Add Health
The National Longitudinal Study of Adolescent to Adult Health

Anthropometric Measures

Report prepared by

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This document summarizes the rationale, equipment, measurement, protocol and data cleaning procedures for each of the anthropometric measures collected at the Wave V home exam. It also documents how constructed variables were derived from the anthropometric measures collected in the field. Whenever possible, data collection and methods in Wave V mirrored those of Wave IV to ensure comparability of data between waves. This document is one in a set of Wave V user guides. User guides are also available to describe protocols for the following biological measures in Wave V:

- Medication Use – Home Exam
- Cardiovascular Measures
- Baroreflex Sensitivity & Hemodynamic Recovery
- Glucose Homeostasis
- Inflammation and Immune Function
- Lipids
- Renal Function

Acknowledgement

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Citation

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1. Introduction

In Waves II and III, Add Health collected basic anthropometric measures from respondents consisting of height and weight. In Wave IV, measures of arm and waist circumference were added. In Wave V, this expanded set of measures was once again collected during the home exam.

Anthropometric Measures Collected

- Arm circumference (cm)
- Height (cm)
- Weight (kg)
- Waist circumference (cm)

In addition, the Add Health Wave V anthropometric data set includes the following constructed measures, derived from the measures listed above:

- Body mass index (BMI, kg/m^2)
- Classification of BMI
- Classification of waist circumference

2. General Overview of Data Collection

2.1. Biomarker Consent & Scheduled Home Exam

At the end of the Wave V Survey, respondents were asked if they would agree to participate in the Wave V home exam administered by a field examiner (FE), which included taking measurements and collecting a blood sample. If the participant agreed, examiners from the Add Health data collection partner (Section 2.2) scheduled a date and time for the home exam. Depending on participant and/or FE availability, the time between the Wave V Survey completion and the home exam ranged from days to years (see the time interval variable **H5TIMESE** in the *bdemo5* data set and codebook). Some respondents completed the home exam before completing the entire Wave V Survey, resulting in a negative time interval. There were two scenarios where this occurred:

a) Sample 1 respondents selected for administration of the modular questionnaire were asked to complete the biomarker consent section after completing Module A of the Web Questionnaire and Mail Questionnaire. These respondents could consent to and complete the home exam before continuing to complete Module B.[1]

b) Respondents who completed the Sample 1 non-response follow up (NRFU) abbreviated telephone interview could consent to and complete the home exam before completing the full Wave V Survey.[1]

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2.2. Home Exam

All data were collected during home exams performed by FEs from two Add Health data collection partners: Examination Management Services, Inc. (2016–2017) and Hooper Holmes, Inc. (2018–2019). All FEs were trained and certified using a custom program specific to the Add Health protocol. FEs used a 7" Samsung Galaxy Tab 4 tablet to record and transmit data. An Add Health data collection application (Open Data Kit or ODK) installed on the tablet guided the FEs through the home exam protocol. In addition, FEs received a series of job aids, both on paper and on the tablet, to serve as quick reference guides when completing the protocol. Each tablet also contained an in-depth Add Health training manual that could be accessed at any time.

Once the home exam was initiated, a few preliminary questions were asked of respondents, blood pressure measurements were taken, and then the anthropometric data was collected. Respondents were free to skip any portion of the data collection or terminate the visit at any time. Particular care was taken to prevent respondents from becoming embarrassed or self-conscious about their anthropometric measures. FEs, for example, were trained to remain courteous and professional at all times, never calling attention to or commenting on a respondent's height, weight or waist circumference. FEs were also trained not to share anthropometric measures with respondents unless they specifically requested them.

3. Arm Circumference (cm) [H5ARMCIR]

3.1. Rationale

Arm circumference was measured to guide selection of an appropriately sized blood pressure cuff (see Cardiovascular Measures User Guide) and to complement the BMI- and waist-based estimation of obesity- and abdominal adiposity-related risks.[2]

3.2. Equipment

FEs used the SECA 201 metric-increment circumference soft tape measure (Seca Corp., North America East; Hanover, MD) to measure arm circumference (Exhibit 1).

Specifications:

- 200 cm maximum range
- 1 mm graduations
- 2-sided cm scaling
- 90 x 25 x 65 mm
- 50 g
- Fiberglass tape
- Plastic case
- Automatic roll-up
- End-peg positioned

Exhibit 1. SECA 201 tape measure

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3.3. Measurement and Protocol

FEs attempted to measure right arm circumference in all respondents regardless of whether or not the respondent chose to have their blood pressure read, unless one of the following contraindications was present:

- open sores, wounds, gauze dressings or rashes;
- casts, splints or shunts;
- intravenous (IV) catheters or other attached medical devices;
- swelling, withering or paralysis; or
- arm on same side as prior mastectomy.

All respondents were asked specifically whether they had a prior mastectomy and, if so, on which side. If there were contraindications to using the right arm for measurement, the left arm was used (H5ARM identifies the arm used for measurement). If there were contraindications to measurement on both arms, neither arm circumference was measured.

To measure arm circumference accurately, FEs asked respondents to remove bulky outer garments (e.g., sweaters or jackets) and, if applicable, push up their shirt sleeves to expose the upper arm. FEs also instructed respondents to relax their shoulders and allow their arm to be measured while hanging loosely at their side. FEs wrapped the SECA tape around the respondent's upper arm, midway between the shoulder and elbow. Arm circumference was measured to the nearest 0.5 cm.

3.4. Data Cleaning

Arm circumferences entered in inches were converted to centimeters. The skip logic and distribution of the entered arm circumferences were checked for outliers and inconsistencies. Outlying measured arm circumferences were identified using the ESD procedure.[3] All outliers identified as described above were investigated for inconsistencies within Wave V. Clearly inconsistent Wave V arm circumferences were recoded to "invalid data" (H5ARMCIR=9999). After recoding, measured arm circumferences were compared to the 2015–2016 National Health and Nutrition Examination Survey (NHANES) age-, sex-, and race-specific 5th and 95 percentiles of arm circumference.[4] Approximately 20.9% of the measured arm circumferences were < the 5th percentile and 1.8% were > the 95th percentile.

4. Height (cm) [H5HGT]

4.1. Rationale

Height was measured to enable computation of body mass index (see section 7.1 below), serving as an independent predictor of cardiovascular disease risk factors, morbidity and mortality, as well as a primary tool used in characterizing the epidemiology of obesity in the U.S.

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4.2. Equipment

Carpenter's square, steel tape measure (1 mm graduation; 7.5 m maximum), and pre-printed, adherent Post-it note (Exhibit 2).

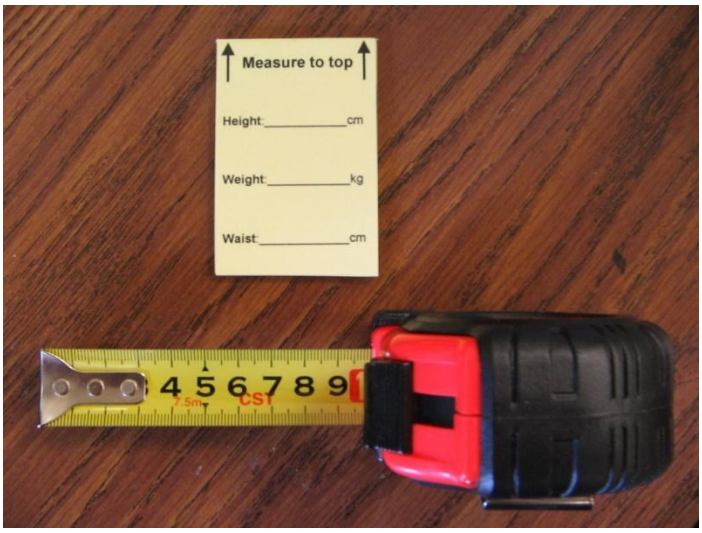

Exhibit 2. Equipment used to measure height

4.3. Measurement

Height was measured to the nearest 0.5 cm for all respondents who were capable of maintaining a standing position without assistance.

4.4. Protocol

FEs were trained to measure height against a smooth wall in an area without rugs or carpeting, if possible. The FE asked the respondent to remove his or her shoes and any hat, hair ornaments, or other accessories that could affect the measurement. If the respondent refused or was unable to remove his or her shoes or interfering accessories, the FE was trained to measure the height of those items separately and record the results in the tablet questionnaire.

The respondent was instructed to stand as tall as possible against the wall, with their feet flat on the floor, both heels together and toes pointed slightly apart. The FE checked to be sure that the respondent's weight was evenly distributed and that their head, shoulder blades, buttocks, and heels touched the wall, to the extent possible. The FE also aligned the respondent's head in the Frankfurt position, with the horizontal line from the ear canal to the lower border of the orbit of the eye parallel to the floor and perpendicular to the wall (Exhibit 3).

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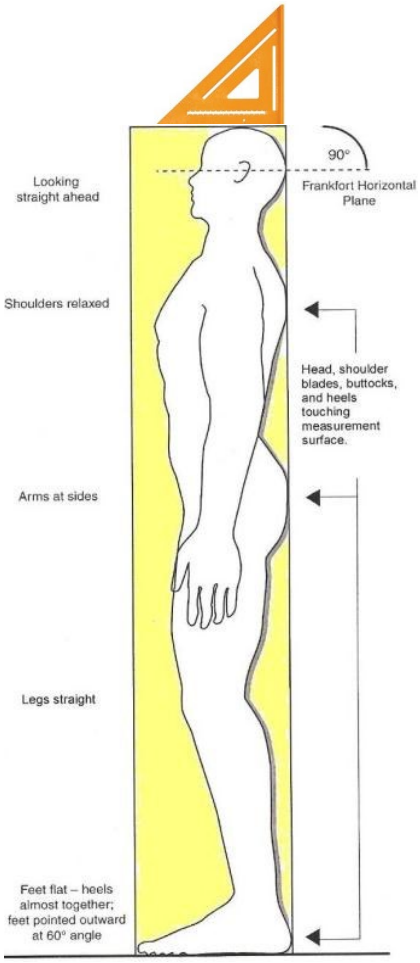

Exhibit 3. Head in Frankfurt position with carpenter's square

To take the measurement, the FE rested the carpenter's square firmly on top of the respondent's head so that the sides of the square that form a right angle were flush with the wall and resting on the respondent. The FE then placed the top edge of a Post-it note at the bottom edge of the square, marking the respondent's height, and asked the respondent to step away from the wall. Next, the FE used the tape measure to measure the distance from the floor to the top of the Post-it note, asking the respondent to hold the bottom end of the tape in place if necessary. The FE measured height to the nearest 0.5 cm and entered this value in the tablet. They could also write the measurement on the Post-it note, in the space marked "Height," if needed, before removing the Post-it note from the wall. The FE could also use the same Post-it note to temporarily record the weight and waist circumference before entering all three measurements into the tablet.

4.5. Data Cleaning

Heights entered in inches were converted to centimeters. The measured heights of shoes, hair ornaments, etc. worn during height measurement were subtracted from the respondent's measured height. The skip logic and distribution of the entered heights were checked for outliers and inconsistencies. Outliers were identified using an extreme studentized deviate (ESD) multiple outlier detection procedure.[3] The ESD procedure identified outlying measured heights as well as outlying

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differences between 1) measured heights at Wave V, 2) survey-based, self-reported heights at Wave V, 3) measured heights at Wave IV, and 4) measured heights at Wave III. All outliers identified as described above were investigated for inconsistencies within Wave V and across Waves III–V. Clearly inconsistent Wave V measured heights were recoded as "invalid data" (H5HGT=9999). After recoding, measured heights were compared to the 2015–2016 National Health and Nutrition Examination Survey (NHANES) age-, sex- and race-specific 5th and 95th percentiles of height.[4] Approximately 5.4% of the measured heights at Wave V were < the 5th percentile and 11.3% were > the 95th percentile.

5. Weight (kg) [H5WGT]

5.1. Rationale

Weight was measured to enable computation of BMI (see section 7.1 below), an independent predictor of cardiovascular disease risk factors, morbidity and mortality, as well as a primary tool used in characterizing the epidemiology of obesity in the U.S.

5.2. Equipment

Health-o-meter 844KL High Capacity Digital Bathroom Scale (Jarden Corporation; Rye, NY) (Exhibit 4).

Specifications:

- 200 kg / 440 lbs maximum capacity
- Tolerance = 1% of weight +/– 0.05 kg
- 0.1 kg / 0.1 lb graduations
- 12 5/8" x 12 5/8" platform
- 4.5 lbs
- Digital display
- 4-point load cell
- Lithium battery
- No moving parts
- Automatic shut-off after 30 seconds of inactivity
- Low battery warning display ("Lo")

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Exhibit 4. Health-o-meter 844KL digital scale

5.3. Measurement

Weight was measured to the nearest 0.1 kg for all respondents who were capable of standing unassisted.

5.4. Protocol

The unit switches of all scales were set to "kg" before being sent into the field. Tape was placed over the unit switches to maintain the metric setting. FEs were also trained to check the switch in the field before each measurement to ensure that weight results were recorded in kilograms.

To measure a respondent's weight, the FE placed the scale on a hard, flat surface, avoiding rugs and carpeting, if possible. The FE asked the respondent to remove their shoes and any change, wallets or keys from their pockets. Respondents were not asked to remove any clothing except for bulky outer garments. The FE instructed the respondent to stand on the scale with their weight evenly distributed, looking straight ahead. The FE recorded the weight to the nearest 0.1 kg. If the respondent weighed over 200 kilograms (441 lbs.), the scale displayed the message "OL." In these cases, the FE noted in the tablet that the respondent's weight was above the scale's capacity. FEs were instructed to immediately report any problems with or damage to the scales. Any scales with suspected problems were withdrawn from the field and replaced.

5.5. Data Cleaning

Weights entered in pounds were converted to kilograms. The skip logic and distribution of the entered weights were checked for outliers and inconsistencies. Outliers were identified using the ESD

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procedure.[3] The ESD procedure identified outlying measured weights as well as outlying differences between 1) measured weights at Wave V, 2) survey-based, self-reported weights at Wave V and 3) measured weights at Wave IV. All outliers identified as described above were investigated for inconsistencies within Wave V and across Waves IV–V. Clearly inconsistent Wave V measured weights were recoded to "invalid data" (H5WGT=9999). After recoding, measured weights were compared to the 2015–2016 National Health and Nutrition Examination Survey (NHANES) age-, sex- and race-specific 5th and 95th percentiles of weight.[4] Approximately 2.9% of the measured weights at Wave V were < the 5th percentile and 6.9% were > the 95th percentile.

6. Waist Circumference (cm) [H5WAIST]

6.1. Rationale

Waist circumference is positively correlated with abdominal fat content. Waist circumference was measured because a disproportionate excess of abdominal fat relative to total body fat is an independent predictor of cardiovascular disease risk factors, morbidity and mortality. In people that are normal or moderately overweight, waist measurement provides an independent prediction of risk over and above that of BMI. It is also a primary tool used in characterizing the epidemiology of obesity in the U.S.

6.2. Equipment

FEs used the SECA 201 metric-increment circumference soft tape measure (Seca Corp., North America East; Hanover, MD) to measure waist circumference (see Exhibit 1).

6.3. Measurement

Waist circumference was measured to the nearest 0.5 cm at the superior border of the iliac crest for all respondents capable of standing unassisted, including pregnant women (Exhibit 5).

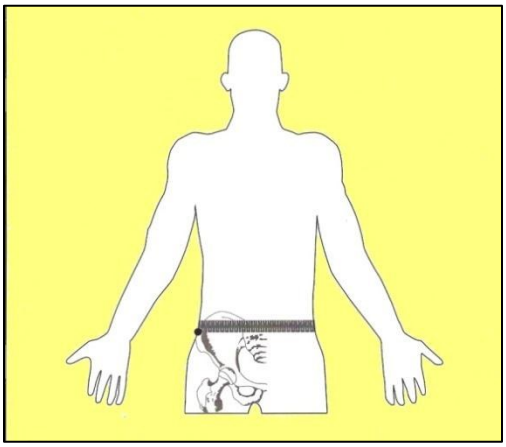

Exhibit 5. Tape measure placement

6.4. Protocol

FEs asked respondents to remove bulky outer garments and stand relaxed, breathing normally, with their weight evenly distributed. To locate the iliac crest, FEs placed their hands on the abdomen at the bottom of the rib cage and gently palpated downward until encountering the left and right superior borders of the pelvis. To avoid surprise and put the respondent at ease, FEs were trained to demonstrate the examination on themselves before obtaining permission to measure the waist circumference of respondents.

Once the upper left and right borders of the iliac crest were located, FEs asked respondents to mark the locations with their own hands so that FEs could measure the waist. FEs wrapped the SECA tape around the waist at the level of the superior iliac crest, making sure that the tape was not twisted and remained parallel to the floor .When FEs could not easily reach around the respondent, they were allowed to ask the respondent to do so and then hand the tape measure back to the FE for adjustment. The protocol also allowed FEs to walk around the respondent with the tape, if needed. The measurement was taken at the end of the respondent's normal exhalation and recorded in the tablet questionnaire. Any broken or malfunctioning SECA tapes were reported and replaced immediately throughout data collection.

6.5. Data Cleaning

Waist circumferences entered in inches were converted to centimeters. The skip logic and distribution of the entered waist circumferences were checked for outliers and inconsistencies. Outliers were identified using the ESD procedure.[3] The ESD procedure identified outlying measured waist circumferences as well as outlying differences between measured waist circumferences at Waves IV–V. All outliers identified as described above were investigated for inconsistencies within Wave V and across Waves IV–V. Clearly inconsistent measured waist circumferences were recoded to "invalid data" (H5WAIST=9999). After recoding, measured waist circumferences were compared to the 2015–2016 National Health and Nutrition Examination Survey (NHANES) age-, sex- and race-specific 5th and 95th percentiles of waist circumference.[4] Approximately 8.4% of the measured waist circumferences at Wave V were < the 5th percentile and 5.4% were > the 95th percentile.

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7. Constructed Measures

7.1. Body Mass Index (BMI) [**H5BMI**]

Body mass index (BMI) was calculated according to the metric imperial formula:

$$\text{BMI}(\text{kg/m}^2) = \frac{\text{weight (kg)}}{\text{height (m}^2)}$$

7.2. Classification of BMI [**H5BMICLS**]

BMI was classified according to the National Institutes of Health Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults (Exhibit 6).[5]

Classification	Obesity Class	BMI (kg/m^2)
1	Underweight	< 18.5
2	Normal	18.5 – 24.9
3	Overweight	25.0 – 29.9
4	Obese I	30.0 – 34.9
5	Obese II	35.0 – 39.9
6	Obese III	≥ 40

Exhibit 6. Classification of BMI

7.3. Classification of Waist Circumference [**H5WSTCLS**]

Waist circumference was classified using sex-specific thresholds identifying increased relative risk for the development of obesity-associated risk factors according to the National Institutes of Health Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults (Exhibit 7).[5]

Classification	Sex	Waist Circumference (cm)
1	Male	≤ 102
	Female	≤ 88
2	Male	> 102
	Female	> 88

Exhibit 7. Classification of waist circumference

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8. Quality Control

8.1. Equipment Evaluation and Accuracy

All field equipment was evaluated before study start-up in 2016 and during the 2017-2018 transition between data collection partners. The evaluation involved estimating the accuracy of weights measured by the Health-o-meter following a two-step protocol. In Step 1, accuracy was estimated by weighing a 65 kg staff person on each scale and discarding all scales returning weights outside the manufacturer's tolerance levels (+/– 0.7 kg). In Step 2, accuracy was estimated by weighing the same staff person on each scale, before and after holding a 5.5 lb weight, and then discarding all scales returning weights differing by < 5 or > 6 lbs.

8.2. Digit Preference

FE-specific digit preference was monitored throughout fieldwork using a Pearson χ^2 test of the null hypothesis that all possible digits (0, 1, 2, …, 9) were observed with equal frequency and a digit preference score (DPS).[6] As at Add Health Wave IV, there was little evidence of penultimate digit preference in FE recording of measured weight, height, waist circumference, or arm circumference (DPS range: 1.6–7.0). There was, however, some evidence of whole- and half-unit rounding of terminal digits despite FE training aimed at eliminating it (DPS range: 18.8–68.6).[7]

8.3. Reliability

Within a race/ethnicity- and sex-stratified random sample of 112 Add Health respondents among whom anthropometric measurements were collected twice, on average 14.1 (95% confidence interval: 13.0–15.3) days apart, typically by the same FE and at approximately the same time of day, the reliability of height, weight, waist circumference, arm circumference, and BMI was estimated as an intra-class correlation coefficient (95% confidence interval) (Exhibit 8). The estimates (range: 0.86–1.00) mirrored those stemming from Add Health Wave IV and suggested that home exam anthropometric measures are comparably reliable at Add Health Wave V.[7]

Measure	N	ICC	95% CI
Height (cm)	110	0.95	(0.93, 0.97)
Weight (kg)	110	1.00	(1.00, 1.00)
Waist	109	0.96	(0.94, 0.97)
Arm	112	0.86	(0.82, 0.91)
BMI (kg/m^2)	110	0.98	(0.98, 0.99)

Exhibit 8. Reliability of anthropometric measures

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9. The Anthropometric Data File (banthro5.xpt)

9.1. Structure

The structure of the disseminated anthropometric data file is flat. This means that it is a respondent-level data file, where each respondent has one and only one record. The respondent's identifying number (the AID variable) will appear in the data file only once.

9.2. Contents

The anthropometric data file includes the variables below, which are described in the corresponding codebook documentation that also contains frequencies.

Variable Name	Variable Description
AID	Respondent Identifier
H5ARM	Q023 Which arm is measured
H5ARMCIR	Measured arm circumference (cm)
H5ARMINS	Flag indicates arm measure was converted from inches to cms
H5HGT	Measured height (cm)
H5HGTINS	Flag indicates height measure was converted from inches to cms
H5WGT	Measured weight (kg)
H5WGTLBS	Flag indicates weight measure was converted from lbs to kgs
H5BMI	BMI (kg/m^2)
H5BMICLS	BMI classification (NIH)
H5WAIST	Measured waist (cm)
H5WSTINS	Flag indicates waist measure was converted from inches to cms
H5WSTCLS	Waist classification (NIH)

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