Descriptive anthropometric reference data for older Americans

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ABSTRACT

Objective To present selected anthropometric data derived from adults aged 60 years and older examined in the third National Health and Nutrition Examination Survey (NHANES III).

Design NHANES III used a complex, stratified, multistage, probability cluster sample design to obtain a nationally representative sample of the US civilian, noninstitutionalized population. Persons aged 60 years and older, Mexican-Americans, and African-Americans were oversampled to produce more reliable estimates for these groups. Trained technicians measured height, weight, skinfold thickness, and circumferences using standardized procedures.

Subjects A total of 5,700 persons aged 60 years and older, and 1,861 persons aged 50 to 59 years.

Statistical analyses performed Mean and selected percentiles for body weight, body mass index, triceps skinfold thickness, mid upper arm circumference, and arm muscle circumference were calculated by gender, race/ethnicity, and 3 age categories. Weight (lb) per height (in) tables were generated for men and women by age group.

Results Mean body weight was lowest for persons aged 80 years and older. A decline in body mass index occurred that paralleled the direction and magnitude of the progressive decrease observed in weight. Muscle loss with increasing age, as indicated by arm muscle circumference, appeared to be greater among men than women.

Applications/conclusions In addition to being relatively simple, quick, and inexpensive, anthropometry is the most reliable and specific indicator of malnutrition in the older adult population. The cross-sectional reference data provided can be used by dietitians to interpret anthropometric measurements of persons aged 60 years and older.

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Older adults, classified as persons aged 60 years and older, are one of the fastest-growing segments of the population in the United States and throughout the world. This group is heterogeneous. Interindividual biological variation is large because of variable rates of aging from person to person and from one physiological system to another within the same person. Thus, a healthy 80-year-old differs from a healthy 60-year-old.

To accurately evaluate the nutritional status of older adults, age- and gender-specific data are required for all of the assessment components (ie, anthropometric, biochemical, clinical, and dietary). Such data may be derived as references or as standards. *References* are data that present cross-sectional descriptions of a well-defined population. Typically, such data are presented as observed range values for distributions of selected variables according to characteristics such as age and gender categories. *Standards* describe desirable values to be attained for selected variables. In a clinical sense, standards may be thought of as target values to be achieved. Standards are usually arrived at through studies of values for variables that are associated with optimal health and minimal morbidity or mortality outcomes.

Despite recognition of the need for age- and gender-specific anthropometric reference values for nutritional status assessment of older adults, existing reference data, especially for the very old, are limited for the US population (1,2). The reliability of existing references has been questioned because data collection was not standardized, the information is dated and may not reflect the current generation of Americans, sample sizes were limited in number and were not nationally representative, and the data do not reflect the current racial/ethnic mix in the United States. Sources of weight-for-height reference data for older adults in the United States, along with the limitations of the data, are provided in Table 1 (3-10).

The worldwide variation in older adult populations reflects lifestyle differences over the life span, environmental influences that affect genetic potential, and differences in health status (11,12). The Expert Committee of the World Health Organization recognized the need for reference data for older

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Table 1
Anthropometric references for older adults in the United States, 1959-1988

Database (ref. no)	Year data collected	Age (y)	Gender	Race	N	Parameters	Limitations
Medical records (3,4)	Before 1959	65-69	M	White	888	Height, weight	Nonstandardized data collection; convenience sample
		70-74	M	White	682		
		75-79	M	White	521		
		80-84	M	White	377		
		85-89	M	White	313		
		90-94	M	White	120		
		95-106	M	White	24		
		65-69	F	White	841		
		70-74	F	White	668		
		75-79	F	White	453		
		80-84	F	White	336		
		85-89	F	White	252		
		90-94	F	White	120		
		95-106	F	White	24		
Metropolitan Life tables (5)	1979 Body Build Study					Height, weight	Sample consists of life insurance policyholders up to age 59 y
Merged NHANES I and NHANES II[a] (6,7)	1971-1974, 1976-1980	55-74	M	All races	4,549	Height, weight, skinfold thickness: triceps, subscapular, arm muscle area	Sample only includes people up to 74 y old; surveys do not include a large sample of Hispanics.
		55-74	F	All races	5,009		
NHANES I epidemiologic follow-up study (8)	1982-1984	65-74	M	White	1,314	Height, weight	Weights per inch of height are presented for ages 55-84 y by 5-y intervals; total sample size was 9,865 persons; original height used; linear regression models were used to adjust for small sample size.
		65-74	M	Black	272		
		65-74	F	White	1,463		
		65-74	F	Black	290		
Chumlea et al (9)	Before 1985	62-104	M	White	119	Height, weight, knee height, triceps and subscapular skinfold thickness, mid arm circumference, mid arm muscle area	Ambulatory residents of institutions in Ohio; nonrepresentative sample.
			F	White	150		
Cincinnati Anthropometric Survey for the Elderly (10)	Before 1988	60-69	M	White	86	Triceps skinfold thickness, mid arm circumference, mid upper arm muscle circumference, mid upper arm muscle area	Sample not nationally representative.
		70-79	M	White	115		
		80-89	M	White	49		
		60-69	F	White	146		
		70-79	F	White	239		
		80-89	F	White	111		

[a]First and second National Health and Nutrition Examination Surveys.

adults but did not recommend the use of universal data from a single source (13). The committee recommended that reference data be presented in gender-specific 10-year age groups, with means and percentiles available for each anthropometric index and age group, and that data for people older than 80 years be included. Few reference data exist for older adult populations in developing countries. The committee also recommended that for countries without local data or the resources to develop them, data from the third National Health and Nutrition Examination Survey (NHANES III; 1988-1994) could be used for comparisons (13).

Our study provides descriptive reference values for selected anthropometric measures derived from a nationally representative sample of noninstitutionalized older US adults examined in NHANES III. These most recent cross-sectional reference data can be used by dietitians and primary care providers to facilitate the interpretation of anthropometric measurements of older adults in the United States.

METHODS

Survey Design

NHANES III used a complex, stratified, multistage, probability cluster sample design to obtain a nationally representative sample of the United States civilian, noninstitutionalized population aged 2 months and older (14). The survey was designed

Table 2
Weight for men and women examined in the third National Health and Nutrition Examination Survey (1988-1994) by race/ethnicity and age

Characteristic	n	Mean±standard error	Percentile		
			15th	50th	85th
		kg			
Men					
All ethnicities					
50-59 y	855	86.0±0.80	72.0	84.1	100.7
60-69 y	1,175	83.1±0.65	67.7	82.4	98.4
70-79 y	875	79.0±0.71	64.2	77.9	93.5
80+ y	700	71.8±0.74	58.4	70.8	84.1
Non-Hispanic white					
50-59 y	418	87.1±0.82	73.6	85.1	102.1
60-69 y	510	84.3±0.71[vw]	69.0	83.6	98.8
70-79 y	524	79.6±0.66[v]	65.5	78.5	93.6
80+ y	560	72.3±0.59[v]	59.8	71.5	84.5
Non-Hispanic black					
50-59 y	217	84.6±1.41	65.8	82.9	101.6
60-69 y	295	80.4±1.02[w]	64.3	78.3	98.3
70-79 y	187	77.2±1.19	60.0	76.2	91.9
80+ y	59	70.7±2.04	57.1[a]	71.8	84.5[a]
Mexican-American					
50-59 y	178	82.8±1.40	68.2	81.5	97.1
60-69 y	337	78.3±0.87[v]	64.6	77.3	92.0
70-79 y	149	73.1±1.31[v]	59.9	74.7	84.9
80+ y	63	66.3±1.62[v]	57.6[a]	66.8	74.5[a]
Women					
All ethnicities					
50-59 y	1,006	74.4±0.84	57.2	71.5	91.6
60-69 y	1,172	70.9±0.71	55.4	68.8	86.9
70-79 y	988	67.4±0.75	52.9	64.7	82.1
80+ y	790	60.5±0.68	47.9	59.7	72.3
Non-Hispanic white					
50-59 y	484	74.3±0.99	57.2	71.4	91.1
60-69 y	501	70.7±0.87[x]	55.5	68.9	86.8
70-79 y	644	66.8±0.74[x]	52.9	64.4	81.1
80+ y	621	60.4±0.63[y]	47.9	59.7	72.2
Non-Hispanic black					
50-59 y	275	80.8±1.34	62.5	79.3	100.1
60-69 y	300	78.8±1.29[xz]	61.5	76.4	95.1
70-79 y	182	75.5±1.57[xy]	58.0	72.6	93.3
80+ y	93	63.1±1.66[z]	50.4	61.8	80.2
Mexican-American					
50-59 y	193	70.9±1.20	56.1	70.0	83.1
60-69 y	321	70.2±0.99[z]	56.8	67.5	82.3
70-79 y	127	63.7±1.38[z]	51.7	61.6	74.5
80+ y	59	53.8±1.74[yz]	40.8[a]	52.7	64.6[a]

[a]Figure does not meet standard of reliability or precision.
[v-z]Within age category, mean weights with the same superscript are significantly different ($P<.05$).

as a 6-year project carried out in 2 consecutive phases. Phase 1 was conducted from 1988 to 1991; phase 2 was conducted from 1991 to 1994. NHANES III was designed to oversample persons aged 60 years and older, Mexican-Americans, and African-Americans to produce more reliable estimates for these groups. The NHANES protocol begins with in-home interviews, which are followed by a multicomponent health examination conducted in a specially designed Mobile Examination Center (MEC). In NHANES III, modified home examination, consisting of a subset of MEC procedures, was offered to a limited number of older adults who could not or would not come to the MEC for the more comprehensive examination (14).

Anthropometric Measurements

Comprehensive anthropometric measurements were obtained for most survey participants and recorded by trained health technicians in the MEC. For older adults examined in their homes, technicians took a subset of body measures (height, weight, triceps skinfold thickness, arm circumference, and knee height) with portable equipment. All health technicians received standardized training, subsequent periodic quality checks by standardized trainers, and retraining as necessary.

Height, weight, skinfold thickness, and circumferences were measured using procedures that closely followed techniques described in the anthropometric standardization reference manual for NHANES III (15). The NHANES III anthropometric

Table 3
Weight by height for all men aged 50 years and older examined in the third National Health and Nutrition Examination Survey (1988-1994)

Height (in) by age group	n	Percentile		
		15th	50th	85th
		← lb →		
50-59 y				
Total n	855	158.4	184.7	221.6
<65	78	140.8[a]	159.5	177.5[a]
65	58	123.6[a]	170.1	215.0[a]
66	92	146.3	173.4	198.5
67	116	156.4	177.6	207.0
68	100	166.2	191.7	225.5
69	127	164.1	184.1	223.0
70	115	166.4	196.3	229.1
71	66	168.0[a]	190.0	224.5[a]
72 and over	103	175.5	205.8	251.6
60-69 y				
Total n	1,175	148.8	181.1	216.4
<65	184	133.8	155.9	177.9
65	112	139.1	157.8	185.0
66	145	146.4	170.6	197.1
67	142	139.5	172.7	197.7
68	173	151.7	183.4	212.7
69	135	159.6	192.2	222.0
70	126	167.4	195.0	229.0
71	73	167.5[a]	205.3	232.7[a]
72 and over	85	178.0	203.0	240.1
70-79 y				
Total n	875	141.2	171.3	205.7
<65	169	129.4	153.3	181.7
65	88	133.5	162.3	189.1
66	125	136.1	159.3	193.2
67	111	150.2	172.1	194.7
68	120	146.7	170.9	211.2
69	93	151.5	181.9	211.2
70 and over	169	160.8	186.8	220.3
80-89 y				
Total n	699	128.4	155.9	185.2
<65	188	119.2	140.8	159.2
65	83	126.5[a]	151.8	170.7[a]
66	110	139.7	161.0	189.1
67	99	133.1	160.2	183.7
68	84	145.8	167.7	189.9
69	54	146.5[a]	172.4	200.2[a]
70 and over	81	141.6	171.5	203.5
60-89 y				
Total n	2,749	143.0	174.3	209.4
<65	541	124.5	151.7	174.2
65	283	134.5	157.0	186.2
66	380	142.0	165.5	195.3
67	352	141.9	170.9	194.7
68	377	149.4	176.2	210.6
69	282	154.2	187.4	215.8
70	249	160.7	184.8	223.0
71	235	165.8	200.1	232.6
72 and over	150	166.7	199.7	236.5

[a]Figure does not meet standard of reliability or precision due to small sample size.

measurement procedures have been documented in a detailed video presentation (16). In the MEC, height was measured with a fixed stadiometer. The measurement was recorded to the nearest millimeter from a photograph of the measuring tape. Body weight was measured with an electronic-load cell scale in kilograms to 2 decimals. Adults wore underpants, a disposable paper examination gown, paper pants, and foam rubber slippers. No adjustment was made for clothing weight (approximately 0.1 to 0.2 kg) in the data analysis. Skinfold thickness was measured to 0.1 mm with a skinfold caliper (Holtain Ltd Crymch, United Kingdom). Circumferences were measured with a steel tape measure (Lufkin Thinline Executive, Apex, NC). All equipment was checked at regular intervals with standardized calibration devices.

Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Arm muscle circumference (AMC) was calculated using the following formula: AMC (cm) = MAC–π×TSF, where MAC is mid upper arm circumference (cm) and TSF is triceps skinfold thickness (cm) (9).

Statistical Analysis

Statistical analyses were performed using the Statistical Analysis System (version 6, 1990, SAS Institute, Cary, NC) and SUDAAN (release 6.40, 1995, Research Triangle Institute, Research Triangle Park, NC) (17,18). For all analyses, persons who were examined in the MEC or at home were included. Therefore, the MEC/home-examined statistical sampling weight was used to produce weighted sample estimates. Sample weights incorporate the selection probabilities and include adjustments for noncoverage and nonresponse. Standard errors and average design effects were calculated using SUDAAN, a program that takes into account the sample weights and the complex sample design for calculating variance estimates.

Mean body weight by gender was calculated for non-Hispanic white, non-Hispanic black, and Mexican-American older adults as well as for a category that includes all other racial/ethnic groups. Differences in mean body weight between racial/ethnic groups for men and women by age grouping were determined using t tests. t Tests were also used to determine whether mean body weight differed significantly between age groups for each racial/ethnic group by gender. The critical t value with a $P<.05$ was calculated by using the Bonferroni approach because multiple comparisons were made (19). The medians and the 15th and 85th percentiles for body weight by height were also calculated for all the racial/ethnic groups combined and reported in pounds and inches, respectively, to facilitate clinical application.

The mean and median for BMI, triceps skinfold thickness, upper arm circumference, and arm muscle circumference for men and women were calculated. These anthropometric variables are used in screening; therefore, percentile distributions were produced for selected major percentiles ranging from the 10th to the 90th percentile.

Statistics for all the anthropometric variables are presented by gender for each decade beginning at age 50 years. Although there was no upper age limit in NHANES III and the maximum age reported was 106 years, sample sizes of persons aged 80 years and older were limited. Therefore, persons aged 80 years and older were combined into a single age grouping, with the exception of the weight-per-height tables, which are truncated at age 80 to 89 years. In these tables, weight data are presented by varying categories of height to take into consideration limited sample sizes. In some instances the higher levels of stature are aggregated to present data that if not combined would be potentially unreliable because of insufficient sample sizes. When sample size is extremely limited, estimated means or proportions may be potentially unreliable in a statistical sense. If the sample size was smaller than 30 times the average design effect, the value is denoted in the tables with a superscript and corresponding footnote.

RESULTS

Sample Characteristics and Response Rates

In NHANES III, 2,620 persons aged 50 to 59 years, 3,346 persons aged 60 to 69 years, 2,756 persons aged 70 to 79 years, and 2,273 persons aged 80 years and older were selected as potential respondents (15). In the survey there were 10,995 persons aged 50 years or older, who constituted approximately 28% of the entire NHANES III sample (10,995 of 39,695); 79% (8,654 of 10,995) were interviewed in their households, and 65% (7,155 of 10,995) were subsequently examined in the MEC. Approximately 1% (n=493) of the sampled persons were examined in their homes rather than the MEC, and these persons were primarily aged 80 years and older. Measurement component response rates were also calculated. Overall, 98% of all persons aged 50 years of age and older completed the body measurement component (15). The final analytic sample consisted of a total of 5,700 persons aged 60 years and older, and 1,861 persons aged 50 to 59 years.

Although all participants in NHANES III were free-living, noninstitutionalized persons, they were not necessarily free of comorbidities. Many of the examined older adults aged 60 years and older had at least one disease condition, such as hypertension (20), diabetes (21), osteoporosis (22), or hyperlipidemia (23), which is not unexpected for the general elderly population.

Anthropometric Data

Mean body weights (±standard error) categorized by gender, age, and racial/ethnic group are presented in Table 2. Among both men and women, for all racial/ethnic groups combined, mean body weight for persons aged 60 to 69 years was significantly greater ($P<.05$) than that of persons aged 70 to 79 years and 80 years and older, and the mean body weight of persons aged 70 to 79 years was significantly greater ($P<.05$) than that of persons aged 80 years and older. Compared with the 50- to 59-year-old age group, mean body weight in the group aged 80 years and older was 14.2 kg lower among men and 13.9 kg lower among women. When examined by race/ethnicity, the largest differences in mean weight between the 50- to 59-year-old age group and the group aged 80 years and older were found for Mexican-American men (16.5 kg) and women (17.1 kg) and for non-Hispanic black women (17.7 kg).

In general, mean body weights of the Mexican-American men and women were less than those reported for non-Hispanic black older adults at each decade. Significant differences between racial/ethnic groups are noted in Table 2. Median values followed a similar pattern.

Weights for given heights for men and women of all ethnicities combined are presented in Tables 3 and 4, respectively. The cross-sectional NHANES III data show a general decline of body weight with age for each inch of height at the 50th and 58th percentiles for both genders. This decline is also seen for men at the 15th percentile of body weight per inch of height.

For all racial/ethnic groups combined, the means and selected percentiles of BMI, upper arm circumference, triceps skinfold thickness, and arm muscle circumference are provided for men in Table 5 and for women in Table 6. A decline in BMI parallels the direction and magnitude of the progressive decrease observed in weight and weight for height with increasing decade of age. Among the percentiles shown for BMI in Tables 5 and 6, the greatest differences occur with increasing age at the 90th percentile: from 50 to 59 years to 80 years and older, men and women experienced a decline in BMI of 4.0 and 5.7, respectively.

Table 4
Weight by height for all women aged 50 years and older examined in the third National Health and Nutrition Examination Survey (1988-1994)

Height (in) by age group	n	Percentile		
		15th	50th	85th
		← *lb* →		
50-59 y				
Total n	1,007	125.7	157.2	201.6
<60	98	112.2	147.2	181.1
60	71	112.5[a]	143.5	187.0[a]
61	133	123.2	153.6	194.1
62	136	120.0	145.7	191.3
63	148	130.2	155.1	211.0
64	149	134.1	165.0	203.2
65	100	126.1	158.1	182.5
66	74	142.0[a]	182.0	200.4[a]
67 and over	98	137.9	171.1	226.5
60-69 y				
Total n	1,172	121.9	151.4	191.1
<60	195	115.4	135.0	165.9
60	128	114.3	140.7	178.2
61	174	117.2	142.0	179.2
62	164	119.9	147.4	193.6
63	158	116.0	153.9	189.5
64	124	129.9	158.4	193.9
65	105	134.6	159.2	209.7
66	48	129.7[a]	160.9	202.1[a]
67 and over	76	142.7[a]	171.3	207.8[a]
70-79 y				
Total n	985	116.3	142.4	180.5
<60	203	97.4	125.8	163.2
60	128	107.4	133.4	164.1
61	157	116.3	140.4	179.5
62	157	117.5	141.2	180.4
63	110	125.8	152.9	183.1
64	103	131.3	159.2	192.4
65 and over	127	130.8	154.4	189.5
80-89 y				
Total n	788	105.4	131.4	159.1
<60	274	96.1	119.0	147.1
60	126	106.5	132.9	155.0
61	120	112.3	138.8	159.7
62	106	110.3	132.0	155.9
63	72	120.0[a]	140.8	170.7[a]
64	45	121.3[a]	139.7	170.4[a]
65 and over	45	112.6[a]	155.7	201.8[a]
60-89 y				
Total n	2,945	115.9	144.6	182.5
<60	672	101.0	126.1	158.9
60	382	110.2	134.7	169.1
61	451	116.2	140.7	172.6
62	427	117.1	141.6	184.3
63	314	121.4	152.0	186.1
64	272	129.6	156.0	191.7
65	206	130.8	157.5	200.1
66	92	131.0	160.9	198.4
67 and over	103	142.5	168.1	206.4

[a]Figure does not meet standard of reliability or precision due to small sample size.

DISCUSSION

In the first half of adulthood (ie, from 20 to 50 years) mean body weights exceed median body weights by approximately 3 kg in men and 4 kg in women, which indicates that the distribution is

Table 5
Body mass index, mid upper arm circumference, triceps skinfold thickness, and arm muscle circumference for men 50 years of age and older examined in the third National Health and Nutrition Examination Survey (1988-1994)

Variable and age group[a]	n	Mean±SE[b]	Selected percentile						
			10th	15th	25th	50th	75th	85th	90th
Body mass index[c]									
50-59 y	855	27.8±0.23	22.6	23.5	24.7	27.2	30.7	32.1	33.5
60-69 y	1,175	27.3±0.18	21.9	23.1	24.4	27.1	30.0	31.7	32.8
70-79 y	875	26.7±0.21	21.5	22.3	23.8	26.1	29.3	30.7	31.7
80+ y	699	25.0±0.22	19.8	21.1	22.4	25.0	27.1	28.7	29.5
Mid upper arm circumference (cm)									
50-59 y	824	33.7±0.18	29.2	30.0	31.1	33.7	35.6	37.2	37.9
60-69 y	1,126	32.8±0.15	28.4	29.2	30.6	32.7	35.2	36.2	37.0
70-79 y	832	31.5±0.17	27.5	28.2	29.3	31.3	33.4	35.1	36.1
80+ y	642	29.5±0.19	25.5	26.2	27.3	29.5	31.5	32.6	33.3
Triceps skinfold thickness (mm)									
50-59 y	813	13.7±0.29	7.5	8.0	9.4	12.6	16.0	18.7	21.8
60-69 y	1,122	14.2±0.25	7.7	8.5	10.1	12.7	17.1	20.2	23.1
70-79 y	825	13.4±0.28	7.3	7.9	9.0	12.4	16.0	18.8	20.6
80+ y	641	12.0±0.28	6.6	7.6	8.7	11.2	13.8	16.2	18.0
Arm muscle circumference (cm)[d]									
50-59 y	811	29.2±0.15	25.6	26.2	27.4	29.2	31.1	32.1	33.0
60-69 y	1,119	28.3±0.13	24.9	25.6	26.7	28.4	30.0	30.9	31.4
70-79 y	824	27.3±0.14	24.4	24.8	25.6	27.2	28.9	30.0	30.5
80+ y	639	25.7±0.16	22.6	23.2	24.0	25.7	27.5	28.2	28.8

[a]All racial/ethnic groups included.
[b]SE=standard error.
[c]Calculated as kg/m^2.
[d]Arm muscle circumference=mid arm circumference (cm)−π×triceps skinfold thickness (cm).

Table 6
Body mass index, mid upper arm circumference, triceps skinfold thickness, and arm muscle circumference for women 50 years of age and older examined in the third National Health and Nutrition Examination Survey (1988-1994)

Variable and age group[a]	n	Mean±SE[b]	Selected percentile						
			10th	15th	25th	50th	75th	85th	90th
Body mass index[c]									
50-59 y	1,006	28.4±0.31	21.0	22.2	23.6	27.2	32.1	35.1	37.1
60-69 y	1,172	27.6±0.27	20.9	21.8	23.5	26.6	30.8	33.6	35.7
70-79 y	985	26.9±0.28	20.7	21.4	22.6	25.9	29.9	32.1	34.5
80+ y	788	25.2±0.26	19.3	20.3	21.7	25.0	28.4	30.0	31.4
Mid upper arm circumference (cm)									
50-59 y	970	32.5±0.25	26.6	27.5	28.7	32.0	35.3	37.5	39.2
60-69 y	1,122	31.7±0.21	26.2	26.9	28.3	31.2	34.3	36.5	38.3
70-79 y	914	30.5±0.23	25.4	26.1	27.4	30.1	33.1	35.1	36.7
80+ y	712	28.5±0.25	23.0	23.8	25.5	28.4	31.5	33.2	34.0
Triceps skinfold thickness (mm)									
50-59 y	929	26.7±0.40	16.4	18.3	20.6	26.7	32.1	35.2	37.0
60-69 y	1,090	24.2±0.37	14.5	15.9	18.2	24.1	29.7	32.9	34.9
70-79 y	902	22.3±0.39	12.5	14.0	16.4	21.8	27.7	30.6	32.1
80+ y	705	18.6±0.42	9.3	11.1	13.1	18.1	23.3	26.4	28.9
Arm muscle circumference (cm)[d]									
50-59 y	927	23.8±0.15	20.4	20.9	21.5	23.3	25.4	26.5	27.8
60-69 y	1,090	23.8±0.12	20.6	21.1	21.9	23.5	25.4	26.6	27.4
70-79 y	898	23.4±0.14	20.3	20.8	21.6	23.0	24.8	26.3	27.0
80+ y	703	22.7±0.16	19.3	20.0	20.9	22.6	24.5	25.4	26.0

[a]All racial/ethnic groups included.
[b]SE=standard error.
[c]Calculated as kg/m^2.
[d]Arm muscle circumference=mid arm circumference (cm)−π×triceps skinfold thickness (cm).

skewed and mean weights are influenced by extreme values. In later decades, beginning at 60 years, the differences between mean and median values for body weight are considerably less. Among men, these differences are in the order of approximately 1 kg; among women, mean weights exceed median weights by approximately 2 to 3 kg. Thus, after the age of 60 years, an apparent "regression to the median" occurs whereby the differences between the mean and median weights by decade of age are reduced. The reasons for this regression may be earlier mortality of the heavier subjects, institutionalization of heavier subjects (hence noncoverage by NHANES sample design), genuine weight loss with increasing age, or a combination of these factors.

Older adults are known to be at increased risk for impaired nutritional status with increasing age. This increased risk is attributable to a variety of factors: diminishing ability to access and prepare food, associated with decreased purchasing power or inadequate access to transportation to affordable shopping areas; lack of appetite or motivation to prepare and eat meals, associated with depression or decreased physical activity patterns; and physical or physiological problems with chewing, swallowing, or digestion, associated with degenerative conditions and diseases that are common with aging (1,24). Early detection of impaired nutritional status is essential to institute secondary prevention or remedial therapeutic interventions to deter the development of further health impairment. It is important, therefore, for primary care providers and health care professionals to have the ability to distinguish normal from abnormal changes in nutritional status indicators associated with progressive aging in older adults.

The mean values for body weight and BMI of persons aged 60 to 74 years examined in NHANES III during the time period 1988 to 1994 are greater than those of persons in the same age group measured in NHANES II (1976-1980) (25). Median body weights of men and women aged 60 to 69 years and 70 to 74 years examined in NHANES III are greater than those examined in NHANES II. The difference in median body weight for men aged 60 to 69 years is 5.6 kg and for men aged 70 to 74 years of age it is 4.3 kg. For women aged 60 to 69 years the difference in median body weight is 3.5 kg and for those aged 70 to 74 years it is 1.8 kg (unpublished findings). BMI is used as a measure of overweight and obesity. The increased prevalence of overweight and of obesity (BMI>30.0) in the United States from NHANES II to NHANES III has been documented for the adult population (26,27). These data include all older adult age groups through 74 years, the maximum age of participants included in NHANES II, and reflect the increase in body weight.

When data for residents of the United States were compared with data from several other nations, it was found that this increase in body weight and BMI also occurred in older adults residing in Sweden in the period 1990 to 1993 (28) and Italy in 1992 (29). High prevalences of obesity among older adults have also been reported in other international studies (11,24,29). These high prevalences are a concern because obesity at a BMI of 30 or greater is associated with increased health risks (30). Despite the increase in the number of people with a high BMI in the US population of adults, including older adults, the observed decreases in weight for height and BMI with increasing age are in agreement with other cross-sectional studies (3,8,29).

The overall loss in weight, weight for height, and BMI that occurs with increasing age is reflected in declines in mid upper arm circumference that occur across all percentiles for both men and women. The components of mid upper arm circumference suggest that women experience a greater proportional loss of subcutaneous fat and men experience a greater proportional loss of arm muscle, although at the of age 80 years men continue to have slightly more arm muscle and women continue to have slightly more subcutaneous fat. Muscle mass appears to decline very little with increasing age among women, and the gap in muscle mass appears to narrow among older men and women.

The percentile distributions presented for skinfold thickness and circumferences are useful for initial classification of older adults. These measures are generally not precise, however, for use in monitoring nutritional status. Small changes in triceps skinfold thickness or mid arm muscle circumference may be difficult to interpret because reliability for these measures is variable. Apparent changes in measures may reflect actual change in body composition and/or change in compressibility of skin and subcutaneous tissue. Aging-related changes in tissue hydration and potential redistribution of body fat from subcutaneous to internal sites, notably intraabdominal accumulation of fat, may account for some of these apparent changes (31,34).

Dramatic loss of muscle and fat in persons aged 90 years and older compared with elderly persons younger than 90 years has been reported (35). Sarcopenia, a condition of a lower than normal level of muscle mass or greater than normal loss of muscle tissue with age, has an impact on functional ability (36). Muscle strength, directly determined by amount of muscle mass, is considered one of the best single predictors of independence and mobility in older adults (37). Therefore, indicators of muscle mass may be helpful in determining needs for interventions such as nutrition programs and assistance with activities of daily living.

The anthropometric component of NHANES III provides reference data for noninstitutionalized older adults aged 60 years and older in the United States. Anthropometric measures were collected by highly trained technicians using standardized methods. The sample sizes in NHANES III are comparatively robust, providing reference data for more than 1,800 persons aged 70 to 79 years and nearly 1,500 persons aged 80 years and older. There is still a lack of reference data for adults aged 90 to 99 years and those aged 100 years and older in developed countries. Ravaglia et al (35) published anthropometric references for 57 healthy, noninstitutionalized persons aged 90 to 99 years and 41 persons aged 100 to 107 years residing in northern Italy. These are relatively small sample sizes, and there is still a need for age-specific references for the oldest age groups.

APPLICATIONS

■ Screening to determine nutritional status should be considered an important component of regular health examinations of older adults. In situations where access to regular and routine health care is limited, it is perhaps even more important to have tools that health care workers can easily implement to screen for overall nutritional status.

- Anthropometry is the most reliable and the most specific indicator of malnutrition in the older adult population (2); in addition, it is relatively simple, quick, and inexpensive. Older adults could be screened in a variety of settings such as congregate feeding sites, at home, and at health screening fairs.
- For clinical and screening purposes, weight and BMI are the most important anthropometric measures for both initial and follow-up assessments of nutritional status. Weight change and BMI are essential components of several currently recommended and widely used nutrition screening instruments developed for the elderly: Determine Your Nutritional Health (38); Nutrition Screening Initiative, levels 1 and 2 screens (38); Nutritional Risk Index (39); and Mini Nutritional Assessment (40).
- Anthropometric reference values provided in this article reflect body measurement data from the most recently completed nationally representative survey of the noninstitutionalized, older adult population in the United States and can be used as the most contemporary data available for persons aged 60 years and older.
- Persons younger than 70 years with a BMI of 30 or greater are considered to be at increased health risk (34). Nutrition education and dietary counseling should be considered for these persons.
- For persons older than 70 years with preexisting disease, guidance on weight control associated with overall clinical treatment should be provided.
- For persons older than 70 years who have remained overweight and do not have one or more chronic conditions, it may be sufficient to advise them to maintain their body weight (34).
- All older adults should be encouraged to increase their physical activity, balance energy intake with energy expenditure, and increase the nutrient density of their diets (41,42).

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