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Anthropometric Reference Data for Children and Adults: U.S. Population, 1999–2002

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Abstract

This report presents national anthropometric reference data based on health examination survey results from the National Health and Nutrition Examination Survey (NHANES), 1999–2002, for all ages of the U.S. population (1,2). Weighted population means, standard errors of the means, and selected percentiles are presented for the total U.S. population by sex, race or ethnic group, and age in years or age group. Findings for some population groups are reported in a way that is comparable with results reported from National Health Examination Surveys (NHES) and NHANES conducted between 1960 and 1994 (3–9). These data add to the knowledge about trends in child growth and development and are used to monitor prevalent conditions in the U.S. population such as overweight and obesity (10–13).

Keywords: • Anthropometry • Body measures • Nutrition surveys • National Health and Nutrition Examination Survey (NHANES)

Introduction

The field of anthropometry encompasses a variety of human body measurements, such as weight, height, and size, including circumferences, lengths, breadths, and skinfold thicknesses. Anthropometry is a key component of nutrition status assessment in children and adults (14). Anthropometric data for children reflect general health status, dietary adequacy, and growth and development over time. In adults, body measurement data are used to evaluate health and dietary status, disease risk, and body composition changes that occur over the adult lifespan. This report provides anthropometric reference data for U.S. children and adults of all ages.

Methods

National Health and Nutrition Examination Surveys are conducted by the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention. NHANES data are the primary source of body measurement and related health and nutrition data for the civilian noninstitutionalized U.S. population. Surveys were conducted on a periodic basis from 1960 to 1994. NHANES became a continuous survey in 1999. Each annual survey sample is nationally representative; 2 or more years of data are required for subgroup analyses (15,16). NHANES 1999–2002 data were released in two, 2-year data sets. A combined 4-year dataset was used for this report because it provides robust sample sizes and more reliable statistical estimates. Additional 2-year data sets will be released as more data become available.

Household interview and health examination methods are used to collect NHANES data. All health examinations are conducted in mobile examination centers (MECs). The MECs provide a standardized environment for the collection of high-quality health data. The MECs are staffed by full-time personnel including health technicians and interviewers, dentists, physicians, dietary interviewers, laboratory technicians, and data managers. All NHANES health technicians complete a comprehensive body measurement training program that uses videotape, demonstration, and practice exercises with an expert examiner. Health technician performance is monitored by means of direct observation, data review, and expert examiner evaluations.

Although portions of the health examination component have varied during the survey's history, much of the

anthropometry component methodology has remained consistent over time. The use of consistent data collection methods makes it possible to examine trends in body measurements over time. NHANES data have been used to produce growth charts for growing infants and children and to produce national prevalence estimates for overweight and obesity.

The NHANES body measurement component is conducted in a dedicated room in the MEC. The room is equipped with a digital scale, wall-mounted stadiometer, bench, wall mirror, infantometer, and computer workstation. A health technician performs the anthropometry exam and is assisted by a recorder. NHANES subjects wear socks and lightweight examination gowns at the MEC.

Sample description

The NHANES 1999–2002 sample includes all ages. Adolescents aged 12–19 years, persons aged 60 years and over, Mexican Americans, black persons, low income persons, and pregnant women are oversampled to improve the precision of statistical estimates produced for these groups. Additional information pertaining to the NHANES 1999–2002 survey design, survey methodology, and public-use microdata is posted on the NHANES Web site (15).

The analytic sample for this report was based on the NHANES 1999–2002 eligible sample composed of 21,004 persons, and of these, 19,759 were examined. All examined persons are eligible for the body measurement component of the NHANES health examination. Pregnant women are excluded from weight and circumference tabulations. The estimates in this report are based on a single body measurement examination.

Anthropometry component

The *NHANES 1999–2000 Body Measurements Training and Procedures Manual* describes the protocol, equipment, and measurement procedures in detail (17). The manual also provides detailed information about equipment survey procedures. NCHS produced an anthropometry methodology videotape during NHANES III (18). Weight is measured to the nearest 0.1 kilogram; height, length, and circumference are measured to the nearest millimeter; skinfold thickness is measured to the nearest 0.1 millimeter. (For this report, weight is also reported in pounds (tables 4, 17, and 30), and height is reported in inches (tables 6, 19, and 32). Kilograms were converted to pounds by multiplying weight in kilograms by a conversion factor of 2.2. Centimeters were converted to inches by dividing height in centimeters by 2.54.)

Weight is measured using a digital floor scale. An infantometer is used to measure recumbent length of infants and young children. Standing height is measured with a wall-mounted stadiometer. Head circumference measurements are made using a plastic head circumference measurement tape. Waist circumference is measured at the lateral border of the ilium bone. Upper arm length is measured from the posterior border of the acromial process to the tip of the olecranon, and the upper-arm-length midpoint is marked. The upper arm length midpoint mark is used to measure mid-arm circumference and the triceps skinfold. Subscapular skinfold is measured on all subjects at a point medial to the inferior angle of the scapula. Weight, recumbent length, and standing height values are recorded automatically; other data are recorded using computer-assisted data entry.

In addition to weight, standing height, upper arm length, mid-arm circumference, waist circumference, and skinfold measurements, three additional measurements are taken on subjects aged 8 years and over. Upper leg length measurements are taken on seated subjects; the distance from the inguinal crease to the distal end of the femur is measured. Maximal calf circumference is also measured in a seated position; a measurement tape is positioned around the calf at the point of maximum circumference. Mid-thigh circumference is measured on standing subjects with the measurement tape placed around the mid-thigh, perpendicular to the long axis of the femur bone.

Statistical analysis

Population means, standard errors of the means, and percentiles were weighted using the NHANES examination sample weights to produce national estimates. The NHANES examination sample weights incorporate the differential probabilities of selection and include adjustments for oversampling of selected populations, noncoverage, and nonresponse. Standard errors were estimated using SUDAAN by Taylor series linearization (19). The reliability of the estimates was determined using the relative standard error (RSE), a calculated figure defined as the ratio of the standard error of the mean. NCHS recommends using an RSE greater than 30 percent to identify unreliable estimates (16). Percentile values that did not meet the standard of reliability or precision were replaced with asterisks in all tables.

The age categories recommended in the *NHANES 1999–2000 Analytic Guidelines*, based on the survey sample domains, were used for adults aged 20 years and over (16). The results for subjects under age 20 years are by single years (or less for the youngest children). All age categories were based on age at the time of the examination.

Results

The anthropometric measurements performed in the survey are listed in figure 1, by measurement and target age. Figure 2 lists the tables in this report by age group and sex, measurement, and unit of measurement.

Results are reported by sex and age groups in all tables; results for adults 20 years of age and over also are presented by race or ethnicity group. Results for infants, children, and teenagers through 19 years are presented in tables 1–15. Results for adults aged 20 years and over are presented in tables 16–41. The NHANES 1999–2002 findings for some population groups may be compared with the results reported from previous NHES and NHANES conducted between 1960 and 1994 (20–28).

Measurement and target ages	Table numbers
Body weight (all ages)	Tables 3 and 4 (males and females birth–19 years) Tables 16 and 17 (females 20 years and over) Tables 29 and 30 (males 20 years and over)
Recumbent length (through 47 months)	Table 2 (males and females 0–47 months)
Standing height (2 years and over)	Tables 5 and 6 (males and females 2–19 years) Tables 18 and 19 (females 20 years and over) Tables 31 and 32 (males 20 years and over)
Upper leg length (8 years and over)	Table 14 (males and females 8–19 years) Table 24 (females 20 years and over) Table 37 (males 20 years and over)
Upper arm length (2 months and over)	Table 10 (males and females 2 months–19 years) Table 22 (females 20 years and over) Table 35 (males 20 years and over)
Head circumference (0–6 months)	Table 1 (males and females 0–6 months)
Mid-upper arm circumference (2 months and over)	Table 9 (males and females 2 months–19 years) Table 21 (females 20 years and over) Table 34 (males 20 years and over)
Waist circumference (2 years and over)	Table 7 (males and females 2–19 years) Table 26 (females 20 years and over) Table 39 (males 20 years and over)
Mid-thigh circumference (8 years and over)	Table 15 (males and females 8–19 years) Table 25 (females 20 years and over) Table 38 (males 20 years and over)
Maximal calf circumference (8 years and over)	Table 13 (males and females 8–19 years) Table 23 (females 20 years and over) Table 36 (males 20 years and over)
Triceps skin fold (2 months and over)	Table 12 (males and females 2 months–19 years) Table 28 (females 20 years and over) Table 41 (males 20 years and over)
Subscapular skin fold (2 months and over)	Table 11 (males and females 2 months–19 years) Table 27 (females 20 years and over) Table 40 (males 20 years and over)
Body mass index	Table 7 (males and females 2–19 years) Table 20 (females 20 years and over) Table 33 (males 20 years and over)

Figure 1. Anthropometric measurements, target ages, and tables: United States, 1999–2002

Table number	Age group and sex	Measurement	Unit of measurement
	Infant, child, and adolescent		
	Both sexes:		
1	Birth through 6 months	Head circumference	Centimeters
2	Birth through 47 months	Recumbent length	Centimeters
3	Birth through 19 years	Weight	Kilograms
4	Birth through 19 years	Weight	Pounds
5	2–19 years	Standing height	Centimeters
6	2–19 years	Standing height	Inches
7	2–19 years	Body mass index	BMI value
8	2–19 years	Waist circumference	Centimeters
9	2 months–19 years	Mid-arm circumference	Centimeters
10	2 months–19 years	Upper arm length	Centimeters
11	2 months–19 years	Subscapular skinfold thickness	Millimeters
12	2 months–19 years	Triceps skinfold thickness	Millimeters
13	8–19 years	Maximal calf circumference	Centimeters
14	8–19 years	Upper leg length	Centimeters
15	8–19 years	Mid-thigh circumference	Centimeters
	Adult		
	Female:		
16	20 years and over	Weight	Kilograms
17	20 years and over	Weight	Pounds
18	20 years and over	Standing height	Centimeters
19	20 years and over	Standing height	Inches
20	20 years and over	Body mass index	BMI value
21	20 years and over	Mid-arm circumference	Centimeters
22	20 years and over	Upper arm length	Centimeters
23	20 years and over	Maximal calf circumference	Centimeters
24	20 years and over	Upper leg length	Centimeters
25	20 years and over	Mid-thigh circumference	Centimeters
26	20 years and over	Waist circumference	Centimeters
27	20 years and over	Subscapular skinfold thickness	Millimeters
28	20 years and over	Triceps skinfold thickness	Millimeters
	Male:		
29	20 years and over	Weight	Kilograms
30	20 years and over	Weight	Pounds
31	20 years and over	Standing height	Centimeters
32	20 years and over	Standing height	Inches
33	20 years and over	Body mass index	BMI value
34	20 years and over	Mid-arm circumference	Centimeters
35	20 years and over	Upper arm length	Centimeters
36	20 years and over	Maximal calf circumference	Centimeters
37	20 years and over	Upper leg length	Centimeters
38	20 years and over	Mid-thigh circumference	Centimeters
39	20 years and over	Waist circumference	Centimeters
40	20 years and over	Subscapular skinfold thickness	Millimeters
41	20 years and over	Triceps skinfold thickness	Millimeters

Figure 2. Data tables by age group and sex, measurement, and unit of measurement

References

1. CDC. 2002a. NHANES 1999–2000 Data File Documentation. Examination File; Body Measurements Dataset. National Center for Health Statistics. 2002b. http://www.cdc.gov/nchs/about/major/nhanes/nhanes99_00.htm #Examination%20Files. 2004.
2. CDC. 2002b. NHANES 2001–2002 Data File Documentation. Examination File; Body Measurements Dataset. National Center for Health Statistics. http://www.cdc.gov/nchs/about/major/nhanes/nhanes01–02.htm# Examination%20Files. 2004.
3. National Center for Health Statistics. Plan and initial program of the Health Examination Survey. National Center for Health Statistics. Vital Health Stat 1(4). 1965.
4. National Center for Health Statistics. Plan, operation, and response results of a program of children's examinations. National Center for Health Statistics. Vital Health Stat 1(5). 1967.
5. National Center for Health Statistics. Plan and operation of a health examination survey of U.S. youths 12–17 years of age. National Center for Health Statistics. Vital Health Stat 1(8). 1969.
6. CDC. Reports and manuals from the first National Health and Nutrition Examination Survey (NHANES I, 1971–75). http://www.cdc.gov/nchs/about/major/nhanes/nh1rrm.htm. 2004.
7. CDC. Reports and manuals from the second National Health and Nutrition Examination Survey (NHANES II, 1976–80). http://www.cdc.gov/nchs/about/major/nhanes/nh2rrm.htm. 2004.
8. CDC. Reports and manuals from the Hispanic Health and Nutrition Examination Survey (HHANES, 1982–84). http://www.cdc.gov/nchs/about/major/nhanes/hhanesrrm.htm. 2004.
9. CDC. Reports and manuals from the third National Health and Nutrition Examination Survey (NHANES III, 1988–94). http://www.cdc.gov/nchs/about/major/nhanes/NHANESIII_Reference_Manuals.htm. 2004.
10. Ogden CL, Fryar CD, Carroll MD, Flegal KM. Mean body weight, height, and body mass index, United from vital and health statistics; no 347. Hyattsville, MD: National Center for Health Statistics. 2004.
11. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: Methods and development. National Center for Health Statistics. Vital Health Stat 11(246). 2002.
12. Flegal KM, Ogden CL, Carroll MD. Prevalence and trends in overweight in Mexican-American adults and children. Nutr Rev 62(7 part 2). S144–8. 2004.
13. Hedley AA, Ogden CL, Johnson Cl, et al. Prevalence of overweight and obesity among U.S. children, adolescents, and adults, 1999–2002. JAMA 291(23). 2,847–50. 2004.
14. Simko MD, Cowell C, Gilbride JA. Nutrition assessment: A comprehensive guide for planning intervention. 2nd ed. Gaithersburg, MD: Aspen Publishers. 1995.
15. CDC. 2004a. Descriptive information about the National Health and Nutrition Examination Survey (NHANES). http://www.cdc.gov/nchs/nhanes.htm. 2004.
16. CDC. 2004b. NHANES 1999–2000 Analytic Guidelines. Hyattsville, MD: National Center for Health Statistics. http://www.cdc.gov/nchs/data/nhanes/guidelines1.pdf. 2003.
17. National Center for Health Statistics. NHANES Anthropometry Procedures Manual. Revised January 2002. http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/body_measures_year_3.pdf. 2004.
18. National Center for Health Statistics. NHANES III: Anthropometric Procedures. [Videotape]. http://www.cdc.gov/nchs/about/major/nhanes/avideo.htm. 1996.
19. Wolter KM. Introduction to variance estimation. New York: Springer-Verlag. 1990.
20. Stoudt HW, Damon A, McFarland RA, Roberts J. Skin folds, body girths, biacromial diameter, and selected anthropometric indices of adults: United States, 1960–1962. National Center for Health Statistics. Vital Health Stat 11(35). 1970.
21. Stoudt HW, Damon A, McFarland R, Roberts J. Weight, height, and selected body dimensions of adults, United States, 1960–1962. National Center for Health Statistics. Vital Health Stat 11(8). 1965.
22. Roberts J. Weight by height and age National Center for Health Statistics. Vital Health Stat 11(14). 1966.
23. Malina RM, Hamill PVV, Lemeshow S. Selected body measurements of children 6–11 years, United States. National Center for Health Statistics. Vital Health Stat 11(123). 1973.
24. Hamill PVV, Johnston FE, Lemeshow S. Height and weight of youths 12–17 years, United States. National Center for Health Statistics. Vital Health Stat 11(124). 1973.
25. Johnson CL, Fulwood R, Abraham S, Bryner JD. Basic data on anthropometric measurements and angular measurements of the hip and knee joints for selected age groups 1–74 years of age, United States, 1971–1975. National Center for Health Statistics. Vital Health Stat 11(219). 1981.
26. Najjar MF, Rowland M. Anthropometric reference data and prevalence of overweight, United States, 1976–80. National Center for Health Statistics. Vital Health Stat 11(238). 1987.
27. Najjar MF, Kuczmarski RJ. Anthropometric data and prevalence of overweight for Hispanics, 1982–84. National Center for Health Statistics. Vital Health Stat 11(239). 1989.
28. CDC. Anthropometric reference data, United States, 1988–1994. http://www.cdc.gov/nchs/about/major/nhanes/Anthropometric%20Measures.htm. 2005.

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