to differing degrees.

The study provided comprehensive activity information for the sample which is described in detail in chapter seven. The findings therefore will be just be briefly summarised here. The majority of pupils in the study were found to be inactive. Approximately two thirds (64.8%) of pupils were classified as inactive or very inactive while approximately one third (35.2%) were classified as moderately active or active. Low activity levels were reflected in the pupils' activity scores (energy expenditure) and in the time they spent in hard/very hard activity in particular, with few appearing to obtain sufficient total activity or sufficient hard/very hard activity to enhance their health. While the sample as a whole were inactive, the girls were found to be particularly inactive and presented a serious cause for concern. A significant difference was found between the activity levels of the boys and girls in the study. Two and a half times as many boys than girls were found to be active or moderately active (50% of boys versus 21.4% of girls), and boys spent more than twice the amount of time in hard/very hard activity than the girls (spending daily averages of 23.86 minutes and 10.31 minutes respectively). On a slightly more positive note, most pupils (97.5%) were found to have engaged in some moderate activity over the period of the study, though it was declared that this was insufficient to have any significant impact on total physical activity and the activity scores obtained by the pupils, and it is felt that it may also have been insufficient to have influenced the cardiovascular health of the pupils. "Huff and puff" activity was similarly found to be quite common amongst most pupils, however for many the duration of the bouts of "huff and puff" activity were relatively short. A number of pupils (17.6%) reported no bouts of "huff and puff" activity lasting for more than 20 minutes.

9.5 Implications of the Research-Part One

The design of the self-report measure may have some important and exciting implications for the future assessment of children's physical activity in this country. If the self-report measure is a valid and reliable measure of physical activity for children, as the initial validation and reliability studies seem to suggest, then a very useful self-report measure for children has been developed and is available for future research.

The interview questionnaire was developed specifically for British children of 11 years and upwards and as such, it represents the only known self-report measure of its kind which has been designed and evaluated in such a systematic and rigorous way. Previous self-reports for children which have provided validity and/or reliability information, such as those developed by Baranowski et al., (1984); Simons-Morton et al., (1990) and Sallis et al., (1993), have been designed for American youngsters and are not therefore very appropriate for British youth. For instance, they contain a number of activities which are rarely if ever engaged in by British children. In contrast, this measure contains lists of activities which are commonly engaged in by

British school children and which were determined based on the results of a preliminary investigation (preliminary study one).

It is hoped that the systematic design and rigorous evaluation studies have provided sufficient justification for the measure's potential value and use in the area of children's physical activity assessment. The design of the measure involved a number of distinct stages and preliminary and pilot studies to ensure that the administration of the measure was practical and feasible. In addition, attention was paid to the development of detailed protocols and a training procedure for interviewers to enable the widespread use of the measure. The results of the validity and reliability studies were also encouraging throughout. Taking all of these factors in to account the measure must be an improvement upon existing self-reports and it is therefore hoped that other researchers will have sufficient confidence to adopt it for use in future studies on children's physical activity. The widespread adoption of the measure would allow comparisons of activity levels across studies to be made. It was noted in the review of literature (see chapter 6, 6.5) how in the past studies have used a diverse range of methods of monitoring physical activity making the findings across studies difficult to compare. What has been needed to date, therefore, has been a measure of children's physical activity which researchers trust, and which they are happy to adopt and administer on a large scale. The interview questionnaire developed in this research may represent one such measure.

The importance of the accurate measurement of physical activity was highlighted in chapter one. According to Sallis et al., (1993) accurate measurement of physical activity is required to adequately document health consequences. It seems from the evaluation studies that the interview questionnaire is capable of providing accurate activity information. In chapter five it was concluded that providing accurate activity information for 1-day (via the questionnaire) is well within the capabilities of most children. As well as accurate activity information been important, however, it seems that detailed activity information is also required. As mentioned earlier, there is still limited information available on the activity levels of British youth. The review of literature revealed how many previous studies have presented rather vague information on the activity levels of British children and highlighted the need for more studies to be conducted to gather more detailed information.

This questionnaire is capable of providing more detailed activity information than most other measures of physical activity. Previous researchers in the area have tended to focus on one dimension of physical activity only. Some have focused on caloric expenditure (Taylor et al., 1978; Bouchard et al., 1983; Wallace et al., 1985; Sallis et al., 1988; Sallis, Buono, Roby, Micale & Nelson, 1993), while others have been concerned with measuring aerobic activity of specific durations, intensities and frequencies (Seliger et al., 1974; Thorland & Gilliam, 1981; Baranowski et al., 1984; Simons-Morton et al., 1990). This measure however, addresses both major dimensions of physical activity: total physical activity (energy expenditure) and aerobic activity (time spent in hard/very hard activity). The decision to address both of these dimensions was made because the physical activity stimulus to achieve health related outcomes is not known (Haskell, 1985) and because the health issues of appropriate physical activity are still beingexplored (Paffenbarger et al., 1993). This issue has been raised consistently throughout this thesis. Indeed, it seems that different dimensions of activity are important for different aspects of health. For example, Blair et al., (1985) and Caspersen et al., (1985) note how the dimension of physical activity associated with caloric expenditure results in the physiological effect of energy utilisation and thereby enhances weight loss or control, which in turn may be useful in managing CHD, diabetes mellitus and obesity (Blair, Jacobs & Powell, 1985; Powell et al., 1987), while the dimension of physical activity that corresponds to aerobic intensity enhances the ability of the cardiorespiratory system and may have a beneficial influence on cardiovascular disease (Morris et al., 1980; Paffenbarger et al., 1978). It is clear then, that both dimensions are important and it could be argued both should therefore be taken into account in monitoring physical activity. Indeed, Davey Smith & Morris (1992) recommend that both dimensions should be considered. This measure has the distinct advantage of being able to provide more detailed information and perhaps more accurate activity information than many other measures. It would seem therefore that this type of self-report measure may be more appropriate if the full health consequences of physical activity are ever to be fully documented.

While the evaluation studies have provided a good deal of confidence in the measure, and while it has been declared a valid and fairly reliable measure of physical activity for children, the problems of conducting validity and reliability studies can not be overlooked. The problems were discussed in chapter two (see 2.8) and in chapter five (see 5.6 & 5.7). The measure was validated and had its reliability checked by the best and most practical means available, nonetheless, the fact that the methods used were less than gold standard remains.

Of course, it should be realised that while there are problems with the evaluation studies, the problems apply to the validation and reliability checks of all measures of physical activity. Caution should therefore be taken against been overly critical or negative about the possible implications and impact the self-report measure designed in this research may have. On a positive note, the measure has been designed in a systematic way and it is feasible, practical and relevant to the population for which it has been designed (i.e., British children aged 11 years and upwards). In addition, and perhaps more importantly, it has been evaluated rigorously, by the best available means, and has shown to be capable of accurately measuring physical activity in children. It has much potential for the future assessment of children's physical activity.

9.6 Implications of the Research-Part Two

Due to a lack of information in the area of children's physical activity research, the exact implications of the findings from the assessment of children's physical activity levels are not really known. Simons-Morton et al., (1987) acknowledged how surprisingly little is known about both children's participation in physical activity and the relationship between children's physical activity and health, and more recently Sopko et al., (1992) claimed that studies in youth have been limited and not sufficiently extensive to produce conclusive results.

What is known however, is that physical activity is important to children's health. Physical inactivity has been declared a risk factor for coronary heart disease (The American Heart Association, 1992) and the numerous benefits of physical activity were highlighted in chapter one (see 1.1). To briefly recall, regular physical activity has been shown to improve cardiovascular and other components of health related fitness in children (Bar-Or, 1983) and has been shown to be related to CHD risk factors such as blood pressure (Fraser et al., 1983; Fripp et al., 85; Strazullo et al., 1988), serum lipoproteins (Durant et al., 1983; Thorland & Gilliam, 1981) and obesity (Clark & Blair, 1988; Walberg & Ward, 1985).

The main problem which is faced in determining the exact implications of these findings relates to the fact that the physical activity stimulus to achieve health related outcomes has not been clearly defined (Haskell, 1985). While the importance of physical activity has been established, neither the type or amount of activity required to enhance children's health, nor the full extent and the possible dangers of inactivity to children's health has. The main debate seems to be whether children should be concerned with total activity and energy expenditure, or whether they should focus on participation in aerobic and more vigorous types of activities. However, whether it be total activity and energy expenditure which is the main concern, or aerobic type and more vigorous activities, the findings and conclusions drawn from both dimensions in this study are consistent. The majority of the pupils in the study were found to be inactive both in terms of energy expenditure and the amount of hard/very hard activity in which they engaged. Thus, even though the precise implications of the findings can not be determined, the general implications can. It seems that the majority of pupils in the study gained insufficient aerobic activity (hard/very hard activity), the type likely to incur cardiovascular benefits, and insufficient amounts of total activity, the type likely to incur any of the other benefits associated with physical activity. In this respect therefore, it seems that the health of many of the pupils in this study may be at risk. The findings are particularly worrying given that physical inactivity is now a recognised risk factor for coronary heart disease (The American Heart Association, 1992). Furthermore, coronary heart disease is known to have its origins in childhood (Lauer et al., 1975; Newman et al., 1986) and risk factors are known to track over time (Freedman et al., 1985; Lauer et al., 1989). The low activity levels of the pupils in this sample should not therefore be taken lightly.

A further and important implication of the findings relates to the influence that such low levels of activity may have on the pupil's future participation in physical activity. Simons-Morton et al., (1990) have acknowledged how physical activity is not only of interest because of its relationship with risk factors but also because of its possible influence on future adult participation in physical activity. A number of researchers have noted how active children will develop the skills, enjoyment and habits that will increase the likelihood that they will be active as adults (Blair et al., 1989; Ross & Gilbert, 1985; Simons-Morton et al., 1987; Simons-Morton et al., 1988). Indeed, the Health of the Nation Document (1992) and the Allied Dunbar National Fitness Survey (1992) also strongly support this view. The Allied Dunbar National Fitness Survey found a strong association between adult participation in physical activity in later years and behaviour at an earlier age. Given the low activity levels of many of the pupils in this study, it seems that many may go through their childhood without developing the necessary skills to be able to enjoy many of the activities which are available to them. If they do not acquire the skills to enjoy physical activities and decide to take up physical activities now, then the research seems to suggest that they will be unlikely to take them up later in life.

In addition, given that the days for which the activity information was collected were reported to be typical for the majority of pupils, the findings are perhaps of even more concern. Pupils in the study did not claim that they "normally did more activity" or were "less active than usual," as may have been expected. Furthermore, the results are particularly worrying considering that the questionnaire assessed all activity the pupils had participated in, including the activity they had done in physical education lessons at school. The activity reported by some of the pupils may have been solely the activity they did during compulsory physical education lessons at school. If this was the case, then in a few years time when these pupils leave school and are no longer required to participate in compulsory physical education, their activity levels may decrease still further. Indeed, a number of studies have reported decreases in activity with age and this seems to be very much the common trend (Wold & Aarø, 1985; Saris, 1985; Vershuur & Kemper, 1985; Engstrom, 1986; Dickenson, 1987; The Sports Council for Wales, 1987; The Northern Ireland Fitness Survey, 1989; Thirlaway & Benton, 1993). Although no differences in activity levels with age were observed in this study, reasons to account for this finding have been suggested and it may be the case that in a few years from now the pupils' activity levels may follow a similar trend to previous studies. Thus, it seems that in time the inactivity problem which has been identified in this sample may get worse.

While these implications are relevant to the sample as a whole, they are particularly pertinent to the girls. As was noted earlier, the girls in the study were found to be far less active than the boys in every dimension of activity. The results of this study seem to suggest that even by the age of 11 many girls have already lost interest in physical activity, opting instead for more sedentary pursuits. As such, the future consequences of the girls' extremely low activity levels may be all the more serious.

On a more positive note, however, the findings for moderate activity and "huff and puff" activity in the study were revealing and may have implications for future research in the area of children's physical activity. Chapter eight concluded that most pupils were found to have engaged in some moderate activity over the period of the study. Indeed, 97.5% of the pupils had engaged in some moderate activity over the 4 days and the daily average time spent in moderate activity was 62.44 minutes. It was declared however, that this was insufficient to have any significant impact on total physical activity and the activity scores obtained by the pupils and it was suggested that it may have been insufficient to have influenced the cardiovascular health of the pupils. Similarly, it was concluded that "huff and puff" activity was found to be quite high amongst most pupils. For many though, the durations of the bouts were relatively short. A number of the bouts (over 1/3) lasted for between just 10 and 20 minutes.

Nonetheless, this activity information is clearly important. The fact that many of the pupils in the study were found to have engaged in some activity rather than none at all is most encouraging. Such findings suggest that for many of the pupils, it may not be necessary to encourage a dramatic change in their activity behaviour . It would not for example, in many cases, be a matter of encouraging totally sedentary individuals to take up exercise or physical activity, rather, it would be a matter of encouraging pupils who are already doing some physical activity (albeit of only a moderate intensity and for short periods of time), to engage in it more vigorously and for longer periods of time. This would entail the pupils participating in more hard/very hard activity rather than moderate activity and sustaining their bouts of activity for longer. This change in behaviour should be attainable and certainly represents a realistic goal in the promotion of physical activity among such a group.

In conclusion, though, the general implications of these findings are still very worrying. If the findings are typical and reflect the activity levels of British children generally, then we may expect there to be serious consequences for the future health of our young population. While gaps in the research do not allow the full and exact implications of the inactivity problem to be ascertained, it is nonetheless certain that the problem is serious, and it can thus be deduced that the resulting implications are likely to be serious. The scale of the problem may not be fully appreciated until many years from now when today's youth are well into their adulthood.

9.7 Recommendations

Considering the results, conclusions and limitations of the research problems highlighted within this thesis, there are several recommendations which can be made for further study in the area of monitoring physical activity in children. This thesis has raised a number of interesting issues and questions throughout, indicating that there is much scope and need for future work in the area. The recommendations arising from each research problem are dealt with separately in this final section. Part one recommendations deal with the methodological issues surrounding the design of the self-report measure and part two recommendations deal with the assessment of, and information on children's physical activity levels.

Part One

1) The evaluation of the interview questionnaire is limited by the small number of subjects involved in the validity and reliability studies. This limitation was due to time and organisational constraints. The studies were time consuming to conduct (for example, the validation study took 2 days per subject to complete). The studies should be replicated on larger sample sizes.

2) The findings from the validity study are based on a largely "inactive" sample. The validity of the interview questionnaire also needs to be established in more active samples.

3) The measure was validated in this research against heart rate and an observational measure. Further work could be conducted to compare the measure with other measures of physical activity.

4) The duration of physical activity is a critical variable in self-report and more research in children's accuracy in reporting this variable is needed. Research needs to be conducted to discover how the ability to estimate time develops, whether the reporting of the duration of physical activity may be improved through training, and if so, how?

5) In scoring the questionnaire adult energy costs of activities were adopted and where energy costs for particular activities were not available, personal judgements about their intensity were made. More research needs to be conducted to establish the energy costs of activities for children. A compendium of physical activity costs for children could then be developed, (similar to the compendium devised by Ainsworth et al., 1993).

6) It was concluded that the interview questionnaire is capable of accurately measuring physical activity in children 11 years and upwards. Future work could involve adapting the measure and/or assessing its validity and reliability for a younger population.

7) The interview questionnaire, while representing a tool which can be used on large numbers, is still relatively time consuming (each interview lasts approximately 10 minutes and each pupil is interviewed four times). Further work may include the refinement of the self administered version of the questionnaire (preliminary study four) to administer to larger numbers of children.

Part Two

1) More information is still needed on the activity levels of British children. The generalisability of the findings from the study needs to be more clearly established by administering the interview questionnaire to more children (throughout the 11-16 age range), from more areas of the country.

2) Longitudinal physical activity information is required for British children. The interview questionnaire should be used in longitudinal studies to establish children's activity patterns from 11 through to 16 years of age.

3) More information is required on the physical activity stimulus required to achieve health related outcomes. This lack of knowledge is impeding research and the interpretation of findings in the area of children's physical activity.

4) More research is needed into the health consequences of different types of activity. This recommendation relates to 3 above. The effect short periods of intense activity (activity of < 20 minutes) has on the cardiopulmonary system needs to be established, for example. "Huff and puff" activity was quite common amongst most pupils in the study, though the duration of the bouts of "huff and puff" activity were often short. What influence, if any, is such activity likely to have on children's health?

5) More information is also required on the influence of lower intensity physical activity on children's health. Indeed, most pupils in the sample were found to have engaged in some

moderate activity over the period of the study and many pupils were found to have engaged in a considerable amount. What influence, if any, is this type of activity likely to have?

6) This study assessed and described the activity levels of children only. It has been beyond the scope of this thesis to try to account for the findings. If any progress in the area of children's physical activity is to be made however, the reasons to account for the children's low activity levels need to be established. This is a very complex and separate issue but one which is nonetheless vital if the inactivity problem identified within this thesis it to be tackled.

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I am trying to construct an important questionnaire for young people of your age.

YOUR SCHOOL HAS AGREED TO HELP ME.

I need some important information from you about the different sorts of activities you do. Your answers to this short questionnaire will help to construct a longer questionnaire.

PLEASE FILL IN BOTH PARTS OF THE FORM AS CAREFULLY AND AS HONESTLY AS POSSIBLE. IN PART ONE I AM INTERESTED IN WHAT YOU DID **YESTERDAY**. PLEASE WRITE WHAT YOU DID IN THE SPACES PROVIDED.

PLEASE NOTE:

1) There are no right or wrong answers.
2) Your answers are strictly confidential.

PART ONE-ABOUT YOURSELF:

AGE ❐❐ years BOY ❐ GIRL ❐ (please tick ✔)

SCHOOL ________________________

What did you do yesterday? (Please list any activities you did, for example, swimming, watched television, played football).

1) In the morning before school

----

2) At breaktime

----

3) At lunchtime

----

4) In the evening

PART TWO-NOW I AM INTERESTED IN WHAT YOU DO GENERALLY. BELOW IS A LIST OF ACTIVITIES YOU MAY OR MAY NOT DO.

1) Please tick ✔ any activities <u>you do or sometimes do</u>.

2) Please cross ✘ any activities you <u>do not do, or would never think of doing</u>.

For example, Jane reads a lot, goes swimming and sometimes goes cycling. She has never been to karate and would never think of going hiking. She would fill this in as follows:

reading	☑
swimming	☑
karate	☒
cycling	☑
hiking	☒

Now about the activities you do:-

watch television	☐	go shopping	☐
watch videos	☐	cook	☐
listen to music	☐	sew	☐
play indoor games	☐	tidy-up	☐
play tag/chasing games	☐	wash-up	☐
draw/paint	☐	general kitchen duties	☐
play a musical instrument	☐	clean/move furniture	☐
use a computer	☐	hoover/dust	☐
care for pets	☐	iron	☐
read a book for pleasure	☐	do the gardening	☐
read magazines	☐	scouts/guides	☐
do homework	☐	do a paper round	☐
go to the cinema	☐	any other part-time job	☐

PTO

swimming	❐	rowing	❐
football	❐	sailing	❐
rugby	❐	ice/roller skating	❐
hockey	❐	bowling	❐
netball	❐	judo/karate	❐
tennis	❐	ballet	❐
badminton	❐	disco dancing	❐
volleyball	❐	golf	❐
basketball	❐	canoeing	❐
gymnastics	❐	horseriding	❐
athletics	❐	scrambling	❐
rounders/softball	❐	hiking/orienteering	❐
cricket	❐	fishing	❐
squash	❐	skateboarding	❐
aerobics	❐	table tennis	❐
running/jogging	❐	weight training	❐
cycling	❐	darts	❐
		pool/snooker	❐

Are there any <u>other</u> activities you do or sometimes do?
If so <u>what are they?</u>

THANK YOU FOR YOUR HELP. YOUR ANSWERS WILL BE VERY USEFUL AND IMPORTANT FOR MY RESEARCH.

APPENDIX B

VERBAL PRODUCTION RESULTS-YEAR 7 AND YEAR 9

Time required to produce	Child's actual time estimated	Error (child's time estimated-time required to be produced)	%Error
10	10 mins 15 secs	+15 secs	2.5%
10	7 mins 45 secs	-2 mins 15 secs (135 secs)	22.5%
10	16 mins 30 secs	+ 6 mins 30 secs (390)	65%
10	9 mins 45 secs	-15 secs	2.5%
10	6 mins 30 secs	- 3 mins 30 secs (210)	35%
10	9 mins	+ 1mins (60)	10%
10	10 mins 15 secs	+ 15 secs (15)	2.5%
10	8 mins 45 secs	-1min 15 secs (75)	12.5%
10	6 MINS	- 4 mins (240)	40%
		1155 secs/ 9 = 128.33 secs	
	Absolute error = 2 mins 8.33 secs		Average error = 21.38%
20	21 mins 30 secs	+ 1min 30 secs (90 secs)	7.5%
20	16 mins 15 secs	- 3 min 45 secs (225)	18.75%
20	18 mins 45 secs	- 1 min 15 secs (75)	6.25%
20	21 mins	+1 min (60)	5%
20	19 mins 30 secs	- 30 secs	2.5%
20	17 mins 30 secs	- 2 secs 30 SECS (150)	12.5%
20	19 mins 45 secs	-15 secs (15)	1.25%
20	20 mins 30 secs	+ 30 secs (30)	2.5%
20	21 mins 45 secs	+ 1 min 45 secs (105)	8.75%
		780 secs/9 = 86.66 secs	
	Absolute error = 1 min 26.66 secs		Average error = 7.22%
30	26 mins	- 4 mins (240)	13.33%
30	30 mins 15 secs	+ 15 secs	0.8%
30	23 mins 45 secs	- 6 mins 15 secs (375)	20.8%
30	31 mins 45 secs	+ 1 min 45 secs (105)	5.8%
30	27 mins 45 secs	- 2 mins 15 secs (135)	7.5%
30	28 mins 30 secs	- 1 min 30 secs (90)	5%
30	30 mins	- 0	0%
30	22 mins	- 8 mins (480)	26.66%
30	25 mins	- 5 mins (300)	16.66%
		1740 secs/9 = 193.33 secs	
	Absolute error = 3 mins 13.33 secs		Average error =10.74%

VERBAL PRODUCTION RESULTS-YEAR 7

Time required to produce	Child's actual time estimated	Error (child's time estimated-time required to be produced)	%Error
10	10 mins 15 secs	+15 secs	2.5%
10	7 mins 45 secs -	2 mins 15 secs (135 secs)	22.5%
10	16 mins 30 secs	+ 6 mins 30 secs (390)	65%
10	9 mins 45 secs	-15 secs	2.5%
10	6 mins 30 secs	- 3 mins 30 secs (210)	35%
		(153 secs) 2 mins 33 secs	Average error=25.5%
20	21 mins 30 secs	+ 1 min 30 secs (90 secs)	7.5%
20	16 mins 15 secs	- 3 mins 45 secs (225)	18.75%
20	18 mins 45 secs	- 1 min 15 secs (75)	6.25%
20	21 mins	+ 1min (60)	5%
20	19 mins 30 secs	- 30 secs	2.5%
		(96 secs) 1 min 36 secs	Average error= 8%
30	26 mins	- 4 mins (240)	13.33%
30	30 mins 15 secs	+ 15 secs	0.8%
30	23 mins 45 secs	- 6 mins 15 secs (375)	20.8%
30	31 mins 45 secs	+ 1 min 45 secs (105)	5.8%
30	27 mins 45 secs	- 2 mins 15 secs (135)	7.5%
		(174 secs) 2 mins 54 secs	Average error= 9.6%

VERBAL PRODUCTION RESULTS-YEAR 9

Time required to produce	Child's actual time estimated	Error (child's time estimated-time required to be produced)	%Error
10	9 mins	+ 1 min (60)	10%
10	10 mins 15 secs	+ 15 secs (15)	2.5%
10	8 mins 45 secs	-1 min 15 secs (75)	12.5%
10	6 mins	- 4 mins (240)	40%
		(90 secs) 1 min 30 secs	Average error=15%
20	17 mins 30 secs	- 2 mins 30 secs (150)	12.5%
20	19 mins 45 secs	-15 secs (15)	1.25%
20	20 mins 30 secs	+ 30 secs (30)	2.5%
20	21 mins 45 secs	+ 1 min 45 secs (105)	8.75%
		(75 secs) 1 min 15 secs	Average error=6.25%
30	28 mins 30 secs	- 1 min 30 secs (90)	5%
30	30 mins	- 0	0%
30	22 mins	- 8 mins (480)	26.66%
30	25 mins	- 5 mins (300)	16.66%
		(217.5 secs) 3 mins 37.5 secs	Average error=12.08%

Summary of Verbal Production Results for Year 7 and Year 9 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	128.33 2 mins 8.33 secs	21.38%
20	86.66 secs 1 min 26.66 secs	7.22%
30	193.33 secs 3 mins 13.33 secs	10.74%
AVERAGE PERCENTAGE ERROR=12.74%		

Summary of Verbal Production Results for year 7 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	153 secs 2 mins 33 secs	25.5%
20	96 secs 1 min 36 secs	8%
30	174 secs 2 mins 54 secs	9.6%
AVERAGE PERCENTAGE ERROR=14.36%		

Summary of Verbal Production Results for Year 9 Pupils

TIME REQUIRED TO PRODUCE	ABSOLUTE ERROR	% ERROR
10	90 secs 1 min 30 secs	15%
20	75 secs 1 min 15 secs	6.25%
30	217.5 secs 3 mins 37.5 secs	12.08%
AVERAGE PERCENTAGE ERROR=11.11%		

VERBAL ESTIMATION RESULTS-YEAR 7

Time required to estimate	Child's actual estimated time	Error(child's estimated time -required estimation time)	% Error
10	6	-4	40%
10	10	-	0%
10	10	-	0%
10	15	+5	50%
10	10	-	0%
10	5 mins 30 secs	-4 mins 30 secs **	45%
10	7	-3 **	30%
10	10	-	0%
10	5 mins 30 secs	- 4 mins 30 secs	45%
10	11mins 30 secs	+ 1 min 30 secs	5%
10	10	-	0%
10	4	-6	60%
10	17?	+7	70%
10	16	+6	60%
10	18	+8	80%
10	8	-2	20%
10	7	-3	30%
10	12	+2	20%
10	20	+10	100%
10	13	+3	30%
10	11	+1	10%
10	5	-5	50%
10	6	-4	40%
10	10	-	0%
10	15	+5	50%
10	20	+10	100%
10	20	+10	100%
10	10	-	0%
10	10	-	0%
10	13	+3	30%
10	15	+5	50%

Absolute error=3 mins 38 secs Total % error=36.3%

Time required to estimate	Child's actual estimated time	Error(child's estimated time -required estimation time)	% Error
20	7	-13 **	65%
20	10	-10 **	50%
20	15	-5	25%
20	10	-10	50%
20	20	-	0%
20	15	-5	25%
20	15	-5	25%
20	25	+5	25%
20	18	-2	10%
20	35	+10	50%
20	27	+7	35%
20	30	+10	50%
20	22	+2	10%
20	18	-2	10%
20	25	+5	25%
20	25	+5	25%
20	11	-9	45%
20	20	-	0%
20	15	-5	25%
20	10	-10	50%
20	20	-	0%
20	40	+20	100%
20	20	-	0%
20	20	-	0%
20	26	+6	30%
20	20	-	0%
20	45	+25	125%
20	30	+10	50%
20	30	+10	50%
20	10	-10	50%
20	10	-10	50%
20	22	+2	10%
20	7	-13	65%

Absolute error= 6 mins 51 secs Total % error=34.25%

Time required to estimate	Child's actual estimated time	Error(child's estimated time -required estimation time)	% Error
30	25	-5	16.66%
30	15	-15	50%
30	20	-10	33.33%
30	20	-10	33.33%
30	30	-	0%
30	25	-5	16.66%
30	22	-8 **	26.66%
30	13	17 **	56.66%
30	30	-	0%
30	25	-5	16.66%
30	40	+10	33.3
30	40	+10	33.33%
30	20	-10	33.33%
30	30	-	0%
30	31	+1	3.33%
30	27	-3	10%
30	45	+15	50%
30	35	+5	16.66%
30	26	-4	13.33%
30	40	+10	33.33%
30	31	+1	3.33%
30	35	+5	16.66%
30	25	-5	16.66%
30	40	+10	33.33%
30	45	+15	50%
30	30	-	0%
30	50	+20	66.66%
30	20	-10	33.33%
30	25	-5	16.66%
30	30	-	0%
30	35	+5	16.66%

Absolute error= 7 mins 3.6 secs Total % error=23.54%

**-denotes atypical lesson-indoor wet weather

VERBAL ESTIMATION RESULTS-YEAR 9

Time required to estimate	Child's actual estimated time	Error(child's estimated time -required estimation time)	% Error
10	10	-	0%
10	15	+5	50%
10	5	-5	50%
10	6	-4	40%
10	15	+5	50%
10	7	-3	30%
10	17	+7	70%
10	15	+5	50%
10	9	-1	10%
10	10	-	0%
10	8	-2	20%
10	20	+10	100%
10	5	-5	50%
10	5	-5	50%
10	8	-2	20%
10	10	-	0%
10	10	-	0%
10	10	-	0%
10	8	-2	20%
10	5	-5	50%
10	10	-	0%
10	10	-	0%
10	13	+3	30%
		Absolute error= 3 mins	Total % error= 30%
20	10	-10	50%
20	10	-10	50%
20	20	-	0%
20	23	+3	15%
20	17	-3	15%
20	20	-	0%
20	20	-	0%
20	20	-	0%
20	12	-8	40%
20	25	+5	25%
20	25	+5	25%
20	25	+5	25%
20	30	+10	50%
20	20	-	0%
20	25	+5	25%
20	30	+10	50%
20	35	+15	75%
20	15	-5	25%
20	25	+5	25%
20	40	+20	100%
		Absolute error=5 mins 57 secs	Total % error= 29.75%

Time required to estimate	Child's actual estimated time	Error(child's estimated time -required estimation time)	% Error
30	45	+15	50%
30	12	-8	26.66%
30	30	-	0%
30	29	-1	3.33%
30	31	+1	3.33%
30	35	+5	16.66%
30	35	+5	16.66%
30	40	+10	33.33%
30	36	+6	20%
30	30	-	0%
30	41	+11	36.66%
30	35	+5	16.66%
30	40	+10	33.33%
30	40	+10	33.33%
30	45	+15	50%
30	45	+15	50%
30	40	+10	33.33%
30	30	-	0%
30	40	+10	33.33%
30	30	-	0%
30	40	+10	33.33%
30	20	-10	33.33%

Absolute error= 7 mins 8.4 secs   Total % error=23.78%

**-denotes atypical lesson-indoor wet weather

Summary of Verbal Estimation Results for Year 7 and Year 9 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins 19 secs	33.15%
20	6 mins 2.4 secs	32.00%
30	7 mins 6 secs	23.66%
AVERAGE PERCENTAGE ERROR=29.59%		

Summary of Verbal Estimation Results for Year 7 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins 38 secs	36.30%
20	6 mins 51 secs	34.25%
30	7 mins 3.4 secs	23.54%
AVERAGE PERCENTAGE ERROR=31.36%		

Summary of Verbal Estimation Results for Year 9 Pupils

TIME REQUIRED TO ESTIMATE	ABSOLUTE ERROR	% ERROR
10	3 mins	30%
20	5 mins 57 secss	29.75%
30	7 mins 8.4 secs	23.78%
AVERAGE PERCENTAGE ERROR=27.84%		

APPENDIX C

Questionnaire Codes-Activity Codes, School Codes, Atypical Day Codes

Table 1

VERY LIGHT ACTIVITIES- AVERAGE 1.5 METS. In alphabetical order

ACTIVITY	CODE
1) card/board games/playing with toys	01
2) using a computer/playing computer games	02
3) drawing/painting	03
4) homework	04
5) listening to music	05
6) playing a musical instrument	06
7) reading for pleasure	07
8) talking with friends	08
9) watching television	09
10) watching videos	10

LIGHT ACTIVITIES- AVERAGE 2.5 METS. In alphabetical order

ACTIVITY	CODE
11) bowling	11
12) caring for pets	12
13) cricket	13
14) darts	14
15) horseriding	15
16) light household chores-washing-up, tidying-up etc.	16
17) doing a part-time job	17
18) pool/snooker	18
19) shopping	19
20) table tennis	20
21) walking/strolling	21
22) going to a youthclub/disco	22

MODERATE ACTIVITIES- AVERAGE 4.0 METS. In alphabetical order

ACTIVITY	CODE
23) badminton	23
24) cleaning/hoovering/moving furniture	24
25) cycling	25
26) football-in the playground	26
27) gardening	27
28) golf	28
29) gymnastics	29
30) hockey	30
31) netball	31
32) doing a paper round	32
33) playing tag/chasing games in the playground	33
34) playing any other ball game in the playground	34
35) rounders	35
36) swimming	36
37) tennis	37
38) volleyball	38
39) walking briskly	39

HARD ACTIVITIES- AVERAGE 6.0 METS. In alphabetical order

ACTIVITY	CODE
40) basketball	40
41) disco dancing	41
42) jogging	42
43) rugby/touch rugby	43

VERY HARD ACTIVITIES- AVERAGE 10.0 METS. In alphabetical order

ACTIVITY	CODE
44) athletics	44
45) football	45
46) running	46
any other activities-(need to be classified as light, very light, moderate, hard etc at interviewer's discretion).	47

NOTE-

JOGGING and RUNNING should be classified differently. JOGGING is a HARD activity and RUNNING a VERY HARD activity.

Differentiation should also be made between STROLLING/WALKING and WALKING BRISKLY. STROLLING/WALKING is a LIGHT activity and WALKING BRISKLY is a MODERATE activity.

Table 2
SCHOOL CODES

SCHOOL	CODE	SCHOOL	CODE
CD	1	G	2
L	3	CoL	4
HP	5	BP	6
R	7	HC	8
Ch	9	Fr	10
LE	11	LG	12
OLCS	13		

Table 3
REASON FOR ATYPICAL DAY CODES

REASON FOR ATYPICAL DAY	CODE
Normally more active/do more	1
Normally less active/do less	2
Stayed up late/later than usual	3
Friends/relatives visited or visited friends/relatives	4
Visited doctors/dentist/hospital	5
Was ill/injured	6
Special occasion-birthday/other celebration	7
An unusual event occured	8
Any other reason	9

QUESTIONNAIRE FORM 1

SCHOOL DAY

SUBJECT NO' ❑❑❑

SCHOOL CODE ❑❑

PART ONE-IN THE MORNING

1) What time did you get up yesterday?

❑❑❑❑ a.m.

2) How did you get to school yesterday?
(Just report the main method of how you got there).

WALK ❑

BUS ❑

CAR ❑

CYCLE ❑

OTHER ❑
(If other, what was it?)

3) How long did the journey take?

❑❑ minutes

IN THE MORNING

YESTERDAY MORNING BEFORE SCHOOL

4) Did you do any of these activities?

watched television	❑
listened to music	❑
talked with friends	❑

5) Did you do any light household chores, wash-up, tidy-up etc.? If so, for how long?

		TOTAL TIME hours	minutes
light household chores	❑	❑	❑❑

6) Did you do any of these activities? If so, for how long? Did you "huff and puff?"

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
played football in the playground	❑	❑	❑❑	❑	❑
played other ball games in the playground	❑	❑	❑❑	❑	❑
played tag/chasing games in the playground	❑	❑	❑❑	❑	❑

7) Any other activity? If so, What?

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
-----------------------------	❑	❑	❑❑	❑	❑

AT SCHOOL

8) Was yesterday a P.E. day?

YES ☐
NO ☐

9) If yes, did you do any of these activities?

(If no, go to Q 11 on next page)

	TOTAL TIME hours	TOTAL TIME minutes	"HUFF AND PUFF?" Yes	"HUFF AND PUFF?" No
swimming	☐ ☐	☐☐	☐	☐
netball	☐ ☐	☐☐	☐	☐
hockey	☐ ☐	☐☐	☐	☐
gymnastics	☐ ☐	☐☐	☐	☐
rounders	☐ ☐	☐☐	☐	☐
basketball	☐ ☐	☐☐	☐	☐
athletics	☐ ☐	☐☐	☐	☐
football	☐ ☐	☐☐	☐	☐
rugby	☐ ☐	☐☐	☐	☐

10) Any other activity?

If so, what?

____________________ ☐ ☐ ☐☐ ☐ ☐

AT BREAK TIME

11)

talked with friends	❑
played card or board games	❑
listened to music	❑

12)

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
played football in the playground	❑	❑	❑❑	❑	❑
played other ball games in the playground	❑	❑	❑❑	❑	❑
played tag/chasing games in the playground	❑	❑	❑❑	❑	❑

13) Any other activity?
If so, What?

------------------------	❑	❑	❑❑	❑	❑

AT LUNCH TIME

14)

talked with friends	❑
played card or board games	❑
listened to music	❑

15)

		TOTAL TIME	
		hours	minutes
walked to the shop	❑	❑	❑❑
walked home for lunch	❑	❑	❑❑

16

		TOTAL TIME		"HUFF AND PUFF?"	
		hours	minutes	Yes	No
played football in the playground	❑	❑	❑❑	❑	❑
played other ball games in the playground	❑	❑	❑❑	❑	❑
played tag/chasing games in the playground	❑	❑	❑❑	❑	❑

17)

		TOTAL TIME		"HUFF AND PUFF?"	
		hours	minutes	Yes	No
swimming	❑	❑	❑❑	❑	❑
netball	❑	❑	❑❑	❑	❑
hockey	❑	❑	❑❑	❑	❑
gymnastics	❑	❑	❑❑	❑	❑
rounders	❑	❑	❑❑	❑	❑
basketball	❑	❑	❑❑	❑	❑
athletics	❑	❑	❑❑	❑	❑
football	❑	❑	❑❑	❑	❑
rugby	❑	❑	❑❑	❑	❑

8) Any other activity?
f so, What?

------------------------ ❑ ❑ ❑❑ ❑ ❑

PART TWO-IN THE AFTERNOON

AFTERNOON BREAK TIME (if the subject does not have an afternoon break go to Q 22).

19)

talked with friends	❑
played card or board games	❑
listened to music	❑

20)

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
played football in the playground	❑	❑	❑❑	❑	❑
played other ball games in the playground	❑	❑	❑❑	❑	❑
played tag/chasing games in the playground	❑	❑	❑❑	❑	❑

21) Any other activity?
If so, What?

_________________________ ❑ ❑ ❑❑ ❑ ❑

PART THREE-AFTER SCHOOL/ IN THE EVENING

22)

talked with friends	❑
played card or board games	❑
listened to music	❑

23)

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
played football in the playground	❑	❑	❑❑	❑	❑
played other ball games in the playground	❑	❑	❑❑	❑	❑
played tag/chasing games in the playground	❑	❑	❑❑	❑	❑

24) How did you get home from school yesterday?
(Just report the main method of how you got home).

WALK	❑
BUS	❑
CAR	❑
CYCLE	❑
OTHER (If other, what was it?)	❑

25) How long did the journey take?

❑❑ minutes

26) Any other activity?
If so, What?

________________________ ❑ ❑ ❑❑ ❑ ❑

IN THE EVENING

27)

watched television	❑
watched videos	❑
listened to music	❑
played card or board games	❑
played with toys	❑
drew or painted	❑
played a musical instrument	❑
used a computer/played computer games	❑
homework	❑
read for pleasure	❑

28)

		TOTAL TIME hours	minutes
cared for pets	❑	❑	❑❑
light household chores, wash-up, tidy-up etc.	❑	❑	❑❑
went for a walk/stroll	❑	❑	❑❑
did a part-time job	❑	❑	❑❑
went to a youthclub or disco	❑	❑	❑❑

IN THE EVENING

29)

	TOTAL TIME			"HUFF AND PUFF?"	
		hours	minutes	Yes	No
clean/hoover or move furniture	☐	☐	☐☐	☐	☐
gardening	☐	☐	☐☐	☐	☐
brisk walking	☐	☐	☐☐	☐	☐
did a paper round	☐	☐	☐☐	☐	☐
cycle	☐	☐	☐☐	☐	☐
golf	☐	☐	☐☐	☐	☐
swimming	☐	☐	☐☐	☐	☐
tennis	☐	☐	☐☐	☐	☐
badminton	☐	☐	☐☐	☐	☐
hockey	☐	☐	☐☐	☐	☐
gymnastics	☐	☐	☐☐	☐	☐
volleyball	☐	☐	☐☐	☐	☐
netball	☐	☐	☐☐	☐	☐
basketball	☐	☐	☐☐	☐	☐
athletics	☐	☐	☐☐	☐	☐
running	☐	☐	☐☐	☐	☐
football	☐	☐	☐☐	☐	☐
rugby	☐	☐	☐☐	☐	☐
disco dancing	☐	☐	☐☐	☐	☐

30) Any other activity?
If so, What?

_________________________ ☐ ☐ ☐☐ ☐ ☐

31) What time did you go to bed yesterday?

☐☐☐☐ p.m.

32) Was yesterday a typical day for you?

YES ☐

NO ☐

If no, why not?

____

QUESTIONNAIRE FORM 2

WEEKEND

SUBJECT NO' ❑❑❑

SCHOOL CODE ❑❑

PART ONE-IN THE MORNING

1) What time did you get up on Saturday/Sunday?

❑❑❑❑ a.m.

2) Did you do any of these activities?

watched television	❑
watched videos	❑
listened to music	❑
played card or board games	❑
played with toys	❑
drew or painted	❑
played a musical instrument	❑
used a computer/played computer games	❑
homework	❑
read for pleasure	❑

3) Did you do any of these activities?
If so, for how long?

		TOTAL TIME hours	minutes
cared for pets	❑	❑	❑❑
light household chores, wash-up, tidy-up etc.	❑	❑	❑❑
went for a walk/stroll	❑	❑	❑❑
did a part-time job	❑	❑	❑❑
went to a youthclub or disco	❑	❑	❑❑

IN THE MORNING

4) Did you do any of these activities?
If so, for how long? Did you "huff and puff?"

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
clean/hoover or move furniture	☐	☐	☐☐	☐	☐
gardening	☐	☐	☐☐	☐	☐
brisk walking	☐	☐	☐☐	☐	☐
did a paper round	☐	☐	☐☐	☐	☐
cycle	☐	☐	☐☐	☐	☐
golf	☐	☐	☐☐	☐	☐
swimming	☐	☐	☐☐	☐	☐
tennis	☐	☐	☐☐	☐	☐
badminton	☐	☐	☐☐	☐	☐
hockey	☐	☐	☐☐	☐	☐
gymnastics	☐	☐	☐☐	☐	☐
volleyball	☐	☐	☐☐	☐	☐
netball	☐	☐	☐☐	☐	☐
basketball	☐	☐	☐☐	☐	☐
athletics	☐	☐	☐☐	☐	☐
running	☐	☐	☐☐	☐	☐
football	☐	☐	☐☐	☐	☐
rugby	☐	☐	☐☐	☐	☐
disco dancing	☐	☐	☐☐	☐	☐

5) Any other activity?
If so, What?

-------------------------	☐	☐	☐☐	☐	☐

PART TWO-IN THE AFTERNOON

6)

watched television	❑
watched videos	❑
listened to music	❑
played card or board games	❑
played with toys	❑
drew or painted	❑
played a musical instrument	❑
used a computer/played computer games	❑
homework	❑
read for pleasure	❑

7)

		TOTAL TIME hours	minutes
cared for pets	❑	❑	❑❑
light household chores, wash-up, tidy-up etc.	❑	❑	❑❑
went for a walk/stroll	❑	❑	❑❑
did a part-time job	❑	❑	❑❑
went to a youthclub or disco	❑	❑	❑❑

IN THE AFTERNOON

8)

	TOTAL TIME hours		minutes	"HUFF AND PUFF?" Yes	No
clean/hoover or move furniture	❑	❑	❑❑	❑	❑
gardening	❑	❑	❑❑	❑	❑
brisk walking	❑	❑	❑❑	❑	❑
did a paper round	❑	❑	❑❑	❑	❑
cycle	❑	❑	❑❑	❑	❑
golf	❑	❑	❑❑	❑	❑
swimming	❑	❑	❑❑	❑	❑
tennis	❑	❑	❑❑	❑	❑
badminton	❑	❑	❑❑	❑	❑
hockey	❑	❑	❑❑	❑	❑
gymnastics	❑	❑	❑❑	❑	❑
volleyball	❑	❑	❑❑	❑	❑
netball	❑	❑	❑❑	❑	❑
basketball	❑	❑	❑❑	❑	❑
athletics	❑	❑	❑❑	❑	❑
running	❑	❑	❑❑	❑	❑
football	❑	❑	❑❑	❑	❑
rugby	❑	❑	❑❑	❑	❑
disco dancing	❑	❑	❑❑	❑	❑

9) Any other activity?
If so, What?

----------------------------	❑	❑	❑❑	❑	❑

PART THREE-IN THE EVENING

10)

watched television	❑
watched videos	❑
listened to music	❑
played card or board games	❑
played with toys	❑
drew or painted	❑
played a musical instrument	❑
used a computer/played computer games	❑
homework	❑
read for pleasure	❑

11)

		TOTAL TIME hours	minutes
cared for pets	❑	❑	❑❑
light household chores, wash-up, tidy-up etc.	❑	❑	❑❑
went for a walk/stroll	❑	❑	❑❑
did a part-time job	❑	❑	❑❑
went to a youthclub or disco	❑	❑	❑❑

IN THE EVENING

12)

		TOTAL TIME hours	minutes	"HUFF AND PUFF?" Yes	No
clean/hoover or move furniture	❑	❑	❑❑	❑	❑
gardening	❑	❑	❑❑	❑	❑
brisk walking	❑	❑	❑❑	❑	❑
did a paper round	❑	❑	❑❑	❑	❑
cycle	❑	❑	❑❑	❑	❑
golf	❑	❑	❑❑	❑	❑
swimming	❑	❑	❑❑	❑	❑
tennis	❑	❑	❑❑	❑	❑
badminton	❑	❑	❑❑	❑	❑
hockey	❑	❑	❑❑	❑	❑
gymnastics	❑	❑	❑❑	❑	❑
volleyball	❑	❑	❑❑	❑	❑
netball	❑	❑	❑❑	❑	❑
basketball	❑	❑	❑❑	❑	❑
athletics	❑	❑	❑❑	❑	❑
running	❑	❑	❑❑	❑	❑
football	❑	❑	❑❑	❑	❑
rugby	❑	❑	❑❑	❑	❑
disco dancing	❑	❑	❑❑	❑	❑

13) Any other activity?
If so, What?

__________________________ ❑ ❑ ❑❑ ❑ ❑

14) What time did you go to bed on Saturday/Sunday?

❑❑❑❑ p.m.

15) Was Saturday/Sunday a typical day for you?

YES ❑

NO ❑

If no, why not?

____

APPENDIX F

SUMMARY SHEET-SCHOOLDAY FORM

				Card columns
SUBJECT'S NO			☐☐☐	☐☐☐ 1 / card 1
SCHOOL	CD	-1	☐☐	☐☐ 6 7
	G	-2		
	L	-3		
	CoL	-4		
	HP	-5		
	BP	-6		
	R	-7		
	HC	-8		
	Ch	-9		
	Fr	-10		
	LE	-11		
	LG	-12		
	OLCS	-13		
SUBJECT'S AGE			☐☐	☐☐ 8 9
BOY			☐ 1	☐ 10
GIRL			☐ 2	
TIME OF YEAR	WINTER		☐ 1	☐ 11
	SUMMER		☐ 2	
DAY OF WEEK	TUESDAY		☐ 1	☐ 12
	WEDNESDAY		☐ 2	
	THURSDAY		☐ 3	
	FRIDAY		☐ 4	
TIME SUBJECT GOT UP			☐☐☐☐ a.m.	☐☐☐☐ 13 14 15 16
TIME SUBJECT WENT TO BED			☐☐☐☐ p.m.	☐☐☐☐ 17 18 19 20
HOURS SLEEP	converted to minutes =		☐☐☐ minutes	☐☐☐ 21 22 23
WAS THE DAY TYPICAL FOR THE SUBJECT?	YES		☐ 1	☐ 24
	NO		☐ 2	☐ 25
IF NO, WHY NOT?	______________________			☐ 26
	______________________			☐ 27
	______________________			

SUMMARY SHEET-PAGE 2

VERY LIGHT ACTIVITIES Please list all codes for very light activities the subject reported.

28 29
30 31
32 33
34 35
36 37
38 39

LIGHT ACTIVITIES Please list all codes for light activities the subject reported and the total time spent in each.

TOTAL TIME
minutes

40 41 42 43 44
45 46 47 48 49
50 51 52 53 54
55 56 57 58 59
60 61 62 63 64
65 66 67 68 69
70 71 72 73 74

Please calculate total time spent in light activities.

TOTAL TIME = mins

75 76 77

card 2

MODERATE ACTIVITIES

Please list all codes for moderate/hard /very hard activities the subject reported, the total time spent in each and whether the activity/ies made the subject 'huff and puff'.

	TOTAL TIME minutes	'HUFF AND PUFF' Y=YES(1) N=NO(2)			
☐☐	☐☐☐	☐	6 7	8 9 10	11
☐☐	☐☐☐	☐	12 13	14 15 16	17
☐☐	☐☐☐	☐	18 19	20 21 22	23
☐☐	☐☐☐	☐	24 25	26 27 28	29
☐☐	☐☐☐	☐	30 31	32 33 34	35
☐☐	☐☐☐	☐	36 37	38 39 40	41
☐☐	☐☐☐	☐	42 43	44 45 46	47

Total time in moderate activities= ☐☐☐ mins (48 49 50)

HARD ACTIVITIES

card 3

	minutes	Y or N			
☐☐	☐☐☐	☐	6 7	8 9 10	11
☐☐	☐☐☐	☐	12 13	14 15 16	17
☐☐	☐☐☐	☐	18 19	20 21 22	23

Total time in hard activities= ☐☐☐ mins (24 25 26)

VERY HARD ACTIVITIES

☐☐	☐☐☐	☐	27 28	29 30 31	32
☐☐	☐☐☐	☐	33 34	35 36 37	38
☐☐	☐☐☐	☐	39 40	41 42 43	44

Total time in very hard activities= ☐☐☐ mins (45 46 47)

WAS THE DAY A P.E. DAY? YES ☐ 1 NO ☐ 2 (48)

SUMMARY SHEET-WEEKEND FORM

2
card 1

SUBJECT'S NO

SCHOOL

CD	-1	
G	-2	
L	-3	
CoL	-4	
HP	-5	
BP	-6	
R	-7	6 7
HC	-8	
Ch	-9	
Fr	-10	
LE	-11	
LG	-12	
OLCS	-13	

SUBJECT'S AGE — 8 9

BOY — 1

GIRL — 2

10

TIME OF YEAR — WINTER 1 / SUMMER 2 — 11

DAY OF WEEK — SATURDAY 1 / SUNDAY 2 — 12

TIME SUBJECT GOT UP — a.m. — 13 14 15 16

TIME SUBJECT WENT TO BED — p.m. — 17 18 19 20

HOURSSLEEP

converted to minutes = minutes — 21 22 23

WAS THE DAY TYPICAL FOR THE SUBJECT? YES 1 / NO 2 — 24

IF NO, WHY NOT?

25

26

27

SUMMARY SHEET-PAGE 2

VERY LIGHT ACTIVITIES Please list all codes for very light activities the subject reported.

28 29

30 31

32 33

34 35

36 37

38 39

LIGHT ACTIVITIES Please list all codes for light activities the subject reported and the total time spent in each.

TOTAL TIME
minutes

40 41 42 43 44

45 46 47 48 49

50 51 52 53 54

55 56 57 58 59

60 61 62 63 64

65 66 67 68 69

70 71 72 73 74

Please calculate total time spent in light activities.

TOTAL TIME = mins

75 76 77

card 2

MODERATE ACTIVITIES

Please list all codes for moderate/hard /very hard activities the subject reported, the total time spent in each and whether the activity/ies made the subject 'huff and puff'.

	TOTAL TIME minutes	'HUFF AND PUFF' Y=YES (1) N=NO (2)				
☐☐	☐☐☐	☐	6 7	8 9 10	11
☐☐	☐☐☐	☐	12 13	14 15 16	17
☐☐	☐☐☐	☐	18 19	20 21 22	23
☐☐	☐☐☐	☐	24 25	26 27 28	29
☐☐	☐☐☐	☐	30 31	32 33 34	35
☐☐	☐☐☐	☐	36 37	38 39 40	41
☐☐	☐☐☐	☐	42 43	44 45 46	47

Total time in moderate activities= ☐☐☐ mins (48 49 50)

HARD ACTIVITIES

card 3

	minutes	Y or N			
☐☐	☐☐☐	☐	6 7	8 9 10	11
☐☐	☐☐☐	☐	12 13	14 15 16	17
☐☐	☐☐☐	☐	18 19	20 21 22	23

Total time in hard activities= ☐☐☐ mins (24 25 26)

VERY HARD ACTIVITIES

☐☐	☐☐☐	☐	27 28	29 30 31	32
☐☐	☐☐☐	☐	33 34	35 36 37	38
☐☐	☐☐☐	☐	39 40	41 42 43	44

Total time in very hard activities= ☐☐☐ mins (45 46 47)

APPENDIX G

SCHOOL DAY FORM PROTOCOL

IF IT IS THE FIRST INTERVIEW FOR THE PUPILS-

Introduce yourself and inform the pupils that you are from Loughborough University. Tell them that, with their permission, you are going to go through a questionnaire together which asks about how they spend their time. Inform them also that you will need to meet with them 3 more times during the year to go through this and a similar questionnaire again with them.

A) INTRODUCING THE QUESTIONNAIRE

1) Please emphasize the importance of the questionnaire to the pupils you interview. Tell them that the purpose of the questionnaire is to find out about how young people spend their time. The questionnaire will ask them questions about what they did **YESTERDAY.**

2) Please stress to the pupils to be honest in the answers they give. The questionnaire is not a test.

3) Please inform the pupils that the answers they give will be strictly confidential. After completion the questionnaire will be sent straight to Loughborough University to be analyzed by computer.

Below is a sample introduction which should be followed:

The purpose of this questionnaire is to find out about how young people spend their time. The questionnaire will ask you about what you did **YESTERDAY**. You should not mention things you have done on any other day. It is not a test. Please just be honest in your answers. All the answers you give will be confidential. After we have gone through the questionnaire it will be sent straight to Loughborough University to be analyzed by computer.
I will show you lists of different activities. I need to know whether you did the activities **YESTERDAY.**
For some of the activities I need to know:

1) How long you did them for.
2) Whether they made you "huff and puff" i.e., out of breathe.

Don't worry if you have not done any of the activities in the lists, we will just go on to the next part of the questionnaire. Before we begin, have you any questions?

Before commencing, check that everything is O.K. with them and that they are quite settled and happy to proceed.

NOTE- If the pupils have already been interviewed once, just remind them of the above.

B) ADMINISTERING THE QUESTIONNAIRE

Prior to completing page 1 of the questionnaire, please ask the pupil his/her age and record this along with his/her sex on the summary sheet. Be sure also to record the pupil's school and number on both the cover of the questionnaire and on the summary sheet.

The questionnaire should be administered in two phases.

PHASE ONE

1) Remind the pupil that he/she should only report activities he/she did YESTERDAY. He/she should not mention things done on any other day.

(The only exception to 1) above is if a pupil was absent from school the previous day, or if the previous day was very atypical, for example, if the pupil felt ill or went on a school trip. In such instances the last typical day at school should be reported).

2) Take the pupil through the questionnaire part by part, i.e., dealing with morning, afternoon and evening in that order. Make it very clear whether you are asking about the morning, afternoon or evening by frequently reinforcing which part is in question.
The guidelines below should be followed as closely as possible in administering the questionnaire:

Page 1

To begin with, I just need to know your age. (This should be filled in on the summary sheet).

Q-1 What time did you get up **YESTERDAY?**

Q-2 How did you get to school **YESTERDAY?**

Q-3 How long did the journey take?

Page 2

Show list of activities

Q-4 Did you do any of these activities **YESTERDAY MORNING?**

Q-5 Did you do any light household chores, wash-up, tidy-up etc?

If so, how long did you do the activity/ies for? (see guideline for recording time estimations).

Q-6 Did you do any of these activities **YESTERDAY MORNING?**

If so, how long did you do the activity/ies for? (see guidelines for recording time estimations).

Did you "huff and puff?" (see guideline 7 for explanation).

Q-7 Is there anything else/any other activity you did **YESTERDAY MORNING** apart from.................that you can think of? (Repeat the activities the pupil has reported to you here to remind him/her of what he/she has said). Pause to allow thinking time.

Pages 3, 4, 5, 6, 7 & 8

Repeat as for page 2.

Page 9

Q-31 What time did you go to bed **YESTERDAY?**

Q-32 Was **YESTERDAY** a typical day for you?-If not, why not?

Having gone through the lists of activities, ask the pupil to think hard about whether there was anything else he/she did **YESTERDAY**, that is not included in the lists. If so, record the activity in the "other" activity category for the relevant time of day. If you feel it is necessary to go through the activities the pupil has told you he/she has done again as a reminder, then do so.

GUIDELINES FOR INTERVIEWERS

1) Do not rush the pupils in their answers. Allow thinking time and encourage the pupils to think hard before giving an answer. If they appear to be rushing and not giving their responses a lot of thought, stress that they should take their time in answering. Alternatively, however, do not allow pupils to ponder for too long over any part of the questionnaire, particularly over the time estimates. Remind pupils that it is estimates that are required, they do not have to be exact, just as accurate as possible.

2) Do not assume that the pupils can read the lists of activities you present to them. To begin with read through the list with them, pointing at each activity as you read it. If it becomes obvious that a pupil is quite able to read the activities for his/herself, then allow him/her to do so (otherwise the procedure does become rather repetitive). However, still

ensure that the pupil reads through the lists carefully and slowly to ensure that activities are not overlooked.

3) It may be necessary to help pupils with the time estimations. Children often have difficulty quantifying the amount of time they have spent doing an activity. Where possible, try to break each part of the day down further for the pupils. For example, for activities reported at lunchtime, it may help to establish with the pupils how long their lunchtime is and then deduce how much time of the total lunchtime was spent engaged in a particular activity.

4) When pupils are making time estimates, ensure that the time they report is the time they actually spent doing the activity. For example, being at the swimming baths for 2 hours does not equate to swimming for 2 hours. Stress to the pupils to report only the time they were actually doing the activity for, excluding changing time, travel time, breaks and so on.

5) Challenge (in a non-threatening way), any answers that may seem exaggerated. Make sure that the time the pupils report does not include changing and/or socialising time etc, as was mentioned in 4) above.

6) Explain clearly what to "HUFF and PUFF" actually means. To huff and puff means to breathe hard, harder than normal. It is associated with activities that make your heart beat faster than usual and tend to make you hot and/or sweaty- running, playing football, gardening (for example, mowing the lawn) and even walking briskly may cause "huffing and puffing." It may be useful to physically demonstrate what is meant by the term to the pupils.

7) Ensure that the same activity is not recorded twice. If a pupil reports that he/she went for a walk twice, for example, check that it was actually two separate walks and that he/she hasn't just forgotten that the activity has already been reported.

PHASE TWO

Having gone through the questionnaire once, ask pupils to think back again to **YESTERDAY** and make sure that they have have reported everything they did.

Having ascertained exactly what the pupils did it is necessary to go through the questionnaire again with them to gather more details about some of the activities they may have reported to have done.
The intensity codes of the reported activities need to be established. These can be found in table 1.

For certain activities, however, it is necessary to probe further to accurately record their intensity. For instance, a child who plays for an organised football team is likely to expend more energy than a child just kicking a ball around with his/her younger brother or sister. It is important from the standpoint of energy costs to make these distinctions and probing questions need to be asked to make such distinctions.

PROBING QUESTIONS

Responses to a number of questions contained in the questionnaire need further questioning and probing. (In phase 1 it might be useful to indicate which activities require coming back to and probing in phase 2 by making a diagonal mark to the right of the page).

1) TRAVEL TO AND HOME FROM SCHOOL

a) If a pupil reports he/she walked to school, please follow this up with:

> "You say you walked to school...Did you stroll to school, i.e., walk slowly, perhaps chatting with friends, or did you walk briskly to school?"

(If the pupil reports that he/she walked briskly, then this should be classified as a moderate activity for the duration of the walk to school and calculated as such in the energy expenditure calculations).

b) The same applies for the journey home from school.

c) The same applies if the pupil reports that he/she walked home for lunch or walked to the shops at lunchtime. The total walking time, i.e., there and back, must be recorded as well as whether the walk was brisk or leisurely.

d) If a pupil reports that they cycled to school, please follow this up with:

"You say you cycled to school...did you cycle steadily to school (moderate activity) or did you cycle hard to school?"
If the pupil reports that he/she cycled hard, this should be re-classified as a hard, rather than a moderate activity (see table 1).

2) PART-TIME JOB

If a pupil reports he/she has a part-time job, please ask for further details:

"What does your job entail?"

If the work is manual, comparable in intensity to cleaning, moving furniture, repair work or gardening, (for example, mowing the lawn, digging), then the work should be classified as moderate intensity and included in the "other" category for the part of the day in question. Time estimations also need to be gained from the pupil with regard to this activity.

3) QUESTIONS REQUIRING TIME ESTIMATIONS

a) For the SPORTING activities which required time estimations to be made in phase 1, for example, went swimming, played football, went running, etc., (excluding sports reported in P.E.), 4 probing questions should be asked in order to more accurately classify the activity. These are outlined below:

"You say you played netball/went swimming/cleaned yesterday.....

1) Did you do/play the activity...

a) with an organised club/regular team?

b) on own or with family/friends?

2) If yes, to question 1, how long have you been doing the activity for?

a) more than 6 months

b) less than 6 months

3) Did you do the activity for...

a) training purposes, i.e., for fitness training or competition?

b) pleasure/for fun?

4) Did you do the activity....

a) fairly continuously and/or vigorously?

b) fairly lightly, not very strenuously?"

NOTE- In some instances a pupil may inform you in phase 1 that the activity/ies did not take place in an organised club and that they were engaged in purely for fun. In such an instance it is neither necessary nor appropriate to ask all of the above questions. It may be useful just to check the details with the pupil.

If a pupil answers a) to 2 or more of these questions, then this may suggest that the activity should be re-classified and included one activity category higher in intensity. For example, table 1 classifies swimming as a moderate activity. However, if a pupil reports that he/she is a club swimmer who trains seriously and/or fairly continuously, and/or has been doing so for more than 6 months, then he/she is likely to expend more energy than if engaging in swimming purely for recreational purposes. In such an instance it would be far more appropriate and accurate to record the activity as hard, or even very hard, i.e., one or two categories higher than it would normally be placed.
Alternatively, if on questioning a pupil it becomes apparent that an activity was engaged in only very lightly, the activity may be classified into a category lower. For example, athletics constitutes very hard activity, regardless of the event. On probing, if it is revealed that the activity has consisted of a few throws of the javelin in an hours athletics session, then clearly the activity does not warrant classification as a very hard activity.

The final decision as to which category to place activities in is at the discretion of the interviewer and demands adequate questioning to arrive at a decision. If a decision is made to include the activity in a higher or lower intensity category, it may be helpful to indicate it as such on the questionnaire by a +1 (i.e., one category higher), or -2 (two categories lower), as appropriate.

It must be noted also that a re-classification of activities must not be restricted only to club or team members. An individual may engage in an activity independently and yet take it very seriously, perhaps training very hard for personal fitness, and/or doing the activity vigorously and/or sustaining it for quite some time.

b) For sports reported as part of P.E. it may be useful to ask question 4- "Did you do the activity fairly continuously and/or vigorously? or fairly lightly, not very strenuously?" to determine whether the activity should be re-classified or not. However, it is anticipated that because of the nature of physical education lessons, where teaching is taking place, activity will tend to be more intermittent and therefore not any more strenuous than is already indicated by the intensity categories in table 1.

c) If a pupil reports an activity that is not listed, record what the activity is and make an estimate of the intensity code for it, based on what the activity entails. If you are unsure of what the activity entails, ask the pupil to describe it. It may help if you ask him/her to think of an activity it is comparable to. Walking and running may provide a useful frame of reference for classifying "other" activities. Most pupils should be familiar with the relative intensity of brisk walking, for example, which represents about the mid-point of the moderate activity category. Therefore, if some "other" activity appears to be about as strenuous to the pupil as brisk walking, then the activity should be coded as moderate.

C) COMPLETING THE QUESTIONNAIRE

Having completed phase one and two of the questionnaire with the pupil, ask:

> "Are you quite sure there is nothing else you did yesterday which you think you should report?"

Finally, please thank the pupil for his/her time and co-operation.

D) COMPLETION OF SUMMARY SHEET

After the interview the summary sheet attached to the back of the questionnaire should be completed. Please ensure that you complete all parts and do the following:

1) Consult table 1 to establish i) the activity code number for each activity reported and ii) the intensity classification of each activity.

2) Record all activity codes in the correct intensity category on the summary sheet along with the amount of time the activity was carried out for and whether it made the subject "huff and puff."

3) Make sure that all time estimations are converted from hours and recorded in minutes. Times reported by the pupils should be rounded off to the **nearest 5 minute interval.**

4) Record the very light activities just once on the summary sheet. (It is not necessary to record, for example, how many times during the day a child watched television).

5) Sum the time spent in the same light activities and record once on the summary sheet. For example 3 separate walks of 10 minutes duration each should be recorded as 30 minutes light activity. All other activities should be recorded each time they are reported to take place, i.e., as separate bouts.

6) If amendments to the intensity category of any activities have been made as a result of the probing questions in phase 2, make sure that they are correctly recorded in their "new" intensity category.

7) Calculate and record the total time spent in each intensity category.

8) Consult table 2 to determine the school code.

Thank you!

APPENDIX H

WEEKEND FORM PROTOCOL

IF IT IS THE FIRST INTERVIEW FOR THE PUPILS-

Introduce yourself and inform the PUPILS that you are from Loughborough University. Tell them that, with their permission, you are going to go through a questionnaire with them which asks them about how they spend their time. Inform them also that you will need to meet with them 3 more times during the year to go through this and a similar questionnaire again with them.

A) INTRODUCING THE QUESTIONNAIRE

1) Please emphasize the importance of the questionnaire to the pupils you interview. Tell them that the purpose of the questionnaire is to find out about how young people spend their time. The questionnaire will ask them questions about what they did on **SATURDAY/SUNDAY.**

2) Please stress to the pupils to be honest in the answers they give. The questionnaire is not a test.

3) Please inform the pupils that the answers they give will be strictly confidential. After completion the questionnaire will be sent straight to Loughborough University to be analyzed by computer.
Below is a sample introduction which should be followed:

The purpose of this questionnaire is to find out about how young people spend their time. The questionnaire will ask you about what you did on **SATURDAY/SUNDAY.** You shouldn't mention things you have done on any other day. It is not a test. Please just be honest in your answers. All the answers you give will be confidential. After we have gone through the questionnaire it will be sent straight to Loughborough University to be analyzed by computer.

I will show you lists of different activities. I need to know whether you did any of the activities on **SATURDAY/SUNDAY.**
For some of the activities I need to know:

1) How long you did them for.
2) Whether they made you "huff and puff" i.e., out of breath.

Don't worry if you have not done any of the activities in the lists, we will just go on to the next part of the questionnaire. Before we begin, have you any questions?

Before commencing, check that everything is O.K. with them and that they are quite settled and happy to proceed.
NOTE- If the pupils have already been interviewed once, just remind them of the above.

B) ADMINISTERING THE QUESTIONNAIRE

Prior to completing page 1 of the questionnaire, please ask the pupils his/her age and record this along with their sex on the summary sheet. Be sure also to enter the pupil's no and school code on both the front cover of the questionnaire and on the summary sheet.

The questionnaire should be administered in two phases.

PHASE ONE

1) Remind the pupil that he/she should only report activities he/she did on **SATURDAY/SUNDAY.** He/she should not mention things done on any other day.

(Select either Saturday or Sunday for the first interview and ask about the other day on the second interview. The only exception would be if one of the days was very atypical, for example, if the pupil was ill in bed all day. In such an instance the most typical day should be reported).

2) Take the pupil through the questionnaire part by part, i.e., dealing with morning, afternoon and evening in that order. Make it very clear whether you are asking about the morning, afternoon or evening by frequently reinforcing which part is in question. The guidelines below should be followed as closely as possible in administering the questionnaire:

Page 1

To begin with, I just need to know your age. (This should be filled in on the summary sheet).

Q-1 What time did you get up on Saturday/Sunday?

Show list of activities

Q-2 Did you do any of these activities on **SATURDAY/SUNDAY MORNING?**

Q-3 Did you do any of these activities on **SATURDAY/SUNDAY MORNING?** If so, how long did you do the activity/ies for?

Page 2

Q-4 Did you do any of these activities on **SATURDAY/SUNDAY MORNING?**

If so, how long did you do the activity /ies for? (see guidelines for recording time estimations).

Did you "huff and puff?," (see guideline 7 for explanation).

Q-5 Is there anything else/any other activity you did on **SATURDAY/SUNDAY MORNING** apart from ....that you can think of? (repeat the activities the pupil has reported to you here to remind them of what they have said). Pause to allow thinking time.

Pages 3, 4, 5, & 6 - Repeat as for pages 1 and 2.

Page 6

Q-14 What time did you go to bed on **SATURDAY/SUNDAY?**

Q-15 Was **SATURDAY/SUNDAY** a typical day for you?-If not, why not?

Having gone through the lists of activities, ask the pupil to think hard about whether there was anything else he/she did on **SATURDAY/SUNDAY**, that is not included in the lists. If so, record the activity in the "other" activity category for the relevant time of day. If you feel it is necessary to go through the activities the pupil has told you they have done again as a reminder, then do so.

GUIDELINES FOR INTERVIEWERS

1) Do not rush the pupils in their answers. Allow thinking time and encourage the pupils to think hard before giving an answer. If they appear to be rushing and not giving their responses a lot of thought, stress that they should take their time in answering. Alternatively, however, do not allow pupils to ponder for too long over any part of the questionnaire, particularly over the time estimates. Remind pupils that it is estimates that are required, they do not have to be exact, just as accurate as possible.

2) Do not assume that the pupils can read the lists of activities you present to them. To begin with read through the list with them, pointing at each activity as you read it. If it becomes obvious that a pupil is quite able to read the activities for his/herself, then allow him/her to do so (otherwise the procedure does become rather repetitive). However, still ensure that the pupil reads through the lists carefully and slowly to ensure that they do not overlook certain activities.

3) It may be necessary to help pupils with the time estimations. Children often have difficulty quantifying the amount of time they have spent doing an activity. Where

possible, try to break each part of the day down further for the pupils. For example, it may be useful to establish when meal times are taken at a weekend and think in terms of amount of time between meal times.

4) When pupils are making time estimates, ensure that the time they report is the time they actually spent doing the activity. For example, being at the swimming baths for 2 hours does not equate to swimming for 2 hours. Stress to the children to report only the time they were actually doing the activity for, excluding changing time, travel time, breaks etc.

5) Challenge (in a non-threatening way), any answers that may seem exaggerated. Make sure that the time the pupils report does not include changing and/or socialising time etc., as was mentioned in 4) above.

6) Explain clearly what to "HUFF and PUFF" actually means. To huff and puff means to breathe hard, harder than normal. It is associated with activities that make your heart beat faster than usual and tend to make you hot and/or sweaty- running, playing football, gardening (for example, mowing the lawn) and even walking briskly may cause "huffing and puffing." It may be useful to physically demonstrate what is meant by the term to the pupils.

7) Ensure that the same activity is not recorded twice. If a pupil reports that he/she went for a walk twice, for example, check that it was two separate walks and that he/she hasn't just forgotten that the activity has already been reported.

PHASE TWO

Having gone through the questionnaire once, ask pupils to think back again to **SATURDAY/SUNDAY** and make sure that they have have reported everything they did.

Having ascertained exactly what the pupils did it is necessary to go through the questionnaire again with the children to gather more details about some of the activities they may have reported to have done.
The intensity codes of the reported activities need to be established. These can be found in table 1.

For certain activities, however, it is necessary to probe further to accurately record their intensity. For instance, a child who plays for an organised football team is likely to expend more energy than a child just kicking a ball around with his/her younger brother or sister. It is important from the standpoint of energy costs to make these distinctions and probing questions need to be asked to make such distinctions.

PROBING QUESTIONS

Responses to a number of the questions contained in the questionnaire need further questioning and probing. (In phase 1 it might be useful to indicate which activities require coming back to and probing in phase 2 by making a diagonal mark to the right of the page).

1) PART-TIME JOB

If a pupil reports he/she has a part-time job, please ask for further details:

"What does your job entail?"

If the work is manual, comparable in intensity to cleaning, moving furniture, repair work or gardening, (for e.g., mowing the lawn, digging), then the work should be classified as being of moderate intensity and included in the "other" category for the particular part of day in question. Time estimations also need to be gained from the pupil with regard to this activity.

2) QUESTIONS REQUIRING TIME ESTIMATIONS

a) For the SPORTING activities which required time estimations to be made in phase 1, for example, went swimming, played football, went running etc., 4 probing questions should be asked in order to more accurately classify the activity. The questions which should be asked are outlined below:

"You say you played netball/went swimming/cleaned on Saturday/Sunday....

1) Did you do/play the activity...

a) with an organised club/regular team?
b) on own or with family/friends?

2) If answered a) to question 1, how long have you been doing the activity with the club or team?

a) more than 6 months
b) less than 6 months

3) Did you do the activity for...

a) training purposes, i.e., for fitness training or competition?

b) pleasure/for fun?

4) Did you do the activity....

a) fairly continuously and/or vigorously?

b) fairly lightly, not very strenuously?"

NOTE- In some instances a pupil may inform you in phase one that the activity/ies did not take place in an organised club and that they were engaged in purely for fun. In such an instance it is neither necessary nor appropriate to ask all of the above questions. It may be useful just to check the details with the pupil.

If a pupil answers a) to 2 or more of these questions, however, then this may suggest that the activity should be re-classified and included one activity category higher in intensity. For example, table 1 classifies swimming as a moderate activity. However, if a pupil reports that he/she is a club swimmer who trains seriously and/or fairly continuously, and/or has been doing so for more than 6 months, then he/she is likely to expend more energy than if engaging in swimming purely for recreational purposes. In such an instance it would be far more appropriate and accurate to record the activity as hard, or even very hard, i.e., one or two categories higher than it would normally be placed.

Alternatively, if on questioning a pupil it becomes apparent that an activity was engaged in only very lightly, the activity may be classified into a category lower. For example, athletics constitutes very hard activity, regardless of the event. On probing, if it is revealed that the activity has consisted of a few throws of the javelin in an hours athletics session, then clearly the activity does not warrant classification as a very hard activity.

The final decision as to which category to place activities in is at the discretion of the interviewer and demands adequate questioning to arrive at a decision. If a decision is made to include the activity in a higher or lower intensity category, it may be helpful to indicate it as such on the questionnaire by a +1 (i.e., one category higher), or -2 (two categories lower), as appropriate.

It must be noted also that a re-classification of activities must not be restricted only to club or team members. An individual may engage in an activity independently and yet take it very seriously, perhaps training very hard for personal fitness, and/or doing the activity vigorously and/or sustaining it for quite some time.

b) If a pupil reports an activity that is not listed, record what the activity is and make an estimate of the intensity code for it, based on what the activity entails. If you are unsure of what the activity entails, ask the pupil to describe it. It may help if you ask him/her to think of an activity it is comparable to. Walking and running may provide a useful frame of reference for classifying "other" activities. Most pupils should be familiar with the relative intensity of brisk walking for example, which represents about the mid-point of the moderate activity category. Therefore, if some "other" activity appears to be about as strenuous to the pupil as brisk walking, then the activity should be coded as moderate.

C) COMPLETING THE QUESTIONNAIRE

Having completed phase one and two of the questionnaire ask:

> "Are you quite sure there is nothing else you did on Saturday/Sunday which you think you should report?"

Finally, please thank the pupil for his/her time and co-operation.

D) COMPLETION OF SUMMARY SHEET

After the interview the summary sheet attached to the back of the questionnaire should be completed. Please ensure that you complete all parts and do the following:

1) Consult table 1 to establish i) the activity code number for each activity reported and ii) the intensity classification of each activity.

2) Record all activity codes in the correct intensity category on the summary sheet along with the amount of time the activity was carried out for and whether it made the pupil "huff and puff."

3) Make sure that all time estimations are converted from hours and recorded in minutes. Times reported by the pupils should be rounded off to the **nearest 5 minute interval.**

4) Record the very light activities just once on the summary sheet. (It is not necessary to record, for example, how many times during the day a child watched television).

5) Sum the time spent in the same light activities and record once on the summary sheet. For example 3 separate walks of 10 minutes duration each should be recorded as 30

minutes light activity. All other activities should be recorded each time they are reported to place, i.e., as separate bouts.

6) If amendments to the intensity category of any activities have been made as a result of the probing questions in phase 2, make sure that they are correctly recorded in their "new" intensity category.

7) Calculate and record the total time spent in each intensity category.

8) Consult table 2 to determine the school code.

Thank you!

APPENDIX I

INFORMATION FOR INTERVIEWERS

A) BACKGROUND TO THE QUESTIONNAIRE-The characteristics and implications in the design and format of the questionnaire.

The questionnaire:

1) Measures four dimensions of activity:
   - i) Physical activity at school (excluding sport)
   - ii) Sport at school
   - iii) Physical activity during leisure-time
   - iv) Sport during leisure-time

2) Measures physical activity in terms of:
   - a) Average daily energy expenditure (METS)
   - b) time spent in moderate activity
   - c) time spent in hard and very hard activity
   - d) number of bouts of "huff and puff" activity

It was decided to measure activity in these ways given that the physical activity stimulus has not been clearly defined to achieve health related outcomes, i.e., it is not really known what type and how much physical activity is necessary for health.

3) Has a detailed protocol for interviewers to follow.
The questionnaire is designed with a detailed protocol which allows the interviewer to take the responsibility for making the necessary decisions with regard to intensity of activity and ask probing questions when necessary. The protocol gives details of the full set of procedures to be followed in conducting the interviews.

4) Records the previous day's activity only.
To try to minimize the problems associated with the child's memory in reporting the activity they have done, it was decided to design the questionnaire to record one day's activity only-the previous days. It has been found that children can recall activity for the previous day reasonably accurately but recall decreases in accuracy with further increases in time. The questionnaire is thus devised to ask about the child's previous day.

5) Consists of two separate forms -a school day and a weekend form.
Obviously one day's activity information can not be said to be very representative of their actual habitual activity pattern, hence it has been decided to collect 4 days of activity information (research indicates this is fairly representative) -including both weekday and weekend activity. A weekend and school day form has therefore been devised. The weekend form will be administered on the Monday following the weekend in question. The school day form can be administered on any day other than a Monday and will ask about the previous day.

It has also been decided to take possible seasonal variations in activity levels into account by taking 2 of the measures (1 weekend and 1 school day) in winter (Dec, Jan or Feb), and 2 of the measures (1 weekend and 1 school day) in the summer months (May, Jun, Jul).

6) Segments the day into parts.
To enhance recall the questionnaire forms are segmented into parts of the day. The school day form is segmented into before school, at school and after school and the weekend form into morning, afternoon and evening. Segmenting the day into parts in this way should enhance recall by imposing a logical ordering, or cueing, over time, enabling the child to remember more.

7) Contains lists of activities.
Activities are listed in the form of a checklist to make completion as straight forward and as time efficient as possible.

B) ADDITIONAL INFORMATION

The activities

The activities in the lists have been decided upon based on an initial pilot questionnaire in which children reported which activities from a given list they most often did or sometimes did, and indicated which activities they did not do or would never think of doing. In this way, and as a result of the pilot, a number of activities have been eliminated from the lists. For example, scrambling, hiking, orienteering, canoeing, judo/karate and fishing were all omitted from the questionnaire.

Application and calculations

The activities are grouped. The groupings and questions have been devised based on the intensity of the activities, i.e. whether they are of very light, light, moderate or hard intensity. Children are asked whether they have done any of the activities in the lists or not. If they have done any light, moderate, hard or very hard activities, time estimations need to be made by the children for these activities to be able to calculate the energy expenditure values. The energy expenditure calculations will be made as follows:
Raw data from the questionnaire (hours in the various categories) will be used to calculate energy expenditure. The basis of these calculations is that resting metabolism (1 MET or RMR) requires 3.5 ml of O_2 per kilogram of body weight per minute. This is equal to approximately 1 kilocalorie (kcal) per kilogram per hour ($Kcal \cdot Kg^{-1} \cdot hour^{-1}$). Thus activities requiring 3 METS (WMR/RMR=3) would expend 3 $Kcal \cdot Kg^{-1} \cdot hour^{-1}$. The activity categories and associated MET values for the questionnaire are as follows:

SLEEP	= 1 MET
VERY LIGHT ACTIVITY	= 1.5 METS
LIGHT ACTIVITY	= 2.5 METS
MODERATE ACTIVITY	= 4 METS
HARD ACTIVITY	= 6 METS
VERY HARD ACTIVITY	= 10 METS

To calculate the energy cost in $Kcal \cdot Kg^{-1} \cdot day^{-1}$, the time spent in an activity category is multiplied by the average MET value for that category and summed over all categories. See example below:

Activity	Raw data (hours)	MET Value for activity	Total ($Kcal \cdot Kg^{-1} \cdot day^{-1}$)
sleep	8.0	1.0	8.0
very light activity*	6.5	1.5	9.75
light activity	6.5	2.5	16.25
moderate activity	2.0	4.0	8.0
hard activity	1.0	6.0	6.0
very hard activity	0.0	10.0	0.0
		Total energy output per day = 48.00	

*Time estimations do not need to be made for very light activities as time spent in very light activity is obtained by subtraction (24 hours minus time spent in sleep, light, moderate, hard and very hard activity).

The question with regard to whether the activity made the child "huff and puff" only needs to be asked for activities of moderate, hard or very hard intensity as it is assumed that subjects will only "huff and puff" if engaging in activities of at least moderate intensity.

C) GENERAL TIPS ABOUT INTERVIEWING

As an interviewer your job is to ensure that:

1) All applicable questions are asked and answered.
2) All answers are clear, unambiguous and complete.

1) There is a standardized format for recording answers. Answers should be:

i) recorded accurately and legibly
ii) recorded at the time of the interview
iii) recorded speedily so as not to impede the flow of the interview
iv) recorded in the correct space
v) recorded in pencil

The answers should be transferred to the summary sheet as soon after the interview as possible.

2) Avoid leading questions.
Avoid making comments such as "so you've been doing the activity for more than 6 months have you?"-or "you did the activity fairly continuously and vigorously did you?" This makes it too easy for the children to just agree with you rather than try to remember. Always give the alternative, for example, How long have you been doing the activity for?-more than 6 months or less than 6 months?

3) Give the child encouragement (to maintain their interest and concentration). In carrying out the interview it will seem natural to you to react in some way to at least some of the answers you are given. It will also seem natural to the child that you should do this. However, be careful to avoid the use of phrases which could convey the idea that you approve of the answers you have been given. Comments like Good, O.K, Fine, can carry this connotation and should be avoided. Try instead to use neutral phrases like I see, or I've got that, I understand. Your aim is to avoid saying anything which could influence the answers you are given but at the same time show enough appreciation and interest to ensure that the child makes a genuine effort to provide the information you want.

4) Try not to allow too much digression on the part of the child. You can not afford to lose his/her interest and attention before the interview is completed by allowing him/her to digress too much in the early stages.

5) When conducting the interview you need to keep it progressing at a pace to suit your subject. The speed at which you ask questions should be governed by the speed at which your subject talks and thinks out his/her answers, rather than by your own natural speed. Pay attention not to speed up your questioning towards the end, when you have become familiar with the questions. Remember, the subject is always hearing the questions for the first time.

Dear Parent/Guardian,

We are currently conducting some detailed research at Loughborough University on children's activities. (Name of school) has kindly agreed to participate in the study and your son/daughter has expressed a wish to be involved. I am therefore writing to ask for your permission for your son/daughter's name to be put forward for the project and to explain briefly what the study will entail.

If your son/daughter is chosen to participate in the study, his/her heart rate will be monitored during a school day. This will involve wearing a lightweight device around the chest and a specially designed wrist watch. Your child will also be interviewed and be asked to complete a questionnaire about their school day activities and general pastimes. The research should not interfere with your child's school work or everyday activities in anyway. Two children in the class will wear the heart rate monitors on any one day (preferably two friends/classmates who are likely to spend the majority of the school day together-this makes monitoring the instrument much easier).

In order to fulfil the aims of our research we request that you do not inform your child of the full details of the study as this may influence the results. The children have been informed that they will be required to wear a heart rate monitor to see how their heart rate varies over the school day. They have not been told about the interview or the questionnaire they will be asked to complete.

I do hope that it will be possible for your child to be involved in the study, the results of which will be very important to us. If you agree to your son/daughter being involved, please could you fill in the form below and return it to school as soon as possible? If you could also name a friend who your son/daughter would like to participate in the study with, it would be very helpful. The friend must be in the same class as your son/daughter.

Thank you very much for your cooperation.

✂--

I do give my permission/do not give my permission for my son/daughter
(name)_________________________________ to be involved in the research project.
(Please delete as appropriate)

He/she would like to participate in the study with (name of friend)
_________________________________ if possible.

I understand that the results of the study will be completely confidential and my son/daughter can withdraw from the study at any time if he/she wishes.

INSTRUCTIONS FOR REMOVING HEART RATE MONITOR

Dear Parent/Guardian,

Thank you for allowing your son/daughter to be involved in this research study. Your son/daughter is currently wearing a heart rate monitor which is recording his/her minute-by-minute heart rate. The monitor consists of a lightweight transmitter around the chest and a wrist watch (receiver).

Your son/daughter should continue to wear the monitor throughout the evening. It should be removed either just before he/she is about to go to bed, or by 9 p.m. at the latest. I would be very grateful if you could help your son/daughter to remove the monitor. The procedure is very straightforward and is explained below.

WHAT TO DO:

Please follow the instructions in the correct order.

1) **Press the OP button on the front of the watch once.** This is the end button on the left hand side of the watch **(See diagram over page)**. This will stop the watch recording. The upper colon (i.e., the dots between the time display) will stop blinking to indicate that recording has stopped. Be careful not to press any other buttons otherwise the recorded information will be erased!

2) Remove the wrist watch.

3) Remove the lightweight transmitter from the chest by gently peeling the sticky tape and electrodes away from the skin.

4) Undo the press studs to detach the transmitter from the electrodes. The electrodes and tape can be thrown away.

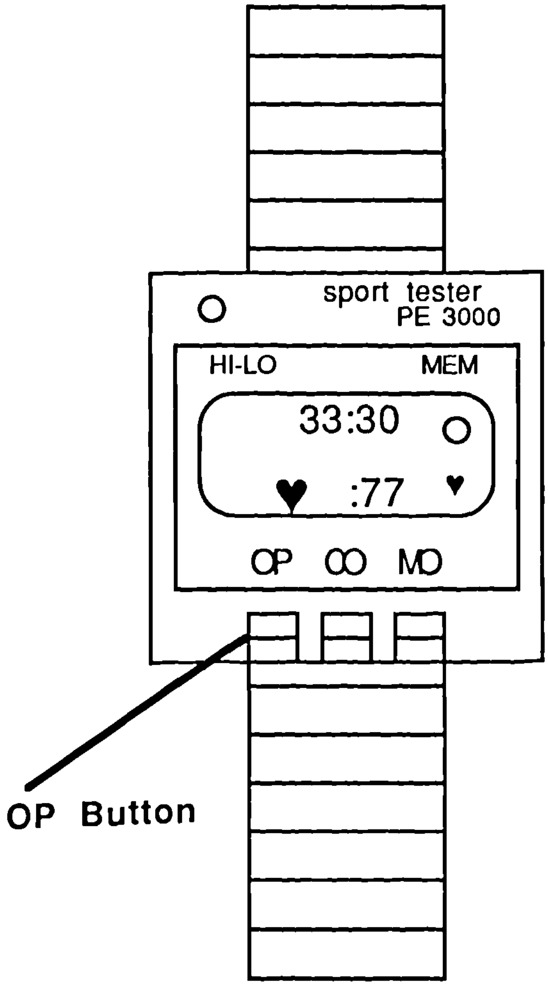
5) Replace the transmitter and watch in the box provided.

Your son/daughter has been asked to return the monitor to school in the morning. I would appreciate it if you could remind him/her.

Thank you very much for all your help. I hope the study has not caused you too much trouble.

Lorraine Cale.

The Heart Rate Monitor



APPENDIX L

OBSERVATION RECORD SHEET

NAME______________________ DAY_______________

FORM__________ DATE_____________

TIME	ACTIVITY	TIME	ACTIVITY
8.30-		2.45	
8.45		3.00	
9.00		3.15	
9.15		3.30	
9.30		3.45	
9.45		4.00	
10.00		4.15	
10.15		4.30	
10.30		4.45	
10.45		5.00	
11.00		5.15	
11.15		5.30	
11.30		5.45	
11.45		6.00	
12.00		6.15	
12.15		6.30	
12.30		6.45	
12.45		7.00	
1.00		7.15	
1.15		7.30	
1.30		7.45	
1.45		8.00	
2.00		8.15	
2.15		8.30	
2.30		8.45	

APPENDIX M

VALIDATION STUDY

INTERVIEW QUESTIONNAIRE AND HEART RATE DATA

SUBJECT	QUESTIONNAIRE (MINUTES IN MODERATE/HARD/VERY HARD ACTIVITY	HEART RATE > 139 BEATS PER MINUTE
1	0	4
2	0	2
3	60	11
4	30	29
5	40	30
6	15	14
7	55	40
8	55	27
9	10	8
10	10	16
11	0	17
12	20	19
13	35	16
14	30	13
15	0	1
16	70	44
17	55	31
18	160	30
19	40	30

CORRELATION

Count:	Covariance:	Correlation:	R-squared:
19	289.327	.614	.337

INTERVIEW QUESTIONNAIRE AND OBSERVATION DATA

SUBJECT	QUESTIONNAIRE (ENERGY EXPENDITURE)	OBSERVATION (ENERGY EXPENDITURE)
1	33.5	33.42
2	34.5	31.66
3	34.88	33.25
4	33.33	32.92
5	33.42	29.08
6	32.46	32.26
7	33.00	33.63
8	34.66	34.42
9	32.04	31.83
10	30.88	30.79
11	31.5	33.25
12	31.75	33.5
13	31.5	31.5
14	32.25	32.17
15	33.46	33.46
16	33.00	33.20
17	31.83	31.83
18	34.71	34.71
19	34.66	34.66
20	34.75	33.92

CORRELATION

Count:	Covariance:	Correlation:	R-squared:
20	1.119	.794	.63

t TEST

DF:	Mean X-Y:	Paired t value:	Prob. (2-tail):
19	.128	.719	.4811

INTER INTERVIEWER RELIABILITY STUDY

INTERVIEWER'S SCORES

SUBJECT	INTERV'ER 1	INTERV'ER 2	INTERV'ER 3	INTERV'ER 4
1	32.75	32.75	32.75	32.75
2	33.79	33.79	33.79	33.79
3	37.95	37.95	37.95	55.29
4	55.29	55.29	43.29	55.29
5	33.00	33.00	33.00	36.00
6	34.70	34.70	33.36	34.70
7	33.50	33.50	33.50	33.50
8	32.08	32.08	32.58	32.08
9	46.33	46.33	46.33	46.33
10	41.50	43.50	41.50	42.50
11	36.13	36.13	36.13	36.01
12	39.25	39.25	39.25	45.25

CORRELATION MATRIX FOR INTER INTERVIEWER RELIABILITY

INTERVIEWER	1	2	3	4
1	1			
2	.997	1		
3	.888	.899	1	
4	.965	.962	.882	1

CORRELATION INTERVIEWER 1 VERSUS INTERVIEWER 2

Count:	Covariance:	Correlation:	R-squared:
12	48.097	.997	.993

CORRELATION INTERVIEWER 1 VERSUS INTERVIEWER 3

Count:	Covariance:	Correlation:	R-squared:
12	28.762	.888	.789

CORRELATION INTERVIEWER 1 VERSUS INTERVIEWER 4

Count:	Covariance:	Correlation:	R-squared:
12	47.182	.965	.931

CORRELATION INTERVIEWER 2 VERSUS INTERVIEWER 3

Count:	Covariance:	Correlation:	R-squared:
12	29.589	.899	.808

CORRELATION INTERVIEWER 2 VERSUS INTERVIEWER 4

Count:	Covariance:	Correlation:	R-squared:
12	47.85	.962	.926

CORRELATION INTERVIEWER 3 VERSUS INTERVIEWER 4

Count:	Covariance:	Correlation:	R-squared:
12	29.42	.882	.778

INTRA-INTERVIEWER RELIABILITY OR TEST-RETEST RELIABILITY

INTER'ER (subject no')	INTERVIEW TEST 1	INTERVIEW RETEST
1 (1)	32.75	32.75
2 (1)	32.75	32.75
3 (1)	32.75	32.75
4 (1)	32.75	32.75
1 (2)	33.79	33.79
2 (2)	33.79	33.79
3 (2)	33.79	33.79
4 (2)	33.58	33.79
1 (3)	37.95	37.95
2 (3)	37.95	37.95
3 (3)	37.95	37.95
4 (3)	37.95	37.95
1 (4)	55.29	55.29
2 (4)	55.29	55.29
3 (4)	43.29	43.29
4 (4)	55.29	55.29
1 (5)	33.00	33.00
2 (5)	33.00	33.00
3 (5)	33.00	35.50
4 (5)	36.00	35.66
1 (6)	34.70	34.70
2 (6)	34.70	34.70
3 (6)	33.36	33.36
4 (6)	34.70	34.70
1 (7)	33.50	33.50
2 (7)	33.50	33.50
3 (7)	33.50	33.50
4 (7)	33.50	33.50
1 (8)	32.08	31.58
2 (8)	32.08	32.08
3 (8)	32.58	32.58
4 (8)	32.08	32.08
1 (9)	56.33	46.33
2 (9)	46.33	46.33
3 (9)	46.33	46.33
4 (9)	46.33	46.33
1 (1)	41.50	43.50
2 (10)	43.50	43.50
3 (10)	41.50	43.50
4 (10)	42.50	46.50
1 (11)	36.13	36.13
2 (11)	36.13	36.13
3 (11)	36.13	36.01
4 (11)	36.01	36.01
1 (12)	39.25	38.25
2 (12)	39.25	39.25
3 (12)	39.25	39.25
4 (12)	45.25	38.25

OVERALL CORRELATION FOR TEST RETEST

Count:	Covariance:	Correlation:	R-squared:
48	39.387	.979	.958

TEST RETEST RELIABILITY SCORES FOR EACH INTERVIEWER SEPARATELY

INTERVIEWER 1

SUBJECT	TEST	RETEST
1	32.75	32.75
2	33.79	33.79
3	37.95	37.95
4	55.29	55.29
5	33.00	33.00
6	34.70	34.70
7	33.50	33.50
8	32.08	31.58
9	46.33	46.33
10	41.50	43.50
11	36.13	36.13
12	39.25	38.25

INTERVIEWER 1-CORRELATION FOR TEST RETEST

Count:	Covariance:	Correlation:	R-squared:
12	48.256	.995	.991

INTERVIEWER 2

SUBJECT	TEST	RETEST
1	32.75	32.75
2	33.79	33.79
3	37.95	37.95
4	55.29	55.29
5	33.00	33.00
6	34.70	34.70
7	33.50	33.50
8	32.08	32.08
9	46.33	46.33
10	43.50	43.50
11	36.13	36.13
12	39.25	39.25

INTERVIEWER 2-CORRELATION FOR TEST RETEST

Count:	Covariance:	Correlation:	R-squared:
12	49.063	1.0	1.0

INTERVIEWER 3

SUBJECT	TEST	RETEST
1	32.75	32.75
2	33.79	33.79
3	37.95	37.95
4	43.29	43.29
5	33.00	35.50
6	33.36	33.36
7	33.50	33.50
8	32.58	32.58
9	46.33	46.33
10	41.50	43.50
11	36.13	36.01
12	39.25	39.25

INTERVIEWER 3-CORRELATION FOR TEST RETEST

Count:	Covariance:	Correlation:	R-squared:
12	22.025	.983	.965

INTERVIEWER 4

SUBJECT	TEST	RETEST
1	32.75	32.75
2	33.58	33.79
3	37.95	37.95
4	59.29	59.29
5	36.00	35.66
6	34.70	34.70
7	33.50	33.50
8	32.08	32.08
9	46.33	46.33
10	42.50	46.50
11	36.01	36.01
12	45.25	38.25

INTERVIEWER 4-CORRELATION FOR TEST RETEST

Count:	Covariance:	Correlation:	R-squared:
12	47.014	.942	.888

APPENDIX N

Dear Headteacher,

As you may be aware, there has been much concern recently that children are not as active as they should be, to the extent that many children's current low activity levels may be detrimental to their health. As physical education professionals, we are very concerned about this and we are currently conducting some research to assess just how active school children are.

Obviously it is important that we obtain as representative a sample of children as possible for our research and we have therefore randomly selected a number of schools in Nottinghamshire, Derbyshire and Leicestershire which we would like to be involved in our study. Your school has been selected as a potential candidate. With your agreement, we would like to interview approximately 20 pupils from your school (10 year 7 pupils, and 10 year 9 pupils), about their daily activities. Each child will be interviewed individually on two separate occasions in the winter (whenever would be most convenient for you) and two occasions in the summer months. The interviews will last approx 10 minutes per pupil and will be conducted during the school day. Given that the interviews will be conducted individually, it is hoped that they will not cause any disruption to lessons.

We sincerely hope that your school will be able to be involved in the study, the results of which will be very important to us. We are very excited about the prospect of conducting a study of this nature and the more schools that agree to be involved, the more valuable the results will be. If you have any questions regarding the research at all, please do not hesitate to contact me-tel (0509) 223259. Please could you fill in the form over the page and return it to me as soon as possible, in the stamped addressed envelope provided. If you give permission for your school to be involved, we will be in touch with you in the near future. We look forward to hearing from you.

Yours Sincerely,

Lorraine Cale.

Please return this form in the SAE provided to:
Lorraine Cale, Dept of Physical Education and Sports Science,
Loughborough University, Loughborough, Leicestershire, LE 11 3TU.

I ________________________________, as headteacher of

__________________________________ (name of school)

would like to be involved in the study.

would not like to be involved in the study. (Please delete as appropriate).

Signed ______________________

APPENDIX O

Dear Parent/Guardian,

We are currently conducting some detailed research at Loughborough University on children's activities. (Name of school) has kindly agreed to participate in the study. I am therefore writing to ask for your permission for your son/daughter to be involved in the study and to explain briefly what this will entail. With your agreement, we would like to interview your son/daughter about his/her daily activities. Your son/daughter will be interviewed individually on two occasions in the winter term and two occasions in the summer term. The interviews will be conducted during the school day and will last only 10 minutes (approx). They should not therefore disrupt your son/daughter's normal school day.

I do hope that it will be possible for your child to be involved in the study, the results of which will be very important to us. If you agree to your son/daughter being involved, please could you fill in the form below and return it to school as soon as possible? If you have any questions regarding the research at all, please do not hesitate to contact me at Loughborough University-Tel (0509) 223259.

Thank you very much for your cooperation.

Lorraine Cale
(Loughborough University)

✂--

I do give my permission/do not give my permission for my son/daughter (name)________________________________ to be involved in the research project. (Please delete as appropriate).

Signed________________________

I understand that the results of the study will be completely confidential and my son/daughter can withdraw from the study at any time if he/she wishes.

APPENDIX P

Mean Time Spent in Moderate Activity by each School

MOD ACTIVITY	School Number 1 n=17	2 n=16	3 n=15	4 n=12	5 n=20	6 n=19	7 n=14	8 n=17	9 n=17	10 n=19	11 n=14	12 n=10	13 n=9
TOTAL TIME (4 DAYS) MINS	232.06 SD= 126.69	217.81 SD= 164.04	237.6 SD= 133.21	406.67 SD= 266.51	227.75 SD= 143.61	253.42 SD= 181.35	232.57 SD= 156.37	186.47 SD= 124.65	341.77 SD= 186.79	239.47 SD= 171.37	206.07 SD= 176.99	281.00 SD= 117.87	237.22 SD= 114.57
AVERAGE DAILY TIME (MINS)	58.02 SD= 31.67	54.45 SD= 41.01	59.40 SD= 33.30	101.67 SD= 66.63	56.94 SD= 35.90	63.36 SD= 45.34	58.14 SD= 39.09	46.62 SD= 31.16	85.44 SD= 46.69	59.87 SD= 42.84	51.52 SD= 44.25	70.25 SD= 29.47	59.31 SD= 28.64

Mean Time Spent in Hard/Very Hard Activity by each School

	School Number												
HARD/V. HARD ACTIVITY	1 n=17	2 n=16	3 n=15	4 n=12	5 n=20	6 n=19	7 n=14	8 n=17	9 n=17	10 n=19	11 n=14	12 n=10	13 n=9
TOTAL TIME (4 DAYS) MINS	83.41 SD= 151.45	41.88 SD= 59.24	86.33 SD= 121.22	49.17 SD= 61.68	97.00 SD= 171.65	83.00 SD= 73.87	29.29 SD= 50.49	35.88 SD= 45.87	74.41 SD= 97.85	109.47 SD= 150.47	41.79 SD= 100.53	69.00 SD= 76.80	31.11 SD= 46.76
AVERAGE DAILY TIME (MINS)	20.85 SD= 37.86	10.47 SD= 14.81	21.58 SD= 30.31	12.29 SD= 15.42	24.25 SD= 42.91	20.75 SD= 18.47	7.32 SD= 12.62	8.97 SD= 11.47	18.60 SD= 24.46	27.37 SD= 37.62	10.45 SD= 25.13	17.25 SD= 19.20	7.78 SD= 11.69

Mean Number of Bouts of "Huff and Puff" Activity

	School Number												
BOUTS ACTIVITY	1 n=17	2 n=16	3 n=15	4 n=12	5 n=20	6 n=19	7 n=14	8 n=17	9 n=17	10 n=19	11 n=14	12 n=10	13 n=9
TOTAL NO' BOUTS	3.94 SD= 2.84	3.63 SD= 2.85	4.33 SD= 2.53	6.08 SD= 4.85	4.00 SD= 3.09	3.95 SD= 3.14	3.07 SD= 2.79	3.29 SD= 2.62	5.29 SD= 4.15	5.21 SD= 4.28	3.00 SD= 4.26	6.00 SD= 2.45	3.00 SD= 2.12
BOUTS > 10 MINS	3.12 SD= 2.45	2.94 SD= 2.32	3.60 SD= 2.19	5.42 SD= 3.80	3.75 SD= 2.83	3.42 SD= 3.04	2.36 SD= 2.27	2.35 SD= 1.84	4.71 SD= 3.67	4.79 SD= 4.13	2.43 SD= 3.55	5.30 SD= 2.36	2.67 SD= 1.66
BOUTS > 20 MINS	2.29 SD= 2.11	2.00 SD= 1.51	2.87 SD= 2.03	4.50 SD- 2.51	3.2 SD= 2.31	2.53 SD= 1.87	1.86 SD= 2.03	1.82 SD= 1.67	3.59 SD= 2.85	3.37 SD= 3.27	2.36 SD= 3.61	3.90 SD= 2.56	1.67 SD= 1.32