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| **About the Measure** |
| **Protocol Id** | 21601 |
| **Domain:** | Anthropometrics  |
| **Measure:** | Waist Circumference  |
| **Definition:** | Waist circumference is a measurement to estimate the abdominal circumference. |
| **Purpose:** | The measure of waist circumference is an indirect measure of abdominal fatness (central obesity), and a large waist circumference is associated with increased risk for diseases such as types 1 and 2 diabetes, dyslipidemia, hypertension, and cardiovascular disease. It is often used in conjunction with hip circumference to calculate the waist-to-hip ratio. |
| **Essential PhenX Protocols:** | Current Age [10101]Sex Assigned at Birth [11601]Gender Identity [11801]  |
| **Related PhenX Protocols:** | Ethnicity and Race [11901]Body Composition - Body Composition by Dual-Energy X-Ray Absorptiometry [20301]Body Composition - Body Composition by Dual-Energy X-Ray Absorptiometry [20302]Body Composition - Triceps Skinfold Thickness [20303]Body Composition - Subscapular Skinfold Thickness [20304]Body Composition - Suprailiac Skinfold Thickness [20305]Height - Knee Height [20701]Height - Recumbent Length [20702]Height - Standing Height [20703]Height - Self-Reported Height [20704]Hip Circumference - Hip Circumference v1 [20801]Hip Circumference - Hip Circumference [20802]Maximum Adult Weight [21001]Weight Loss/Gain [21401]Weight - Measured Weight [21501]Weight - Self-Reported Weight [21502]Growth Charts [221201]  |
| **Measure Release Date:** | October 01, 2015  |

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| **About the Protocol** |
| **Protocol Release Date:** | March 27, 2009  |
| **Protocol Review Date:** | October 01, 2015  |
| **PhenX Protocol Name:** | Waist Circumference - Waist Circumference NHANES  |
| **Protocol Name From Source:** | National Health and Nutrition Examination Survey (NHANES), Anthropometry Procedures Manual, 2007  |
| **Protocol Availability:** | Available  |
| **Keywords:** | Anthropometrics; abdominal obesity; obesity; weight; girth; Waist-To-Hip Ratio; WHR; Waist-to-Height Ratio; WtHR; metabolic syndrome; NHANES; NCFS  |
| **Description:** | Waist circumference is measured at several body sites in the scientific literature. For the National Health and Nutrition Examination Survey (NHANES), the measurement of the participant’s abdominal (waist) circumference is made at the uppermost lateral border of the ilium using a tape measure. This measurement protocol was developed specifically for NHANES III (1988-1994) to improve reliability by standardizing the bony landmarks needed to determine the plane for measurement, and it is rarely used outside of the United States. In both children and adults, and compared with measurements taken using other protocols, measurements taken over the iliac crest tend to be several centimeters larger than measurements taken midway between the lowest rib and iliac crest (Protocol 021601) or at the level of the umbilicus (Protocol 021603), except when waist circumference is measured at the level of the umbilicus in an obese participant and the umbilicus has been displaced downward (i.e., pendulous abdomen). This protocol is recommended for use by the National Heart, Lung, and Blood Institute to define central obesity (greater than 102 cm in men; greater than 88 cm in women), and references by race/ethnicity have been developed for children and adolescents. It should not be used to calculate a waist-to-height ratio (WHtR) because it will overestimate the prevalence in the abnormal range (WHtR greater than 0.5). The relationship of this measure with cardiometabolic risk factors is, however, comparable with waist circumference measures taken at other sites.NOTE: Waist circumference can be measured on pregnant women. However, national reference data do not include pregnant women, and waist circumference has different associations with abdominal and total body fat among those who are not pregnant.  |
| **Specific Instructions:** | Several overarching, critical issues for high-quality data collection of anthropometric measures that optimize the data in gene-environment etiologic research include (1) the need for training (and retraining) 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 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 a single measurement. This improvement in measurement reliability, however, depends on the reliability of a single measurement in the hands of the data collectors in a particular study (Himes, 1989). For example, if a measure such as 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 measurements in analyses will improve the reliability to only 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 three-fold improvement compared with recumbent length. The intraclass correlation coefficient is specifically recommended here for assessing reliability because it takes account of both random and systematic errors of measurement, whereas the interclass correlation (e.g., Pearson correlation) takes account of only random errors of measurement. 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 is greater than or equal to 0.95, the recommendation is that replicate measurements are not necessary and will yield little practical benefit. If the measurement reliability is less than 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 more than 1.0 cm in those 12 years or older and by more than 0.50 cm in those younger than 12 years. If it is necessary to take a third measurement, the two closest measurements are averaged. Should the third measurement fall equally between the first two measurements, all three should be averaged. |
| **Protocol:** | Abdominal (Waist) Circumference (ages 2 years and older): Follow the procedures below to obtain this measure: This measurement should be taken on bare skin.1. Mark the measurement site: Stand on the participant’s right side. Palpate the hip area to locate the right ilium of the pelvis. You may ask the participant to locate his/her ilium before palpation. With the cosmetic pencil, draw a horizontal line just above the uppermost lateral border of the right ilium. Cross this mark at the midaxillary line, which extends from the armpit down the side of the torso. Exhibit 1 shows the anatomical location of the abdominal waist at the ilium. Repeat the same process on the participant’s left side.
2. Take the measurement: Make sure the participant does not inhale while his/her waist circumference is being measured and that the tape is not twisted. Wrap the tape measure around the individual’s waist as you would a belt, making sure that the zero end of the measure is at the beginning of the circumference. A retractable, tension-controlled steel measuring tape is used. When measuring the waist, be sure to position the tape in a horizontal plane at the level of the measurement mark. A wall mirror is useful to view the tape to ensure the horizontal alignment of the tape. Another person positioned on the opposite side of the participant should check that the tape sits parallel to the floor and lies snug but does not compress the skin. If a mirror or other person is not available, check the horizontal alignment of the tape before taking the measurement. Always position the zero end of the tape below the section containing the measurement value. Exhibit 1 demonstrates the correct placement of the tape at the ilium. Take the measurement to the nearest 0.1 cm at the end of the participant’s normal expiration.
3. Remove the tape measure and record the result.
4. Repeat the measurement.

Note: Tools are available that include a retractable tape with an anchoring pin that fits into the handle. These tools also assist the participant to lightly cinch the tape. If the investigator uses these tools, the protocol should be altered slightly to comply with directions of the manufacturer. See protocol B for use of this tool when measuring a different waist circumference.Note: Detailed videos illustrating this procedure can be found on the NHANES website at: [link[www.cdc.gov/nchs/nhanes/nhanes3/anthropometric\_videos.htm|http://www.cdc.gov/nchs/nhanes/nhanes3/anthropometric\_videos.htm]] Accessed January 10, 2015. Note: Hospital gown or correct underclothing should be worn by the participant before measurement. [img[21601\_Waist\_Circumference\_1.jpg|]]Exhibit 1. Location of Measurement Landmarks between the Lowest Rib and Iliac Crest (Ilium).Note: Graphic from the "For Good Measure" Study. Personal Communication, M. Forman. Exhibit 1 displays the anatomical features that are referenced by the various waist circumference measurement protocols.  |
| **Selection Rationale:** | The state of the science does not indicate a clear choice of protocol at this time. Therefore, the PhenX Expert Review Panel recommends that one protocol be selected in measuring the waist circumference and that the protocol correspond to the reference data used. Further, the exact protocol used should be recorded and reported. These recommendations differ from those included in the original PhenX datasheets. Previously, slightly different protocols were recommended for youth and adults; these are now combined into three protocols appropriate for all age groups. Also, it is now recommended that only one protocol be used in a particular study rather than using all three protocols. |
| **Source:** | Centers for Disease Control and Prevention, National Center for Health Statistics. (2007-2008). *National Health and Nutrition Examination Study (NHANES) Anthropometry Procedures Manual*. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. 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]]Certification for the Spanish translation can be found [link[www.phenxtoolkit.org/toolkit\_content/Spanish/translation\_certification\_feb2018.pdf|here]]. |
| **Language** | EnglishSpanishChinese  |
| **Participant:** | Participant aged 16 years or older, although the protocol can be used at ages 2 years or older |
| **Personnel and Training Required:** | Trained examiner: Individuals need to be trained to identify the waist location on persons of varying body mass; training should include dexterity in wrapping the tape around participants, in ensuring a horizontal plane for measurement, in using one standardized tape measure, in positioning the tape measure; and in knowing how to measure adults and children. A pocket guide detailing the protocol is helpful for personnel to carry for review. Training should include methods for recording (e.g., forms, computer screens). Have all personnel practice on the same people to compare reproducibility of measurements and verify against an expert examiner to assure validity; retrain regularly on the same volunteer to ensure reproducibility. |
| **Equipment Needs:** | Retractable steel measuring tape |
| **Standards** |

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| **Standard** | **Name** | **ID** | **Source** |
| Logical Observation Identifiers Names and Codes (LOINC) | Child Waist Circumf | 56087-0 | [LOINC](http://s.details.loinc.org/LOINC/%3CINSERT_ID%3E.html?sections=Web) |

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| **General References:** | Because of the variability in the site of measurement of waist circumference, different cutoffs for metabolic syndrome in adults of various racial/ethnic groups, and variations among different populations of children and adolescents, more references are provided for potential users than for some other anthropometric measurements. Further, publications providing percentile curves (often including the 90th percentile) for children and adolescents have been included in the references as examples that may be suitable reference data for some investigations.Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., . . . Smith, S. C. (2009). Harmonizing the metabolic syndrome: A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation, 120*(16), 1640-1645.Brannsether, B., Roelants, M., Bjerknes, R., & Júlíusson, P. B. (2011). Waist circumference and waist-to-height ratio in Norwegian children 4-18 years of age: Reference values and cut-off levels. *Acta Paediatrica, 100*(12), 1576-82.Bergen Growth Study, 2,945 boys and 2,780 girls, aged 4-18 yearsFreedman, D. S., Serdula, M. K., Srinivasan, S. R., & Berenson, G. S. (1999). Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: The Bogalusa Heart Study. *American Journal of Clinical Nutrition, 69*(2), 308-317.Galcheva, S. V., Iotova, V. M., Yotov, Y. T., Grozdeva, K. P., Stratev, V. K., & Tzaneva, V. I. (2009). Waist circumference percentile curves for Bulgarian children and adolescents aged 6-18 years. *International Journal of Pediatric Obesity, 4*(4), 381-388.Bulgarian children, 2,052 boys and 1,758 girls, aged 6-18 yearsHarrington, D. M., Staiano, A. E., Broyles, S. T., Gupta, A. K., & Katzmarzyk, P. K. (2012). Waist circumference measurement site does not affect relationships with visceral adiposity and cardiometabolic risk factors in children. *Pediatric Obesity, 8*(3), 199-206.Jackson, R. T., Al Hamad, N., Prakash, P., & Al Somaie. M. (2011). Waist circumference percentiles for Kuwaiti children and adolescents. *Public Health Nutrition, 14*(1), 70-76.Kuwait Nutrition Surveillance System (KNSS), schoolchildren, 4,843 boys and 4,750 girls, aged 5-18.9 yearsJi, C. Y., Yt Sung, R., Ma, G. S., Ma, J., He, Z. H., & Chen, T. J. (2010). Waist circumference distribution of Chinese school-age children and adolescents. *Biomedical and Environmental Sciences,* *23*(1), 12-20.Hong Kong and 15 mainland China provinces, 160,225 children and adolescents, aged 7-18 yearsKuriyan, R., Thomas, T., Lokesh, D. P., Sheth, N. R., Mahendra, A., Joy, R., . . . Kurpad, A. V. (2011). Waist circumference and waist for height percentiles in urban South Indian children aged 3-16 years. *Indian Pediatrics, 48*(10), 765-771.PEACH (Pediatric Epidemiology and Child Health) Study, Bangalore, urban preschool- and school-age children, 5,172 boys and 3,888 girls, aged 3-16 years Mancini, M. C. (2009). Metabolic syndrome in children and adolescents: Criteria for diagnosis. *Diabetology & Metabolic Syndrome, 1*, 20 doi:10.1186/1758-5996-1-20Mason, C., & Katzmarzyk, P. T. (2009). Variability in waist circumference measurements according to anatomic measurement site. *Obesity, 17*(9), 1789-1795. doi:10.1038/oby.2009.87Ross, R., Berentzen, T., Bradshaw, A. J., Janssen, I., Kahn, H. S., Katzmarzyk, P. T., . . . Després, J. P. (2008). Does the relationship between waist circumference, morbidity and mortality depend on measurement protocol for waist circumference? *Obesity Reviews, 9*(4), 312-325. Samson, S. L., & Garber, A. J. (2014). Metabolic syndrome. *Endocrinology Metabolism Clinics of North America,* *43*, 1-23.World Health Organization. (2011). *Waist circumference and waist-hip ratio: Report of a WHO expert consultation, Geneva, 8-11 December 2008*. World Health Organization: Geneva. |
| **Mode of Administration:** | Physical Examination  |
| **Derived Variables:** | Waist-to-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR) |
| **Requirements:** |

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| **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 |

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| **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 replicate measure language• Changed unit of measurementBack-compatible: no changes to Data Dictionary Previous version in Toolkit archive ([link[www.phenxtoolkit.org/domains/view/20000#tab5content|link]]) |