Anthropometric Reference Data for Children and Adults: United States, 2003–2006

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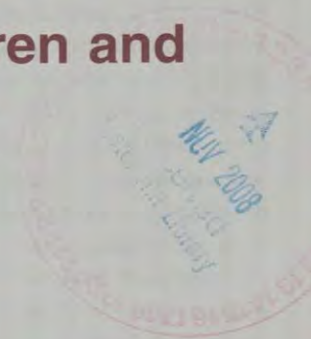
Abstract

Objective—This report presents national anthropometric reference data for all ages of the U.S. population in 2003–2006, adding to results published previously from 1960–2002.

Methods—Data are from the National Health and Nutrition Examination Survey (NHANES), a complex, stratified, and multistage probability sample of the civilian, noninstitutionalized U.S. population. Anthropometry measurements were obtained from 19,593 survey participants. The anthropometric measures included weight, height, recumbent length, circumferences, limb lengths, and skinfold thickness measurements.

Results—The tables in this report include weighted population means, standard errors of the means, and selected percentiles of body measurement values. Because measurements varied by sex and age (as well as race and ethnicity in adults), results are reported by these subgroups.

Conclusions—These latest NHANES data add to the knowledge about trends in child growth and development and trends in the distribution of body measurements, such as weight and height, in the U.S. population.

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 skinfold thicknesses, circumferences, lengths, and breadths. Anthropometry is a key component of nutritional status assessment in children and adults (1). 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 (NHANES) are conducted by the the the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS). 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 of the continuous NHANES annual survey samples is nationally representative; 2 or more years of data are required for subgroup analyses (2). NHANES 1999–2006 data were released publicly in four data sets, each one spanning 2 years (1999–2000, 2001–2002, 2003–2004, and 2005–2006) (3–5). A combined 4-year dataset based on 2003–2004 and 2005–2006 data was used for this report to improve the stability and reliability of the statistical estimates (4–5). Additional 2-year data sets will be released in the future as more data become available.

Household interviews and health examinations are used to collect NHANES data. All health examinations

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are conducted in mobile examination centers. The examination centers are staffed by full-time personnel, including health technicians who obtain body measurements from survey participants. All of the NHANES health technicians completed a comprehensive body measurement training program that utilized videotape, demonstration, and practice exercises with an expert examiner. Health technician performance was monitored by means of direct observation, data review, and expert examiner evaluations.

Although portions of the health examination component have varied during the surveys' history, much of the anthropometry component methodology has remained consistent over time. The NHANES anthropometry examinations are completed in a room that is equipped with a digital scale, a wall-mounted stadiometer, a bench, a wall mirror, an infantometer, and a computer workstation. A health technician performs the anthropometry exam and is assisted by a recorder. NHANES subjects wear socks and disposable examination gowns during the examination. The use of consistent data collection methods in representative population samples makes possible the examination of trends in body measurements over time in the U.S. population.

Sample description

NHANES is a complex, multistage probability sample of the civilian noninstitutionalized U.S. population. The NHANES 2003–2006 sample included participants of all ages. Adolescents 12–19 years of age, persons 60 years of age and older, Mexican Americans, black persons, and low-income persons were oversampled to improve the precision of the statistical estimates for these groups. Additional information pertaining to the NHANES 2003–2006 survey design, survey methodology, and public-use data is available on the NHANES website (4, 5).

females were excluded from the tabulations of weight, body mass index (BMI), circumference measurements, and skinfold thickness data.

Anthropometry examination component

The *NHANES 2005–2006 Anthropometry Training and Procedures Manual* describes the protocol, equipment, quality control, and measurement procedures that were used during the NHANES anthropometry examination (6). An anthropometry methodology videotape that was produced during NHANES III (1988–1994) illustrates the NHANES anthropometry methodology that was used to collect the 2003–2006 data (7).

Weight was measured to the nearest 0.1 kilogram. Stature, length, and circumference measurements were made to the nearest millimeter. Skinfold thickness measures were made to the nearest 0.1 millimeter. Weight was measured using a digital floor scale, and an infantometer was used to measure recumbent length on infants and young children. Standing height was measured with a wall-mounted stadiometer. Head circumference measurements were made using a plastic head circumference measurement tape. Upper arm length was measured with a tape measure from the posterior border of the acromion process to the tip of the olecranon process; during the measurement the upper arm length midpoint was marked. The mid-arm circumference was measured with a tape measure. Triceps and subscapular skinfolds were measured with a skinfold caliper. Waist circumference was measured with a tape measure at the uppermost lateral border of the hip crest (ilium). Weight, recumbent length, and standing height values were recorded automatically. The other body measurement data were recorded using computer-assisted data entry, and all results were based on a single body measurement examination.

In addition to the measurements above, three additional measurements

participants; the distance from the inguinal crease to the distal end of the femur was measured. Maximal calf circumference was also measured in a seated position; a measurement tape was positioned around the calf at the point of maximum circumference. Mid-thigh circumference was measured on standing participants 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 because of the complex sample design (8).

The reliability of the estimates produced for this report was evaluated. The relative standard error (RSE), calculated as the standard error divided by the estimate, and minimum sample size criterion were used. NCHS recommends that an estimate with an RSE greater than 30 percent be considered unreliable (2). The recommended minimum sample sizes were based on a combination of the average design effects and specified proportions (or percentiles) (9). The average design effects reflect the impact of the complex sample design on variance estimates. They were calculated as the ratio of the variance of a statistic (accounting for the complex sample design) to the variance of the same statistic based on a hypothetical simple random sample of the same size. Average design effects were calculated for each anthropometry variable over sex for children and adolescents and over sex and race-ethnicity for adults

estimates that did not meet the standards for either RSE or minimum sample size were replaced with asterisks (Tables 1–41).

The age categories used for adults aged 20 years and older were based on the survey sample domains that were recommended in the NHANES Analytic Guidelines (2). The results for participants who were under 20 years of age are by single years or, in the case of infants under 1 year of age, single months of age.

Results

The anthropometric measurements that were performed in the survey are listed in Table A. Results for children

are reported by sex and age group, and the results for adults aged 20 years and older are also presented by sex, race-ethnicity group, and age. Results from previous surveys for most measurements have been reported for the National Health Examination Survey and NHANES conducted from 1960–2002 (10–30).

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Table A. Anthropometric measurments performed in the National Health and Nutrition Examination Survey, 2003–2006

Table number	Measurement (unit of measure)	Age group and sex
1	Weight (kilograms)	Birth–19 years of age
2	Weight (pounds)	Birth–19 years of age
3	Weight (kilograms)	Females 20 years and older
4	Weight (pounds)	Females 20 years and older
5	Weight (kilograms)	Males 20 years and older
6	Weight (pounds)	Males 20 years and older
7	Standing height (centimeters)	Males and females 2–19 years
8	Standing height (inches)	Males and females 2–19 years
9	Standing height (centimeters)	Females 20 years and older
10	Standing height (inches)	Females 20 years and older
11	Standing height (centimeters)	Males 20 years and older
12	Standing height (inches)	Males 20 years and older
13	Body mass index (BMI value)	Males and females 2–19 years
14	Body mass index (BMI value)	Females 20 years and older
15	Body mass index (BMI value)	Males 20 years and older
16	Head circumference (centimeters)	Birth–6 months
17	Recumbent length (centimeters)	Birth–47 months
18	Waist circumference (centimeters)	Males and females 2–19 years
19	Waist circumference (centimeters)	Females 20 years and older
20	Waist circumference (centimeters)	Males 20 years and older
21	Mid-arm circumference (centimeters)	Males and females 2 months–19 years
22	Mid-arm circumference (centimeters)	Females 20 years and older
23	Mid-arm circumference (centimeters)	Males 20 years and older
24	Upper arm length (centimeters)	Males and females 2 months–19 years
25	Upper arm length (centimeters)	Females 20 years and older
26	Upper arm length (centimeters)	Males 20 years and older
27	Subscapular skinfold (millimeters)	Males and females 2 months–19 years
28	Subscapular skinfold (millimeters)	Females 20 years and older
29	Subscapular skinfold (millimeters)	Males 20 years and older
30	Triceps skinfold (millimeters)	Males and females 2 months–19 years
31	Triceps skinfold (millimeters)	Females 20 years and older
32	Triceps skinfold (millimeters)	Males 20 years and older
33	Maximal calf circumference (centimeters)	Males and females 8–19 years
34	Maximal calf circumference (centimeters)	Females 20 years and older
35	Maximal calf circumference (centimeters)	Males 20 years and older
36	Upper leg length (centimeters)	Males and females 8–19 years
37	Upper leg length (centimeters)	Females 20 years and older

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Table 1. Weight in kilograms for children and adolescents from birth through 19 years of age by sex and age, by mean, standard error of the mean, and selected percentiles: United States, 2003–2006

Sex and age[1]	Number examined	Mean	Standard error	Percentile								
				5th	10th	15th	25th	50th	75th	85th	90th	95th
Male								Kilograms				
Birth to 2 months	101	5.2	0.12	*	*	4.2	4.6	5.2	5.9	6.3	*	*
3–5 months	139	7.3	0.08	*	6.2	6.4	6.7	7.2	7.8	8.0	8.2	*
6–8 months	130	8.4	0.13	*	6.8	7.2	7.6	8.4	9.1	9.5	9.9	*
9–11 months	124	9.7	0.15	*	*	8.6	8.9	9.7	10.4	10.6	*	*
1 year	360	11.6	0.12	8.9	9.2	9.8	10.5	11.5	12.6	13.3	13.8	14.4
2 years	292	14.1	0.14	11.3	12.0	12.3	12.8	13.9	15.1	15.8	16.4	16.9
3 years	210	15.8	0.16	*	13.4	13.6	14.2	15.3	17.1	18.1	18.7	*
4 years	208	18.6	0.31	*	15.2	15.5	16.2	18.1	20.0	21.3	22.7	*
5 years	202	22.1	0.49	*	17.4	18.1	18.9	21.0	23.5	25.2	26.9	*
6 years	176	24.2	0.33	*	19.5	20.0	20.9	23.7	26.2	27.6	29.5	*
7 years	181	26.6	0.58	*	19.6	21.0	22.4	25.6	29.6	32.3	33.9	*
8 years	151	31.4	0.90	*	23.4	24.2	25.3	29.0	34.3	38.3	41.9	*
9 years	176	34.6	0.71	*	25.8	26.6	28.2	32.3	39.4	42.5	44.1	*
10 years	172	40.1	0.86	*	28.4	29.7	31.7	37.3	45.1	53.6	56.8	*
11 years	158	46.8	1.62	*	33.2	34.1	35.5	44.2	54.0	63.3	67.0	*
12 years	275	50.8	1.23	32.0	35.9	37.0	39.5	46.9	57.3	65.1	72.8	82.9
13 years	284	57.8	1.37	35.9	39.4	41.9	43.9	55.6	64.4	73.5	81.0	90.9
14 years	260	63.1	1.73	42.5	43.9	47.2	51.4	59.8	70.7	76.5	84.3	99.1
15 years	270	70.2	1.36	48.5	52.4	55.0	58.2	66.3	76.9	84.7	89.9	100.4
16 years	308	76.1	1.50	53.4	55.3	57.9	61.5	70.7	88.5	96.3	101.9	116.1
17 years	279	75.0	1.30	54.1	56.7	58.6	60.9	70.6	84.2	92.0	101.3	111.0
18 years	283	77.2	1.67	53.7	57.2	59.4	64.0	72.7	83.7	97.8	105.8	110.4
19 years	271	80.2	1.60	54.3	58.1	61.2	64.7	76.5	92.9	99.6	107.3	117.3
Female												
Birth to 2 months	81	4.9	0.10	*	*	*	4.4	4.9	5.4	*	*	*
3–5 months	94	6.8	0.10	*	*	*	6.2	6.6	7.3	*	*	*
6–8 months	122	8.1	0.13	*	*	7.1	7.3	8.0	8.8	9.2	*	*
9–11 months	126	9.2	0.11	*	*	8.0	8.2	9.0	10.0	10.3	*	*
1 year	328	10.9	0.11	8.4	8.8	9.1	9.9	10.9	11.9	12.5	13.0	13.4
2 years	335	13.4	0.13	10.2	10.7	11.2	12.1	13.1	14.4	15.4	16.1	16.8
3 years	191	15.8	0.20	*	12.8	13.4	14.1	15.5	16.8	17.8	18.5	*
4 years	226	17.9	0.21	*	14.8	15.2	16.1	17.5	19.4	20.2	20.8	*
5 years	199	20.5	0.37	*	15.9	16.9	17.6	19.6	22.1	24.4	25.5	*
6 years	193	23.4	0.49	*	18.4	19.1	19.9	22.1	25.3	27.4	29.7	*
7 years	157	27.3	0.62	*	21.1	21.7	23.9	25.7	29.7	33.6	35.5	*
8 years	184	30.7	0.94	*	22.3	23.5	25.0	28.2	33.9	39.1	42.1	*
9 years	185	36.7	0.99	*	26.2	27.8	29.6	34.0	42.0	46.7	50.7	*
10 years	189	42.4	1.07	*	29.1	30.7	32.5	40.5	49.0	55.5	58.5	*
11 years	175	49.2	1.31	*	33.3	34.8	38.0	47.3	56.7	62.4	68.2	*
12 years	249	52.9	1.31	*	36.4	40.4	43.6	49.5	59.7	67.4	76.2	*
13 years	292	57.4	0.98	36.8	41.2	43.0	47.1	54.4	63.4	72.6	76.0	88.5
14 years	269	58.8	1.75	*	44.0	45.8	48.5	54.4	64.8	75.8	81.0	*
15 years	248	60.9	0.76	*	46.5	47.6	50.7	57.6	67.6	76.7	81.0	*
16 years	253	61.5	0.95	*	47.2	49.5	53.2	58.8	67.0	71.5	79.6	*
17 years	252	66.0	1.66	*	49.1	51.4	54.1	60.6	71.9	79.7	87.3	*
18 years	272	67.6	2.15	*	47.8	49.7	54.6	63.0	76.2	86.2	92.1	*
19 years	239	67.4	1.79	*	50.9	52.8	55.3	63.0	73.6	84.3	92.7	*

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