Analyzing 20 Years of Insubstantial Change in ASTM D4910: Calling for Modernity and Transparency in the Infant Body Sizing Standards Development Process

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Introduction. The body sizing standards produced by the American Society for Testing and Materials (ASTM) are typically used by apparel researchers to determine how well these standards work for their intended population. Researchers generally compare the measurement values of the current version of the standard to a current or easily available anthropometric data source and then propose an improved methodology for developing body sizing standards for that population (e.g., Ashdown, 1998). Currently, the only portion of the standards that have been analyzed are the measurement values. Other content (e.g., introduction, references, definitions) within the standard have been left unanalyzed, leaving a gap in our understanding of how well ASTM body sizing standards serve their intended populations.

Since the research on infants in textiles and apparel is sparse (Akashi et al., 1981; Kwok et al., 1997, 2007) and the research on *ASTM D4910 Standard Tables of Body Measurements for Infants* is non-existent, the analysis of "other content" can offer valuable insights into how well ASTM D4910 has served the infant population over time. Thus, the purpose of this study was to examine what shifts have occurred over time with the introductory content, size ranges, and measurement definitions used in the six different versions of ASTM D4910. This abstract supports the broader argument that standards should only include measurements that suit the intended audience and purpose of the standard, while the methods for measurement inclusion, exclusion, and analysis must be valid, reliable, and transparent.

Method. ASTM D4910 has the most versions of any ASTM body sizing standard (N = 6), and the longest time range between the first and most recent standards (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 standard committee. For this study, the two versions were treated as one case rather than two to eliminate redundancy. Content analysis of the introductory content, size ranges, and measurement definitions was conducted by comparing word choice, sentence structure, and labeling across the six versions of ASTM D4910. Microsoft Word was used to conduct analysis of the introductory content, while Microsoft Excel was used to analyze the size ranges and measurement definitions.

Results and Discussion. Word choice, sentence structure, and referenced data sources in ASTM D4910's introductory content revealed that -99 and -02 had identical introductions with the same three referenced data sources. D4910-07e^2, -08, -08 (2013), and -19 all shared referenced data sources (four total) and intent, though their word choice and sentence structure differed slightly. Two data sources were referenced for all six versions: Snyder (1977) and the National Center for Health Statistics (NCHS), though for the latter data source, the year changed from 1980 (-99, -02, & -07e^2) to 2002 [-08, -08 (2013), -19]. A review of the references showed that there were no 1980 data sources from the NCHS for infants; the closest data source was Hamill (1977). Other key citation issues include: (a) the citations from -07e^2 were used in -08,

but the data sources the citations link to are not the same, and (b) not citing one source (*AnthroKids*) used in D4910-08, -08 (2013), and -19. Explanations of inclusion, exclusion, and analysis of data sources were not provided in any version. Improvements must be made in the accuracy and transparency of ASTM D4910's introductory content, specifically the data sources, to ensure the standard is reliable and valid.

The results demonstrated that the size ranges for ASTM D4910 have changed over time. There are eight sizes in the current standard (-19) and the three preceding standards [-08 (2013), -08, and -07e^2], which all share the same nomenclature: Preemie, Newborn, 3M, 6M, 9M, 12M, 18M, and 24M. There were six sizes in the -02 and -99 standards: 0 to 3, 3 to 6, 6 to 9, 9 to 12, 12 to 18, and 18 to 24. Comparisons of the values for -02's 0 to 3 size and -07e^2's Preemie size suggest that the -02 0 to 3 size did not accommodate the premature infant population; thus, the Preemie size was probably added to the -07e^2 size range for wider applicability of the standard. However, because there were new data sources cited in -07e^2 and the method of analysis was not included, it was challenging to determine if the new sizes in -07e^2 were derived from a reconfiguration of the -02 version or completely new.

Th analysis of how the ASTM D4910 measurement definitions changed over time revealed that: (a) the number of measurements per standard has increased over time; (b) the organization of the measurements has altered over time; and (c) the word choice and sentence structure of the measurement definitions has altered over time. The number of measurements per standard increased from 32 in -99 to 69 in -19, though all 32 measurements from -99 are present in each of the later versions. The largest increase in number of measurements occurred between -08 (2013) and -19, with 27 new measurements added (e.g., preferred waist girth, mid-thigh girth, underarm length), presumably to align with current adult standards. According to Kwok et al.'s (2007) study on the anthropometric assessment of 13 body measurements for premature infants, the total number of measurements necessary for an infant body sizing system could be quite small and function well. Further discussion on the number of body measurements necessary for infants is crucial to properly serve this population.

The organization of ASTM D4910's measurements changed from a single grouping with the most used measurements placed at the top (-99) to a set of four categories with measurements arranged from head-to-floor (-19). D4910-02 introduced the four categories used in all following standards (Overall, Girth, Vertical, and Width & Length), while -07e^2 introduced the current arrangement. Order of arrangement should be based on the intended audience and purpose of the standard, which indicates a need for increased awareness of how practitioners use the standard.

For the 32 measurements shared by all six versions of ASTM D4910, word choice and sentence structure for their definitions has altered slightly over time. There were 3-4 different definitions found per measurement, and the intent was generally the same. For example, the definition of neck base girth differed in word choice and sentence structure for -99, -07e^2, -08, and -19 but retained the intent of measuring the circumference of the neck with the cervicale and collarbone as key touchpoints. Seven measurements differed in intent: (a) weight was changed from 'nude' to 'in undergarments' in -07e^2; (b) elbow girth, head & neck length, scye depth, and shoulder length all changed between -99 and -02, with -02 definition intents adopted for all later

versions; and (c) upper arm girth and hip/seat height were changed between -08 (2013) and -19. In total, 23 measurements with shared intent occurred across all versions of ASTM D4910. These findings suggest that our understanding of infant measurement best practices has undergone little substantial change over the past 20 years. Kwok et al. (2007) noted the fragility of premature infant skin as a key factor in measurement, indicating the need for deeper understanding of infant measurement practice.

Conclusion. It is imperative to research which measurements are truly necessary for an infant body sizing system. Findings revealed the need for updated, valid, and reliable data sources, accuracy and transparency in data analysis methods, and a re-conceptualization of which measurements are necessary for infants and how to capture them safely, accurately, and reliably. Analysis of ASTM D4910's "other content" deepened our understanding of how insubstantial the shifts in standard documents can be, strengthening the argument for a transparent overhaul of the development process to better serve the intended audience and purpose of the standard.

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