The effect of washing cycles on garment fit, dimensional stability, and skewness

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Introduction. The frequency of laundering, or the number of washing cycles, is the primary reason that causes changes in fabric qualities and the deformation of the garment's fit (Truncyte et al., 2007). Especially knit fabrics experience major changes to their dimensional stability and display deformation with repeated washing (Melnyk & Kyzymchuk, 2023). This occurrence, referred to as skewness or torque, can result in a problematic twisting of the fabric, causing displacement of seams, sleeves, legs, and other parts of the garment (Cottonworks, n.d.). In addition, textiles that possess inadequate dimensional stability may demonstrate shrinkage or expansion, adversely affecting their fit and appropriateness for their designated purpose. (Collier & Epps, 1999; Kadolph, 1998).

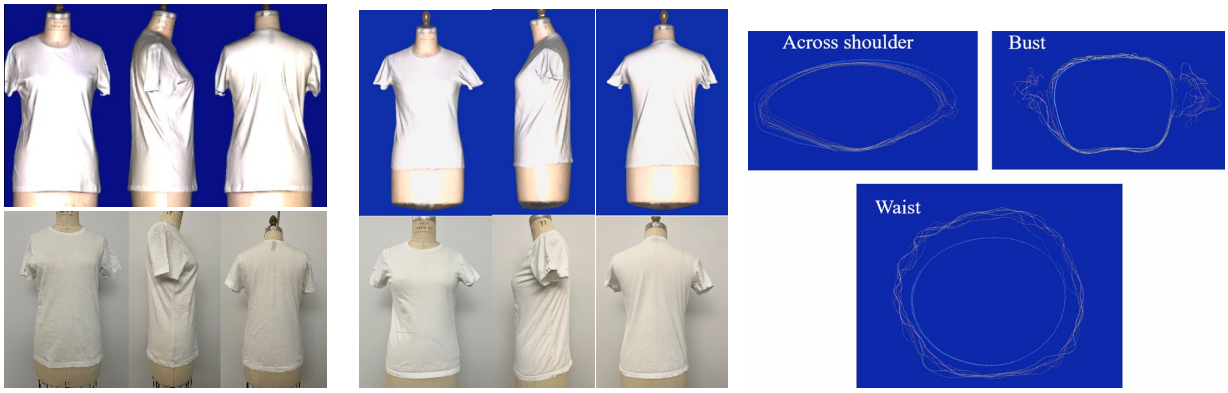
Garment fit can be visually assessed by examining images and using 3D body scanning, which allows for overlaying body and garment and evaluating body-garment relationships from cross sections (Chun, 2007). However, there is a lack of research to utilize 3D scanning fit assessment in evaluating the effect of washing cycles on garment fit and properties. By comparing the measurements and overlaid images obtained from scanning the body and garment before and after each washing cycle, one may assess the extent of distortion induced by washing. Therefore, the current study aimed to gain insights into how the increase in cleaning cycles affects the relationship between the garment fit and the fabric properties of garments related to dimensional stability and changes in skewness.

Method. For this experimental research, 12 size L "Gildan" brand t-shirts made from 100% cotton single jersey fabric were used. Fabric properties and fitting were tested after 1 wash, 5 washes, 10 washes, 15 washes, and 20 washes. AATCC 150-2003 and AATCC 179-2004 standards were used to assess the alterations in the dimension of clothes and skewness of knit fabric after undergoing multiple cycles of automatic laundering, which is routinely practiced in households. For fit assessment, a Wolf dress form in size 11 (equal to size L) was selected to put the test garments on after each washing cycle. T-shirt fit was assessed at the shoulder, bust, waist, hem, full length, and side seam locations, and then overall fit scores were computed using a five-point Likert-type scale ranging from 1=Poor fit to 5= Excellent fit. For every washing cycle, three garments in the same sizes were used to evaluate fit and fabric properties, and average fit scores from the three garments were calculated. Fit evaluations from the body scan images and pictures before and after 20 washes were compared by using descriptive statistics.

Results. Compared to before washing (Figure 1a), and after 20 washes (Figure 1b) the t-shirts showed twice as much skewness (approximately 11.4%) and shrinkage (10% to 13%) in the shoulder, full-length, and side seam locations. After 20 washes, there was a small change in the dimensions at the bust, waist, and hem, as the shrinkage rate variation ranged from 1% to 2%. After 10 washes, there was a very small variation in dimensional change and skewness across all locations. The discrepancy in shrinkage and skewness percentage between 10 washes and 20

washes was less than 1%, indicating that t-shirts became stable after 10 washes. 3D scanning results indicated that after passing 20 washes, t-shirts had an 11% reduction in length, rendering them incapable of adequately covering the hip area. In 3D scans, side seams were not visible (Figures 1a and 1b). When examining cross-section images (Figure 1c), no visible ease changes were identified between the body and the garment at any location. After 20 washes, visual evaluation of the 3D body scanning images yielded a "good" average overall fit rate (M=3.14, SD=0.23), meaning that the t-shirts demonstrated adequate balance and were not excessively tight. Meanwhile, throughout the traditional visual fit assessment, after undergoing 20 washes, the garment exhibited a “fair” fit (M=2.44, SD=0.47) due to the torqued side seam, puckering at the hem, shortened body length, and narrow bust ease.

Overall fit ratings changed from a well-fitting state (Figure 1a) to a fair-fitting state (Figure 1b) from one to 20 washings. T-shirts had a reduction in size by two sizes following 20 cycles of washing in the experiment. For instance, a garment originally sized as L was reduced to S. The full length of the t-shirts changed from an average of 26.75cm (SD=0) to 23.75cm (SD=0). The cross shoulder also shortened from an average of 15.42cm (SD=0.12) to 13.38cm (SD=0.18).



(a) (b) (c)

Figure 1. 3D body scanning and images (a) before washing (b) after 20 washes, and (c) body-garment relationship from cross sections of the body scans.

Conclusions. Recognizing the complex interplay of various factors influencing dimensional stability and skewness on garment fit is crucial. The current study shed light on the effect of washing cycles on the fit of a 100% cotton single jersey t-shirt due to the increase in shrinkage and changes in skewness. Using 3D body scanning provided in-depth fit analysis. Findings revealed that to enhance the durability of clothing and preserve its proper fit, consumers should carefully follow the care instructions. It is advisable to prevent excessive washing and consider utilizing alternative cleaning techniques, such as spot cleaning, wherever feasible. In addition, consumers should invest in high-quality garments crafted from durable materials that are resistant to shrinking and distortion. Buying a larger size for cotton clothes to extend their lifespan can also be a valuable strategy for consumers. This can allow for shrinkage from multiple washings while maintaining a comfortable fit, thus extending the garment's lifespan.

Further research exploring the impact of cleaning cycles on diverse fabrics, constructions, and garment types would contribute to a more comprehensive understanding of consumer garment usage behavior and guide the development of longer-lasting garments. This research is highly pertinent in the ongoing conversations around sustainable fashion and the circular economy, specifically emphasizing enhancing the longevity of garments.

References

American Association of Textile Chemists and Colorists (2003). AATCC 150-2003: Dimensional changes of garment after home laundering. https://members.aatcc.org/store/tm150/556/

American Association of Textile Chemists and Colorists (2003). AATCC 179-2004: Skewness change in fabric and garment twist resulting from automatic home laundering. https://members.aatcc.org/store/tm179/577/

Chun, J. (2007). Communication of sizing and fit. In Ashdown, S. P. Editor, *Sizing in Clothing* (pp. 220-245). Woodhead Publishing. https://doi.org/10.1533/9781845692582.220

Collier, B.J. & Epps, H. H. (1999). *Textile Testing and Analysis*. Prentice-Hall, Englewood Cliffs, NJ.

Cottonworks (n.d). *Quality testing: Care & Appearance*. https://cottonworks.com/en/topics/sourcing-manufacturing/quality-assurance/care-appearance/#:~:text=One%20of%20the%20most%20important,fit%2C%20size%2C%20and%20serviceability.

Kadolph, S. J. (1998). *Quality Assurance for Textiles and Apparel.* Fairchild, New York, NY.

Melnyk, L. & Kyzymchuk, O. (2023, September). Effects of laundering on the structure and properties of elastic warp knitted fabrics. *The 18th Romanian Textiles and Leather Conference CORTEP 2022*, Iasi, Romania. https://doi.org/10.2478/9788367405133-002

Truncyte, D., Daukantiene, V., & Gutauskas, M. (2007). The influence of washing on fabric wearing properties. *Tekstil, 56*(8), 493-498. https://hrcak.srce.hr/file/35871