Challenges to Examining the Evolution of Measurement Values in Infant Body Sizing: Highlighting the Necessity of Transparent Procedures in ASTM D4910

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Introduction. Analyses of the American Society for Testing and Materials (ASTM) body sizing standards traditionally compare the measurement values from the current version of a standard to those from a current or easily available anthropometric database (e.g., Ashdown, 1998, Alexander et al., 2012). These analyses help to determine how well the current standard serves the current population but leave the standard's evolution unanalyzed. In addition, the adult female standards receive the most attention (e.g., Goldsberry et al., 1996; Simmons et al., 2004), providing little critical analysis on how well the rest of the ASTM body sizing standards serve their intended populations.

No previous studies have compared the measurement values from different versions of the same standard to each other, textile and apparel research on infants is sparse (Akashi et al., 1981; Kwok et al., 1997, 2007), and research on *ASTM D4910 Standard Tables of Body Measurements for Infants* is non-existent. Therefore, the purpose of this study was to examine what changes have occurred over time for the measurement values used in the six different versions of ASTM D4910. This abstract supports the broader argument that body sizing standards should only include measurements that suit the standard's intended audience and purpose, with measurement values derived directly from the intended population using valid, reliable, and transparent procedures.

Method. ASTM D4910 has the most versions of any ASTM body sizing standard (N = 6), with the longest time range between the first and most recent versions (1999 to 2019), making it an ideal dataset for analysis. D4910-08 and D4910-08 (2013) are identical, as the '(2013)' indicates that the -08 version was reviewed and accepted without alteration by the ASTM committee; thus, they were treated as one case rather than two. As shown in Table 1, 23 measurements remained constant in intent for all versions of ASTM D4910 and were the basic units of analysis for this study. In Microsoft Excel, the older version's value was subtracted from the newer version's value for each version. When the difference is positive, it means the value in the newer version is greater than the value in the older version. When the difference is negative, it means the value in the newer version is less than the value in the older version.

Table 1. The 23 measurements shared across all six versions of ASTM D4910.

Measurements		
Head Girth	Total Vertical Trunk Length	Ankle Height
Neck Base Girth	Height	Center Front Waist Length
Bust Girth	Cervical Height	Center Back Waist Length
Waist Girth	Cervical to Knee Height	Total Crotch Length
Hip Girth	Waist to Knee Height	Across Back Shoulder Width

Thigh Girth	Waist Height	Cervicale to Wrist Length
Armscye Girth	Crotch Height	Arm Length
Wrist Girth	Knee Height	

Results and Discussion. There were no differences between D4910-19 and D4910-08 (2013) for the 23 measurements. The measurement values for these 23 shared measurements from the -19 version came from 2008, making them at least 11 years old when they were accepted for use in 2019. Many of the D4910-08 and D4910-07e^2 measurement values were equal, indicating that some of the -19 measurement values came from 2007 and were 12 years old. For example, head girth was equal for sizes 3M through 18M, meaning that the head girth measurement values for the -19 version were directly derived from the -07e^2 version.

While there were multiple instances of D4910-07e^2 and D4910-08 being equal, particularly for sizes 3M to 18M, there were many differences between these versions across all sizes and all measurements. Within the head girth measurement, the Preemie, Newborn, and 24M values differed between the two versions: -08 was smaller than -07e^2 by 1" for the Preemie size and by ¼" for the Newborn size, while -08 was larger than -07e^2 by ½" for the 24M size. The range of differences between these two versions was -5" to 2 $^7/_8$". Clear patterns of differences were not readily apparent, indicating more in-depth analysis is necessary. Most of the -08 measurement values for the Preemie and Newborn sizes were smaller than those in the -07e^2 version. Lastly, while there were four data sources for both versions, only two sources carried over from the -07e^2 version.

D4910- 02 and D4910-07e^2 marked the boundary where the number of sizes changed in the standard and where the data sources used to develop the standard changed. D4910-02 included six sizes (0 to 3, 3 to 6, 6 to 9, 9 to 12, 12 to 18, and 18 to 24) and three data sources were referenced. D4910-07e^2 included eight sizes (Preemie, Newborn, 3M, 6M, 9M, 12M, 18M, and 24M) and four data sources were referenced with two carried over from -02. The range of differences between these two versions was -4 ¾" to 1 ¾". To accurately compare the -02 and -07e^2 versions, the 3M, 6M, 9M, 12M, and 18M sizes from -07e^2 were compared to two of the -02 sizes, while the Preemie, Newborn, and 24M sizes from -07e^2 were each compared to one of the -02 sizes, for a total of 13 comparisons. For example, 3M was compared to 0 to 3 and 3 to 6. In a pattern that held true for all double comparisons, 3M values were often larger than or equal to the 0 to 3 size, and smaller than the 3 to 6 size.

Few differences were identified between D4910-99 and D4910-02 and they were centered on three measurements: across back shoulder width, cervicale to wrist length, and arm length. The range of differences for the full comparison was -1" to 2", while the ranges for these three measurements were: -½" to 1 $^3/_8$" for across back shoulder width, -$^1/_8$" to 0" for cervicale to wrist length, and -$^1/_8$" to 1 $^1/_8$" for arm length. These two versions pulled from the exact same three data sources, which begs the question of why they differed at all. These minor changes may be interpreted as errors corrected by the ASTM committee through the utilization of improved statistical analysis methods for -02. However, because the procedures for building the body

sizing system were not fully disclosed speculation on the reasons for the differences between the two versions is challenging.

Conclusion. Patterns of differences between versions of ASTM D4910 are challenging to determine, especially because the procedures for developing the ASTM D4910 were not fully disclosed. Most measurements in the current version of ASTM D4910 were from 2008 and some were from 2007. It is difficult to argue if any measurements extended from 2002 or 1999 because the method of changing sizes between D4910-02 and D4910-07e^2 was not clearly documented. Two possible interpretations are that: (a) the measurement values from D4910-02 were simply rearranged in D4910-07e^2 or (b) the new calculations were the result of the new data sources. Findings revealed the need for transparent data collection and analysis procedures to be included in ASTM D4910, as well as updated measurement values that reflect current infant anthropometrics. This study highlights the challenge of assessing trends in measurement values between the different versions of a standard when the procedures used to choose the values and size ranges are not fully disclosed, supporting the necessity of including data analysis and collection procedures in future ASTM body sizing standards.

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