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Original Article

The combined effect of Kinesio tape and exercise on risk reduction, pain relief, and hand function improvement in assembly workers of a manufacturing industry

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Abstract

Background and aims: Nowadays, one of the purposes of ergonomics is to identify the risk factors of musculoskeletal disorders and provide solutions to reduce them. The aim of this study was to investigate the effect of using Kinesio tape and doing exercise during working hours for 8 weeks on the reduction of risk and pain and improvement of hand function during daily activities.

Methods: This clinical trial study was carried out on 40 female workers employed in the manufacturing industry. The subjects were divided into three groups, including exercise-taping, exercise, and control, and performed an 8-week rehabilitation program twice a week. To assess the upper limb function, the cognitive demand of the assigned task, and hand strength, the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, Borg Scale, and a dynamometer were used, respectively.

Results: The results of this study indicated a decrease in upper limb disability and increased grip strength in the tape plus exercise group compared to the control group ($P<0.05$). However, no significant change in the Borg scale was found in any of the three groups ($P>0.05$).

Conclusion: It can be concluded that attending at least 2 or 3 exercise sessions per week and using Kinesio tape can be effective in reducing pain in the upper limb.

Keywords: Disability, Upper limb, Assembly workers, Exercise, Kinesio tape

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Introduction

Musculoskeletal risk factors are related to repetitive work, poor posture, use of force, and job stress and satisfaction in the workplace (1,2). Most musculoskeletal disorders result from human occupation or work activities (2).

Work-related musculoskeletal disorders (WMSDs) refer to those in which blood, muscles, nerves, and vessels are involved (3). WMSDs can reduce productivity and working time and increase the health costs of industrial injuries (4). The risk of MSDs increases when the body is repeatedly used (5). These disorders are among the main causes of disabilities in developed countries and are common among employees. A proper workstation is an essential option in industries (6).

Neglecting ergonomic factors in the workstation causes damage to the worker`s musculoskeletal system (7). In the assembly lines, the job includes repetitive and precise activities; therefore, assembly workers suffer from the resulting physical and psychological stresses, which lead to musculoskeletal disorders. For example, in electronic components manufacturing companies, there are a lot of procedures that require the use of upper limbs, especially hands, which can cause WMSD (8). A study by Yahya and Zahid, aimed at evaluating WMSD among the assembly employees of the electronic industry, showed that more than half of the participants reported pain in their shoulders, wrists, and lower back (9).

Recently, excessive time spent with low energy expenditure (e.g., ≤ 1.5 metabolic equivalents (METs)) has been a potential risk factor for musculoskeletal disorders (10). Moreover, due to the repetitive nature of the assembly process, WMSDs such as carpal tunnel syndrome (CTS), vibration white finger, and back pain can occur in the upper, lower back, and lower parts of the trunk. Moreover, the related studies revealed that the incidence of CTS in women is 5 times as many as those in men. These studies highlight the importance of early preventive interventions in reducing WMSDs and lowering health care costs. In recent decades, most studies have examined the benefits of physical activity plans for WRMSDs. Besides, in various studies, the importance of exercise in the treatment of several diseases has been

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proven (11).

Doing exercises to prevent upper limb and neck WRMSDs has attracted the attention of many researchers. In this line, several studies have been carried out on office workers (12-14), industrial technicians (15-17), and slaughterhouse workers. The exercises in which flexion-extension of the fingers and wrists are actively performed can reduce the pressure in the carpal tunnel resulting in pain reduction. It is said that the main reason for not exercising is the lack of time. Therefore, interventions in the workplace including physical exercise during work hours and in the presence of colleagues can be helpful to those who are less motivated to do sports. On the other hand, given that most people work several hours a day and several days a week, the workplace can provide a suitable environment for health promotion. Previous studies have documented the effectiveness of workplace interventions including physical exercises in preventing and relieving neck, shoulder, and back pain (18).

Following the instructions of the body surface anatomy and applying them correctly, one can remove pressure from a particular tendon so that the tendon can be recovered. Many body injuries are healed by rest, but the problem is that there are so many daily activities one should do that the tendon has no time to recover.

In such a situation, the use of Kinesio tape helps the patient to remove daily pressure from the tendon and increases the rate of tissue repair while doing everyday activities (19). Kinesio tape is a thin elastic cotton strip with an acrylic adhesive. This adhesive tape can be stretched up to 140% of its normal length, without limiting the movement of the joint and the muscle. The mechanism of the effect of Kinesio tapes on pain relief is unclear. The blood flow increases below the area that was taped. Murray stated that Kinesio tape improves ankle joint position sense by stimulating the mechanical receptors of the skin. Kinesio tape is used in muscle treatment in two ways as follows: (1) For muscles that are stretched, or the muscles in the acute phase or those that are involved in overwork activities, the brigade is pushed from the muscular end to the muscle's origin, with the aim of inhibiting muscle function, (2) For muscles that are in the chronic phase or weak muscles, the tape is pulled from the muscle origin to the muscle end, which facilitates muscle function (20).

With the initial observation of the workers in the companies of electrical equipment production, as well as the nature of the production process, musculoskeletal disorders that a person experiences during his routine work (repeated movements of hands, standing or sitting for long periods of time, using excessive force, and maintaining awkward postures) can be easily traced. Therefore, this study was conducted to examine the effectiveness of performing appropriate exercises in the workplace and using Kinesio tape in reducing pain symptoms and increasing the strength of the upper extremities.

Materials and Methods

This clinical trial study was conducted on female workers in the assembly line of an electrical equipment manufacturing industry in Iran.

Study stages

There were 100 female workers in the assembly line of the company, 66% of whom were enrolled in this research. The inclusion criteria in this study were the lack of osteoporosis, inflammatory diseases such as rheumatoid arthritis, metabolic diseases such as hypothyroidism, hand surgery in recent years, malignant diseases, and hand disorders. Exclusion criteria were irregular participation in exercises, unwillingness to cooperate, having an allergy to Kinesio tape adhesives, and not completing the research tests. The flow diagram of the study procedure is represented in Figure 1.

Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire

The DASH questionnaire was used to measure the function of the arm, shoulder, and hand of the workers. The DASH questionnaire contains 30 questions that measure performance and physical symptoms. This questionnaire describes the upper limb disabilities and disorders experienced. Each question has five options ranging from "no difficulty" to "unable to perform activity" which are scored on a five-point scale. Finally, the questionnaire score is calculated using the existing formulas (21). In 2008, Mousavi et al prepared the Persian version of the questionnaire and confirmed its validity and reliability (22).

Borg scale

To measure the perceived hardness and the intensity of the activity, the Borg scale was used (23). In work environment studies, this scale is usually used to examine the individual's feelings during the task and determine the extent to which the operator puts effort at various levels of workload. This scale is user-friendly scale and includes values ranging from 6 (no exertion) to 20 (maximum exertion) (24). The individual worker must determine the level of his/her efforts during the task by selecting one of these values. The validity of this scale was confirmed in different national studies (25). In this study, this scale was used to determine the difficulty level of the task by the assembly operator and to reach the conclusion that doing exercise can change the worker's perception of his own effort.

Dynamometer

To measure grip strength, the American Society of Hand Therapists (ASHT) protocol was used. According to the ASHT protocol, the participants sit on a chair. Then, their arms are held tightly to their body without any rotation, and the wrists are fixed in 0-30 degrees of extension and 0-15 degrees of ulnar deviation. In this study, the grip

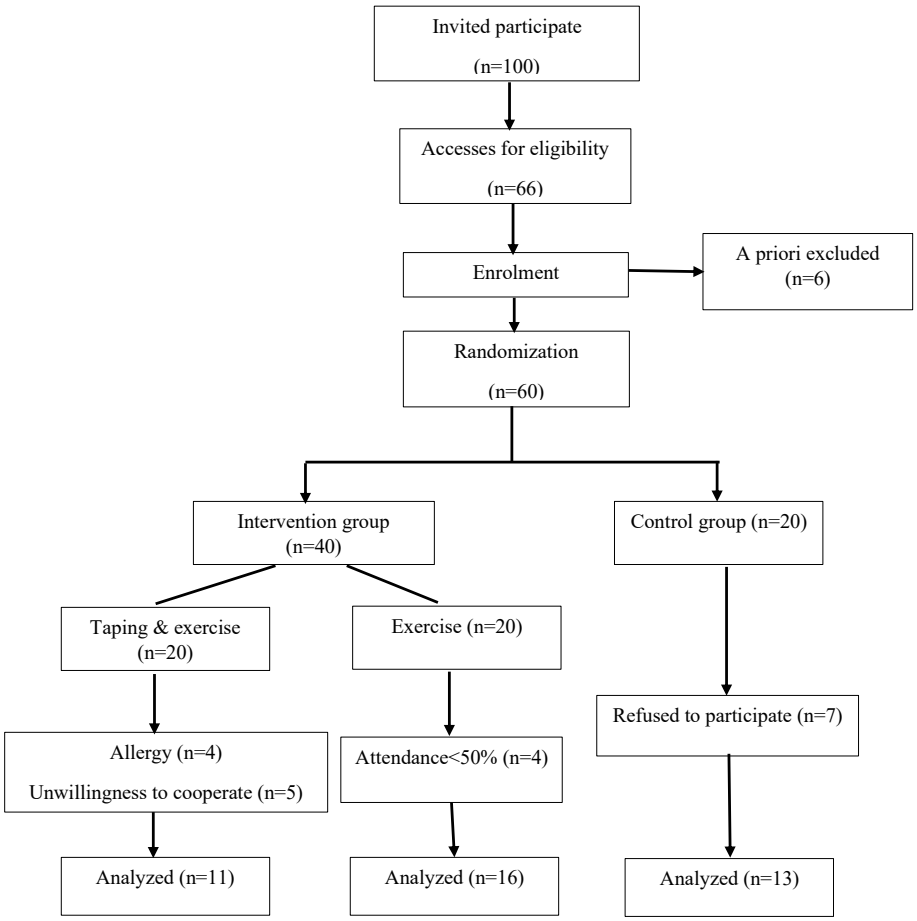

Figure 1. The flow diagram of the study procedure

strength was measured three times, and the average of the maximum force applied by the individual to the dynamometer handle in the three trials was recorded in kgf. The validity and reliability of the dynamometer have been documented and it was described as a standard for measuring (26).

Intervention program

A standardized intervention program, including stretching and strengthening exercises based on wrist-related injuries and CTS, was trained and implemented (27). The intervention was performed twice a week for 8 weeks. All sessions were held at the workplace and supervised by a physiotherapist. At the beginning of each session, the participants performed four stretching and strengthening exercises with a 30-second rest between repetitions. The four training exercises used in the present study are represented in Figure 2.

At the end of the exercises, workers returned to their workplace. It should be noted that Kinesio type was not used during exercise. The attachment location of Kinesio tape is shown in Figure 3.

Data Analysis

Data analysis was carried out using SPSS version 20.0. Chi-square test, ANCOVA test, one-way ANOVA test, and *t*-test were used for data analysis in this study. It is noteworthy to mention that P value < 0.05 was considered statistically significant.

Results

The mean and standard deviation of the age and work experience of the participants were 33.67 years (±6.88) and 4.03 years (±3.77), respectively. One-way analysis of variance showed that there was no significant difference between the three groups in the mean of demographic variables. The data are shown in Table 1.

Descriptive statistics for qualitative variables and demographic information of 40 participants in this study were also presented in Table 1. The results of Chi-square test showed a statistically significant difference in the history of hand pain between the three groups ($P=0.026$), while no significant difference was found in other variables between the three groups ($P>0.05$).

The analysis of the data recorded in the 3 groups after 8 weeks of intervention and practice showed that DASH score in the tape plus exercise group and the exercise group significantly decreased compared to the control group, indicating improvement in hand function. Additionally, the results of paired *t* test showed that the grip strength of both hands significantly increased in the two intervention groups compared to the control group. These variations in the Borg scale were not significant in any of the three groups after 8 weeks of exercise ($P=0.470$). The data in

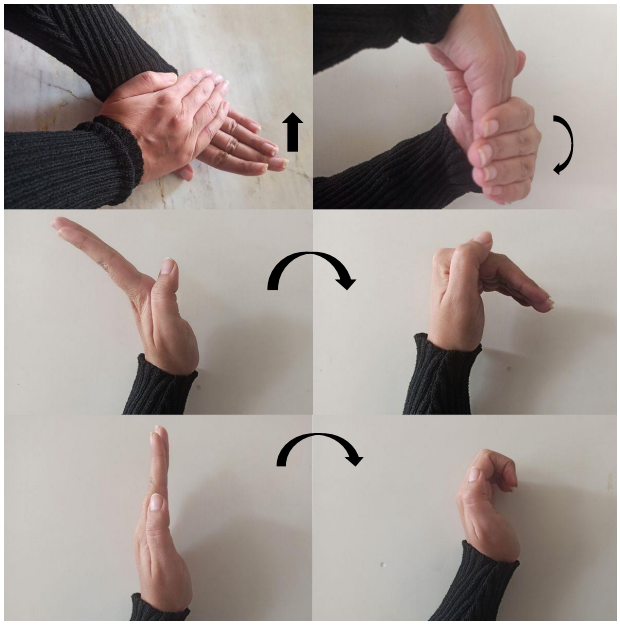

Figure 2. The four training exercises used in the present study

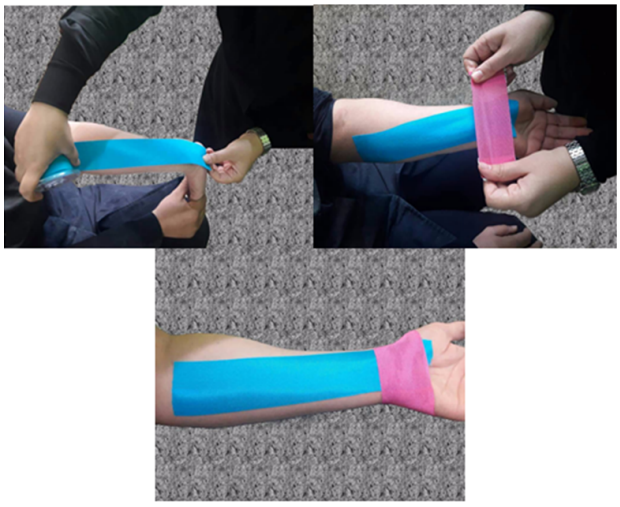

Figure 3. Frontal view of the hand after the application of Kinesio tape

this section are presented in Table 2. The mean of changes in the above-mentioned variables was also statistically analyzed before and after the intervention. The results of ANCOVA test showed that the differences in the mean changes in the DASH score and grip strength of left and right hands before and after the intervention were significant between the 3 groups ($P=0.000$), but these changes were not significant regarding the Borg scale variable ($P>0.05$).

Moreover, the mean of changes in the variables between every two groups was statistically analyzed using the Bonferroni test. The mean of changes in DASH score and hand grip strength in the intervention groups was greater compared to the control group ($P=0.000$). As a result, it seems that the use of Kinesio tape did not improve hand function significantly ($P>0.05$), but as revealed in Figure 4, the changes in the group that used the tape and performed the exercises were greater compared to the group that only performed the exercises.

Therefore, if we increase the number of participants in this group or increase the intervention sessions, this difference will be significant and the combined effect of the use of the Kinesio tape and exercise will be greater than the effect of mere exercise. There was no significant change in any of the groups in the Borg scale.

Discussion

This study aimed to investigate the combined effect of using Kinesio tape and doing exercise during 8 weeks on risk reduction, pain relief, and hand function in daily working activities of female workers who are more vulnerable to CTS due to physiological characteristics and the repetitive nature of their work. The results of this study showed a decrease in DASH score and an increase in hand grip strength in the two groups of exercise and exercise plus tape compared to the control group. However, the intervention did not lead to a significant change in the Borg scale in any of the 3 groups. This means that the participants still find their job hard and exercise does not reduce the difficulty level of their job. Based on the results, to improve hand function, it is not necessary to do exercise every day, and it is enough to do exercise two to three times a week. Bang and Deyle concluded that performing exercises two or three times a week has better outcomes than daily exercise but may be inapplicable due to time limitations, which is in line with the results of the present study (28). Furthermore, a systematic review has shown the benefits of therapeutic exercises over other treatments such as laser therapy, ultrasound, and acupuncture (29). Camargo et al also found that conducting an appropriate rehabilitation program could improve DASH score. They suggest an intervention program including strengthening and stretching during working hours twice a week to reduce pain and physical impairment in male workers with subacromial impingement syndrome (30). In a similar study, Rasotto et al investigated the effectiveness of an appropriate physical activity program in the workplace in reducing symptoms in the upper extremities and neck. The results indicated a significant reduction in the symptoms of pain in the neck, shoulders, elbows, and wrists and significant improvements in muscle strength, upper limb mobility, and DASH score. This protocol demonstrates that conducting an appropriate exercise program helps to reduce the pain and disabilities of upper limb WRMDs (31). On the other hand, the results of our study showed that the mean differences in DASH score and hand grip strength were significant between the intervention groups and the control group ($P=0.000$) but no significant difference was found between the two intervention groups. Accordingly, it seems that the use of Kinesio tape did not play a significant role in improving the function of the hands, but as reported in Figure 4, the changes in the group that used Kinesio tape and performed exercise were greater than those in the exercise group. Therefore, if we increase the number of participants in this group or increase the intervention sessions, this

Table 1. Demographic characteristics of the participants in this study

Variable		Taping and exercise	Exercise	Control	*P* value
Age (y)		35.81 ± 6.60	32.31 ± 6.03	33.53 ± 8.08	0.439
Weight (kg)		66.81 ± 9.78	63.81 ± 10.17	65.07 ± 5.34	0.685
Height (cm)		161.00 ± 7.78	162.56 ± 6.43	163.30 ± 6.47	0.708
Body mass index (kg/m²)		25.74 ± 2.82	24.25 ± 4.22	24.50 ± 2.72	0.520
Marital status	Single	2 (18.2)	1 (6.3)	2 (15.4)	0.913
	Married	9 (81.8)	15 (93.8)	11 (84.6)	
Number of children	0	1 (9.09)	0 (0)	2 (15.38)	0.302
	1	2 (18.18)	6 (37.50)	3 (23.07)	
	2	4 (36.36)	8 (50.00)	8 (61.53)	
	>2	4 (36.36)	2 (12.50)	0(0)	
Work experience (y)		4.59 ± 2.76	2.84 ± 2.26	5.03 ± 5.51	0.259
Sports program	Yes	1 (9.1)	3 (18.8)	4 (30.8)	0.399
	No	10 (90.9)	13 (81.2)	9 (69.2)	
Dominant hand	Right	8 (72.7)	13 (81.2)	12 (92.3)	0.424
	Left	3 (27.3)	3 (18.8)	1 (7.7)	
Past history of hand pain	Right	3 (27.3)	6 (37.6)	5 (38.5)	0.026
	Left	7 (63.6)	5 (31.2)	0	
	No	1 (9.1)	5 (31.2)	8 (61.5)	
Another health professional or other health professionals	Yes	5 (45.45)	4 (25)	2 (15.4)	0.814
	No	5 (45.5)	7 (43.8)	3 (23.1)	
	Missing data	1 (9.1)	5 (31.3)	8 (61.5)	

The data in the table are reported as Mean ± SD and N (%).

Table 2. Mean ± SE of the dependent variables at baseline and 8 weeks after the intervention in experimental and control groups

Variable		Taping plus exercise	Exercise	Control	Between the groups	Pairwise *P* value	*P* value
Borg scale	Baseline	6.72 ± 0.33	6.81 ± 0.36	7.76 ± 0.54	Control - tape and exercise	0.340	0.470
	After 8 weeks	7.09 ± 0.53	6.75 ± 0.44	7.76 ± 0.42	Control - exercise	0.332	
	P-value	0.459	0.901	1.000	Exercise - tape and exercise	1.000	
DASH score	Baseline	38.71 ± 8.20	20.36 ± 4.70	12.14 ± 4.02	Control - tape and exercise	0.009	0.000
	After 8 weeks	25.07 ± 5.87	10.96 ± 2.93	13.63 ± 4.48	Control - exercise	0.855	
	P-value	0.002	0.000	0.097	Exercise - tape and exercise	0.080	
The strength of the right hand grip (kgf)	Baseline	22.90 ± 1.68	27.88 ± 1.01	29.71 ± 1.98	Control - tape and exercise	0.016	0.000
	After 8 weeks	26.11 ± 1.68	30.59 ± 0.98	29.12 ± 1.98	Control - exercise	1.000	
	P-value	0.000	0.000	0.215	Exercise - tape and exercise	0.090	
The strength of the left hand grip (kgf)	Baseline	19.93 ± 1.27	24.92 ± 1.04	26.53 ± 1.56	Control - tape and exercise	0.005	0.000
	After 8 weeks	23.08 ± 1.12	27.22 ± 1.04	25.52 ± 1.67	Control - exercise	1.000	
	P-value	0.000	0.000	0.102	Exercise - tape and exercise	0.031	

difference will be significant between the two intervention groups and the combined effect of the use of the Kinesio tape and exercise will be greater than the effect of the exercise alone. However, the simultaneous use of Kinesio tape and exercise may be psychologically more effective than exercise alone. In 2012, Donec et al examined the effect of Kinesio tape on the maximum grip strength of 54 healthy non-athlete players in both hands. The results showed that in the Kinesio tape group, the maximum grip strength increased significantly. However, grip strength did not significantly change in the two other groups (placebo and control) (32). In 2013, Ali et al examined the effect of Kinesio tape on pain reduction in 60 patients with CTS with an average age of 40 years. In this study, the participants were divided into two equal groups (A and B). The treatment in group A included a standard physiotherapy program plus Kinesio tape every other day for 4 weeks and the treatment in group B included only standard physiotherapy. The results of the study showed that the pain level was significantly reduced in both groups, especially in the Kinesio tape group (33). Thelen et al performed a study on 42 students with impingement or rotator cuff tendonitis. The results showed immediate pain relief and an increase in motion range in the Kinesio

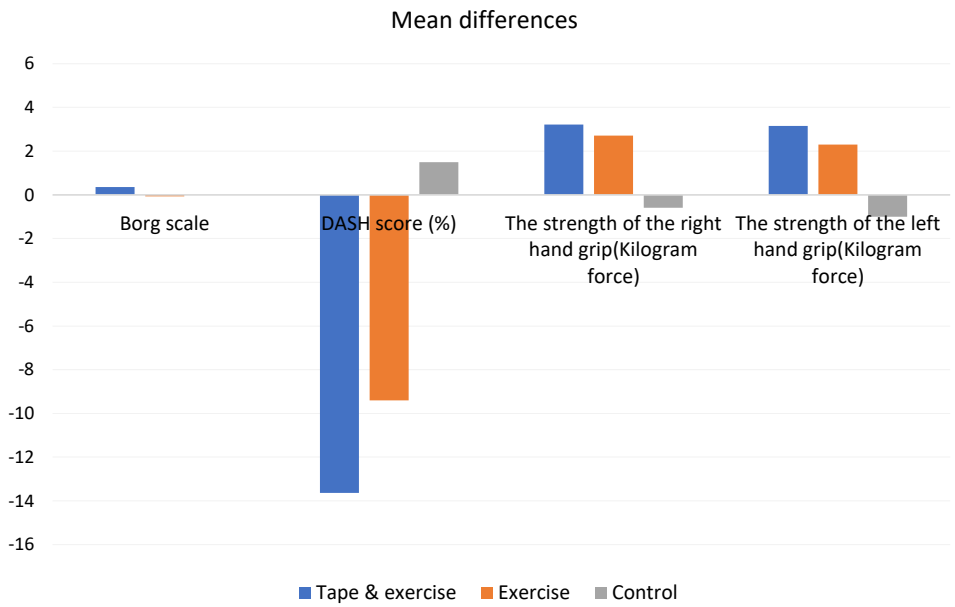

Figure 4. The mean difference of variables before and after the intervention in the three groups

tape group as compared to the control group (34).

Similar to other studies, the present study also suffers from some limitations. One of the limitations of this study is the loss of samples during the work due to unwillingness to cooperate and participate in exercises and having an allergy to Kinesio tape, which ultimately reduced the number of samples. It should be noted that musculoskeletal disorders as well as pain sensation are simultaneously affected by physical and psychological factors, while only the physical dimension was measured. Another limitation is related to the nature of the instruments used in this study. As DASH is a self-report instrument, the participants may magnify or minimize the effects of the variables examined in this questionnaire. It should be noted that the effect of Kinesio tape and exercise on hand function should be investigated in both genders considering psychological factors in various groups including Kinesio taping group, exercise group, Kinesio and exercise group, placebo and exercise group, placebo group, and control group.

Conclusion

In general, the results of this study suggest that an intervention program including the combined use of Kinesio tape and exercise at least 2 or 3 exercise sessions per week during working hours is more effective in reducing risk and improving hand function in assembly workers of the manufacturing industry compared to exercise alone. It is suggested that further studies should be conducted to closely examine the effect of Kinesio tape use on the pain and performance of assembly workers.

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Authors' Contribution

Conceptualization: Farzaneh Fadaei.
Data curation: Zahra Ordudari.
Formal analysis: Zahra Ordudari.
Investigation: Farzaneh Fadaei.
Methodology: Zahra Ordudari.
Project administration: Ehsanollah Habibi.
Resources: Farzaneh Fadaei.
Supervision: Ehsanollah Habibi.
Validation: Zahra Ordudari.
Writing-original draft: Farzaneh Fadaei.
Writing-review & editing: Zahra Ordudari.

Competing Interests

The authors declare no conflict of interests.

Ethical Approval

The Ethics Committee of Isfahan University of Medical Sciences reviewed and confirmed the present study protocol (IR.MUI.REC.1396.1.217). All participants signed a consent form after they were fully informed of the study procedure in which all the principles of ethics in the research were observed.

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