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Research Article

The Effects of a Game Changing Posture Gear on Chest Expansion and Rehabilitation

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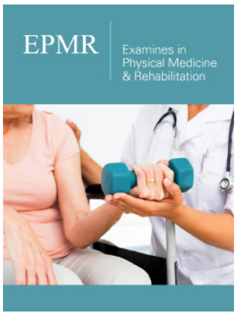

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Introduction

Chronic poor posture can be either acquired or the result of a genetic disorder. It is a prevalent issue and can lead to numerous musculoskeletal complaints, impacting physical and mental health. Kyphosis, or progressive slouching, is also associated with restricted thoracic mobility and a sedentary lifestyle, and often leads to limited chest expansion and poor pulmonary functions**.** One study found that those who are in a sedentary environment for over seven hours per day have reduced thoracic mobility because of habitual poor posture [1]. A decrease in thoracic mobility is associated with neck and shoulder muscle pain [2,3]. Forward head posture has also been found to cause structural changes that lead to defects in breathing and respiratory functions [4]. A sedentary position corresponds with high levels of Electro Myographic (EMG) activity in the neck and shoulders relative to those of a straight, standing posture, showing there is increased strain on these muscles when sitting [5]. A study conducted by Tudor L et al. [6] found that people with sedentary occupations spend about 11 hours per day sitting down. These findings suggest that the excessive time people spend in sedentary positions through work or other lifestyle factors puts stress on the body, affecting their posture and breathing, as well as neck and shoulder muscles.

Smartphone usage has also led to adverse effects on posture. A study done by Berolo et al. [7] shows that cell phone usage leads to a buildup of pain and tension in the neck, upper back, right and left shoulders, and right hand. Not only is this painful in the short term, but cell phone-induced posture misalignment can cause lasting effects on the body such as impaired respiratory function [7], increased risk for spinal problems [8], and even the emergence of an occipital protuberance [9]. This problem will only get worse with the increasing use of mobile phones and technology, suggesting the importance for ergonomic device development [7,8].

Poor posture causes a variety of adverse effects on physical and mental wellness. Chronic poor posture can lead to several musculoskeletal issues, specifically in the neck, shoulder, and upper back [10]. This leads to poor ergonomics and lost days at work, ultimately decreasing a person's quality of life. Posture also affects confidence and doubt [11], and poor posture has been associated with higher stress and negative emotional experiences [12]. Additionally, posture impacts memory, recall, and mood. A chronic slouching position is associated with easier retrieval of negative memories and mood, as well as lower energy. In one study, 86% of participants found that it was easier to recall negative memories in a collapsed position, and 87% of participants felt it was easier to recall positive memories in an erect position [12]. This highlights the importance of proper posture to improve positive mood and reduce depression in daily living and the workplace.

Restricted chest expansion has long been considered an indicator of poor posture and spinal dysfunction [13,14]. Restricted chest expansion has been associated with decreased vital lung capacity and abnormal lung function, which has significant implications for exercise tolerance [15]. Chest expansion is also correlated with maximal inspiratory and expiratory pressures [16], suggesting greater strength of the respiratory muscles. Poor posture leads to a decrease in oxygen intake within the lungs, which inhibits the ability to breathe deep and makes the abdominals weaker [17]. A slouched seating position also significantly decreased lung capacity and expiratory flow [18]. Long-term therapeutic interventions have been shown to improve chest expansion. One study found that a group undergoing exercises to correct their thoracic posture experienced greater chest expansion and improvements in thoracic kyphosis angles relative to the control [19]. Another study employed a 6-week yoga intervention and saw significant improvements in chest expansion and lung capacity in participants compared to pre-intervention measurements and compared to the control group [20]. However, no research has been done on therapy or solution that can instantly increase chest expansion through a posture-correction apparel.

The overall objective of this study was to further examine a smart posture apparel technology on chest expansion. This study aimed to use chest expansion as a physical measure of posture correction due to its prevalence in previous research concerning posture and its association with increased vital lung capacity [13,14,18,19]. Prior research has validated the reliability of using a cloth tape measure for measuring chest expansion [21,22]. We hypothesized that participants would experience greater chest expansion when wearing the IFGfit smart posture apparel.

Methods

Subjects

The research protocol was approved by Western Institute Review Board. Tracking number 20191834. Work order number 1-1199365-1. This study examined 33 subjects, of whom 60.6% were male (n=20) and 39.4% were female (n=13). Subjects were from a diverse background-51.5% were Caucasian (n=17), 27.3% were Asian (n=9), 18.2% were African American (n=6), and 3.0% were Hispanic/Latino (n=1). In reporting their self-identified weight classes, 66.7% were "About the right weight" (n=22), 24.2% were "Slightly overweight" (n=8), and 9.1% were "Slightly underweight" (n=3). Recruitment of participants was based on their ability and willingness to participate within the provided timeframe of the study. All participants were compensated $10 for their time. Potential participants were excluded from the study for the following reasons: the participant was less than 18 years old or the participant had worn or was familiar with the IFGfit smart posture gear prior to the study.

Equipment

Using a within-subjects design, each participant underwent two conditions: the experimental condition in which participants wore an IFGfit (Los Angeles, CA) smart posture sports shirt, and the control condition in which participants wore a Hanes sports shirt. Women wore a Hanes Nano-T Jersey V-Neck T-Shirt, and men wore a Hanes Sport Cool Dri-Performance Tee. IFGfit smart posture gear is an FDA 510K exempt medical device containing PPR® horizontal tension technology that instantly and continuously maintain shoulder blades symmetrical and closer to the spinous processes. The smart technology stimulates muscle proprioception by training the body to maintain proper head, neck, and spinal alignment. Each subject was randomized to start with either the IFGfit smart posture shirt or the control shirt before repeating the process with the other shirt. In order to ensure the participants were blind to the brand of each of the shirts, the logos on all shirts were covered with masking tape. Participants were given a choice between small, medium, and large sizes.

Procedure

Participants were asked to change so that the shirts were directly in contact with their skin. Participants wearing either a bra or tank top were allowed to wear the shirts over their undergarments. Chest expansion was measured circumferentially using a tape measure [21,22] wrapped around the chest, underneath the armpits, and 3 cm above the nipple line in the front. Chest measurements were taken both before and after they took three deep breaths. Before each breath, participants were instructed to "exhale completely" and "relax." A chest size measurement was taken at this resting state. Following the pre-inhalation measurements, participants were instructed to "take a deep breath" and a measurement was taken following their complete inhalation. This process was repeated 3 times per condition per participant, resulting in a total of 6 measurements (3 pre-inhalations, 3post-inhalation). The average of each participant's chest circumference before inhaling and their average chest circumference after inhaling were calculated separately for each shirt.

Following the chest measurements, participants completed a questionnaire that asked them to subjectively evaluate their experience wearing the posture-perfecting garment. The questionnaire items were primarily "Yes/No" questions or asked participants to respond using a 4-point Likert scale (1=Not at all; 2=A little; 3=Quite a bit; 4=Very much). Questions were focused on comfort level, workplace discomfort, perception of posture improvement, as well as overall satisfaction with the smart posture shirt.

Result

Using a pairwise two-tailed t-test, we analyzed the difference between average pre-inhalation ("resting state") chest circumferences for each participant, and found that there was a 1.0cm greater mean chest circumference for the IFGfit condition (M=94.6, SD=9.6) compared to the control condition (M=93.6, SD=9.5), significant at the $\alpha=0.01$ level ($p << 0.001$, df=32) (Figure 1). We used the same method to analyze the difference between average post-inhalation measures and found that there was a 0.9cm higher mean post-inhalation chest circumference in the IFGfit smart posture apparel condition (M=98.2, SD=9.3), compared to the control condition (M=97.4, 9.5), significant at the $\alpha=0.01$ level ($p << 0.001$, df=32) (Figure 2).

In the questionnaire, 75.8% (n=25) of subjects indicated that they would recommend the IFGfit smart posture apparel to other people, while 63.6% (n=21) felt their posture improved quite a bit or very much. Also, 84.8% (n=28) of participants felt that the shirt would help with daily activities, 78.78% (n=26) of participants would consider using the IFGfit smart posture apparel for physical therapy/recovery, 81.83% (n=27) liked the feel of the fabric, and 72.7% (n=24) felt that the fabric was breathable. Additionally, 54.5% (n=18) felt their chest expand quite or bit or very much.

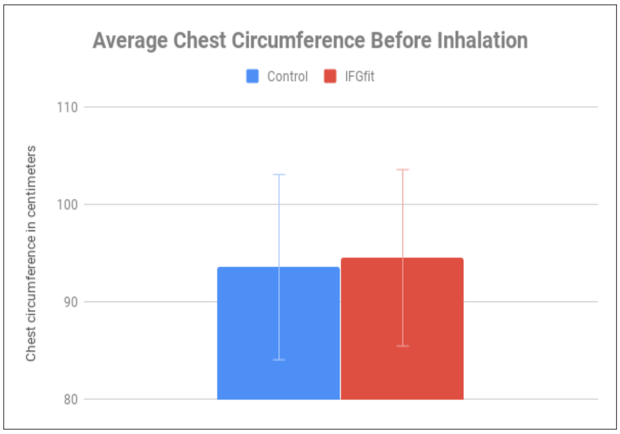

Figure 1: Average chest circumference before inhalation (error bars show standard deviations).

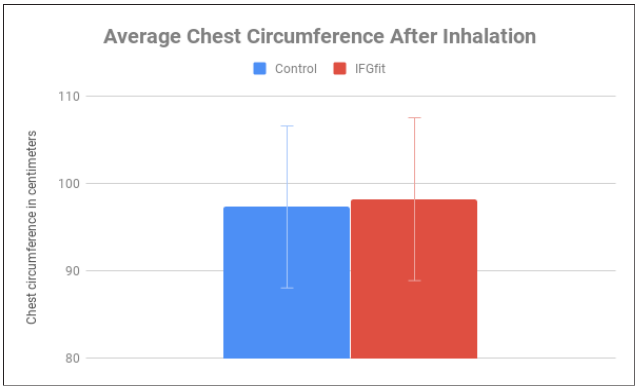

Figure 2: Average chest circumference after inhalation (error bars show standard deviations).

Discussion

This is the first study to investigate the effects of smart clothing on chest expansion, specifically a smart posture-perfecting apparel on chest expansion. The smart posture apparel used here is crafted with patented horizontal tension technology to keep shoulder blades down and back closer to the spinous processes. Several companies have developed vertical tension compression posture apparel that claimed to correct posture by expanding the chest. The vertical tension posture apparel has been claimed to promote deeper breathing, and reduce posture-related pain, although there has been no clinical data to support these claims. One study found that posture-correcting compression apparel provided benefits including faster recovery for cyclists, improved mobility, increased comfort, and reduced fatigue [23,24]. However, compression garments have been shown to negatively impact performance and increase health risks. In a study on golfers, compression wear was found to restrict movement, and there was no significant improvement in participants' swing velocity [25]. In contrast, various recent studies have evaluated the effectiveness of a horizontal tension, non-compression smart posture-perfecting apparel (IFGfit, Los Angeles, CA). One study found that 93% of participants experienced high levels of comfort while wearing the IFGfit garment, and 88% felt an improvement in posture after wearing it [25,26]. Another study found a significant reduction in scapular protraction while wearing an IFGfit garment [27]. In a study with division one student athletes, 95% of subjects felt an improvement in their posture after they wore an IFGfit shirt, and 90% said they would use the IFGfit shirt as a physical therapy intervention or for recovery [27]. These studies provided clinical, biomechanics, as well as physiological evidence that IFGfit smart posture apparel may induce chest expansion thru its postural perfecting biomechanics and improved thoracic mobility.

The subjective results of the current study showed a similar subjective outcome compared to previous studies [26,27] that over 80% of participants would use IFGfit smart posture activewear for physical therapy and for recovery. The study also shows similar ratings on comfort and feel of the fabric. Most importantly, the objective findings were that participants' chest circumference both before inhaling and after inhaling were significantly larger when wearing the IFGfit smart posture apparel than when wearing the control shirt [28]. This increase in chest circumference is due to the alteration in biomechanics induced by the patented horizontal tension technology in the inner smart layer that keep the shoulder blades closer to the spinous processes and improve thoracic and rib cage mobility. The significant increase in pre-inhalation chest circumference indicates that participants' chest cavity was expanded in a more upright posture position.

Also, chest expansion measured post-inhalation chest circumference was significantly larger in the IFGfit posture apparel than in the control shirt. In other words, participants' chests were able to expand to a greater circumference when they breathed in the IFGfit shirt. These results further suggest that participants' lung capacity was higher in the posture apparel as chest expansion is associated with lung capacity [20]. These improvements in posture and lung capacity have been shown to lead to improved pulmonary function and therefore greater exercise tolerance [15,16]. Chest expansion is also correlated with maximal inspiratory and expiratory pressures [17,18]. The current findings also suggest an improvement in respiratory strength and respiratory function [19,20,29,30].

The initial goal of this study was to determine whether participants experienced greater chest expansion while wearing an IFGfit posture technology apparel relative to wearing a control shirt, where chest expansion is defined as the increase in chest circumference at pre-inhalation, and post inhalation. As the IFGfit shirts improved participants' resting posture and expanded their chests, their chests may have reached maximum expansion effortlessly. During inhalation further expansion may be limited by their more upright posture. As participants' chests before inhaling were larger, there was less room for them to expand. Further research should be conducted using more objective physiological measures, such as those taken with an incentive spirometer, that can accurately indicate the effectiveness of the IFGfit posture technology apparel on improving vital lung capacity.

This is the first IRB-approved study that has been conducted on both the objective and subjective effects of a smart posture-perfecting apparel on posture and chest expansion. We found that the examined smart posture apparel significantly increased chest circumference at rest and on inhalation. These results indicate that the studied posture apparel improved thoracic and rib cage mobility, boosted upright posture, and increased lung capacity. It is effective in improving posture and chest expansion and should be considered for use to improve posture during work or play and to improve posture in more progressive spinal disorders, i.e. ankylosing spondylitis, scoliosis, rheumatoid arthritis, or kyphosis. The subjective outcome was similar to previous studies showing compliance and use in adjunct to Physical Therapy. Future research should look at other physiological measures to assess the IFGfit smart posture garment's therapeutic effects on breathing, oxygenation, and vital lung capacity.

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