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A Study of the Usability of Ergonomic Camera Vest Based on Spirometry Parameters

Shirazeh Arghami [a,*], Mohsen Asghari [a]

[a] *Department of Occupational Health Engineering, Zanjan University of Medical Sciences, Zanjan, Iran.*

Corresponding author. *E-mail address: arghami@zums.ac.ir

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Background: Being a cameraman is one of those occupations that expose people to musculoskeletal disorders (MSDs). Therefore, control measures should be taken to protect cameramen's health. To solve the given problem, a vest was designed for cameramen to prevent MSDs by reducing the pressure and contact stress while carrying the camera on their shoulder. However, the usability of vest had to be considered. The aim of this study was to determine the usability of the proposed vest using the spirometry parameters indicator.

Methods: In this experimental study, 120 spirometry experiments were conducted with 40 male volunteer subjects with and without designed vest. Data were analyzed using SPSS-16 with dependent t-test, at 0.05 significance level.

Results: Based on the spirometry results, there is a significant difference between Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1) and heart rate in activity with and without vest (p<0.001).

Conclusion: The results suggest that the promising impact of this invention on the health of cameramen makes this domestically designed camera vest a good option for mass production.

1. Introduction

Musculoskeletal disorders (MSDs) are the most common cause of pain and discomfort. Most people experience these disorders at different stages of their life [1]. They are common in all age and sex groups and have significant effects on health [2]. Therefore, they are considered as one of the biggest occupational health problems in the world [3]. MSDs are chronic and include disorders in muscles, tendons, peripheral nerve, joints, bone, ligament, and blood vessels associated with motor system [4]. It has been shown in studies that chronic musculoskeletal pain has an adverse effect on the quality of physical and mental performance of individuals. Therefor, measures need to be taken to improve these conditions [5]. In addition, MSDs impose many costs on the society. In the United States (2010), the popularity of these disorders in the private sector has been estimated to be around 29 to 35% and the median lost days due to these disorders was about 8 to 11 days [6]. In Europe, it is estimated that the cost of MSDs is about 2% of gross domestic production (GDP) [7]. A worse situation is predicted for Central Asia [8]. Hence, pathology and more importantly, control of MSDs is necessary.

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There is a direct relationship between MSDs and heavy physical work (such as carrying heavy loads) and this has been proven [9]. One of the occupational groups dealing with this situation is the cameramen [10]. These people have to carry heavy cameras on their shoulder, and sometimes, run fast at the same time [11]. Therefore, appropriate control measures should be taken to help maintain their health. Scientific research has shown that the best approach to reduce this pain is to implement interventions [12].

Therefore, an ergonomic vest was designed for cameramen to use on a hand-held camera (Patent No. 87749 dated 17 Jan 2016). The designed ergonomic vest is as shown in Fig. 1.

The ergonomic vest is made of light weight and resistant material that can reduce the pressure and contact stress on cameramen while carrying the camera on their shoulder. The ergonomic vest is designed based on the average weight of cameramen (55 to 70 kg). Naturally, when it reaches the commercial production stage, it can be resized for any other weight (just like the sizing of shoes and cloths). However, for now only one sample has been made for 55 to 70 kg weight. The weight of this ergonomic vest is 400 g (equivalent to the weight of a safe helmet) (Fig. 1).

The registration process for this vest is over and it is considered to be ergonomic intervention. However, all ergonomic interventions should pass a usability test to be considered as an effective tool. Usability is an approach to ensure the usefulness of a product, system or service. Usability tests can be carried out based on different methods from the user's perspective to instrumentation tests [13]. It is obvious that the results of the instrumentation tests will be more acceptable [14, 15].

One of the measurable methods for testing the usability of tools that need to be carried is to examine the spirometry parameters index of an individual when using the tool [16, 17]. The aim of the present study was to determine the usability of the proposed ergonomic camera vest using the spirometry parameters indicator.

2. Materials and Methods

This study is an analytical interventional study conducted in ergonomic laboratory of the School of Public Health at Zanjan University of Medical Sciences. In this study, based on the sample size formula at 95% confidence level, 40 healthy male university students with an average weight of 55 to 70 kg were enrolled as subjects. Individuals with MSDs, cardiovascular and respiratory problems and those who smoked or had a cold were excluded.

All students were informed about the designed vest and the confidentiality of the related information. Before conducting the test, subjects were asked to express their willingness and consent to participate in the test by signing the consent form. Each subject participated in the experiment twice (with/without the ergonomic camera vest). Each time, they run on a treadmill at a speed of 5.5 km/h for 15 min while carrying a camera on their shoulder. Before and after each test,

A. Side View

B. Back View

Fig. 1: The Designed Ergonomic Vest.

their heart rate, FEV_1 and FVC were measured. Heart rate was measured using Beurer PM25 Heart Monitor made in Korea. Spirometric parameters were measured using the spirometer device (spirolabII model made by

MIR[1] Company of Italy) with disposable turbine (which was replaced in every 15 spirometers according to the standards of the Iranian Association of Occupational Medicine and Health).

Data was analyzed using SPSS-16. Dependent t-test was used to test the hypothesis and the level of significance was set at less than 0.05 and the confidence level was 95%.

3. Results and Discussion

Based on the results of the data analysis, a significant relationship was found between measured variables and the designed vest. According to the results shown in Table 1, the average heart rate of subjects during activity without using the vest was 113.2 min^{-1} while during activity with the vest was 94.2 min^{-1}. Significance level at 0.001 shows the positive effect of using the designed vest to reduce heart rate. The maximum forced vital capacity (FVC) with and without using the vest is 103.67 and 90.52, respectively, which shows that FVC during the carrying of camera without the use of the vest is significantly less than FVC during the carrying of camera with the use of the vest (p <0.001).

Also, the maximum forced expiratory volume in first second (FEV_1) in activities with and without vest was 110.25 and 89.67, respectively and p =0.001 showed significant differences, which in turn shows that the vest has a positive effect on this variable.

To date, new ergonomic designs are proposed to reduce MSDs [18]. Since manual material handling (MMH) is the main concern, many new designs of tools and gadgets have been introduced to make the load bearable [19]. This study was conducted to investigate the usability of the designed ergonomic camera vest using spirometry parameters [VO_2] and heart rate. It has been accepted that there is a direct linear relationship between the spirometry parameters and heart rate in moderate and severe activities [20]. As shown by the results of the data analysis, a significant relationship was found between the measured variables and the designed vest; As such it can be concluded that the ergonomic vest used by subjects in carrying of camera on their shoulder has a positive effect in terms reducing the pressure and contact stress.

The designed vest has been recommended to be used by a wide range of cameramen working in different fields including documentary, sport events shooting, and photo journalism who need to carry a monocular camera on their shoulder and sometimes run quickly at the same time. The designed ergonomic vest has a much lower weight than the ones introduced on the web. This is very important in maintaining the health of the trunk and spine. For example, the vest shown in Fig. 2 has a weight of 6.8 pounds (equivalent to 3.1 kg) and the one in Figure 3 is 10 pounds (equivalent to 4.5 kg), while the designed ergonomic vest is only 400 g (similar to the weight of a safe helmet that the cervical spine can bear for several hours).

Fig. 2: A Camera Vest with the Weight of 3.1.

Fig. 3: A Camera Vest with the Weight of 4.5.

The designed ergonomic vest has a lesser number of accessories (camera holder lever, bolts, and nuts). This feature has some advantages such as: the need for repair is reduced; it is easier to carry; it is lighter; and it is an easy-to-use vest because it does not need the assembling of numerous parts, in the shootings that the cameramen need to move a lot in order to perform their task appropriately. The designed ergonomic vest does not affect their agility. A similar vest was found on the web (Fig. 4 and 5). The distribution of force in the vests (shown in Fig. 4 and 5) seems to be less successful when compared with the designed ergonomic vest.

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Similar samples found on the web are good for cameras with a monitor, which provide the ability for the cameramen to see farther distance with their eyes; recording with monocular cameras requires the cameramen to constantly keep the camera on their shoulder, so the vests found on the web are not good for this kind of cameras. There is a significant difference between the price of similar vests found on web and the ergonomically designed vest. Vests found on web are $ 2,000 to $ 3,000, while the final fixed price of the designed ergonomic vest is less than 600$ (equal to 2,500,000 Rials- Iran's currency).

Table 1: Summary of the Results of Dependent T- Test.

Variable	Indicator			
	Average of Variables	**Average of Group**	**T**	**Significance Level**
Heart Rate before Activity	79.50	-1.44	-7.33	0.001
Heart Rate during Activity with the Vest	94.20			
Heart Rate during Activity without the Vest	113.2	1.90	7.959	0.001
Heart Rate during Activity with the Vest	94.20			
Maximum Forced Vital Capacity (FVC) before Activity	100.62	-3.05	-3.255	0.02
Maximum Forced Vital Capacity (FVC) during Activity with the Vest	100			
Maximum Forced Vital Capacity (FVC) during Activity without the Vest	90.52	-1.31	-6.662	0.001
Maximum Forced Vital Capacity (FVC) during Activity with the Vest	100			
Maximum Forced Expiratory Volume in First Seconds (FEV_1) before Activity	105.95	-4.30	-3.713	0.001
Maximum Forced Expiratory Volume in First Seconds (FEV_1) during Activity with the Vest	110.25			
Maximum Forced Expiratory Volume in First Seconds (FEV_1) during Activity without the Vest	89.67	-2.05	-7.623	0.001
Maximum Forced Expiratory Volume in First Seconds (FEV_1) during Activity with the Vest	110.25			

Fig. 4: A Camera Vest Found on the Web.

Fig. 5: A Camera Vest Found on the Web.

4 . Conclusion

The results showed that the introduced ergonomic vest is usable for cameramen, therefore, the potential impact of this invention on cameramen health makes this vest a good option for mass production.

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Limitation

The results of this study were promising. However to get more assure about the usability of cameraman ergonomic vest, it is better to measure the spirometry parameters in real field, too.

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