

# A Case for Standardization of Body Measurement Definitions: Investigation of Torso Girths

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## Abstract

Accurate body measurements are necessary for wearable product design. Measurements must be unequivocally defined and precisely taken to use anthropometric data across different datasets with confidence and produce accurate sizing. Key body measurements are the body dimensions from which product sizing is developed and communicated to the consumer. For example, for menswear chest girth is taken as a key dimension whereas for womenswear, bust girth is an important factor. These measurements are followed by waist girth and hip girth measurements. The current study examined and compared definitions of two key body measurements of the torso, i.e., bust and hip girths, across several anthropometric datasets and sizing standards. Across sources, discrepancies such as using different names for the same measurement or using the same name for different measurements appear to stem from assigning to a measurement one of several commonly used but not clearly defined words that refer to a particular area on the body.

**Keywords:** hip circumference, maximum girth, bust circumference, anthropometry

## 1. Introduction

Taking precise body measurements is crucial for product design, particularly for developing clothing and equipment that must fit the body closely. Measurement's location and methodology of taking it must be defined unequivocally and precisely to successfully function as a determinant of the product's dimensions [1]. Moreover, when working with multiple anthropometric data sets describing different populations, the measurements used for comparison must follow the same definitions. Key measurements are used to develop product sizing and communicate sizes to the consumer. They also hold importance in steering any potential garment mass customization and personalization efforts [2]. Examination of anthropometric datasets and their documentation often reveals differences in terminology, measurement definitions, and/or methodologies used. Past research has documented the confusion related to the definitions of key torso measurements crucial for clothing construction (e.g., waist, bust, and hip) [2-5]. Such discrepancies can lead to errors in using the data and have implications for the sizing and fit of mass-produced clothing.

In the field of apparel design, studies for collecting anthropometric data adhere to international standards such as ISO, ASTM, and anthropometric surveys such as the Civilian American and European Surface Anthropometry Resource (CAESAR) as well as more garment-specific surveys such as SizeUK and SizeUSA [3]. The measurements are taken from landmark locations, which are usually defined on the bones or "easily defined features of soft tissues such as nipples and the navel" [5, pp.85]. One should not expect that the same methods be used when taking measurements for different sizing surveys even if the measurement names are the same [5]. The same confusion would be true for the otherwise, that is, names can be different, but the definitions would be the same in different standards [5]. The hip is one of the key measurements in the lower body and represents the largest circumference. However, this measurement location is defined as a region that should be searched between the waist and crotch. Additionally, it depends on where fat depositions may occur [2]. Similar to the hip definition, there is unclarity in bust measurements, or finding the largest circumference in the upper torso [2]. Detailed explanations were given and definitions were compared in the Results and Discussion section.

## 2. Purpose of the study

The study was prompted by the need for clarity and consistency of measurement definitions as practitioners encounter different sources in their work. In educational settings, discovering the differences in definitions and the impact of such differences has an educational value; however, it can also cause confusion, misunderstandings, mistakes, and, unfortunately, distrust towards the national and international standardization bodies. It is hoped that this study will bring more attention to the need

for standardization of body measurement naming and definitions and serve as a call to move towards a unified agreed-upon terminology similar to the practices set forth in the medical field, for example.

The hip and bust are two of the most important body areas in terms of defining body size and shape. The hip and bust girths are typically used as principal measurements in garment pattern drafting and in building sizing systems for mass production of ready-to-wear garments. Given the importance of bust and hip girths, this study focused on investigating some of the definitions for hip and bust one may encounter. Therefore, the purpose of the current study was two-fold (1) to examine and compare definitions of key torso girths (i.e., hip and bust) across several anthropometric studies and sizing standards to determine the extent of their similarities and differences, and (2) to evaluate the possible impact of differences in measurement definitions as related to garment sizing. In particular, the definitions of hip and bust girths were examined as they are most used for body size and shape determination. The SizeUSA anthropometric dataset for females was used to perform numerical evaluations.

### 3. Methods

The documentation of 11 anthropometric surveys and sizing standards was collected and examined. The selection of sources covered a range of current and historical standards, databases, and their documentation. The examination focused on the definitions of the largest torso girth measurements - bust/chest and hip, as these are the dimensions typically used for sizing apparel. Comparison of body measurement definitions across sources focused on the terms used in the definitions; the location of the measurement; the method of the measurement; the precision of the definitions; and compatibility with related measurements within the source itself. Similarities and differences among sources were established and tabulated.

Key measurements, for which discrepancies in measurement definitions across two or more sources were found, were considered for further analysis. A comparison of selected measurements was done if data for the measurements being compared were available within the same dataset. Descriptive statistics and graphical representations were used in the numerical evaluations.

### 4. Results and Discussion

#### 4.1. Sources – anthropometric databases and sizing standards

Table 1 shows the sources examined in this study – four anthropometric surveys [6-9], labeled A1 through A4, and seven sizing standards [10-16], labeled S1 through S7. The sources are ordered in chronological order, showing a span of about eight decades. Four of the older sizing standards (marked with an asterisk) are by now withdrawn. However, their inclusion in this investigation helps to understand the thought process in creating, refining, and revising body measurement definitions.

Table 1. Sources examined in the study

Code	Source	Reference
A1	USDA (1941)	[6]
A2	CAESAR (2002)	[7]
A3	SizeUSA (2004)	[8]
A4	ANSUR-II (2012)	[9]
S1*	CS 215-58 (1958)	[10]
S2*	BDS 8371-89 (1989)	[11]
S3*	ISO 8559: 1989 (1989)	[12]
S4*	EN 13402-1: 2001 (2001)	[13]
S5	ASTM D5219-15 (2015)	[14]
S6	ISO 7250-1: 2017 (2017)	[15]
S7	ISO 8559-1: 2017 (2017)	[16]

**Legend**

- A- anthropometric study
- S- sizing standard
- \* -withdrawn standard

Source A1, the 1941 Miscellaneous Publication No.454 by the United States Department of Agriculture (USDA) [6] reported on the work headed by O’Brien and Shelton on collecting and analyzing body measurements taken specifically for the purposes of women’s garment and pattern construction, reportedly, the first scientific study of this kind [6]. Source A2, CAESAR [7] is a set of data collected from civilians in 2002 in three countries from the North Atlantic Treaty Organization (NATO) – the United

States of America (USA), the Netherlands, and Italy. The dataset was unique in that it was the first one to include 3D full-body scans of participants along with the traditional measurements taken manually. Source A3, the 2004 SizeUSA national sizing survey of the United States [8], was designed to collect 3D body scans from the US civilian population and have all (but 10) body measurements automatically extracted from the scans. The last source A4, the 2012 Anthropometric Survey II (ANSUR II) [9], was an updated survey of the US Army personnel, following the 1988 ANSUR study, whereby not only were new data collected but a key measurement was revised to reflect the body dimensions more accurately.

The earliest of the seven sizing standards considered in this study was S1, the commercial standard CS 215-58, published in 1958 [10]. It was a result of a research study, which built upon the analysis methods developed for the 1941 USDA Miscellaneous Publication No. 454 [7]. Source S2, the BDS 8371-89 published in 1989 [11] was a sizing standard establishing the body types and sizes for women's clothing for the Peoples Republic of Bulgaria. Source S3, was the first, now withdrawn, edition of the ISO 8559 developed in 1989 by the International Standardization Organization (ISO) [12] to provide definitions for body dimensions for garment construction and anthropometric surveys. Source S4 was the European standard EN 13402-1 [13] on size designation, definitions, and procedures for clothing; it is now withdrawn. Source S5, the ASTM D5219 [14] is the active standard related to body dimensions used in the USA. Source S6 – the ISO 7250-1 published in 2017 [15] is the second edition of the standard on body measurement definitions and landmarks for technological design to be used for building anthropometric databases and comparing populations, particularly for the purposes of ergonomic design of spaces occupied by people. Source S7 is the current, second edition of ISO 8559 published in 2017 [16] by the ISO and approved by the European Committee for Standardization (CEN) as a European Standard and by the national committees of member countries of CEN as their national standard. It is meant to serve as a basis for creating anthropometric databases serving the needs of the clothing industry.

#### 4.2. Girths in the hip area

Table 2 presents the terms and measurements related to the hip area that were extracted from the eleven data sources A1-A4 and S1-S7. Generally, to describe the hip area – the part of the torso between the waist and crotch, the various hip measurements refer to one or more of the unique landmarks that can be easily identified on the body. Unequivocally are identified the levels of the (a) the level of the most protruding contour on the side as seen from the front (or back), (b) the most protruding point of the body in the back as seen from the side, and (c) the maximum circumference in the lower torso. These three levels are typically named in a fairly consistent way across sources. However, discrepancies arise when hip-related measurements are named, using different names for the same measurement or using the same name for different measurements. These discrepancies appear to stem from assigning to a measurement one of several commonly used but not clearly defined layman's words that refer to the same or different areas of the lower torso. For example, the terms “hip” (used in A1, A2, A3, S1, S2, S3, S4, S6), “seat” (used in A3, S7), “hip/seat” (used in S5), “buttock” (used in A4), “hips” (used in A3), and “maximum-girth-below-waist” (used in A3) were used. The term “hip” was used in names of measurements related (a) to the widest part as seen from the front (A1, A2, S1, S3, S6, S7); (b) to the most protruding part in the back as seen from the side (A3, A4, S2, S5); (c) to the maximum circumference in the area or to its level (A2, A3, S4, S7). The term “hips” was used to refer to the maximum girth, while at the same time “hip” was referring to the maximum girth as well as to the girth at the most protruding part in the back (A3). The term “seat” was used in the name for the girth at the most protruding part as seen from the side (A3, S5) or for the maximum girth (S7), while the composite name “hip/seat” has been used to refer to the girth at the level of the greatest protrusion of the body as seen from the side (S5). The measurement “Maximum Hip Girth (Seat Measure Girth)” (S7) combined “hip”, “seat”, and “maximum” to refer to the maximum girth found below the hip level, which is identified as the level of the greatest protrusion in the back as seen from the side. The term “buttock” has been used consistently across sources in reference to the greatest protrusion in the back as seen from the side; that includes its use in the name of measurement “buttock circumference” (A4), which is defined as the “horizontal circumference at the level of the buttock point posterior”.

Table 2. Terms related to hip area

Source code	Description	Notes
A1 [6]	<p><b>Anthropometric study</b></p> <p><b>Level of hip girth, Hip Height</b>                      Hip level is average of the left and right "most prominent bony point in the region of the trochnater major"</p> <p><b>Hip Girth</b>                      Circumference at Hip Level taken horizontally</p>	<p>@ level of widest part laterally (trochanterion)</p> <p>The widest part of the lower torso as seen from the front in the hip area.</p> <p>@ level of widest part laterally (trochanterion)</p>
A2 [7]	<p><b>Anthropometric study</b></p> <p><b>Hip Circumference, Maximum</b>                      Maximum circumference around torso; below the iliac crest; starting about 2cm above the maximum protrusion of the buttocks (as seen from the side).</p> <p><b>Hip Circumference, Maximum, Height</b>                      Distance from floor "to the level of maximum Hip Circumference."</p> <p><b>Hip Breadth, Sitting</b>                      Breadth across the hip area when sitting with the thighs, knees, feet together</p>	<p>find maximum girth (below iliac)</p> <p>Maximum circumference is found by moving the measuring tape up and down parallel to the standing surface. To avoid measuring the waist if larger than hip, search for maximum girth is below the top of the pelvis (iliac crest).</p> <p>@ level of the maximum girth (below iliac)</p> <p>@ widest part laterally when sitting                      (Reference to hip)</p>
A3 [8]	<p><b>Anthropometric study</b></p> <p><b>Hip</b>                      "Maximum circumference of the body measured between the waist and crotch, parallel to the floor."</p> <p><b>Hip Height</b>                      Distance "from the full hip level to the soles of the feet." Measure on the side of the body.</p> <p><b>Hips</b>                      Refers to Maximum circumference of body.</p> <p><b>Hip Height</b>                      "Distance between fullest part of buttocks and ground."</p> <p><b>Hip Girth</b>                      "Circumference of the hip measured around the fullest part of the buttocks."</p> <p><b>Seat</b>                      Refers to maximum posterior prominence of buttocks; refers to rear prominence (i.e. buttocks protrusion)</p> <p><b>Seat Girth Height from ground (straight)</b>                      "Distance between maximum back seat prominence and ground level."</p> <p><b>Maximum Girth Below Waist</b>                      "Maximum girth between waist and crotch levels."</p>	<p>@ maximum girth between levels of waist and crotch</p> <p>Full hip not defined.</p> <p>@ maximum girth between levels of waist and crotch</p> <p>@ buttock prominence                      Refers to Maximum Posterior Prominence of Buttocks.</p> <p>@ buttock prominence                      Refers to Maximum Posterior Prominence of buttocks.</p> <p>@ buttock prominence</p> <p>@ back seat prominence                      [Simultaneously] refers to maximum lateral trochanteric projection.</p> <p>find maximum girth (between waist and crotch)</p>
A4 [9]	<p><b>Anthropometric study</b></p> <p><b>Buttock points (posterior, left lateral, right lateral)</b>                      Posterior: "The point of maximum protrusion of the right buttock of a standing participant." Left and right: Transfer the posterior mark to each side of the body laterally.</p> <p><b>Buttock circumference</b>                      Horizontal circumference around torso at the level of the buttock point posterior.</p> <p><b>Hip Breadth</b>                      "The horizontal distance between the lateral buttock landmarks on the sides of the hips."</p>	<p>@ level of right buttock prominence</p> <p>@ level of right buttock prominence</p> <p>@ at the lateral buttock points</p>
S1* [10]	<p><b>Sizing standard</b></p> <p><b>Hip</b>                      "The outer bony prominence of the upper end of the thigh bone (femur)."</p> <p><b>Hip Girth</b>                      "Girth measured horizontally at hip level."</p>	<p>@ level of widest laterally (trochanterion)                      The widest part of the lower torso as seen from the front in the hip area.</p> <p>@ level of widest laterally (trochanterion)                      Hip level at level of maximum protrusion laterally over trochanter.</p>

Table 2 (Continued). Terms related to hip area

Source code	Description	Notes
S2* [11]	<b>Sizing standard</b>	
	<p><b>Hip with accounting for abdomen protrusion</b>                      Measuring tape passes horizontally at the level of the greatest protrusion on the back and over a flexible vertical folio resting against the abdomen</p> <p><b>Hip without accounting for abdomen protrusion</b>                      Measuring tape passes horizontally at the level of the greatest protrusion on the back (buttocks)</p>	<p>@ at level of buttock prominence + abdomen prominence                      Combined buttock-and-abdoment circumference.</p> <p>@ level of buttock prominence</p>
S3* [12]	<b>Sizing standard</b>	
	<p><b>Hip Height</b>                      "The vertical distance from the trochanteric projections to the ground."</p> <p><b>Hip Girth</b>                      "The horizontal girth measured round the buttocks at the level of the greatest lateral trochanteric projections."</p>	<p>@ widest front (trochanter)</p> <p>@ widest front (trochanter)</p>
S4* [13]	<b>Sizing standard</b>	
	<p><b>Hip Girth</b>                      Measure hip girth horizontally at the level of the maximum girth.</p>	<p>find maximum girth (below waist)</p>
S5 [14]	<b>Sizing standard</b>	
	<p><b>Hip</b>                      "The laterally projecting region formed by the lateral parts of the pelvis and the upper part of the femur together with the flesh covering them."</p> <p><b>Hip/seat girth</b>                      "Maximum horizontal circumference around the torso taken at the greatest protrusion of the buttocks as seen from the side."</p>	<p>@ region of lateral projection</p> <p>@ level of buttock prominence</p>
S6 [15]	<b>Sizing standard</b>	
	<p><b>Buttock</b>                      Reference to maximum posterior protrusion of the buttock</p> <p><b>Hip Girth</b>                      No definition</p> <p><b>Hip Breadth</b>                      "Maximum horizontal distance across the hips."</p>	<p>@ buttock prominence</p> <p>@ widest front (trochanter)</p> <p>Subject stands erect with feet together. Measurement is taken without pressing into the flesh of the hips.</p>
S7 [16]	<b>Sizing standard</b>	
	<p><b>Hip Level</b>                      "Level of the greatest projection at the back of the body (buttocks)"</p> <p><b>Hip Girth</b>                      "The horizontal girth of the body measured at the hip level"</p> <p><b>Hip Breadth</b>                      "Maximum horizontal distance across the hips."</p> <p><b>Maximum Hip Girth (Seat Measure Girth)</b>                      "Maximum horizontal girth of the body below the hip level."</p>	<p>@ buttock prominence                      Find hip level at the level of the greatest projection at the back of the body (buttocks)</p> <p>@ level maximum lateral projection?                      Maximum horizontal distance across the hips as seen from the front</p> <p>@maximum girth below hip level (at buttock prominence)</p>

A unique girth measurement called "hip with accounting for abdomen protrusion", was introduced in source S2. The measurement was done at the level of the largest protrusion of the body in the back (buttock level). The measurement combined the back girth of the body at that level (spanning from the side seam on one side to the side seam along the back on the opposite side of the body) with the extension of the abdomen in front by following a flexible (folio) surface dropped down from and resting against the abdomen. This combined measurement, while not a true body measurement, was justified by its usefulness for patternmaking as it relates directly to dimensions needed for drafting lower body garments. Moreover, this measurement was shown to correlate statistically with other girth measurements better than the buttock girth itself [17] and therefore, was used as a key measurement in the sizing system of source S2.

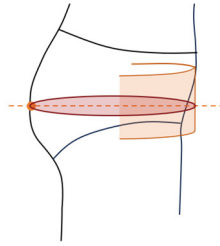


Figure 1. Hip with accounting for abdomen protrusion [11, 17].

A close observation of the data in Table 2 shows a significant shift in the hip definitions included in sources S3 and S7, which are two editions of the same standard spanning almost 30 years. While hip girth was measured at the level of the greatest trochanteric projections (side to side of the body as seen from the front), S7 shifted the hip girth to be measured at “the level of the greatest projection at the back of the body (buttocks)”.

Hip girth definition that is based on the most protruding point in the back is conceptually different from the definitions tying the hip to either the maximum torso girth or to the girth at the maximum trochanteric protrusion. The differences in the locations and the values of the measured circumferences have a significant effect on the way garments would be drafted to fit the body and, consequently, how well such garments will fit the body. The differences also may be large enough to bring about changes that are significant for the process in sizing. Provided data are available, the magnitude of the differences due to discrepancies in the definitions can be evaluated through plots and statistics.

Based on female body scan data from source A3, Figure 2 presents the difference between the maximum girth below the waist and the girth at the buttock level (buttock prominence) vs the distance of the level of the maximum lower torso girth (above the crotch) from the level of the buttock along with the abdomen girth level as a reference.

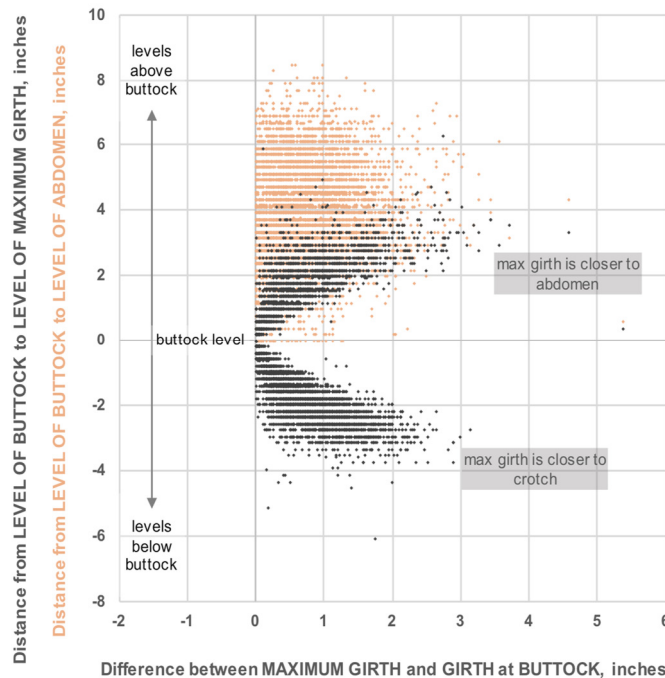


Figure 2. Differences between the girths and the levels of the maximum-girth-below-waist and girth-at-the buttock-level.

Findings show that for 32.8% (n=2069), 1.5% (n=97), and 65.7% (n=4143) of the sample (N=6309) the maximum girth was above, at, and below the level of the buttock girth, respectively, with the differences in the girths ranging from 0 to 13.7 cm (5.38 in), with an average of  $1.9 \pm 1.4$  cm ( $0.77 \pm 0.55$  in). The maximum girth being located above the level of the buttock could be attributed to a larger abdomen, while the maximum girth being located below the level of the buttock could be attributed to a larger abdomen as well as to laterally larger thighs. Differences of this magnitude can have implications for

pattern construction (e.g., for placement of darts) as well as for sizing. For 52.5% of the sample the maximum girth was larger than the buttock girth by 1.2 to 3.8 cm (0.5 to 1.5 in), or within the tolerance of the (typical) next clothing size.

#### 4.3. Girths in the bust/chest area

Table 3 lists some of the terms related to the bust/chest area in the investigated sources. The general assumption that the most protruding point of the bust/chest in front will be the maximum girth that defines the size of the body was still posited. Like with the girth definitions in the hip area, naming the various girths in the bust/chest area had variation that led to discrepancies in terminology, using same term for different measurements or multiple terms for the same measurement. For example, for the upper torso, the terms “bust girth” (A1, A3, S1, S3, S4, S7), “chest girth” (A1, A2, A3, S3, S4, S5, S7), “chest girth at scye” (A1, A2), “chest girth at axilla” (S7), “chest circumference” (A4, S6), “upper chest girth” (S7), were used to refer to the (a) circumferences for men or women, (b) the location (level) of the girth, or (c) whether the measurement was taken horizontally in a plane or along a curved surface, which is leveled (horizontal) in the back but sloped up in front to allow the tape to go above the breasts. In the present study, this non-leveled measurement (A3, S2, S5, S7) was referred to as “curved girth”. In some cases, “bust” and “chest” were used together in the name as “chest/bust” or “bust/chest” (A2, S5). The term “upper chest girth” referred to a curved girth (S5).

In some sources nipple is taken as the bust point (S3, S6) where the maximum bust girth should be measured whereas in other studies bust point is defined as the greatest protrusion (i.e., not nipple) of the breast in the side view (A1, A2, A4, S4, S5, S6, S7). Source S2 utilized a different approach in naming the various girths in the area, calling them Chest Girth I, II, III, and IV.

Similar to the shift in the hip definition in sources S3 and S7, for the chest point and chest girth a change in measurement definitions have happened in source A4: the definition of chest circumference in A4 was reworded to specify that the chest girth is measured at the level of the chest point, which was changed to identify the point of greatest anterior protrusion in the area of the chest instead of the level of the nipple as it was set in the 1988 first edition of the anthropometric survey of the U.S. Army Personnel (ANSUR) [9]. The change was prompted by the realization that the measuring at the level of the nipple was failing to identify the level of the fullest breadth. The new definition had redefined the levels of measurement of the chest circumference and the chest breadth but had not changed the chest circumference dimension as it was previously defined as the circumference “at the fullest part of the breast” [9]. The assumption that the most protruding part of the contour identifies the fullest circumference at that level still stood.

Evaluation of the female sample of source A3 (N=6309) indicated that for 1.95% (n=123) of the sample bust level (at largest anterior protrusion) was higher than the leveled chest level (at level of axilla back). 72.20% (n=4555) of the women had bust girth levels lower than the leveled chest girth level, and the bust girth was larger than both curved and leveled chest girths. 26% (n=1645) of the women had bust girth smaller than leveled chest girth. Moreover, 15.3% (n=966) of the women had a bust girth smaller than both the leveled and the curved chest girth; 8.3% (n=523) of the women had a bust girth smaller than the curved chest girth. Bust girth could be smaller if the curved girth (which is at the level of the bust girth in the back and angles up above the breasts in front) goes into the folds of the underarm tissue, producing a larger than the bust girth measurement. The leveled chest girth (at axilla) could be larger than the bust girth if the protrusion of the shoulder blades or the measurement through the folds of the underarm tissue produces a larger measurement.

Based on female body scan data (N=6309) from source A3 [8], Figure 3 presents the difference between the bust girth and leveled chest girth (black markers) vs the distance between the levels of the bust girth and the leveled chest girth and the differences between the bust girth and curved chest girth (orange markers) vs the distance between the levels of the bust girth and the leveled chest girth. The plot reveals the distributions of the group of women for whom the bust level was higher than the chest level, as well as those for whom the bust girth was smaller than the leveled chest girth (n= 523, girth differences ranging between 0 cm and 30.7 cm with average of 0.5 cm) and those for whom the bust girth was smaller than curved chest girth (n= 1645, girth differences ranging between 0 cm and 7.1 cm with average of 1.3 cm).

Table 3. Terms related to bust/chest area

Source code	Description	Notes
A1 [6]	<p><b>Anthropometric study</b></p> <p><b>Maximum Bust Girth (women)</b>                      Horizontal maximum girth at the level where "the bust girth appeared to be the greatest"; average of left and right level.</p> <p><b>Chest girth at armscye</b>                      Horizontal girth at the level of the underarm midpoint.</p>	<p>@ level of apparent maximum bust ~ bust prominence</p> <p>Evaluated by looking from each side (and averaging) for maximum bust girth would occur (presumably the greatest protrusion of bust)                      Leveled (horizontal) circumference.</p> <p>@ level of underarm midpoint (armpit)</p> <p>Level of underarm midpoint was evaluated on one side (the side where the underarm folds were clearer to see); looking at the "natural folds in the armpit"; decide at what level a "blouse could extend without forming an uncomfortable surplus of fabric when the arm is lowered".</p>
A2 [7]	<p><b>Anthropometric study</b></p> <p><b>Thelion / Bust Point</b>                      "Most anterior protrusion of the bra cup on women. Center of nipple on men."</p> <p><b>Chest height</b>                      "Vertical distance from the standing surface to right bustpoint landmark on women or to right thelion landmark on men."</p> <p><b>Bust/ Chest Circumference</b>                      "Circumference of the torso measured at nipple level."</p> <p><b>Chest Girth (Chest Circumference at Scye )</b>                      Maximum circumference of the body over the shoulder blades, under the arms, and across the upper chest.</p>	<p>@ level of bust prominence (women) - side; nipple (men)</p> <p>@ level of thelion / bust point?</p> <p>@ level of thelion / bust point?</p> <p>@ level of armpit (scye)</p> <p>Armpit is set at the "lowest point on the anterior axillary fold". Leveled (horizontal) circumference.</p>
A3 [8]	<p><b>Anthropometric study</b></p> <p><b>Bust Level Height</b>                      "Distance between level of maximum chest and ground."</p> <p><b>Bust Girth</b>                      Maximum circumference around the torso "over/under the shoulder blades, under the armpits and across the bust points"; parallel to floor.</p> <p><b>Chest Girth</b>                      Maximum circumference of chest around torso starting at "the bust level at center back under the armpits and above the breasts".</p> <p><b>Chest Level Height</b>                      "Distance between level of maximum chest and ground."</p> <p><b>Chest Girth</b>                      "Maximum circumference" around torso starting at center back at the level of the armpits; under the armpits; across the chest in front.</p>	<p><b>Anthropometric study</b></p> <p>@ level of maximum breast projection</p> <p>Maximum bust projection is bust apex or bust point.</p> <p>@ level of bust points</p> <p>Not leveled</p> <p>Ambiguity: Maximum chest girth or projection.</p> <p>@ armpits level</p>
A4 [9]	<p><b>Anthropometric study</b></p> <p><b>Chest Point, anterior (men and women)</b>                      "The most anterior right point on the chest."</p> <p><b>Chest circumference</b>                      "Maximum horizontal circumference of the chest at the level of chest point, anterior."</p>	<p>@ chest prominence front</p> <p>Same as bust point at bust prominence.</p> <p>@ chest prominence front</p>
S1* [10]	<p><b>Bust Girth</b>                      Horizontal girth at level of (apparent) maximum bust girth.</p>	<p><b>Sizing standard - women</b></p> <p>@ max bust ~ bust prominence level</p> <p>Leveled (horizontal) girth.</p>
S2* [11]	<p><b>Bust Girth 1st (Above Bust)</b>                      Circumference over the shoulder blades, horizontally under the arms, and closing above the bust.</p> <p><b>Bust Girth 3th (Main Bust Girth)</b>                      Horizontal circumference below the shoulder blades, under the arms, and over the most protrusion at the front</p>	<p><b>Sizing standard</b></p> <p>Not leveled</p> <p>@ bust prominence</p> <p>Leveled (horizontal) circumference over most protruding parts in front.</p>



Table 3 (Continued). Terms related to bust/chest area

Source code	Description	Notes
S3* [12]	<b>Sizing standard</b>	
	<b>Chest Girth</b> "The maximum horizontal girth measured" "with tape measure over the shoulder blades" "under the armpits," "and across the chest nipples."	@ nipples
	<b>Bust Girth</b> "The maximum horizontal girth measured" "with tape measure over the shoulder blades", "under the armpits", "and across the nipples."	@ nipples
S4* [13]	<b>Sizing standard</b>	
	<b>Chest Girth</b> The maximum horizontal girth measured with tape measure over the shoulder blades under the armpits, and across the chest.	@ chest prominence Leveled. Higher than bust prominence.
	<b>Bust Girth</b> The maximum horizontal girth measured with tape measure under the shoulder blades, under the armpits, and over the most protruding part of the bust.	@ bust prominence Leveled
S5 [14]	<b>Sizing standard</b>	
	<b>Apex</b> "The greatest protrusion of the breast"	@ breast prominenece In side view
	<b>Chest/ Bust Girth</b> "Horizontal circumference around the torso, taken under the arms and across the fullest part of the chest/bust apex including the lower portion of the shoulder blades."	@ breast prominenece
	<b>Upper Chest Girth</b> "Horizontal circumference around the torso, taken under the arms and above the fullest part of the chest including the lower portion of the shoulder blades."	Not leveled Defined as horizontal. Described and pictured not leveled.
S6 [15]	<b>Sizing standard</b>	
	<b>Mesosternale</b> "Point on the union of the third and fourth sternbrae in the midsagittal plane."	@ mesosternale Take Chest breadth, Chest depth at this level.
	<b>Thelion</b> "Centre of the nipple. In females, the corresponding point is the most anterior projection of the bust (bust point)."	@ nipples
	<b>Chest Circumference</b> "Circumference of the torso" "at the nipple level." (Women wear usual bra.)	@ nipples Not at level defined as chest level.
S7 [16]	<b>Sizing standard</b>	
	<b>Cetre Chest Point</b> "Point on the union of the third and fourth sternbrae."	@ mesosternale Same as mesosternale.
	<b>Chest Height</b> "Vertical distance from armpit back fold to the ground."	@ back armpit fold (armpit)
	<b>Chest Girth (at Axilla)</b> "Horizontal girth of torso measured at axilla."	@ axilla Axilla not defined. Shown as at back armpit fold (armpit).
	<b>Upper Chest Girth</b> Chest measured from the bust level at center back, under armpits, and above bust to the front.	Not leveled Find bust level at level of the bust points (most anterior point when wearing a bra)
	<b>Bust Point</b> "Most anterior point of the bust when wearing a bra."	@ bust prominence
	<b>Bust Height</b> "Vertical distance from bust point to the ground."	@ bust prominence
	<b>Bust Girth</b> "Horizontal girth measured at bust point level."	@ bust prominence

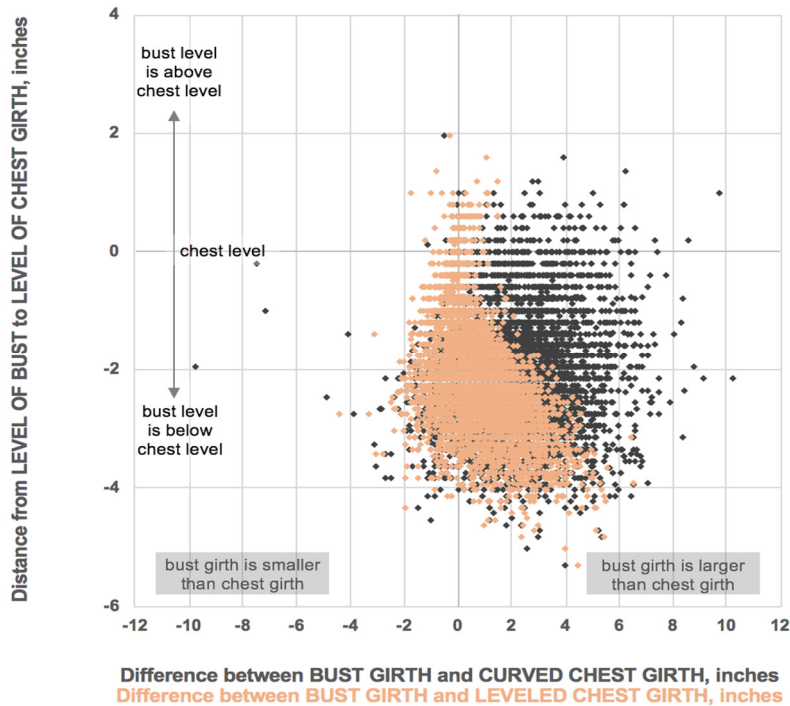


Figure 3. Differences between the maximum bust and chest girths and the distance from bust level to chest level.

## 5. Conclusions

The investigation of the terms showed that close attention must be paid to the descriptions of the measurements, especially in comparative studies where multiple data sources may be involved. It should not be expected a measurement to have the same name across different sources or to be measured in exactly the same way. Moreover, users should be cautious of instances where the same term may be used differently for different measurements within the same source. For example, in source A3 [8], there are two definitions of hip height referring to different levels, and two definitions of hip girth, respectively. While the assumption that the most protruding point of a body contour can be used as an identifier of maximum girth seems intuitive and justified, data show that that may not be the case.

Findings demonstrated that selecting measurements, identifying key torso dimensions, being precise in constructing measurement definitions, and being consistent in using agreed-upon terminology are crucial to product design and sizing as well as communication.

It is recommended that terms and definitions are standardized, communicated clearly, and used in a consistent manner across anthropometric studies and standards. The present study had the following limitations: only USA and European standards and anthropometric surveys were examined. Only female data was analyzed. Suggestions for future studies include expanding the pool to include definitions from other parts of the world and analyzing data from men to identify additional discrepancies.

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