Healing the Everyday Athlete, Evaluating the Impact of Recovery Wear Garment Use on Musculoskeletal Health in an Occupational Setting

Kara Radzak and John Mercer
Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, U.S.A.

Keywords: Occupational Pain, Sleeve, Germanium, Overuse.

Abstract: While musculoskeletal injuries are commonly associated with sports, work-related musculoskeletal disorders greatly impact the workforce efficacy and account for a high volume of workers compensation cases. This study evaluated the effect of a carbonized charcoal and germanium recovery wear product on reducing musculoskeletal discomfort among first responders, a group prone to overuse injuries. Participants included 13 firefighters and law enforcement officers who used the recovery wear product over two months. Measures of musculoskeletal function and discomfort were assessed using the Fusionetics® Movement Health Questionnaire. Results indicated no change in measures of musculoskeletal function and discomfort over the 2-month period. Despite a small sample size of the present study, it is important to research the potential of recovery wear products as a practical intervention for managing work-related musculoskeletal disorders in physically demanding professions. Further research with larger samples and objective measures is needed to confirm these preliminary results and explore long-term benefits. This study provides a foundation for future investigations into wearable technology for occupational health.

1 INTRODUCTION

While musculoskeletal injuries are synonymous with "sports injuries," work-related musculoskeletal disorders account for 31% of workers compensation cases in the United States and have direct cost of $1.5 billion, annually (Bureau of Labor Statistics, 2016). In addition, each worker with a musculoskeletal disorder requires a mean of 12 days recovery before returning to work. (Bureau of Labor Statistics, 2016). Similar to athletes, overuse injuries are prevalent in an occupational setting, with 33.9 cases per 10,000 full-time workers attributed to overexertion mechanisms of injury in 2015 (Bureau of Labor Statistics, 2016). Thus, a large contributor to the costly problem of work-related musculoskeletal disorders in the "occupational athlete" are overuse in nature and result from occupational task induced microtrauma and its associated inflammatory response (Barbe, Barr, 2006).

Two primary options exist for mitigating overuse work-related pain or discomfort: 1) decrease the microtrauma induced by the worker's job task, and/or 2) increase the body's ability to heal and not succumb to the microtrauma (Barbe, Barr, 206). Often, the worker's tasks cannot be changed nor can exposure to microtrauma inducing repetitive actives be decrease. Thus, the most viable option for decreasing musculoskeletal overuse is to mitigate the effects of the microtrauma in hopes that the individual at risk can maintain working below the threshold of microtrauma that would result in a decreasing musculoskeletal discomfort and preventing development of musculoskeletal injuries. One theoretical avenue of intervention is to decrease the noxious effects of chronic inflammation associated with work-related overuse. (Barbe, Barr, 206).

While some recovery products rely upon compression, other wearable recovery products are garments with semiconductors (carbonized charcoal and germanium) interwoven into the garment's fabric. Body heat causes the semiconductor elements of the fabric to release negative ions and create a localized, micro electromagnetic field to increase circulation and lymphatic flow (Marino et al., 2019; Lee et al., 2018) In theory, by increasing circulation, more oxygen and nutrients delivered to the area under the product, which optimizes the body's natural healing process and

Radzak, K. and Mercer, J.
Healing the Everyday Athlete, Evaluating the Impact of Recovery Wear Garment Use on Musculoskeletal Health in an Occupational Setting.
DOI: 10.5220/0012934300003828

In *Proceedings of the 12th International Conference on Sport Sciences Research and Technology Support (icSPORTS 2024)*, pages 155-159
ISBN: 978-989-758-719-1; ISSN: 2184-3201

accelerates recovery. This provides a technical advance to the traditional compression sleeves commonly used in athletics and occupational workers. Thus, germanium-embedded recover wear products hold the potential to intervene in the job task-related microtrauma cycle, and decrease perceptions of work-related discomfort. The current study aimed to evaluate the impact of the recovery wear product on self-reported measures of work-related musculoskeletal discomfort in members of a physically demanding profession – first responders. We hypothesize that the use of the products will improve measures of musculoskeletal function and readiness, as measured using the Fusionetics® system's Movement Health Questionnaire.

2 METHODOLOGY

A survey-based study was designed to evaluate perceptions of musculoskeletal discomfort and function prior to and following the use a recovery wear product. The study was approved by the university's institutional review board prior to the initiation of data collection.

2.1 Participants

Inclusionary criteria consisted of being over the age of 18, being in a physically demanding profession, and being employed at one of the companies/municipalities that allowed for recruiting from within their employees. Participants were either firefighters or law enforcement officers employed by one of two large metropolitan cities in the mountain west region of the United States.

Participants were recruited through word of mouth and study flyers displayed at their employer's physical location. Individuals interested in participating contacted the research team and were provided a copy of the informed consent document. Individuals then underwent the informed consent process either in person or via telephone. During the informed consent meeting, a member of the research team confirmed that the individual met inclusionary criteria, provided instructions on study participation, answered any questions on the study protocol, and obtained the participants verbal consent to participate. During this meeting, baseline health quality of life was also collected.

2.2 Survey Instruments

Health quality of life was collected using the Center for Disease Control's (CDC) Health-Related Quality of Life (HRQOL) instrument. For this study, the standard 4-item "Health Days" core questions were used (HRQOL-4) as well as the additional 5-item Activity Limitations Module.

Measures of musculoskeletal function were collected via the Fusionetics® Movement Health Questionnaire. Fusionetics® is a web-based or mobile application platform that collects human performance and movement quality data. Fusionetics® has been traditionally utilized by sports teams for injury prevention and strength and conditioning performance improvement by members of the sports team's sports medicine professionals. For the purposes of the study each participant was listed as an "athlete" in the research study's "team" where only the researchers had access to the participants' data. Each participant was onboarded to their own unique Fustionetics® "athlete" account through the research study's "team" account using the preferred email address provided by the participant during the consent process. The participant then received an email instructing them on, (1) how to access and download the Fusionetics® mobile application if they choose to interact with the Fusionetics® platform from a mobile device, (2) to complete their individual account onboarding, and (3) take the Movement Health Questionnaire. The Movement Health Questionnaire asks questions related to function, previous injury history over the previous one-year recall timeframe, musculoskeletal soreness (Figure 1), and perceived readiness (Figure 2). The Fusionetics® platform then uses a proprietary algorithm to determine a total movement health score with sub-scores in the categories of function, injury history, soreness, and readiness.

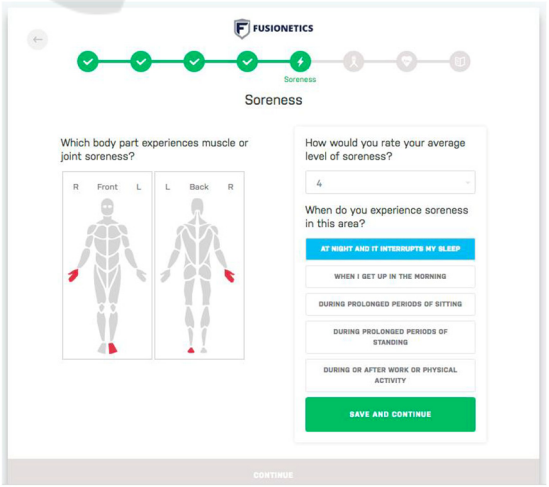

Figure 1: Example of the "soreness" question item in the Fusionetics® Movement Health Questionnaire.

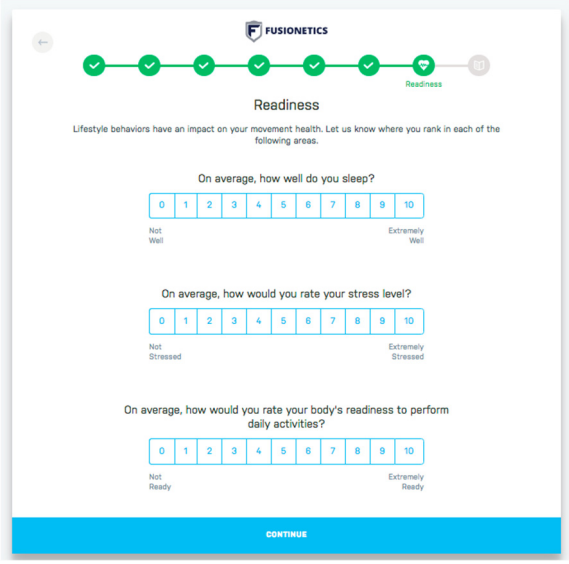

Figure 2: Example of the "readiness" question items in the Fusionetics® Movement Health Questionnaire.

2.3 Data Collection Procedures

After the informed consent meeting and collection of baseline HRQOL data, participants were provided with instructions on how to access the Fusionetics® platform and directed to complete the baseline Movement Health Questionnaire. Participants were also provided with, or given access to a centralized location to pick up the recovery wear product to be used in the study.

Participants were allowed to select one recovery wear product (Incrediwear®, Chico, CA, USA), at no cost, of their choosing from the following products: knee sleeve, back brace, elbow sleeve, wrist sleeve, or crew socks. Participants were instructed to select their study-provided product based upon what body region they most commonly had occupation related musculoskeletal discomfort. Participants were instructed to wear the product in accordance to their preference, as long as manufacture guidelines were followed. While this added variability into the duration and time period (e.g., at rest or during activity) the participants wore the product, this methodology was truer to consumer usage. Participants were instructed to use the product over the duration of the two-month intervention period.

Following the two-month recovery wear usage intervention period, participants were emailed to complete the follow-up data collection. These emails included links to the follow-up HRQOL and Movement Health questionnaires. Participants were allowed to keep the recovery wear product at the conclusion of the study.

2.4 Statistical Analysis

Data were analysed using Excel (Microsoft) and significance set at $p < 0.05$. Changes from pre- to post-intervention were evaluated using one-tailed, paired sample t-tests. Descriptive statistics were reported as means, standard deviations, and ranges.

3 RESULTS

A total of 13 individuals (12 males, 1 female) participated in the two-month intervention. Participant demographics are reported in Table 1. Recovery wear products used included seven knee sleeves, two elbow sleeves, two back braces, and one pair of crew socks.

Table 1: Participant demographics (n=13).

	Mean	Standard Deviation	Range
Age (years)	45.08	8.14	28 - 58
Height (m)	1.80	0.07	1.6 - 1.88
Body Mass (kg)	94.10	14.03	65.77 – 117.93

For the baseline HRQOL, general health was reported to be "fair" by one participant, "good" by two participants, "very good" by eight participants, and "excellent" by two participants. Total unhealthy days were over the previous 30 days was reported as 4.6 ± 7.1 days (range: 0-23), with four participants reporting zero unhealthy days. Six individuals reported that they were not limited in any way in any activities because of impairments or health problems, three reported being "not sure" and four reported being limited. Those that reported being limited in activities cited the joint which they obtained a product being the source of their limitation. Changes in the Fusionetics® Movement Health Scores and associated subscores, where higher scores indicate improvements, are reported in Table 2. There were no significant differences found between pre- and post-scores.

Table 2: Comparison of Fusionetics® Movement Health Scores, including subscores, prior to and following a two-month intervention period (mean ± SD).

Variable	Pre-intervention	Post-intervention	p-value
Total Movement Health Score	46.81 ± 11.44	50.50 ± 17.28	0.19
Function Subscore	40.19 ± 13.28	40.19 ± 16.12	0.50
Injury Subscore	46.08 ± 20.11	53.08 ± 27.98	0.14
Soreness Subscore	35.77 ± 20.19	38.46 ± 20.04	0.17
Readiness Subscore	60.77 ± 14.12	58.85 ± 15.16	0.36

4 DISCUSSION

The present study aimed to evaluate the impact of a semi-conductor based recovery wear product on self-reported measures of work-related musculoskeletal discomfort among first responders, a physically demanding profession. The study's results, while limited by a small sample size, suggest that the use of the recovery wear products did not influence musculoskeletal function and readiness, as measured by the Fusionetics® Movement Health Questionnaire, for a group that self-reported being healthy at baseline.

This project's overarching goal was to study the management of work-related musculoskeletal disorders, particularly among first responders who cannot easily modify their job tasks or reduce exposure to repetitive activities. The use of recovery wear products offers a practical intervention that can be easily integrated into daily routines, providing a non-invasive means to enhance recovery and reduce discomfort. The recovery wear product used in the current study has been previously found to decrease patient discomfort and increase range of motion following total knee replacement (Justice, Jacob, 2024). While there was no difference found in the current study, this is not unexpected, due to the well-documented difficulty in decreasing musculoskeletal injuries in a tactical or first responder population. A meta-analysis of interventions to reduce musculoskeletal overuse injuries in tactical populations found weak evidence to support common injury prevention strategies, such as training load or footwear modifications (Sinnott et al., 2023).

A challenge with interpreting the results of the study is that the sample size was small, with only 13 participants completing the two-month intervention, which limits the generalizability of the findings. Additionally, the study relied on self-reported measures of discomfort and function, which may be subject to response bias. The variability in product usage (e.g., duration and time of use) also introduces a level of inconsistency in the intervention, although this was intended to reflect real-world consumer behaviours. Nevertheless, conducting research in a real-world situation is important. Investigations evaluating if there is a dosage effect for recovery wear products, such as those used in the current study, would aid in both practical usage and enhance future research protocols. A previous investigation of the use of same recovery wear product used in the current study in a population of knee osteoarthritis patients had the participants continuously wear the knee sleeve for a six-month time period (Marino et al., 2019). Those with grade 1 or 2 osteoarthritis had significantly improved patient-reported outcome scores and decreased pain, whereas those with grade 3 osteoarthritis did not have significant improvements (Marino et al., 2019).

Future research should aim to further test the hypothesis that recovery wear products, such as those used in the current study, influence measures of musculoskeletal function and readiness with a larger, more diverse sample to enhance the generalizability of the results. While individuals at all career stages and ages were recruited to participate, the current study's participants had a mean age of 45 and ranged from 28-58 years old. The higher concentration of participants over the age of 40 could have influenced our findings. These individuals may have had age-associated co-morbidities (e.g., cardiovascular conditions), as hypertension is the second most common preventable disease in police officers and firefighters, with musculoskeletal injuries being the first (Santos et al., 2022). Longitudinal studies with

extended follow-up periods could provide more comprehensive insights into the long-term effects of products on musculoskeletal health. Future studies focused on one anatomical location (e.g., knee sleeve) and incorporating control groups (e.g., sham products, controls matched by age and gender) should be performed. Additionally, incorporating objective measures of musculoskeletal function and recovery, such as biomechanical assessments or physiological markers of inflammation, could strengthen the evidence base and provide a more nuanced understanding of the mechanisms underlying the observed benefits.

ACKNOWLEDGEMENTS

Funding for this study was provided by a GOED Catalyst grant from the UNLV Sports Research Innovation Initiative, with included matching funds from Incrediwear®, LLC.

The authors would like to thank Shin Hwa Noh for his work in data collection and analysis.

REFERENCES

Barbe, M. F., & Barr, A. E. (2006). Inflammation and the pathophysiology of work-related musculoskeletal disorders. *Brain, Behavior, and Immunity*, *20*(5), 423–429. https://doi.org/10.1016/j.bbi.2006.03.001

Bureau of Labor Statistics. (2016). Nonfatal Occupational Injuries and Illnesses Requiring Days Away from Work. https://www.bls.gov/opub/ted/2017/nonfatal-occupational-injuries-and-illnesses-resulting-in-days-away-from-work-in-2016.htm#:~:text=Among%20the%2023%20occupational%20groups,away%2Dfrom%2Dwork%20cases.

Justice, T. E., & Jacob, P. B. (2024). Non-compressive sleeves versus compression stockings after total knee arthroplasty: A prospective pilot study. *Journal of Orthopaedics*, *49*, 102–106. https://doi.org/10.1016/j.jor.2023.11.044

Lee, P. Y. F., Brock, J., Mansoor, S., & Whiting, B. (2018). Knee Braces and Anti-Inflammatory Sleeves in Osteoarthritis, innovation for the 21st century? *Journal of Arthritis*, *07*(02). https://doi.org/10.4172/2167-7921.1000e117

Marino, K., Lee, R., & Lee, P. (2019). Effect of Germanium-Embedded knee sleeve on osteoarthritis of the knee. *Orthopaedic Journal of Sports Medicine*, *7*(10), 232596711987912. https://doi.org/10.1177/2325967119879124

Santos, A. R. D., Ihlenfeld, M. F. K., Olandoski, M., & Barreto, F. C. (2022). Comparative analysis of the health status of military police officers and firefighters: a cross-sectional study in the State of Paraná, Brazil. *BMJ Open*, *12*(9), e049182. https://doi.org/10.1136/bmjopen-2021-049182

Sinnott, A. M., Krajewski, K. T., LaGoy, A. D., Beckner, M. E., Proessl, F., Canino, M. C., Nindl, B. C., Turner, R. L., Lovalekar, M. T., Connaboy, C., & Flanagan, S. D. (2022). Prevention of Lower Extremity Musculoskeletal Injuries in Tactical and First Responder Populations: A Systematic Review and Meta-Analysis of Randomized Trials From 1955 to 2020. *Journal of Strength and Conditioning Research*, *37*(1), 239–252. https://doi.org/10.1519/jsc.0000000000004293.