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Original Article

The effect of physical stretching fitness on decreasing musculoskeletal disorders among clinical nurses

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Objective: The prevalence of musculoskeletal disorders (MSDs) is high among nurses; however, there remain few research studies contributing findings supportive of evidence-based interventions for MSDs. This study was performed to evaluate the effectiveness of physical stretching fitness exercises on decreasing the prevalence of MSDs in nurses in one medical center. **Methods:** Two hundred thirty-six nurses diagnosed with MSDs by the Nordic Musculoskeletal Questionnaire (NMQ) participated in this randomized clinical study conducted in one medical center. These nurses were divided into two groups: the intervention and control group. Nurses in the intervention group were educated to do daily physical stretching and exercises and were evaluated before and after using six physical indicators: body mass index (BMI), grip strength, flexibility, abdominal muscle durability, back strength and, cardiopulmonary strength, but the control group received no physical stretching fitness. **Results:** Nurses in the intervention group had a significant improvement in the six physical indicators using logistic regression analysis. Compared to the control group, nurses in the intervention group were more flexible (OR=2.12, p<.001), had stronger back strength (OR=2.44, p<.001), and had better cardiopulmonary strength than before (OR=3.69, p<.001). **Conclusion:** Nurses are advised to do physical stretching and exercise regularly to decrease the possibility of developing or reducing the effects of MSDs.

Key words: musculoskeletal disorders (MSDs), randomized clinical study, physical stretching fitness, interventional program.

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Introduction

Nurses represent an important occupational group frequently affected by musculoskeletal disorders (MSDs) due to their heavy workloads, working shifts, poor posture, giving shots, making

beds, lifting patients, bending their waist and insufficient rest time every day[1-4]. Previous studies[4-6] have shown that MSDs are common in nurses worldwide and that the prevalence rate for nurses in Taiwan is 65 to 72%. MSDs can affect the quality of care nurses give their patients and can also cause a high turnover rate among nurses. Furthermore, if nurses who have MSDs do not receive treatment, their conditions will worsen. MSDs are prevalent among nurses in Taiwan. Seventy-eight percents of nurses have lower back pain (LBP). The three most common types of MSDs among nurses in Taiwan are back pain (47%), pain in the legs (28%), and pain in the shoulders (25%)[7-8]. Previous studies[9-10] have shown that ergonomic risk factors, including physical exertion at work, frequent bending and twisting, heavy lifting and other patient-handling tasks, contribute to the occurrence of MSDs. There is a significant association between wrist and knee pain and the number of highest-risk patient-handling tasks performed per hour interacting with lifting loads[11]. Therefore, hospitals are trying to reduce the prevalence of MSDs among nurses by improving the hospitals' facilities, training nurses, and having nurses follow standard operational procedures (SOP). The success of one effective low-cost solution called the Participatory Action Oriented Training (PAOT), which is an approach of addressing the unique problems that cause work-related injuries in diverse workplaces (e.g., farm villages and factories), has been well documented[12]. It has also been found that a multifaceted ergonomic intervention program to reduce the prevalence of MSDs among nurses by encouraging nurses to do more physical activity will make them more flexible and increase their strength[13]. Despite the high prevalence of MSDs among nurses[4], which has been consistently observed in the studies of Western countries, there is very little information about the use of interventional programs to prevent or reduced suffer caused by MSDs available in Taiwan.

Methods

Aims

Because there is still limited quality research to support evidence-based ergonomic interventions in practice with MSDs, we performed a randomized interventional study to evaluate the effectiveness of intervention programs which encourage nurses with MSD to engage in more fitness activity.

Design

In this randomized clinical study, a pre- and post-intervention design with intervention group and control group were used to evaluate the effectiveness of the program in a medical center. Two hundred thirty-six nurses were randomly assigned to the intervention group or control group. They underwent baseline and follow-up assessments.

Participants

Three hundred sixty-three out of 512 nurses at our medical center participated in this study. Nurses who had cardiovascular diseases (CVD), diabetes mellitus (DM), renal disease, lung disease, arthritis, and nurses who were pregnant were excluded. Two hundred thirty-six were found to have MSDs and were enrolled into the study. These nurses were randomly divided into two groups: the intervention group (n=118) and the control group (n=118). Fifteen nurses in the intervention group and 23 in the control group did not complete the study, leaving them with 103 and 95 nurses, respectively, to participate in our six-month study. Nurses in the intervention group were taught how to perform daily physical stretching fitness exercises and were evaluated before and after using six physical indicators of fitness: body mass index (BMI), grip strength, flexibility, abdominal muscle durability, back strength and, cardiopulmonary strength. The control group received physical stretching fitness training.

Intervention

MSDs diagnosed by Nordic Musculoskeletal Questionnaire (NMQ)

All of the participants were evaluated for MSDs using the Nordic Musculoskeletal Questionnaire (NMQ)[6] modified to include demographic data, the use of oral contraception, regularity of menstruation, method of child delivery, household

chores, and frequency of exercise. Presence of MSDs was diagnosed by orthopedic physicians. In addition, nurses completed an NMQ questionnaire to determine the severity and duration of their pain, whether their daily activities were affected by pain, and whether they received proper treatment. Both groups received the questionnaire prior to intervention. Content validity was assessed by seven specialists in nursing, public health, physician, ergonomist and statistics. The content validity index (CVI) of the questionnaire was 0.85. Test-retest reliability of the questionnaire was assessed by ten nurses. Coefficient of correlation was 0.92 for work status and 0.93 and for MSDs, respectively.

Physical Fitness Test for nurses

Before the intervention began, we visited the hospital and trained the intervention group to engage in physical activity and mind physical fitness every day. Each nurse was given an exercise DVD. Physical activity was defined as bodily movement produced by skeletal muscle contraction resulting in energy expenditure and further described as including a wide range of body movements, including traditional exercise as well as recreational and leisure-time physical activity. Physical fitness was defined as various attributes that enable an individual to be able to engage in physical activity easily[14]. Each nurse was instructed to keep a daily physical activity and physical fitness record, which included the date, maximum heart rate after exercise, and duration of exercise. Nurses in the control group maintained their normal workload, and did not participate in the intervention program. In addition, we followed the guidelines found a booklet entitled "Physical Fitness Test for Workers" published by the Institute of Occupational Safety and Health (IOSH) in Taiwan in 2003 to measure six physical fitness indicators: body mass index (BMI), grip strength, flexibility, abdominal muscle durability, back muscle durability and cardiopulmonary durability. We measured the nurses' height, weight, grip strength, flexibility (sitting while bending forward), abdominal muscle durability (bent-knee sit-ups), back muscle durability (prone back bend), and cardiopulmonary durability (a 3-minute stair-stepping test). The method of evaluation is described in detail in Yuan's study[6]. We calibrated all the equipment before we used it and recorded the six physical fitness indicators in both groups before and after the intervention program and used these indicators to evaluate the effectiveness of this program.

Ethical considerations

Our study was approved by the ethics committee in this medical center. Consent forms were signed, and participants were informed that they could withdraw from the study at any time. Fifteen nurses in the intervention group and 23 nurses in the control group did not complete the study, either because they quit their jobs or they were unwilling to complete the study.

Data Analysis

We used EXCEL software to record the data, and analyzed the data using SPSS 18. A chi-square test was used to compare the demographics of the two groups. An independent t-test was used to examine pre- and post- intervention data in both groups. At the end of the study, each nurse in both groups was classified in two groups (improved or not improved) based on the six fitness indicators. A nurse was categorized as improved when the physical fitness indicator after the intervention program was greater than the fitness indicators before the baseline in intervention program. Using multivariate logistic regression, we compared the improvement of the six physical fitness indicators in both groups.

Results

Comparison on demographic data

Table 1 compares both group's demographic data. Seventy-two percent of the nurses were under 30 years old, and 71% of the nurses were university or grad school graduates. Fifty-one percent had been nurses for less than five years, and 8% of them had been nurses for more than 16 years. Twenty-three percent believed their workloads were excessive.

Comparison of six indicators after fitness exercise

Table 1. Comparison on demographic data in the intervention and in the control group (N=198)

	Intervention group N=103		Control group N=95		p
	n	(%)	n	(%)	
Age (years)					0.268
30	79	76.7	63	66.3	
31~40	19	18.4	25	26.3	
41	5	4.9	7	7.4	
Education					0.338
college	26	25.2	32	33.7	
University	75	72.8	60	63.2	
Graduate institute	2	1.9	3	3.2	
Marital status					0.106
No	78	75.5	62	65.3	
Yes	25	24.3	33	34.7	
Work duration (years)					0.259
5	57	55.3	40	42.1	
6~10	26	25.2	34	35.8	
11~15	13	12.6	12	12.6	
16	7	6.8	9	9.5	
Workload					0.237
minor	27	26.2	20	21.1	
somewhat	57	55.3	48	50.5	
heavy	19	18.4	27	28.4	
Regularly exercise					0.958
No	81	78.6	75	78.9	
Yes	22	21.4	20	21.1	

Table 2 shows the pre- and post-intervention of six fitness indicators in the two groups. There was a significant difference only regarding flexibility and cardiopulmonary strength in the two groups before they participated in this intervention program. After nurses participated in this program, the intervention group were found to have significant improvements in the following physical fitness indicators: flexibility, abdominal muscle durability, back strength, and cardiopulmonary strength.

Comparison of fitness indicators in both groups using multivariate linear regression

Table 3 shows a comparison of six fitness indicators in both groups using multivariate linear regression adjusted for marital status, work duration, workload, exercise, and six pre-

Table 2. Comparison of six indicators after fitness exercise in the intervention and in the control group

	Pre-intervention		p	Post-intervention		p
	Intervention group N=103	Control group N=95		Intervention group N=103	Control group N=95	
Body Mass Index (kg/m^2)	20.40 ± 2.10	20.85 ± 2.79	0.198	20.51 ± 1.92	21.15 ± 2.77	0.062
Grip strength (time/sec)	29.87 ± 7.81	29.15 ± 6.44	0.482	30.62 ± 7.42	29.32 ± 5.94	0.177
Flexibility (time/sec)	29.77 ± 5.71	27.94 ± 5.77	0.026	33.61 ± 6.22	29.62 ± 6.05	<0.001
Abdominal muscle durability (time/sec)	19.89 ± 3.80	18.76 ± 4.53	0.057	22.51 ± 4.41	19.59 ± 5.02	<0.001
Back strength (time/sec)	45.26 ± 7.36	44.56 ± 6.73	0.484	50.34 ± 8.21	46.46 ± 7.40	0.001
Cardiopulmonary strength (ml/kg/min)	49.99 ± 4.48	47.36 ± 4.43	<0.001	53.09 ± 5.18	48.36 ± 4.65	<0.001

Table 3. Comparison of fitness indicators in both groups using multivariate linear regression

	Control group	Intervention group	p
Body mass index (kg/m^2)	Referent	-0.184	0.011
Grip strength (time/sec)	Referent	0.669	0.004
Body flexibility (time/sec)	Referent	2.071	<0.001
Abdominal muscle durability (time/sec)	Referent	1.649	<0.001
Back strength (time/sec)	Referent	3.166	<0.001
Cardiopulmonary strength (ml/kg/min)	Referent	1.906	<0.001

Notes: adjusted for marital status, work duration, workload, exercise, and six pre- intervention indicators.

intervention indicators. The intervention group significantly improved in all six fitness indicators. BMI decreased by 0.184 kg/m^2, grip strength increased by 0.669 time/sec, flexibility increased by 2.071 time/sec, abdominal muscle durability increased by 1.649 time/sec, back muscle durability increased by 3.166 time/sec, and cardiopulmonary durability increased by 1.906 ml/kg/min.

Effectiveness of intervention program

Table 4 shows an improvement in the six fitness indicators after nurses participated in the intervention program using multivariate logistic regression adjusted for marital status, work duration, workload, exercise, and six pre-intervention indicators. After adjustment, no significant differences were found in BMI, grip strength, and back strength between the two groups. However, the intervention group improved significantly in flexibility (OR=2.98), abdominal muscle durability (OR=2.43), and cardiopulmonary durability (OR=5.14).

Discussion

Ergonomic stress and MSDs

The physically demanding nature of physiotherapy itself may contribute to the development of musculoskeletal problems. Numerous studies[15] have been conducted regarding the prevalence of cumulative trauma disorders (CTDs) among nurses. Office workers who often use computers commonly experience neck and shoulder pain. Similarly, nurses who spend a lot of time using computers to write reports perform more extensor-flexional and pronation-supranational movements of the wrist with inadequate time to recover, making them prone to carpal tunnel syndrome (CTS). In addition, nurses are required to lift their patients or boxes which may result in LBP, a multifactorial biopsychosocial problem. Work overload, psychological and physical factors have been independently associated with LBP in nursing students[16]. Common work activities were reported to contribute particularly to recurrence of LBP symptoms: manually handling patients (OR=2.07 to 11.97) and undertaking physically laborious work (OR=2.09 to 2.76). High mental pressure has also been identified as a significant risk factor for LBP of the neck (OR= 1.53) and shoulders (OR=2.07) [17]. Furthermore, repetitive tasks, such as patient

Table 4. Improvement in the six fitness indicators after nurses participated in the intervention program using multivariate logistic regression

	Control group	Intervention group		p
		OR	Adjusted OR (95%C.I.)	
Body mass index (kg/m^2)	1	0.424	0.279 (0.067-1.169)	0.081
Grip strength (time/sec)	1	1.204	0.802 (0.599-1.074)	0.138
Body flexibility (time/sec)	1	2.979	2.123 (1.406-3.204)	<0.001
Abdominal muscle durability (time/sec)	1	2.425	2.436 (1.567-3.787)	<0.001
Back strength (time/sec)	1	1.478	1.061 (0.849-1.325)	0.603
Cardiopulmonary strength (ml/kg/min)	1	5.141	3.692 (2.102-6.482)	<0.001

Notes: adjusted for marital status, work duration and workload.

bathing, helping patients to change their clothes, changing sheets, and transferring patients can result in work-related MSDs[7,18]. In addition, nurses who often bend over to lift patients and often raise their hands above their shoulders are prone to suffer from elbow problems. Nurses who do not regularly exercise and who have poor posture often suffer from MSDs, including neck and shoulder stiffness, soreness of the hand or wrist, and LBP. This is similar to the results of Feng's study[8] which showed that nurses who do not regularly exercise but are required to do heavy lifting often have shoulder problems. Alcohol consumption, tobacco smoking, and having children were found to be significant risk factors of MSDs[17]. A study[19] of LBP among nurses, found that smokers were 1.97 times more likely to experience back pain compared to non-smoking nurses. Furthermore, previous studies[20-22] have shown that psychosocial factors (e.g., premenstrual tension and mental pressure) were significant predictors for MSDs. However, results regarding the association between high stress or fatigue, psychosocial factors and occurrence of MSDs have been inconsistent, so further research is needed to further investigate this possible association.

Effective program to prevent work-related MSDs among nurses

Taiwan's IOSH is encouraging workers to regularly stretch and exercise, which should reduce their likelihood of suffering from MSDs. The IOSH has also produced a DVD which shows workers how to stretch and exercise. This DVD is available to workers free of charge. Moreover, the Department of Health (DOH) in Taiwan has established a program to help hospital employees exercise more, eat a balanced diet, and deal with stress. Hospitals which implement this program are then certified by the DOH. This program has been established because hospital employees can provide better care for their patients if they are healthy, themselves. Our study showed that the nurses who stretched and exercised every day were more flexible, had stronger abdominal muscles, and stronger cardiopulmonary systems.

An effective program can help prevent work-related MSDs among nurses, though 3 main domains should be included: host (demographic information), environment (setting or operation) and agents (ergonomic risk factors)[18]. Our study focused on increasing nurses' flexibility and strengthening their muscle by regular physical activity and stretching. Before work each day, the nurses practiced stretching and exercising their muscles to strengthen biomechanical loading and demand. Alternatively, the modification of environment to prevent work-related musculoskeletal disorders in hospital nurses has been developed based on the participatory approach, such as the Participatory Action Oriented Training (PAOT) program[23]. To sustain the developed strategies, working units are assessed to monitor progress and encourage the nurses to continue improving their working environment after participating in the workshop. The advantage of this program results in the most effective solutions to problems in particular work settings through the sharing of mutual inquiries and joint problem-solving strategies by instructors and participants[18]. Pompeii et al.[24] suggested defining the circumstances surrounding patient handling injuries and identifying potential preventive measures. They suggested that use of mechanical lift equipment could significantly reduce the risk of some patient handling injuries but additional interventions need to be considered that address other patient handling tasks.

The long-term goal of intervention is to produce safe working environments for hospital nurses by agent modification to correct potential environmental risk factors in hospital settings. However, due to the cost constraint inherent of in this study, several major suggestions of structure modifications, such as improving nurses' work stations, could not fully and immediately implemented[18]. For example, three risk factors, including manual transfer of patients between bed/wheelchair and bath cart, perceived physical exertion, and psychological demands, were significantly associated with LBP among nursing staff, especially in nursing aides. These problems of transfer movement or physical effort may not been easily solved using environmental change in nursing

setting. Moreover, lifting devices, biomechanical training, bigger rooms, adequate set-up and additional staff are suggested improvements of work-related low back injury among nurses in the orthopedic and intensive care unit departments of the hospital[25]. Moreover, muscle fatigue is a frequently discussed physiological change connected with the development of MSDs. Therefore, monitoring fatigue would be a relevant marker for exposure to low-level repetitive work, such as nursing work.

Strengths and Limitations

Our study has several strengths. First, orthopedic surgeons diagnosed MSDs in nurses using the Standardized Nordic Questionnaire, which is a well-known ergonomic assessment tool and has been widely used in many countries for almost 20 years. Second, the study was designed using a randomized test which meant that confounding factors in the intervention group and the control group were comparable. Next, hospital administrators encouraged nurses to participate in this intervention program. Finally, our randomized clinical study was the first in Taiwan to encourage physical activity and physical fitness to lower the likelihood of suffering from MSDs in nurses. Due to the effectiveness of our intervention program, our study can be used as a model by other hospitals in Taiwan, hopefully lowering the turnover rate among nurses. However, this study has some limitations. First, there was a possibility of cross-contamination in the two groups and fitness exercise used by the intervention group can be shared or mimicked by the control group. These results may result in underestimation of our findings resulting from possible sharing if fitness information which would increase the effectiveness in the control group. Second, information obtained in the intervention group came from self-reports or diary record data, though the effectiveness of fitness exercise was consistent with the frequency of fitness exercise. The MSDs symptoms in the intervention group were alleviated by performing the fitness exercises. There is possibility of confounding by the Hawthorne effect if nurses in intervention group understand the objective of this study. Different criteria of effectiveness were objectively assessed by trained staff members, who were blinded to which groups the participant were assigned. Similarly, the self-reporting of subjective symptoms such as MSDs may also introduce some bias. Because in the beginning all nurses had comparable MSD severity and were educated and provided sufficient knowledge toward the prevention of MSDs.

Conclusion

The intervention group showed significant improvement in the six physical fitness indicators. These nurses were more flexible (OR= 2.12, $p<0.001$), their back strength increased (OR= 2.44, $p<0.001$), and their cardiopulmonary strength increased (OR= 3.69, $p<0.001$). Nurses should exercise regularly to reduce risk of MSDs. Nurses who are physically active and engage in physical exercise are more flexible and become stronger.

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Original Article

伸展操介入改善臨床護理人員肌肉骨骼不適症狀之成效

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目的：護理人員有肌肉骨骼不適之高發生率，無論如何，這一直是能進一步支持肌肉骨骼不適之介入措施實證基礎的研究限制。因此，本研究之目的在評值護理人員經伸展操運動介入後降低肌肉骨骼不適（MSDs）之成效。

方法：招募236位地區醫院的護理人員，以隨機臨床研究，將護理人員分成介入組及控制組，介入組為每天做伸展操運動，在介入前後使用六項指標：身體質量指數（BMI）、握力、柔軟度、腹肌耐力、背肌耐力及心肺耐力等量測，但控制組沒有介入伸展操之運動。

結果：以邏輯斯複迴歸分析介入組的護理人員在六項指標均有進步，其中，介入組在握力（OR=2.12, p<.001）、背肌耐力（OR=2.44, p<.001）及心肺耐力（OR=3.69, p<.001）均比控制組在統計上有顯著性之差異。

結論：本研究結果顯示護理人員如能規律的執行伸展操運動可顯著性降低肌肉骨骼不適之症狀。

關鍵詞：肌肉骨骼不適、隨機臨床研究、伸展操運動、介入方案

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