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Construction of Compression Garments for High Performance Sports.

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ABSTRACT:

Compression clothing has a long history of use in a variety of sports applications. The construction features of knit compression garments are analysed for suitability in sports applications. The basic and practical criteria of comfort, breathable, light weight, anti-static, and anti-odour qualities can be designed into sportswear through ideal fibre, fabric, and sewing features have been studied. Knowing every kind of stitch and seam is essential for creating high-quality compression sportswear and depending on the seam's functional or aesthetic requirements, a particular stitch type is selected. An overview of fibre type, fabric, seam, stitch, SPI, machine, comfort properties of compression sportswear are provided in this paper.

Keywords: Compression, fibre, fabric, stitch, seam, comfort, sportswear

INTRODUCTION:

Sportswear and fashion are now interconnected, combining fashionable looks with functionality and durability. Specialized clothing known as compression garments is worn to exert significant mechanical pressure on certain body parts in order to compress, support and stabilise underlying tissues. They have received extensive research and are used in the fields of medicine, sports, and body-shaping applications. Athletes today rely on top quality products produced using the latest fibre, yarn, fabric and trim technologies to outperform opponents, particularly in sports like swimming and track[3]. The most essential step in creating a sportswear or any good product is sewing. It is the art of joining things using stitches created with a needle and thread. A method of sewing garment components together with thread forming stitches and seams is the most common way to make garments. The essential sewing factors include: stitches, seams, stitching and machinery.[4] A seam cannot be held without a stitch, the two terms seam and stitches are connected. A stitch is made up of one or more threads or loops of thread, whereas a seam is the joining of two or more plies of fabric. The strength, longevity, elasticity, security, and aesthetics of a sewn garment are mostly influenced by the type of seam and stitch used to create it. The choice is made based on the end use application and the respective values given to these attributes [6].Adapted test procedures are required to demonstrate the benefits of these garments during athletic activities and enable producers in differentiating the performance of these garments. The test procedures evaluate the interactions between the garment and the wearer's skin and the entire body [5].

METHODOLOGY:

It is considered the current issues the athlete is experiencing while competing. The fit, performance evaluation which are current trends for compression clothing are investigated. Stretch clothing evaluation is interpretive; the quality of the body-contouring fit is closely related to fabric stretch capability. The fibre properties, fabric knit and characteristics of fabric, factors affecting sewing of compression clothing like stitch class, seams are taken into account. Machines and methods used in sewing of compression clothing are studied.

Compression sportswear performance requirements

The safety and protection elements help shield wearers from bad weather (wind, rain, and snow, etc). The cross sections of the fibre can be altered, and special chemicals can be used to create fabrics with excellent moisture transport capabilities. Such fabric keeps the body dry by preventing liquid or vapourised moisture from touching the surface of the body. Anti-static movement. Sportswear fabrics can discharge electrical charge due to their high electrical conductivity. Antimicrobial and anti-odour activities [5]. A high level of comfort and personal hygiene is provided by maintaining a normal level of bacteria on the skin, especially during physical activity. Ultraviolet defence Sports fabrics provide a higher level of protection against skin-damaging UV-A and UV-B rays than most common natural and synthetic fibres [2].

FIBRES MOSTLY USED FOR COMPRESSION WEAR

Nylon:. Nylon is the most commonly used fabric in compression sportswear. They are super strong and resilient, abrasion-resistant fabric is nylon. The fabric is naturally water-resistant. Stains, heat, UV rays, and chemicals cannot harm nylon fabric.[5]

Spandex: Spandex is a lightweight synthetic fabric recognised for its expanding and durable characteristics, able to withstand a 500% stretch without breaking,

Able to recover its original length after being stretched repeatedly, resists abrasion, stronger and longer-lasting than rubber, Soft, supple, and smooth, resistant to lotions, body oils, sweat, and detergents, No issues with static or pilling. It is commonly used in sporting and athleisure wear.[5]

Polyester: Polyester fibres cannot absorb water, making them a great material for sportswear. Strong, Crisp, delicate touch, resistant to stretching and shrinking.

Washable or dry-clean only, drying up quickly, Resilient, wrinkle-resistant, and excellent pleat retention resistance to abrasion, resistant to the majority of chemicals are properties of polyester.[3]

FABRICS THAT ARE USED IN COMPRESSION SPORTSWEAR:

For sportswear, a wide variety of knitted materials are widely available. Various fabrics have different structural qualities, such as entrapped air, pore size and shape, mass, and surface properties, which may have an impact on how well they transmit heat and moisture.[2] Knitted materials are typically used for sportswear as they offer greater stretch and elasticity than woven fabrics, allowing for unlimited range of movement and the transfer of body moisture to the following fabric layer in the garment system. Knitted fabric seems to be the appropriate base for active sportswear due to its greater elasticity and stretchability compared to woven fabric which is essential for freedom of body movement in sports.[2] The act of simultaneously knitting fabric in parallel columns using a zigzag pattern of intertwined threads is known as warp knitting. Warp knit is mostly used in compression sportswear because it is more stable, helps in fabric tightness, air transmission and variety of design construction.[3]

Two way stretchable warp knit: The two-way stretch warp knit fabrics can be stretched either in width or lengthwise direction.

Four way stretchable warp knit: The two-way stretch warp knit fabrics can be stretched in both width and lengthwise direction.

Factors affecting sewing of compression clothing:

1.Stitch class

2.Seam type

3.SPI

Stitch class:

There are three types in the Class-500 (Over Edge Stitch): 503, 504, and 512. This kind of stitch is used for dancewear and athletic wear, as well as to neaten knitted fabric edges where stitch extensibility is essential.

Class 600(covering chain stitch): Stitch types 602, which are a two-needle cover seam with a top cover, 605, which are a three needle cover seam with a top cover, and 607, which are a four needle flat seam, are the most frequently used when attempting to achieve flat neat seams that offer good elongation properties. These are primarily employed to fasten tape, lace, braid, elastic, etc. to knit fabrics. Additionally, it can be used as an ornamental stitch.

SPI:

By counting the number of thread lengths contained within an inch, SPI (stitches per inch) is calculated.

Swimwear -SPI 12-16

In order to reduce stitch cracking, more SPI should be used on elastic seams.

Jersey T-shirt-SPI 10-12

A higher SPI raises the risk of needle cutting.

Stretch knits (Lycra, spandex)-SPI 14-18

For the proper seam elasticity, more stitches must be made per inch.

SEAM:

Depending on the product's design, the complexity of seams in sportswear clothing differs. The complexity of seams in other stitched products is comparable. Strength, aesthetic appeal, extensibility, durability, ease of assembly, security, and comfort are all factors in seam performance.[8]

Lapped seam: Material plies must be lapped and stitched together in this type of seam using one or more rows. A lapped seam is created by overlapping two pieces of fabric, which is frequently done to join garment parts like the yoke, gusset, and other parts.[8]

Superimposed seam: Two or more plies of fabric are typically placed on top of one another and superimposed in the same direction to create superimposed seams. They have one or more rows of stitching close to the edge. You can sew the rows of stitching either simultaneously or sequentially.[8]

Double overlapped seam: Two or more plies of fabric are lapped together in a seam that is then held together by one or more rows of stitching. The double-lap felled seam with two or more rows of stitching is one of the most popular seam types. This offers a sturdy seam that protects the fabric's edges. In judo and karate suits, this seam is frequently used on the side seam.[8]

Bound seam: In order to create bound seams, a binding strip is folded around the raw fabric edges and fastened with one or more rows of stitching. On an edge that is frequently exposed to wear or view, this creates a secured neat seam.[8]

Flat seam: Flat seams are created by interjecting at least two plies of fabric together on the same level at the raw edge with at least two rows of stitching On one or both surfaces, the rows are joined and introduced simultaneously. In knit clothing, especially in sportswear and undergarments, these seams are frequently used to reduce bulk at the seam. The flatlock machine is the device most frequently used for this joining operation.[8]

Flat lock: Cover stitches are typically made on flat lock machines. They are useful for hemming the sleeves and bottoms of knit clothing and have two to three needles. Decorative cover stitches on garments are also made using this kind of sewing machinery.

Mock flat lock: Perfect when you want a flat, non-chafing seam for knits and activewear. Three threads are used, the needle tension is loosened, and the lower looper tension is tightened.

Comfort properties of compression garments:

Thermo-physiological comfort, skin sensory comfort, ergonomic wear comfort, and psychological comfort are the four basic categories of wear comfort. The body makes an effort to keep its internal temperature at 37°C. Conduction, convection, radiation, and evaporation are the four types of heat transmission that the human body uses to maintain its internal temperature regulation [10]. 80% of the energy used for physical activity is turned into heat, and convection increases heat loads in warmer climates when air temperatures are greater than body temperatures. Evaporation continues to be the only mode of heat loss in these circumstances. The sum of metabolic thermal radiation and radiative and convective heat exchanges determines the amount of evaporation needed to maintain the body's core temperature [11]. The rate of perspiration and the environment's ability to absorb moisture both impacts how much heat evaporates. Sweat is distributed all over the human body in various areas. According to surveys, the perspiration in back is far more intense than perspiration in the chest of the player [12]. The control of moisture and breathability are determined by thermo-physiological comfort. Wearing clothing creates a microclimate between the body and the outside world and prevents heat and moisture from transferring from the skin to the environment [13] Surface friction, roughness, and softness of sportswear determine its skin sensory or tactile comfort [14]. The most frequent issue in physical activity is chafing, which is brought on by the mechanical rubbing of the skin with clothing or other skin-related objects [15]. Fit and freedom of movement are determined by ergonomic comfort, which is dependent on fit design, fabric elasticity, and pattern construction [16]. Due to intense body movement during vigorous sports like jogging, skin extends and contracts, changing the appropriate body measures. These movements should not be restricted by sportswear otherwise discomfort from unwanted garment pressure on the body would result [17]. Tight-fitting running shorts frequently made of elastic fabric offer the ideal size and shape with enough room for movement [18].

Evaluation methods of comfort properties:

The subjective and objective evaluation can be used to assess the comfort of clothing. The wear trial method is primarily utilised in subjective evaluation. Each participant must rate the sportswear on a specific comfort sense while exercising, such as clammy, clinging, sticky, moist, heavy, etc. It has been observed that the biggest contributing component to the overall comfort of sportswear is the sensory experience of moisture comfort [19]. The heat flux sensing principle can be used with permetest [20] and sweating guarded hot plate [21] to measure the transport of moisture vapour and heat through fabric that measures evaporative heat loss under steady state circumstances to replicate sweating skin and estimate the moisture vapour resistance of fabric. The latest cutting-edge technique for assessing combined heat and moisture transmission is the thermal manikin. There are two different kinds of manikins: dry manikins and sweating manikins [15]. Whereas the sweating manikin mimics a human body that is perspiring, the first one is used to monitor dry heat flow. Heaters inside the trunk keep the core temperature at 37ºC. Strong, porous, waterproof fabric is used to make the skin, which is then filled with water to create a soft surface that resembles human skin [22]. To monitor the heat and moisture transfer from various body portions of a sweating manikin, independently-controlled thermal zones can be generated at various locations [23]. The contact angle can be used to gauge a material's wettability. Several approaches, such automatic contact angle testers and drop analyser testers, use the image processing principle [24]. Following soaking, wicking is the process in which liquid travels along capillaries created within the fabric. Either an unlimited reservoir or a finite reservoir can be used to evaluate wicking

[25]. Spot test is one type of wicking from a finite reservoir, whereas longitudinal wicking, in-plane wicking, and transverse wicking are different types of wicking from an infinite reservoir [26]. Using an electrical resistance technique, moisture management testers assess the properties of liquid moisture transmission in various fabric directions as well as liquid transfer from one fabric face to another [27]. The friction between fabric skin and surface roughness affects skin sensory comfort [28]. The four modules of the Kawabata Evaluation System of Fabric Handle are the most used evaluation system (KES-F system) An evaluation system to measure the surface properties of sportswear under wet conditions has been suggested because the presence of moisture in active sports can alter the perception of roughness [29]. It is also reported that the presence of moisture increases friction and fabric clinging, producing an unpleasant sensation [30]. By evaluating the wearing tension and other relevant perceptions using both subjective and objective methods [31], it is possible to assess the ergonomic comfort of sportswear. Sportswear motion performance can be evaluated using joint movement and clothing pressure [32]. Another approach was using video-based motion analysis to assess how sportswear affected body motion [34].

Findings of the study:

Stretch fabrics are chosen for sportswear because they are highly valued for producing clothing that fits tightly and is both comfortable and well-suited to the human body. In addition to reducing the size of the pattern construction, which affects the value of pressure, the pressure comfort of clothing also affects the mechanical properties. Stitch type, method of sewing, machinery plays a significant role in enhancing the performance [1-9The comfort of the garment could be assessed by evaluating through the methods [17-19].

CONCLUSION:

Major part of the review focuses on the design of the clothing, including the fabric and its characteristics, knitting techniques and construction, and the design system. Following that, the pressure measurement and modelling of compression clothing has received special attention. Additionally, the use of compression garments for sportswear, body shaping, orthodontic supports, scar management, chronic venous disease, and scar management has introduced the action principle and appropriate pressure for various effects and body parts. The pressure therapy and sportswear could achieve the best results by selecting the proper materials, construction, and garment design in accordance with the body's anatomy and curves, as well as the appropriate pressure for body.

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