

A Compliance Evaluation of a Wearable Technology for Posture Ergonomics

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Abstract

Objectives: The prevalence of back and neck complaints resulting from poor posture is high, and the rate of posture related back pain and healthcare costs have been increasing rapidly with the widespread use of smartphones, computers, and work-related risks. Compliance with traditional back braces and other solutions for treating this pain is low, which affects patients' ability to perform and recover. The objective of the current study is to determine subjective compliance of an innovative posture wearable technology.

Methods: 128 Volunteers underwent subjective evaluation after wearing the FDA registered IFGfit wearable technology. After trying on the apparel, they were asked to complete a subjective questionnaire, which included questions on demographic information, back or neck complaints prior to wearing the garment, history of physical therapy, comfort level and perceived posture improvement while and after wearing the shirt.

Results: The comfort level survey results showed that 93 percent of the sample, (n=111), reported a comfort level rating of good or excellent while wearing the garment, and that 88 percent of participants, (n=108), reported that their posture had improved very much or quite a bit after wearing the apparel. Exploratory analyses showed that previous level of back pain and comfort level were not correlated, $rs(126) = .133, p = .134$, nor was there a correlation between previous back, neck and shoulder pain and perceived posture improvement level, $rs(126) = .092, p = .304$.

Conclusion: Over 90% of participants reported high comfort levels and an improvement in their posture after taking it off. The positive user response suggests that this apparel technology has the potential to alleviate and prevent posture related back pain on a large scale with high patient compliance.

Keywords: Apparel technology; PPR; Back; Neck pain; Postural recovery; Shoulder pain

Introduction

Poor posture is a progressive and widespread phenomenon that is exacerbated by certain daily activities, occupational demands and aging, and its prevalence is only increasing along with the use of smartphones, computers, the demands of modern transportation and participation in athletic activities. Studies have shown that the increasing use of smartphones has exacerbated posture related problems by putting excessive pressure and tension on people's necks and shoulders [1].

Over time, poor posture can affect head-neck-scapular biomechanics and muscular activities, which may result in pain and progressive tension in the back, neck and shoulder region. According to one study, up to eighty percent of people in the United States will experience a neck or back problem during their lifetime [2]. This prevalence of posture related problems comes with high financial costs in addition to physical pain. Another study found that Americans spend close to 90 billion dollars on the diagnosis and treatment of back pain each year [3].

Given the prevalence of posture related injury and pain, an easily accessible and cost- effective solution that is both preventative and therapeutic is necessary to mitigate its associated personal and financial costs. Previous posture correcting clothing has attempted to address these issues, but almost all of these products are poorly tolerated, focus on compression or constraining devices, the design and use of which differ greatly from the wearable technology used in this study. Thus far, the data evaluating posture recovery and training apparel are limited, and user experience has not been well documented. The current study utilizes an innovative wearable technology using a two-apparel design and construction method.

The IFGfit (Los Angeles, CA, USA) is a dynamic posture training and recovery wearable that naturally pulls the scapulae posteriorly, inferiorly, and most importantly, to instantly restore posture while expanding the lungs for better breathing. It acts as a form of relief for those who already experience back pain, and as a preventative health measure for those at risk for back and neck pain in the future.

The current study is a continuation of a previous study by Matsumura et al., in which the IFGfit apparel was shown to significantly affect the kinematics of the shoulders and spine [4]. Additionally, Matsumura et al. found that EMG data showed decreased activity in the middle trapezius and increased activity in the erector

spine muscle groups, and although these results were not significant, they indicated positive trends of relaxation in the shoulder muscles and activation in the spinal muscles [4]. Although the previous study demonstrated the kinematics of the IFGfit PPR wearable tech, the current study aims to assess user experience with a subjective study using a questionnaire, since user compliance is crucial to the garment's ability to correct posture and prevent back pain over time.

One study by Rahman et al. demonstrates the importance of patient compliance in treating scoliosis with back braces [5]. Their study showed that most participants did not comply with the back-brace treatment as instructed, and that the level of participant compliance was strongly related to the effectiveness of the treatment.

Given the high levels of noncompliance, which reached levels of 85 percent in the study by Rahman et al., the current study aims to further understand the potential for the IFGfit PPR apparel technology to become a widespread preventative solution to musculoskeletal pain by assessing participants' reported comfort level and perceived improvement in posture while and after wearing the apparel [5].

A positive response to the apparel would illustrate its potential to affect a large percentage of the population and to improve participant compliance that is lacking with other treatment options. Additionally, this study aims to understand whether participants with a history of back pain will report increase relief from the apparel compared with those who do not have back pain.

Overall, if participants respond positively to the apparel and report that they would be inclined to use it during daily activities, this would indicate a high potential in the market for the widespread deployment of the apparel as an alternative way to manage posture related pathologies, and that patient compliance might be higher for this apparel technology than for more traditional and restrictive back braces or compression wear.

Methods

Subjects

A random sample of 128 volunteers, 51 female, 76 male and one subject who did not report gender, participated in the current study. Data was collected from August 2018 to February 2019. The ages of participants ranged from 19 to 79. Participants were not compensated for their participation and were not affiliated with IFGfit.

Participants came from diverse professional and cultural backgrounds, and were surveyed in numerous locations across the country including California, New York, Massachusetts, Rhode Island, Washington, Michigan, Pennsylvania, Florida, Georgia, Texas, Ohio, Illinois and Connecticut, as well as some overseas locations.

Materials

IFGfit (Los Angeles, USA) apparel, powered by PPR, was used for testing. The apparel consisted of an outer lightweight poly-blend crew or V neck tee shirt, integrated with an inner shirt engineered with PPR woven technology, and inner and outer woven fabrics with variable tension naturally inducing proprioception for instant posture correction and chest expansion.

The questionnaire was created for the purposes of the study, and was adapted from a Quality of Life Questionnaire used in a previous study by Chawla et al. [6]. The questionnaire in the current study

included 33 short answer, multiple choice and yes/no questions on demographic information, profession, typical number of hours worked per day, whether they have a history of back pain, and their response to the apparel, which included rating their comfort level while wearing the apparel and any improvement in posture that they perceived after having worn the apparel. A copy of the survey can be found in Appendix A.

A total comfort level score was used for analysis and was calculated by taking the sum of the answers to questions 12 through 16, and dividing the resulting score into four categories of comfort: excellent, good, satisfactory and poor. An improvement score was used for analysis and was simply the answer to question 17.

Level of pain was taken from question six in the pre-questionnaire, to which participants responded with their typical level of pain after a long day of work or school on a scale from 1 (minimal) to 10 (severe).

Procedure

Participation in all parts of the study was voluntary. All participants were randomly selected and asked to wear an IFGfit apparel garment during the study. After giving their written consent, participants chose an appropriately sized garment and wearing it for at least 15 minutes (range 15 minutes to 3 weeks).

Participants wore the garment in different settings and while performing different activities, including sitting in conference rooms, completing fitness tasks or performing their professional duties. After wearing the apparel, participants were given the questionnaire, which was either given to them in person and completed on paper or sent to them by email and completed via an electronic form.

Results

The comfort level survey results showed that 93 percent of the sample, (n=111), reported a comfort level rating of good or excellent while wearing the garment, while only seven percent of participants, (n=8), reported a comfort level score of satisfactory, and zero participants reported a poor comfort level score as depicted in Figure 1.

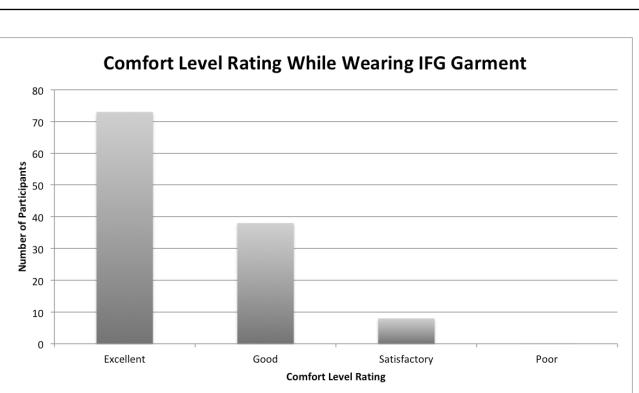


Figure 1: Comfort level rating while wearing the IFGfit garment.

Nine participants (n=9) had missing data and were excluded from the comfort level calculations. Additionally, 88 percent of participants, (n=108), reported that they felt their posture had improved very much or quite a bit after wearing the garment, while only 12 percent of

participants, (n=15), reported that they thought their posture had improved a little or not at all as depicted in Figure 2.

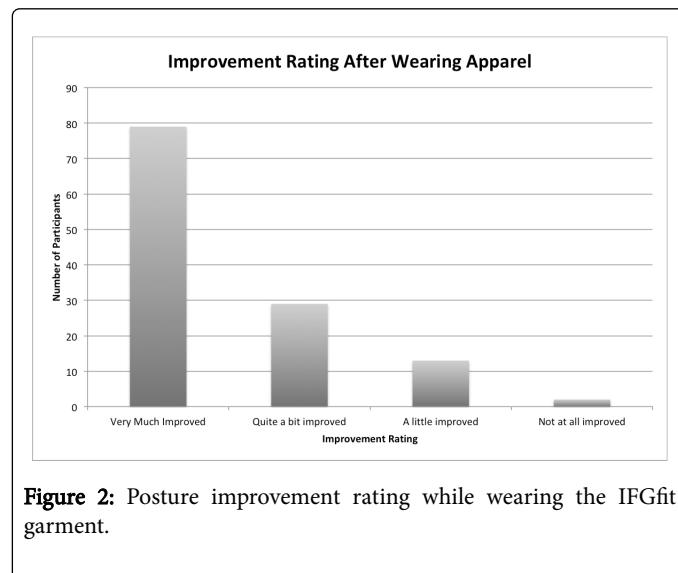


Figure 2: Posture improvement rating while wearing the IFGfit garment.

Five participants (n=5) had missing data and were excluded from the perceived improvement calculations.

Additionally, 85 percent of the participants reported having experienced back, neck or shoulder aches and pains before (n=109), 15 percent had not (n=19) as shown in Figure 3.

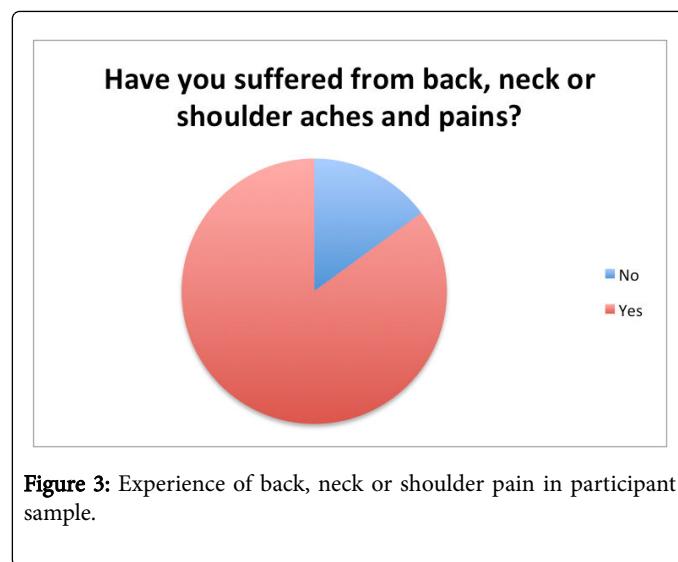


Figure 3: Experience of back, neck or shoulder pain in participant sample.

To test the hypothesis that people with higher levels of back pain would see an even stronger positive response to the shirt, a Spearman's correlation was run to test for a positive relationship between the typical level of back pain felt by participants after a day of work or school, and the comfort level rating they responded with while wearing the apparel.

The results did not find a significant correlation between typical level of back pain and comfort rating after a long day of work, $rs(126)=.133$, $p=.134$. A scatter plot of the relationship between back pain level and comfort rating can be found in Figure 4.

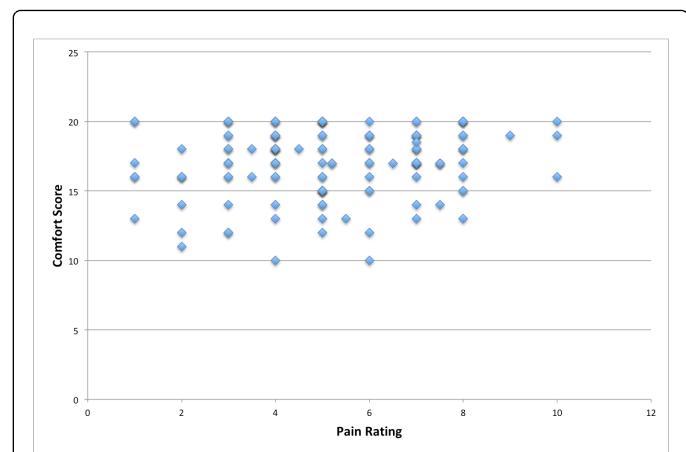


Figure 4: Relationship between experience of back, neck or shoulder pain (Pain Rating) and participant comfort level while wearing the IFGfit shirt (Comfort Score) in participant sample (not significant).

Additionally, a Spearman correlation was run to determine whether there was a positive correlation between typical level of back pain after a long day of work, and whether participants felt an improvement in their posture as a result of wearing the garment.

Again, the data did not show a significant relationship between level of back pain and perceived improvement in posture after wearing the shirt, $rs(126)=.092$, $p=.304$. A scatter plot of the relationship between back pain level and comfort rating can be found in Figure 5.

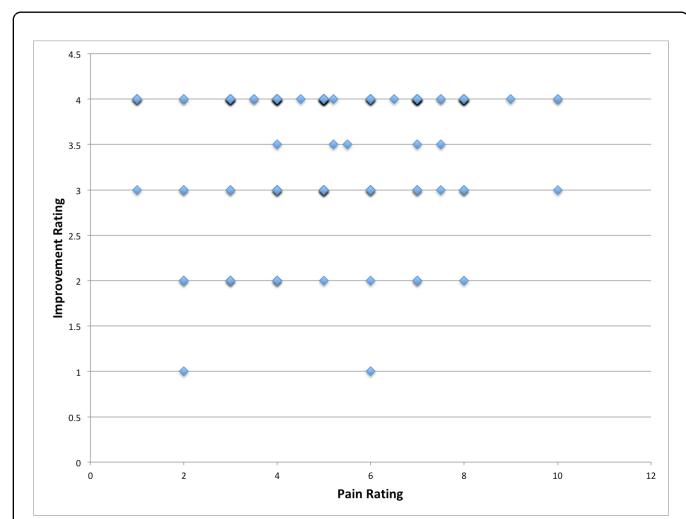


Figure 5: Relationship between experience of back, neck or shoulder pain (Pain Rating) and perceived improvement in posture from the IFGfit shirt (Improvement Rating) in participant sample (not significant).

In order to gain a more comprehensive understanding of participants' reaction to the apparel, participants were also asked to respond to three short answer questions. When asked, "Have you had a similar experience with any other garment," of the 49 participants who responded, 39 responded that they had not, six responded that they had, but preferred the IFGfit garment, and only four said that they had

experienced something similar before. When asked, "Do you like the look of the garment? Any feedback/Suggestions?" of the 42 who responded, 30 said yes in some form, e.g., "Yes, it does not look as if there is special supportive fabric in the clothing," or "I like the look."

"It is very versatile," while 12 had specific requests and suggestions, such as "Please keep the exterior design as plain as possible so that we can wear it in the office."

The last item in the questionnaire was a comment section, where participants could add any additional suggestions or feedback. Of the 20 participants who responded to this question, most (n=14) reported that they loved the product, e.g., "Can't wait for this to be available for purchase," one said "I think that for a few days a week this would work as a helpful nudge, not sure it would replace my daily clothing style though," and five people had complaints about discomfort or fit.

Additional Yes or No questions included: "Do you think wearing this apparel would help you in your daily activities?" To which 96 percent of the sample (n=123) responded "Yes," one percent of the sample (n=1) responded "No," and three percent of the sample (n=4) responded "N/A" or didn't provide a response, "Would you recommend this apparel to someone else?" To which 96 percent of the sample (n=123) responded "Yes," zero people responded "No," and four percent of the sample (n=5) responded "N/A" or didn't provide a response, "Would you consider using this apparel as part of your physical therapy or recovery?" to which 86 percent of the sample (n=110) responded "Yes," zero people responded "No," and 14 percent of the sample (n=18) responded "N/A" or didn't provide a response, and finally, "Do you like the feel of the fabric?" to which 92 percent of the sample (n=118) responded "Yes," two percent of the sample (n=2) responded "No" and six percent of the sample (n=8) responded "N/A" or didn't provide a response.

Charts illustrating the results from these four questions can be found in Figures 6-9.

Do you think wearing this apparel would help you in your daily activities?



Figure 6: Do you think wearing this apparel would help you in your daily activities?

Would you recommend this apparel to someone else?



Figure 7: Would you recommend this apparel to someone else?

Would you consider using this apparel as part of your physical therapy or recovery?

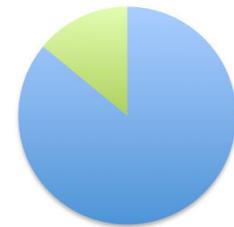


Figure 8: Would you consider using this apparel as part of your physical therapy or recovery?

Do you like the feel of the fabric?

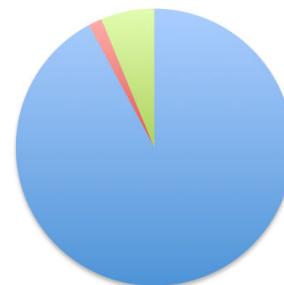


Figure 9: Do you like the feel of the fabric?

Discussion and Conclusion

In the current study we were interested in participants' subjective responses to the IFGfit FDA registered apparel, including whether they found the apparel comfortable, whether they felt that it improved their

posture, and how they thought it may impact their neck or back pain. Close to 90% of participants responded positively to the apparel, indicating that they did find it comfortable, and that they felt their posture recover as a result of wearing it. Additionally, most participants indicated that they thought the apparel would help them with their daily activities, that they would recommend it to a friend, that they would consider using it for recovery purposes, and that they liked the feel of the fabric. Taken with the results from the previous study by Matsumura et al., which found that the IFGfit apparel actively decreases the distance between the scapulae and that sEMG data trends indicated improved posture, the current study suggests that this garment also has potential for high user compliance due to the positive response of participants to the apparel, further suggesting that this garment could help reduce and prevent back pain on a wide scale [4]. The results of this study were expected and are consistent with previous literature on similar posture correcting garments which have become popular, especially among athletes and physically active people. For example, one study by Cipriani et al. on a posture-cueing compression shirt showed that a sample of experienced cyclists perceived an improvement in their riding posture, post-ride posture, spine discomfort and post-ride recovery due to the shirt [7].

The current study adds to this literature due to the nature of the garment tested, as it differs in design and function from previously tested compression wear.

Additionally, an interesting analytical point to consider was whether or not people who already experience back pain found the IFGfit apparel particularly helpful, which would mean that the apparel could be an even greater source of relief to those who have high occupational risk of poor posture or those who suffer from spinal or shoulder pathologies. The results did not support this hypothesis and did not show that participants who reported greater levels of back pain after a typical day of work were more likely to find the apparel more relieving or beneficial to their posture. Since back pain had no apparent relationship to how comfortable or beneficial to posture the shirt was, it stands to reason that the IFGfit apparel could be helpful across a broad spectrum of the population, regardless of how bad one's posture already is or how much pain one is already experiencing. More research and perhaps a large sample size will be needed before any firm conclusions can be made about the relationship between pain and perceived comfort and posture improvement, however, since approximately 90 percent of the sample reported having experienced some level of back, neck or shoulder aches and pains in their lives, it

could be concluded that the IFGfit apparel would benefit a large percentage of the population to some degree at least, and should not be marketed specifically to those with high levels of back pain, but rather to the general population, since most people could benefit from improved posture and improved breathing.

User satisfaction with the IFGfit apparel, powered by PPR, was high, and taken with previous research by Matsumura et al., the results suggest that this garment could be an effective preventative and therapeutic treatment of musculoskeletal complaints of the spine, neck and shoulders [4]. Future research should address limitations of the current study with a larger sample size and by studying the potential for participant compliance using a longitudinal design to determine whether participants are in fact more likely to wear IFGfit apparel compared with a more restrictive, traditional back brace or compression garment. Additionally, future research should focus on testing the garment for longer time periods, and should examine its effect on posture during physical training, performance and recovery, in addition to examining compliance of participants wearing the garment at work and during daily life.

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