

Notes:

1. From NHANES III, Published in monograph entitled, "Anthropometric Standards" by A. Roberto Frisancho, 2008 (see last page of this pdf)

2. Sitting height index = sitting height/stature (this page)

is probably more useful than just the sitting height (next page) in kids with short stature.

Table IV.9.

Mean (M), standard deviation (SD), and percentiles of sitting height index (sitting height/stature x 100) by age for males and females of 2 to 90 years

Age Group (years)	Mean Age (years)	N	M	SD	Percentiles								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Males													
2.0-2.9	2.46	619	56.9	2.01	53.7	54.4	54.9	55.6	56.9	58.3	59.0	59.6	60.3
3.0-3.9	3.45	508	55.5	1.8	52.6	53.2	53.6	54.3	55.6	56.8	57.5	58.0	58.7
4.0-4.9	4.47	553	54.4	1.8	51.6	52.2	52.6	53.2	54.4	55.6	56.3	56.7	57.4
5.0-5.9	5.43	496	53.5	1.7	50.8	51.4	51.8	52.4	53.5	54.6	55.3	55.7	56.3
6.0-6.9	6.45	262	52.7	1.6	50.2	50.7	51.1	51.7	52.7	53.8	54.4	54.8	55.5
7.0-7.9	7.47	273	52.1	0.0	49.7	50.2	50.6	51.1	52.2	53.2	53.8	54.2	54.8
8.0-8.9	8.46	267	51.7	0.1	49.3	49.8	50.2	50.7	51.7	52.8	53.3	53.7	54.3
9.0-9.9	9.50	281	51.4	0.1	49.0	49.5	49.9	50.4	51.4	52.4	53.0	53.4	53.9
10.0-10.9	10.45	288	51.2	1.5	48.8	49.3	49.7	50.2	51.2	52.2	52.8	53.1	53.7
11.0-11.9	11.44	275	51.0	1.4	48.7	49.2	49.6	50.1	51.1	52.1	52.6	53.0	53.6
12.0-12.9	12.47	204	51.0	1.4	48.7	49.2	49.5	50.0	51.0	52.0	52.6	52.9	53.5
13.0-13.9	13.47	192	51.0	1.4	48.7	49.2	49.5	50.0	51.0	52.0	52.6	52.9	53.5
14.0-14.9	14.49	186	51.1	1.5	48.7	49.2	49.6	50.1	51.1	52.1	52.6	53.0	53.6
15.0-15.9	15.45	182	51.2	1.5	48.8	49.3	49.6	50.2	51.1	52.2	52.7	53.1	53.7
16.0-16.9	16.45	196	51.3	1.5	48.9	49.4	49.7	50.3	51.3	52.3	52.8	53.2	53.8
17.0-17.9	17.45	191	51.4	1.5	49.0	49.5	49.8	50.4	51.4	52.4	53.0	53.4	53.9
18.0-18.9	18.45	172	51.6	1.5	49.1	49.6	50.0	50.5	51.5	52.6	53.1	53.5	54.1
19.0-19.9	19.43	160	51.7	1.5	49.2	49.7	50.1	50.6	51.7	52.7	53.3	53.7	54.3
20.0-29.9	24.96	1620	52.3	1.5	49.8	50.3	50.7	51.2	52.2	53.3	53.8	54.2	54.8
30.0-39.9	34.72	1452	52.4	1.6	49.9	50.4	50.8	51.3	52.4	53.4	54.0	54.4	55.0
40.0-49.9	44.35	1195	52.2	1.5	49.9	50.4	50.8	51.3	52.3	53.4	53.9	54.3	54.9
50.0-59.9	54.89	835	52.1	1.5	49.8	50.3	50.7	51.2	52.2	53.3	53.8	54.2	54.8
60.0-69.9	64.83	1129	51.9	1.5	49.7	50.2	50.6	51.1	52.1	53.1	53.6	54.0	54.5
70.0-79.9	74.16	798	51.7	1.4	49.5	50.0	50.4	50.9	51.8	52.8	53.3	53.7	54.2
80.0-90.9	84.09	566	51.5	1.4	49.3	49.8	50.1	50.6	51.5	52.5	53.0	53.3	53.9
Females													
2.0-2.9	2.45	584	56.9	1.9	52.9	53.5	54.0	54.7	55.9	57.2	57.9	58.4	59.1
3.0-3.9	3.46	586	55.3	1.8	52.1	52.7	53.2	53.8	55.0	56.2	56.9	57.4	58.1
4.0-4.9	4.43	528	54.1	1.6	51.5	52.1	52.5	53.1	54.3	55.4	56.1	56.5	57.2
5.0-5.9	5.46	543	53.2	1.6	50.9	51.5	51.9	52.5	53.6	54.7	55.4	55.8	56.4
6.0-6.9	6.47	273	52.5	1.6	50.4	51.0	51.4	52.0	53.1	54.2	54.8	55.2	55.8
7.0-7.9	7.44	268	52.1	1.4	50.1	50.7	51.0	51.6	52.7	53.7	54.3	54.7	55.3
8.0-8.9	8.47	247	51.8	1.5	49.8	50.4	50.7	51.3	52.3	53.4	54.0	54.3	54.9
9.0-9.9	9.43	273	51.7	1.5	49.6	50.1	50.5	51.0	52.1	53.1	53.7	54.1	54.7
10.0-10.9	10.43	260	51.6	1.5	49.5	50.0	50.3	50.9	51.9	52.9	53.5	53.9	54.4
11.0-11.9	11.46	288	51.6	1.4	49.4	49.9	50.2	50.8	51.8	52.8	53.3	53.7	54.3
12.0-12.9	12.46	221	51.7	1.5	49.3	49.9	50.2	50.7	51.7	52.7	53.3	53.6	54.2
13.0-13.9	13.45	227	51.8	1.5	49.3	49.8	50.2	50.7	51.7	52.7	53.2	53.6	54.2
14.0-14.9	14.47	216	52.0	1.5	49.4	49.9	50.2	50.7	51.7	52.7	53.3	53.6	54.2
15.0-15.9	15.47	189	52.1	1.5	49.4	50.0	50.3	50.8	51.8	52.8	53.3	53.7	54.2
16.0-16.9	16.46	224	52.2	1.5	49.5	50.0	50.4	50.9	51.9	52.9	53.4	53.8	54.3
17.0-17.9	17.45	213	52.4	1.4	49.6	50.1	50.5	51.0	52.0	53.0	53.5	53.9	54.4
18.0-18.9	18.43	186	52.5	1.4	49.8	50.3	50.6	51.1	52.1	53.1	53.6	54.0	54.6
19.0-19.9	19.48	191	52.6	1.3	49.9	50.4	50.8	51.3	52.3	53.2	53.8	54.2	54.7
20.0-29.9	24.91	1842	52.9	1.5	50.2	50.8	51.1	51.7	52.7	53.8	54.3	54.7	55.3
30.0-39.9	34.85	1837	52.8	1.5	50.5	51.0	51.4	51.9	52.9	53.9	54.5	54.9	55.5
40.0-49.9	44.28	1328	52.8	1.5	50.5	51.1	51.4	51.9	52.9	53.9	54.5	54.9	55.4
50.0-59.9	54.83	979	52.8	1.5	50.4	50.9	51.3	51.8	52.8	53.8	54.3	54.7	55.2
60.0-69.9	64.82	1110	52.3	1.5	50.1	50.6	50.9	51.4	52.4	53.4	54.0	54.3	54.9
70.0-79.9	74.46	893	52.0	1.5	49.5	50.0	50.4	50.9	51.9	52.9	53.5	53.9	54.4
80.0-90.9	84.45	599	51.1	1.5	48.8	49.3	49.7	50.2	51.2	52.2	52.8	53.2	53.8

Note: Sitting height (this page) may not be as useful as Sitting height index = sitting height/stature (previous page) in kids with short stature.

reference

Table IV.8.
Mean (M), standard deviation (SD), and percentiles of sitting height (cm) by age for males and females of 2 to 90 years

Age Group (years)	Mean Age (years)	N	M	SD	Percentiles								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Males													
2.0-2.9	2.46	620	52.3	2.5	48.1	48.9	49.5	50.4	52.0	53.7	54.7	55.3	56.3
3.0-3.9	3.45	508	54.9	2.6	50.7	51.6	52.2	53.1	54.8	56.6	57.5	58.2	59.2
4.0-4.9	4.47	554	57.4	2.7	53.2	54.1	54.8	55.7	57.5	59.4	60.4	61.1	62.1
5.0-5.9	5.43	496	59.9	2.8	55.9	56.9	57.5	58.5	60.4	62.4	63.4	64.2	65.3
6.0-6.9	6.45	262	62.6	3.3	57.8	58.9	59.7	60.8	63.0	65.3	66.5	67.4	68.6
7.0-7.9	7.47	273	65.4	3.5	60.3	61.5	62.3	63.6	65.9	68.3	69.7	70.6	72.0
8.0-8.9	8.46	267	68.2	3.3	62.8	64.0	64.7	65.8	68.0	70.2	71.5	72.3	73.6
9.0-9.9	9.50	282	71.2	3.3	65.6	66.8	67.5	68.7	70.9	73.2	74.4	75.3	76.6
10.0-10.9	10.45	288	73.9	4.0	66.5	67.8	68.8	70.1	72.7	75.4	76.9	77.9	79.5
11.0-11.9	11.44	275	76.6	4.4	67.9	69.4	70.3	71.8	74.7	77.7	79.3	80.5	82.2
12.0-12.9	12.47	204	79.4	4.5	70.9	72.4	73.4	75.0	77.9	81.0	82.6	83.8	85.6
13.0-13.9	13.47	192	81.8	4.9	74.8	76.4	77.6	79.3	82.6	86.0	87.8	89.2	91.1
14.0-14.9	14.49	186	84.1	4.6	78.5	80.1	81.1	82.8	85.9	89.1	90.9	92.2	94.0
15.0-15.9	15.45	182	86.1	4.1	81.0	82.4	83.4	84.8	87.6	90.5	92.1	93.2	94.8
16.0-16.9	16.45	196	87.8	4.2	82.1	83.5	84.5	86.0	88.8	91.7	93.3	94.4	96.1
17.0-17.9	17.45	191	89.3	3.9	83.2	84.5	85.4	86.8	89.4	92.1	93.6	94.6	96.1
18.0-18.9	18.45	172	90.4	3.6	84.6	85.8	86.7	88.0	90.5	93.0	94.4	95.3	96.8
19.0-19.9	19.43	160	90.3	3.6	84.7	85.9	86.7	88.0	90.4	92.9	94.2	95.2	96.6
20.0-29.9	24.96	1620	90.4	3.6	84.7	85.9	86.7	88.0	90.4	92.9	94.2	95.2	96.6
30.0-39.9	34.72	1452	91.2	3.8	85.0	86.3	87.2	88.6	91.1	93.7	95.2	96.1	97.6
40.0-49.9	44.35	1195	91.1	3.8	85.0	86.3	87.2	88.6	91.1	93.7	95.2	96.1	97.6
50.0-59.9	54.89	835	91.0	3.8	84.8	86.1	87.0	88.4	90.9	93.5	94.9	95.9	97.4
60.0-69.9	64.83	1129	89.5	3.8	83.5	84.8	85.7	87.0	89.5	92.1	93.5	94.5	95.9
70.0-79.9	74.16	798	88.6	3.7	82.7	84.0	84.8	86.1	88.6	91.1	92.5	93.5	94.9
80.0-90.9	84.09	566	87.1	3.7	81.3	82.5	83.4	84.7	87.1	89.6	91.0	91.9	93.3
Females													
2.0-2.9	2.45	585	52.0	2.6	47.2	48.0	48.6	49.5	51.2	53.0	53.9	54.6	55.6
3.0-3.9	3.46	586	53.7	2.7	49.8	50.8	51.4	52.3	54.1	56.0	57.0	57.7	58.8
4.0-4.9	4.43	528	56.1	2.7	52.7	53.6	54.2	55.2	57.0	58.9	59.9	60.6	61.7
5.0-5.9	5.46	543	59.2	3.1	55.0	56.0	56.8	57.8	59.9	62.0	63.2	64.0	65.3
6.0-6.9	6.47	273	62.4	3.4	57.2	58.3	59.1	60.3	62.5	64.8	66.1	67.0	68.3
7.0-7.9	7.44	268	65.6	3.2	60.1	61.2	62.0	63.1	65.3	67.5	68.7	69.6	70.9
8.0-8.9	8.47	247	68.9	3.6	62.2	63.4	64.3	65.5	67.9	70.4	71.7	72.7	74.1
9.0-9.9	9.43	273	71.9	3.7	64.3	65.5	66.3	67.6	70.0	72.5	73.9	74.8	76.3
10.0-10.9	10.43	260	74.7	4.0	67.1	68.5	69.4	70.8	73.5	76.3	77.8	78.9	80.5
11.0-11.9	11.46	288	77.2	4.3	71.1	72.6	73.5	75.0	77.9	80.8	82.4	83.5	85.2
12.0-12.9	12.46	221	79.3	4.2	73.7	75.1	76.1	77.6	80.4	83.3	84.9	86.1	87.7
13.0-13.9	13.45	227	81.1	3.9	76.4	77.8	78.7	80.1	82.7	85.4	86.9	88.0	89.5
14.0-14.9	14.47	216	82.6	3.8	77.3	78.6	79.5	80.8	83.4	86.0	87.4	88.4	89.9
15.0-15.9	15.47	189	83.8	3.4	79.1	80.3	81.1	82.3	84.6	87.0	88.2	89.1	90.4
16.0-16.9	16.46	224	84.6	3.6	78.8	80.1	80.9	82.2	84.6	87.1	88.5	89.4	90.8
17.0-17.9	17.45	213	85.2	3.7	79.2	80.4	81.3	82.6	85.0	87.5	88.9	89.8	91.2
18.0-18.9	18.43	186	85.6	3.8	79.1	80.4	81.2	82.5	85.0	87.6	89.0	90.0	91.4
19.0-19.9	19.48	191	85.8	3.6	79.5	80.8	81.6	82.8	85.2	87.7	89.0	89.9	91.3
20.0-29.9	24.91	1842	85.1	3.6	79.2	80.5	81.3	82.5	84.9	87.3	88.7	89.6	91.0
30.0-39.9	34.85	1837	85.2	3.6	79.6	80.8	81.7	82.9	85.3	87.8	89.1	90.0	91.4
40.0-49.9	44.28	1328	85.3	3.4	79.9	81.0	81.8	83.0	85.3	87.6	88.9	89.8	91.1
50.0-59.9	54.83	979	84.3	3.5	79.1	80.3	81.1	82.3	84.7	87.1	88.5	89.4	90.8
60.0-69.9	64.82	1110	83.3	3.5	77.6	78.8	79.6	80.8	83.1	85.5	86.8	87.7	89.1
70.0-79.9	74.46	893	81.8	3.5	76.4	77.6	78.4	79.7	82.0	84.4	85.7	86.6	88.0
80.0-90.9	84.45	599	79.2	3.4	73.9	75.0	75.8	77.0	79.3	81.6	82.9	83.8	85.1

CHAPTER IV

POSTNATAL ANTHROPOMETRIC REFERENCE BASED ON NHANES III FOR CHILDREN AND ADULTS

This chapter focuses on the various statistical approaches and the methodology used in the development of the anthropometric reference. The resulting new anthropometric references for the evaluation of growth and nutritional status of children and adults from 2 months to 90 years of age are presented in tabular and graphic form. These references give the medians, generalized coefficients of variation, and percentiles by age and gender for each of the body measures collected in the third National Health and Nutrition Examination Survey. This chapter also includes the statistical rationale for using Z-scores and percentiles when evaluating anthropometric nutritional status of children and adults.

DEVELOPMENT OF SMOOTHED NORMALIZED ANTHROPOMETRIC DISTANCE PERCENTILE CURVES

Skewness Factor

The purpose of a dimensional reference or standard is to provide a uniform, normally distributed baseline. However, anthropometric variables, especially those that indicate body composition (e.g., weight, body mass index, fat, etc.), are not normally distributed (3) and are skewed with the right tail of the distribution longer than the left. Therefore, evaluation of nutritional status using as a reference non-normalized anthropometric data and employing conventional statistical methods that assume a normal distribution can lead to erroneous conclusions. For this reason, to construct a normally distributed anthropometric reference, the skewness factor was removed from the distribution of all the anthropometric variables. For this purpose we used the LMS method (1,2). The LMS method provides a way to obtain normalized percentile anthropometric measurements (e.g., height, weight, circumferences, or skinfolds). This method uses a power transformation referred to as L (for lambda), which stretches one tail of the distribution and shrinks the other, removing the skewness for each of a series of age groups. In addition, the LMS method calculates the median (Md) and the coefficient of variation (S) for

Meanwhile, the child either sits in the parent's lap, on the footstool, or stands. The examiner holds the tape snugly around the head. The tape is moved up and down over the back of the head to locate the maximal circumference of the head. The tape should be perpendicular to the long axis of the face and should be pulled firmly to compress the hair and underlying soft tissues. **Note:** Make sure that hair ornaments and braids are removed prior to the measurement. Record the measurement to the nearest 0.1 cm.

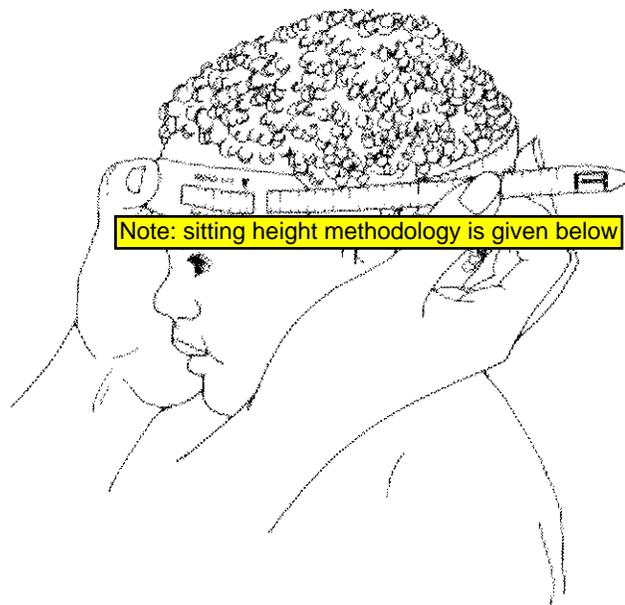


Figure I.4. Measurements of Head Circumference of Infants. From refer. #1: Frisancho (1990).

Sitting Height

Sitting height is measured with an anthropometer. The subject sits erect on a 30 x 40 x 50 cm box. The subject sits on the table or box with the legs hanging unsupported over the edge and the hands resting on the thighs (see **Figure I.3b**). The subject sits as erect as possible, with the head in the Frankfort horizontal plane and the eyes also in a horizontal plane looking straight ahead. The head, shoulders, and buttocks should touch the vertical surface of the measuring device. The subject should be asked to inhale deeply and maintain a fully erect position and the measurement is made just before the subject exhales. The movable block is brought down until it touches the head. The knees are directed straight ahead while the subject sits fully erect with the head in the same position as for the measurement of stature. Sufficient pressure is applied to

compress the hair. The measurement is recorded to the nearest 0.1 cm. Two measurements are taken and if the difference between both readings is less than 1 cm, the mean is then recorded.

Sitting Height Index

The sitting height index (%), also known as the Cormic index, is derived by computation as the ratio of sitting height to stature times 100:

$$\text{Sitting Height Index (\%)} = (\text{Sitting height, cm} / \text{stature, cm}) \times 100$$

Upper Leg (Thigh) Length

The subject sits straight on the measuring box with the right knee bent at a 90° angle. Upper leg length is measured from the midpoint of the inguinal ligament to the proximal edge of the patella (see **Figure I.5**). A non-stretchable tape measure is used. No pressure is to be applied at the inguinal crease; however, folds of fat tissue may have to be lifted on some obese subjects to measure at the crease. The exam gown should be lifted and the pants slightly pulled to smooth out gathers.

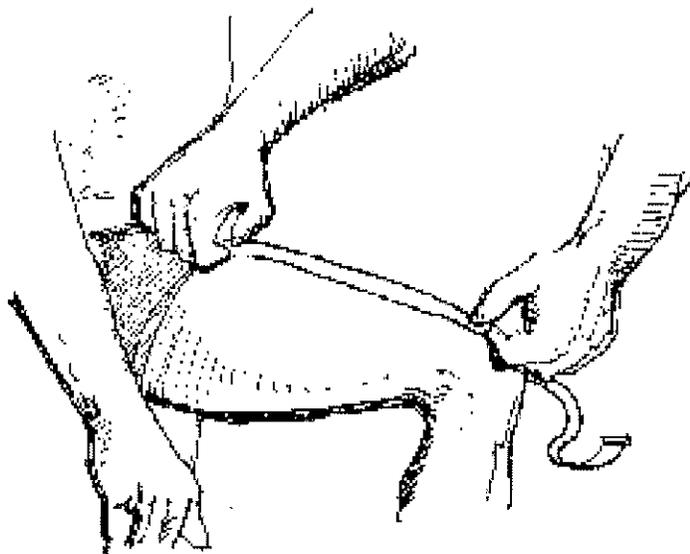


Figure I.5. Measurements of Upper Leg (thigh) Length. Upper leg (thigh) length is measured with non-stretchable tape. From refer. # 3: Lohman et al. (1988).

Anthropometric Standards: An Interactive Nutritional Reference of Body Size and Body Composition for Children and Adults

A. Roberto Frisancho

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