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| **About the Measure** | |
| **Protocol Id** | 20303 |
| **Domain:** | Anthropometrics |
| **Measure:** | Body Composition |
| **Definition:** | Body composition defined most broadly refers to the proportions of fat mass (FM) and fat-free mass (FFM) or lean body mass (LBM) but also encompasses a related concept of regional body fatness. With an increase in FM or adiposity, there may be changes in the relative distribution of fat, for example, toward visceral or dorsal deposits and away from limb fat. Regional distribution of fat also changes normally with maturation and differentially between sexes; changes that may be aggravated by overweight or obesity. Early identification of patterns of regional fatness that may be associated with risky profiles is also encouraged.  Scientific and practical guidance on which protocol may be best suited for a study’s needs are offered here: [Body Composition Guidance](http://www.phenxtoolkit.org/toolkit_content/supplemental_info/anthropometrics/additional_info/Body_Composition_Guidance.doc) |
| **Purpose:** | The study of body composition looks at the differences in bone, muscle, organs, and fat. Body composition analysis is an indicator of overall health as determined by a person's percentage of fat and lean mass. Body composition tests are designed to give a "whole picture" of the body, but measures can also be used to estimate regional fat distribution. This information is useful to help develop nutrition and exercise programs to benefit the individual and to assess risk for later-life chronic diseases. |
| **Essential PhenX Protocols:** | Current Age [10101] Ethnicity and Race [11901] Sex Assigned at Birth [11601] Gender Identity [11801] Height - Knee Height [20701] Height - Recumbent Length [20702] Height - Standing Height [20703] Height - Self-Reported Height [20704] Weight - Measured Weight [21501] Weight - Self-Reported Weight [21502] |
| **Related PhenX Protocols:** | Hip Circumference - Hip Circumference v1 [20801] Hip Circumference - Hip Circumference [20802] Waist Circumference - Waist Circumference NHANES [21601] Waist Circumference - Waist Circumference NCFS [21602] Waist Circumference - Framingham Heart Study [21603] |
| **Measure Release Date:** | October 01, 2015 |

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| **About the Protocol** | |
| **Protocol Release Date:** | October 01, 2015 |
| **Protocol Review Date:** | October 01, 2015 |
| **PhenX Protocol Name:** | Body Composition - Triceps Skinfold Thickness |
| **Protocol Name From Source:** | National Health and Nutrition Examination Survey (NHANES), Anthropometry Procedures Manual, 2007 |
| **Protocol Availability:** | Available |
| **Keywords:** | Anthropometrics; body fat; body mass index; BMI; obesity lean body mass; muscle mass; fat body mass; diabetes; bone density; bone mineral density; BMD; body fat; bone mass; fat mass; skinfold thickness; BIA; metabolic syndrome; DEXA; DXA; NHANES |
| **Description:** | Measurement of the study subject subcutaneous fat mass using calipers to measure skinfold thickness over the triceps muscle. Skinfold thicknesses may also be measured at the number of other sites, including the midaxillary, pectoral, abdominal, anterior thigh, suprapatellar, medical calf, biceps, and forearm sites. If these latter sites are of interest, definitions and protocols are available in manuals that describe anthropometric measurements. |
| **Specific Instructions:** | There are several overarching, critical issues for high-quality data collection of anthropometric measures that optimize the data in gene-environment etiologic research. These issues include: (1) the need for training (and re-training) of study staff in anthropometric data collection; (2) duplicate collection of measurements, especially under field conditions; (3) use of more than one person for proper collection of measurements where required; (4) accurate recording of the protocols and the measurement units of data collection; and (5) use of required and properly calibrated equipment.  The notion of recommending replicate measurements comes from the reduction in random errors of measurement and accompanying improved measurement reliability when the mean of multiple measurements is used rather than the a single measurement. This improvement in measurement reliability, however, depends upon the reliability of a single measurement in the hands of the data collectors in a particular study (Himes, 1989). For example, if a measure like recumbent length in a given study has a measurement reliability of 0.95 (expressed as an intraclass correlation coefficient), taking a second measurement and using the mean of the two in analyses will only improve the reliability to 0.97, yielding only a 2% reduction in error variance for the additional effort. If in the same study the reliability of a single triceps skinfold measurement was 0.85, using the mean including a replicate measurement would raise the reliability to 0.92 and yield a 7% reduction in error variance, more than a threefold improvement compared with recumbent length.Because the benefits of taking replicate measurements are so closely linked with the existing measurement reliability, it is recommended that as a part of the training of those who will be collecting anthropometry data, a reliability study be conducted that will yield measurement reliability estimates for the data collectors, protocols, settings and participants involved in that particular study (Himes, 1989). If the measurement reliability for a single measurement ≥ 0.95 the recommendation is that replicate measurement are not necessary and will yield little practical benefit. If the measurement reliability <0.95 the recommendation is to include replicate measurements as prescribed.  If replicate measurements are indicated because of relatively low reliability, a second measurement should be taken, including repositioning the participant. A third measurement should be taken if the first two measurements differ by >2.0 mm. If it is necessary to take a third measurement, the two closest measurements are averaged. If the third measurement falls equally between the first two measurements, all three should be averaged.  The Expert Review Panel notes that measurements should be made at the precision levels of the calipers chosen (dial graduation mark). Suggestions for acceptable calipers and their precision are given below. |
| **Protocol:** | **Triceps Skinfold:** The triceps skinfold is measured at the mid-point of the upper arm. The procedures for making this mark are explained in Upper Arm Length. Follow the procedures after that to perform the triceps skinfold measure.  Upper Arm Length  1. Position the participant:Direct the participant to turn away from you. Ask him or her to stand upright with weight evenly distributed on both feet, the right arm bent 90º at the elbow, and the right palm facing up. Demonstrate the correct position if necessary.  2. Mark the measurement site: Locate the end of the spine of the right scapula by following the scapula out to the arm until it makes a sharp V-turn to the front of the body. Using the cosmetic pencil, make a horizontal line on the uppermost edge of the posterior border of the spine extending from the acromion process (see Exhibit 1).  3. Take the measurement: Hold the zero end of the measuring tape at this mark and extend the tape down the posterior surface of the arm to the tip of the olecranon process, the bony part of the mid-elbow (Exhibit 2). Take the measurement to the nearest 0.1 cm. IMPORTANT: The tape must be centered on the posterior surface of the arm. Exhibit 2 shows the correct placement of the measuring tape centered on the posterior surface of the arm, whereas Exhibit 3 shows the measuring tape placed incorrectly.  4. Divide the measure in half to calculate the mid-point of the measured length. Make a horizontal mark at the mid-point and cross this mark with a perpendicular line (Exhibit 4). IMPORTANT: The vertical line must be centered on the posterior surface of the arm.  5. After marking the arm, the participant can relax his or her arm.   |  | | --- | | [img[020303\_Body\_Composition\_Triceps\_1.jpg|]]  1. Position the participant: Ask the participant to turn so that you stand behind his or her right side. Have the participant stand upright with weight evenly distributed on both feet, the shoulders relaxed, and the arms hanging loosely at the sides. Flexing or tightening the arm muscles when the measurement is made will yield an inaccurate measurement.  2. Grasp the skinfold: Using your thumb and index finger, grasp a fold of skin and subcutaneous adipose tissue approximately 2.0 cm above the mid-arm circumference mark. If you have difficulty separating the skinfold from the triceps muscle, start at the elbow where the tissue tends to be looser and work your way up to the mark. Ensure that the skinfold consists of a double thickness and sits parallel to the long axis of the arm.  3. Position the caliper: Holding the skinfold 2.0 cm above the circumference mark, place the tips of the caliper jaws over the complete skinfold. Ensure that the mark remains centered between the tips and that the jaws sit perpendicular to the length of the skinfold. Exhibit 5 shows the correct placement of the caliper for this measurement.  4. Take the measurement: Continue to hold the skinfold in place and release the caliper handle to exert full tension on the skinfold. Wait 3 seconds for the needle on the caliper dial to settle on an accurate measurement. Read the thickness to the nearest 0.2 mm.  5. Record the result. Remove the caliper jaws first and then release the skinfold.  Exhibit 5. Location of triceps skinfold  [img[020303\_Body\_Composition\_Triceps\_2.jpg|]] | |
| **Selection Rationale:** | Throughout all of the cycles where skinfolds were collected, National Health and Nutrition Examination Survey (NHANES) kept to a rigorous training and reliability schedule for their anthropometrists, and the NHANES protocols are consistent with best practices in the field. Skinfold-based measures of fatness and fat distribution in children and adults have been consistently found to agree better with fatness and fat distribution measured by dual-energy x-ray absorptiometry (DXA) than other commonly used indices of body composition, e.g., body mass index (BMI) and waist-to-hip ratio (WHR), that are collected in field situations. |
| **Source:** | Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS). (2007). National Health and Nutrition Examination Survey 2007-2008 Anthropometry Procedures Manual. Retrieved from [link[/www.cdc.gov/nchs/data/nhanes/nhanes\_07\_08/manual\_an.pdf|http://www.cdc.gov/nchs/data/nhanes/nhanes\_07\_08/manual\_an.pdf]] |
| **Language** | English |
| **Participant:** | **Participants at all ages, including neonates** |
| **Personnel and Training Required:** | Trained to use skinfold calipers, NHANES training video available at: [link[www.cdc.gov/nchs/nhanes/nhanes3/anthropometric\_videos.htm|http://www.cdc.gov/nchs/nhanes/nhanes3/anthropometric\_videos.htm]] |
| **Equipment Needs:** | Skinfold caliper, the type of caliper used should be recorded. A table of commonly used skinfold calipers appears below.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Caliper |  | Measuring range | Dial graduation | Measuring pressure | | Harpenden Skinfold Caliper | [img[020303\_Body\_Composition\_Triceps\_3.jpg|]] | 0 to 80 mm | 0.2 mm, accurate to 0.2 mm | 10 g/mm2 | | Lange Skinfold Caliper | [img[020303\_Body\_Composition\_Triceps\_4.jpg|]] | 0 to 60 mm | 1.0 mm, accurate to 0.5 mm | 10 g/mm2 | | Holtain Tanner/Whitehouse Skinfold Caliper | [img[020303\_Body\_Composition\_Triceps\_5.jpg|]] | 0 to 46 mm | 0.2 mm, accurate to 0.2 mm | 10 g/mm2 | |
| **Standards** |  |
| **General References:** | Addo, O. Y., & Himes, J. H. (2014). Are field measures of adiposity sufficient to establish fatness-related linkages with metabolic outcomes in adolescents. *Eur J Clin Nutr, 68*(6), 671-676. doi: 10.1038/ejcn.2014.14  Addo, O. Y., Pereira, M. A., & Himes, J. H. (2012). Is skinfold thickness as good as DXA when measuring adiposity contributions to insulin resistance in adolescents? *Amer J Hum Bio, 24*(6), 806-811. doi: 10.1002/ajhb.22321  Fosbol, M., & Zehran, B. (2014). Contemporary methods of body composition measurement. *Clinical Physiology and Functional Imaging, 35*(2), 81-97. doi:1111/cpf.12152.  Himes, J. H. (1989). Reliability of anthropometric methods and replicate measurements. *American Journal of Physical Anthropology,* *79*(1), 77-80.  Ketel, I. J. G., Volman, M. N. M., Seidell, J. C., Stehouwer, C. D. A., Twisk, J. W., & Lambalk, C. B. (2007). Superiority of skinfold measurements and waist over waist-to-hip ratio for determination of body fat distribution in a population-based cohort of Caucasian Dutch adults. *Eur J Endocr, 156*(6), 655-661. doi: 10.1530/eje-06-0730  Lohman, T. G., Roche, A. F., & Martorell, R. (1988). *Anthropometric standardization reference manual* (31, pp. 1493-1494). Champaign, IL, Human Kinetics Books.  Ward, L. C., Poston, L., Godfrey, K. M., & Koletzko, B. (2013). Assessing early growth and adiposity: Report from an Early Nutrition Academy workshop. *Annals of Nutrition and Metabolism, 63*(1-2), 120-130. doi:10.1159/000350702  Wang, J., Thornton, J. C., Kolesnik, S., Pierson, R. N., Jr. (2000). Anthropometry in body composition. An overview. *Annals of the New York Academy of Science, 904*, 317-326.  Wells, J. C. K. (2014). Toward Body Composition Reference Data for Infants, Children, and Adolescents. *Advances in Nutrition: An International Review Journal, 5*(3), 320S-329S. doi: 10.3945/an.113.005371  Wohlfahrt-Veje, C., Tinggaard, J., Winther, K., Mouritsen, A., Hagen, C. P., Mieritz, M. G., . . . Main, K. M. (2014). Body fat throughout childhood in 2647 healthy Danish children: agreement of BMI, waist circumference, skinfolds with dual X-ray absorptiometry. *Eur J Clin Nutr, 68*(6), 664-670. doi: 10.1038/ejcn.2013.282 |
| **Mode of Administration:** | Physical Measurement |
| **Derived Variables:** | Centripetal Fat Ratio (CFR), % Body Fat (various equations) |
| **Requirements:** | |  |  | | --- | --- | | **Requirement Category** | **Required (Yes/No)** | | **Major equipment** | No | | **Specialized training** | No | | **Specialized requirements for biospecimen collection** | No | | **Average time of greater than 15 minutes in an unaffected individual** | No | |
| **Annotations for Specific Conditions:** | None |
| **Process and Review:** | The [link[phenxtoolkit.org/about/teams#erp1-members|Expert Review Panel #1]] reviewed the measures in the Anthropometrics, Diabetes, Physical Activity and Physical Fitness, and Nutrition and Dietary Supplements domains.  Guidance from the ERP includes:  • Added a new protocol  • New Data Dictionary |