VERIFYING PERFORMANCE CHARACTERISTICS OF SMART APPAREL

EXECUTIVE SUMMARY

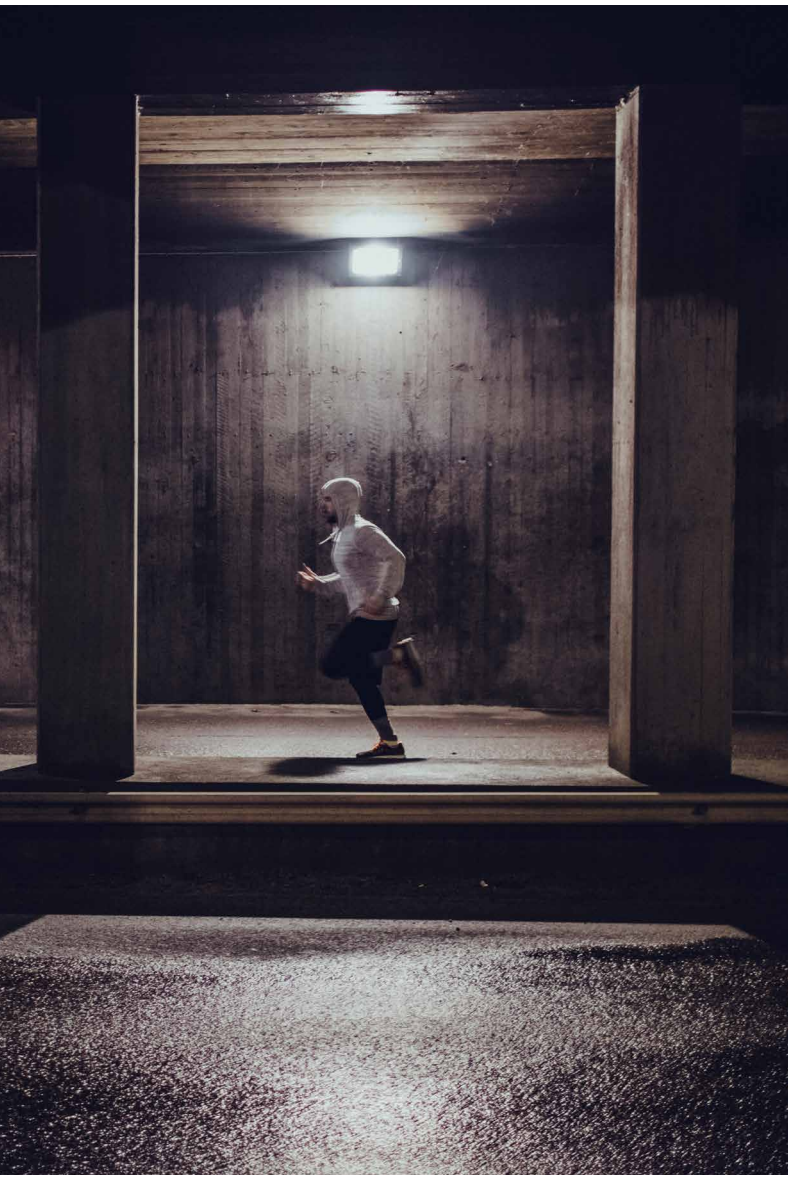
As technology has increasingly become an integral part of our daily lives, it is no surprise that the market for smart clothing and footwear is poised for significant growth in the years ahead. Global revenue from the sale of smart apparel is expected to top $3.7 billion (USD) by 2022, up from just $150 million in 2016.[1] This growth in being driven, in part, by the broad consumer interest in physical health and performance. At the same time, smart apparel is also being more widely used in healthcare applications to monitor human vital signs in real time, and in industrial applications to help protect workers from potentially hazardous environments and workplace safety hazards.

In many jurisdictions around the world, smart apparel is subject to certain regulations intended to help ensure the safety of users. However, in addition to these requirements, commercial and industrial buyers, retailers and consumers are increasingly seeking assurances regarding the quality and performance of these products, including substantiation of claims regarding these characteristics. Smart products which have been tested against key performance criteria and certified by established and recognized independent third parties, can help to provide both buyers and consumers with these assurances.

This UL white paper identifies some of the key quality and performance considerations for smart clothing and footwear products, and reviews the challenges of vague or unsubstantiated marketing claims used in the promotion of these products. The white paper also discusses the importance of verifying product performance claims, and offers an overview of UL's verification services for smart apparel.

BACKGROUND

Smart apparel can generally be defined as clothing, clothing accessories and footwear featuring embedded technologies that allow for the monitoring and/or transmission of information. Medical and health applications include reporting of physiological and biometric data, such as heart and respiratory rates, body and skin temperatures, and oxygen saturation. Representing a logical extension of wearable technologies like smart watches and fitness bands, smart apparel available today include shirts, pants, jackets, hats, gloves, shoes and even socks and underwear. Smart versions of these and other types of apparel can provide wearers with access to even more detailed health and wellness information, without the need for additional, extraneous devices.



Some examples of innovative smart apparel products now (or soon to be) available include:

- Jackets made of advanced denim fabric that allows the wearer to directly connect to wireless services, such as music or navigational aids, all without touching their smartphone; [2]
- Running shorts that track core body movements and provides real-time performance coaching in audio form through a connected smartphone; [3]
- Men's dress suits featuring buttons equipped with near field communications (NFC) capabilities, enabling a wearer to swap business cards digitally or make electronic payments; [4]
- Socks for infants that monitor heart rate and sleeping and breathing patterns, and help identify potential health issues; [5]
- "Recovery" sleepwear that incorporates bioceramic particles that absorb the body's natural heat and reflect it back, helping to reduce temporary inflammation. [6]

Demand by consumers for smart apparel for sports and fitness activities is expected to lead the overall growth in this important industry segment in the coming years as producers continue to develop new smart apparel products offering true smart functionality that are also attractive and comfortable to wear. But innovation in smart apparel designed to address specialized healthcare and workplace safety considerations are likely to gain increased traction, as the full potential of smart apparel is realized. As a result of the need to address healthcare and workplace safety, shipments of smart apparel are projected to reach nearly 27 million units by 2022, a compound annual growth rate of nearly 60 percent over 2016 shipments. [7]

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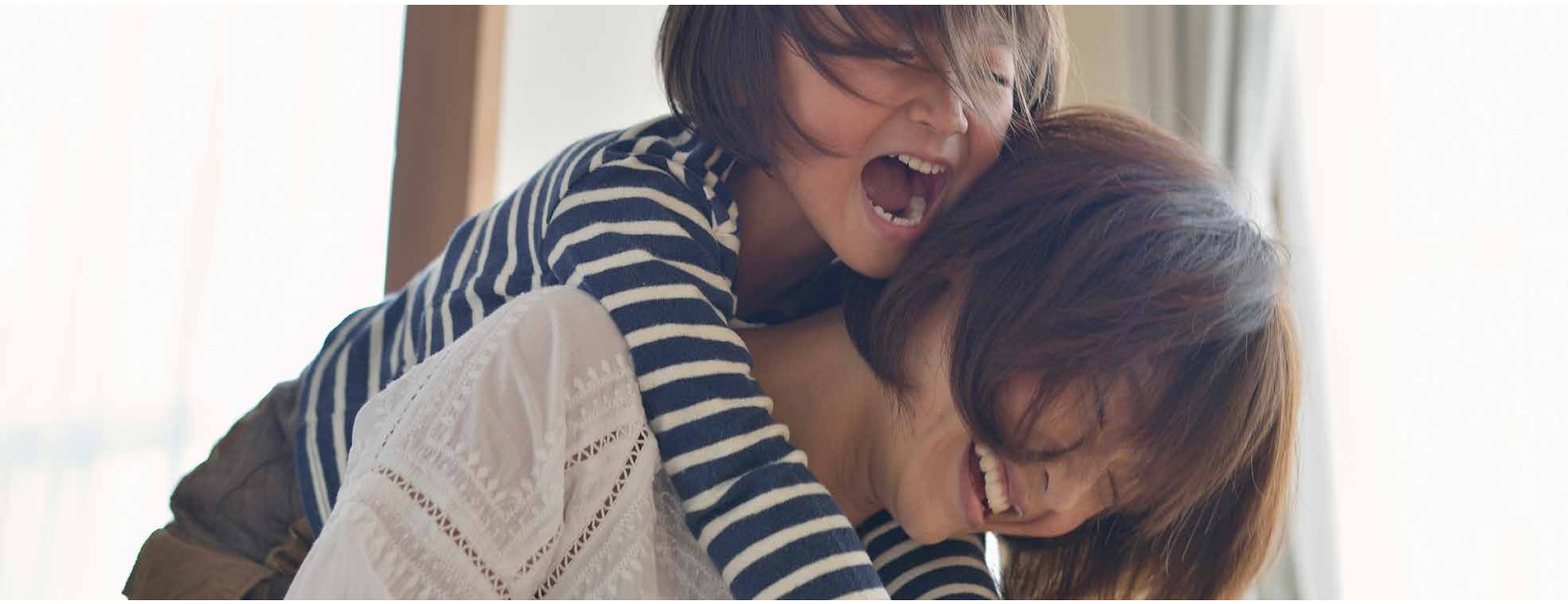
SAFETY TESTING FOR SMART APPAREL

Like most apparel products, smart clothing and footwear are subject to certain safety-related testing and assessments. Typically, the safety testing of apparel is intended to address the following concerns:

- **CHEMICAL CONTENT AND BIOCOMPATIBILITY —** The components and materials used in apparel products, including smart clothing and footwear, may include chemicals that can be harmful as a result of prolonged exposure. A chemical content assessment identifies levels of potentially harmful chemicals in apparel products and materials.
- **FLAMMABILITY —** Most apparel products must be fabricated from textiles and fabrics that minimize the risk of catching fire or burning. Specific tests are used to determine the relative flammability of textiles based on the speed at which a flame applied to an item spreads.
- **APPAREL FOR INFANTS AND CHILDREN —** In general, safety requirements for apparel intended for use primarily by infants and children must meet more stringent requirements related to chemical content and flammability. In addition, some jurisdictions impose safety requirements on specific apparel elements, such as drawstrings or small parts, which could pose a choking hazard.

With smart clothing and footwear, incorporating embedded technologies, such as sensors, processors and communications modules, increases the potential risks to wearers, as well as the types of safety testing that may be required. Depending on its construction or intended use, smart apparel products may be subject to some or all of the following tests:

- **ELECTRIC SAFETY AND MECHANICAL HAZARDS —** At a minimum, this includes evaluating and testing a smart apparel product for risks from electrical shock, thermal burns, battery explosion, and mechanical hazards, such as sharp points. Some smart apparel products, such as those intended for use in medical or health and wellness applications, may be subject to additional product safety assessments.
- **ELECTROMAGNETIC COMPATIBILITY (EMC) —** Regardless of their power source, smart apparel products must not create unintended electromagnetic interference with other electrical devices, and must also be immune to electromagnetic interference from other devices. Testing may be required to assess both emission and immunity characteristics.
- **SPECIFIC ABSORPTION RATE (SAR) —** Certain smart apparel products incorporating wireless technology are often subject to testing to determine the amount of electromagnetic radiation produced by the product under the most extreme use conditions at a given distance from the human head or body.



QUALITY AND PERFORMANCE TESTING OF SMART APPAREL

Beyond demonstrating compliance with mandatory safety requirements, the market for smart apparel products is increasingly demanding assurances from manufacturers, distributors and retailers regarding the quality and performance of a given product. To meet this expectation, many smart apparel producers are subjecting their products to a range of additional tests and assessments to validate quality and performance claims. These tests typically address the following product characteristics:

- **CHEMICAL CONTENT AND BIOCOMPATIBILITY —** The components and materials used in apparel products, including smart clothing and footwear, may include chemicals that can be harmful as a result of prolonged exposure. A chemical content assessment identifies levels of potentially harmful chemicals in apparel products and materials.
- **PHYSICAL PROPERTIES —** The assessment of a smart apparel product's physical properties can include testing for dimensional stability, which provides assurances that an apparel product will continue to fit after repeated washing of dry cleaning, and for colorfastness, which evaluates the resilience of a product's color over time. Other testing can evaluate a garment's resistance to tearing or abrasion. Footwear can be tested for flexing and flexing resistance.
- **WIRELESS INTEROPERABILITY —** Many smart apparel products transmit data to other devices via wireless technologies and protocols. Wireless interoperability testing evaluates a particular technology's effectiveness in exchanging information with other compatible wireless technologies.
- **ENERGY EFFICIENCY —** Users expect smart clothing and footwear products to operate for reasonable periods of time between recharging, thereby requiring devices to use available energy as efficiently as possible.
- **ENVIRONMENTAL AND SUSTAINABILITY CONSIDERATIONS —** Smart apparel products that use materials from environmentally sustainable resources and minimize end-of-life environmental waste are important considerations for many buyers.
- **PRIVACY AND DATA SECURITY —** The security of private information has become a primary concern for many. Privacy and security testing evaluates potential vulnerabilities that could make a smart apparel product a target for malicious cyber or physical layer attacks.

THE CHALLENGES AND CONSEQUENCES OF SMART PRODUCT QUALITY AND PERFORMANCE CLAIMS

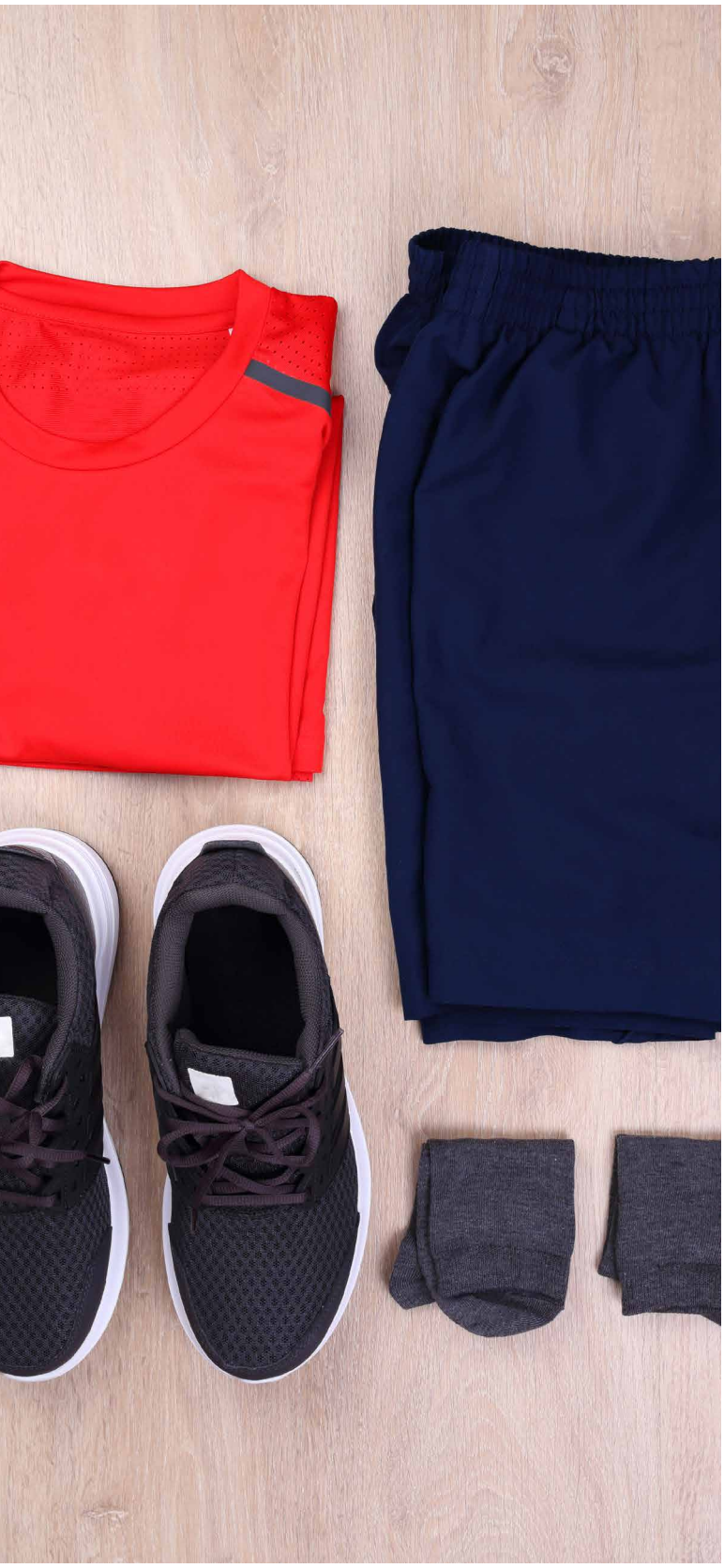
As the previous lists of required and recommended tests clearly illustrate, effectively evaluating the safety, quality and performance of smart apparel products is a far more extensive and complex process than what would be applicable to traditional clothing and footwear. At the same time, producers are continuing their efforts to develop new smart versions of traditional clothing and footwear products to meet growing consumer demand for even more innovative types of smart apparel. Unfortunately, in many cases, the development of smart apparel products offering new features can quickly outpace efforts to create new or updated technical standards and requirements that can serve as the basis for assessing the promised performance characteristics of those features.

In this vacuum, some producers may find themselves making claims regarding the quality or performance characteristics of their smart apparel products that may not hold up to independent scrutiny. Such claims typically fall into one of the following categories:

- **VAGUE OR MISLEADING CLAIMS —** Claims that are vague or misleading promise potential benefits that may be subject to different interpretations, or which give buyers a false impression. For example, whether a product "keeps you cool and comfortable" can only be based on a subjective interpretation by the wearer;
- **UNMEASURED CLAIMS —** These are claims for which no valid form of assessment has been conducted. A claim that a smart apparel garment "increases blood flow and oxygen levels" may represent conjecture not based on clinical evidence;
- **UNVERIFIED CLAIMS —** Unverified claims are those that have not been, but could be, verified or qualified by the application of an independent standard. The claim "provides UV protection" could be verified by applying standardized testing to identify a product's ultraviolet protection factor (UPF);
- **OBVIOUS OR SELF-EVIDENT CLAIMS —** These are claims that point to quality or performance characteristics that are readily-apparent and required no substantiation. In the case of smart apparel products, an obvious claim might be "tracks your running performance."

Unfortunately, the use of these and other types of unsubstantiated claims in the marketing and promotion of smart apparel products poses a number of potential consequences. Among the most likely is the risk of confusing or disappointing buyers regarding the purported qualities or benefits associated with a given smart apparel product. Buyers are likely to factor their disappointment into future buying decisions about other products from the same source, and can also be expected to share their disappointment through social media platforms, thereby potentially influencing thousands of other prospective buyers. This may also place the retailer that sold the product at risk based on an individual bad experience.

Other potential consequences stemming from the use of unsubstantiated claims may include challenges from regulatory authorities regarding the violation of consumer protection statutes intended to prevent fraud, deception and unfair business practices. And producers of smart apparel products that knowingly market products that pose potential health and safety-related concerns may also be subject to legal action, potentially resulting in time-consuming and costly litigation, as well as adverse publicity that can severely damage a brand's reputation in the market.



UL'S VERIFICATION SERVICES FOR SMART APPAREL AND FOOTWEAR

UL's verification services can support efforts by producers of smart apparel products to independently verify marketing claims related to the performance of their products. While UL's verification services are appropriate for all smart clothing and footwear producers, they can prove especially beneficial for those working with innovative technologies and advanced materials who are seeking to independently verify significant performance advantages in their products, despite the absence of established standards or testing protocols.

Based on scientifically sound, repeatable testing and evaluation methodologies, UL's verification process is expressly designed to assess the validity of specific advertising or promotional statements associated with a given product. The verification process can be applied to almost any marketing claim regarding performance that:

- Communicates a specific attribute or feature;
- Can be assessed in a scientifically rigorous and repeatable manner;
- Is specific and measurable against defined requirements;
- Complies with all relevant laws and regulations.

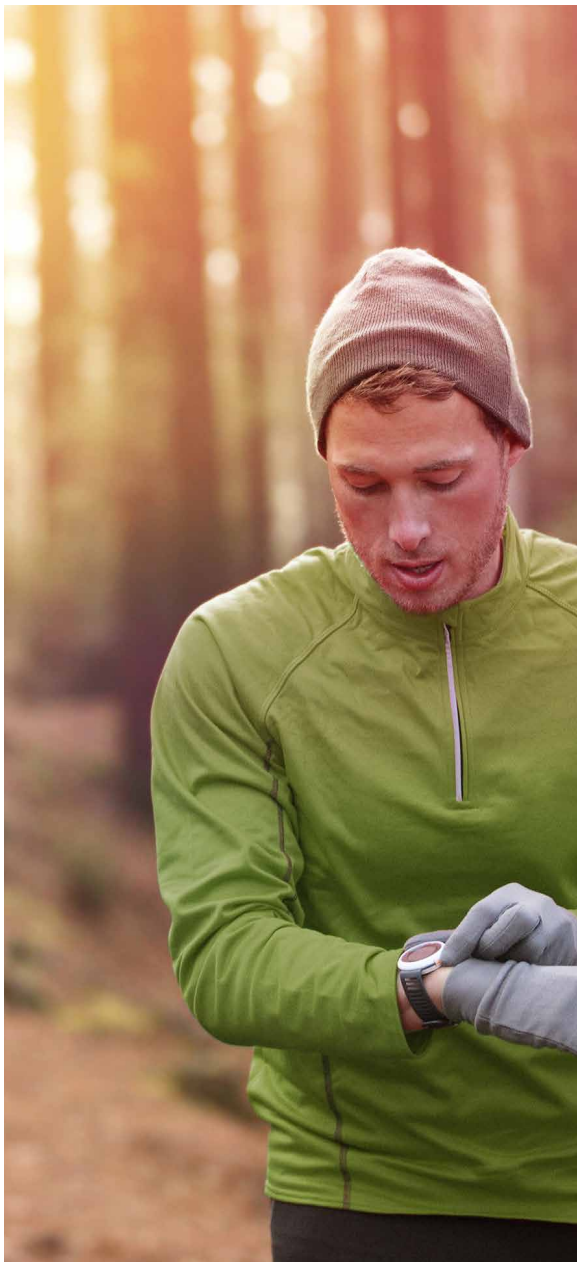
Marketing claims that are verified under the UL verification process are typically subject to review and renewal at one- or two-year intervals. In addition, retesting and reverification is required in cases where there are any changes to the manufacturing process, the facilities producing the product, and/or any materials used in the production of the product. And evaluations may include quality audits and inspections of those facilities involved in the manufacturing of the product.

Smart apparel products whose marketing claims have been verified are eligible to display the UL Verification Mark. Each Mark includes a unique identifier that facilitates access to additional claims information at UL Verify, UL's publicly-accessible online claims platform (www.Verify.UL.com).

Please note that UL's performance verification services are not a substitute for any safety or material testing or certification required to achieve compliance with applicable regulatory requirements.

SUMMARY + CONCLUSION

In coming years, the market for smart apparel products will see the introduction of new and advanced clothing and footwear incorporating innovative smart technologies, potentially providing users with untold benefits and value. However, vague or unverified claims regarding the performance of these products may well lead to confusion and, ultimately, disappointment among buyers. Producers are increasingly turning to trusted third parties to independently evaluate and verify product performance claims as part of an overall strategy to increase buyer confidence in their products and to gain an important advantage in an increasingly competitive market.



For additional information about UL's verification services for performance claims associated with smart apparel, please contact UL at QAInfo@ul.com.

END NOTES

1. "Smart Clothing and Body Sensor Shipments to Reach 119 Million Units Annually by 2020," press release by research firm Tractica, August 24, 2017. Web. 21 September 2017. https://www.tractica.com/newsroom/press-releases/smart-clothing-and-body-sensor-shipments-to-reach-119-million-units-annually-by-2022/.

2. "The New Workout Secret: Clothing Sensors That Up Your Game," Wall Street Journal, October 7-8, 2017. Web. 12 December 2017. https://www.wsj.com/articles/when-your-gym-shorts-tell-you-to-work-out-harder-1507215619?tesla=y.

3. "#3 Smart Clothing Technologies that Could be the Next Big Thing in Wearables," Entrepreneur India, March 15, 2017. Web. 12 December 2017. https://www.entrepreneur.com/article/290483.

4. "The best smart clothing: From biometric shirts to contactless payment jackets," posting on the website Wearble, September 26, 2017. Web. 12 December 2017. https://www.wareable.com/smart-clothing/best-smart-clothing.

5. See Endnote #4.

6. "Moving away from the wrist—the best smart clothing," posting on the website Gadgets & Wearables, August 22, 2017. Web. 12 December 2017. http://gadgetsandwearables.com/2017/08/22/best-smart-clothing/.

7. See Endnote #1.