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An Effective Physical Fitness Program for Small and Medium-sized Enterprises

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Abstract: The aim of this study is to develop a practicable worksite physical fitness program for small and medium-sized enterprises (SMEs). Community-based intervention consisting of a three-month exercise course was conducted, and its benefits evaluated. A self-administrated structured questionnaire and physical fitness examination were designed to compare the difference between pre and post intervention. A total of 133 SME workers completed the lifestyle/exercise course and filled out the questionnaire, but 16 were excluded from the exercise group due to health reasons. After the intervention, health indicators such as weight, blood pressure, resting heart rate, waistline, BMI, front and back trunk flexibility, abdominal muscle durability and back muscle strength were significantly improved, and improvements in musculoskeletal disorders were seen in reduced neck pain (18.8%), wrist pain (17.4%), and upper/lower back pain (8.7% and 21.7%, respectively). Cardiovascular risk factors (BMI and resting heart rate) showed a significant improvement related to frequent participation in the program (p=0.02), and the exercise group reported a significant difference in overall health (p=0.02). This study has demonstrated an effective approach to community-based fitness intervention through SMEs.

Key words: Small and medium-sized enterprises, Community-based intervention, Physical fitness program, Musculoskeletal disorders, Cardiovascular risk factors

Introduction

Over 95 percent of Taiwan's businesses are small and medium in size. These small and medium enterprises (SMEs) provide a third of all industrial employment and also account for the largest part of industrial development[1]. Due to a lack of manpower and other resources for promoting occupational health, it has been difficult to carry out health promotion programs in SMEs. Much research has addressed the difficulties of how to implement worksite health promotion (WHP) in SMEs in many countries[2–5]. Compared to larger enterprises, the SME employers and workers infrequently engage in WHP. According to Kari *et al.*[3], a lack of knowledge, skills and financial resources was the reason for limited health promotion intervention in Finland. Park *et al.*[4] also point out that Korean SMEs utilized less resources for occupational health services than larger enterprises. The reason was that employers in SMEs lacked the financial ability to invest in health services. In previous studies, researchers demonstrated that workers in SMEs have less easy access to health promotion activities than those in large enterprises[5].

Starting in the 1960s, community-based prevention programs were developed with the aim of reducing the high rate of cardiovascular disease[6, 7]. Community-based health projects demonstrated a model conceptual framework for evaluating primary preventive health[7]. The programs involved multiple interventions, which included 1) targeting change at the individual, group, and organizational levels, and 2) suggesting strategies to

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create better policies and environmental changes[8]. An increasing number of findings have shown that the environmental approach can be a relatively effective way to encourage physical activities[9–12]. Evidence shows that physical inactivity can have a negative impact on an individual's health[13–15]. In addition, other findings suggest that effective community-based intervention promoting physical activity can greatly contribute to public health[16–19]. For instance, The Pawtucket Heart Health Program (PHHP), a federal research project, demonstrated that the effectiveness of community-based physical activity intervention reduced cardiovascular disease risk factors such as blood cholesterol levels, high blood pressure and obesity[20]. Numerous studies have also demonstrated that supervised dietary and exercise interventions in a controlled environment have salutary effects on hyperglycemia, high cholesterol and hypertension[21–23], while others indicated that regular exercise optimized the functioning of the human body to enhance recovery from musculoskeletal disorders[24–26].

Despite the fact that regular exercise can maintain health, workers in Taiwan commonly do not get enough exercise due to lack of time, energy, and location, especially in SMEs[2]. Larger enterprises tend to be more sensitive with regard to health care issues; however, the greater physical health risks of SME employees create an increased need for health promotion activities. Results of previous studies have only shown the effects of exercise programs in larger enterprises and other groups in Taiwan[27–29]. The fact that resources and financial aid are scarce in SMEs is obvious. The purpose of this study was to create a cost-sharing community-based intervention program with a more comprehensive fitness protocol which encompasses musculoskeletal strengthening and occupational injury prevention in addition to the usual aerobic activities.

Subjects and Methods

Study design and participant selection

The excise program was conducted from November 2007 to January 2008, and was promoted as a community-based concept. The participants were recruited from a large local office building that housed multiple SMEs (an SME was defined as an enterprise with fewer than 100 employees). An orientation was conducted and employees were invited to participate in a three-month exercise program along with instruction promoting the importance of lifestyle and exercise for individual health. The exercise program was administered after work, and the voluntary subjects were gathered in assigned public basketball courts near the building. Among the employees who attended the orientation, 133 completed the structured questionnaire but only 85 joined the exercise program as the exercise group. The remaining 48 employees chose not to participate in the program, and they served as the control group. Physical fitness examinations were given within one week before and after the intervention program. However, of the 85 participants in the exercise group, 16 were excluded for reasons such as falling ill, quitting their job, and not completing the physical fitness examination (Fig. 1). Of the final 117 voluntary participants, 107 were working in office administration and 10 in physical labor. The protocol for this study was approved by the Taipei Medical University institutional review board.

Exercise protocol

The subjects were recruited from among SME workers and each worker was encouraged to participate in all of the exercise sessions. The exercise program was developed using physical fitness exercise for the occupational environment (15 min), aerobic exercise (30 min)

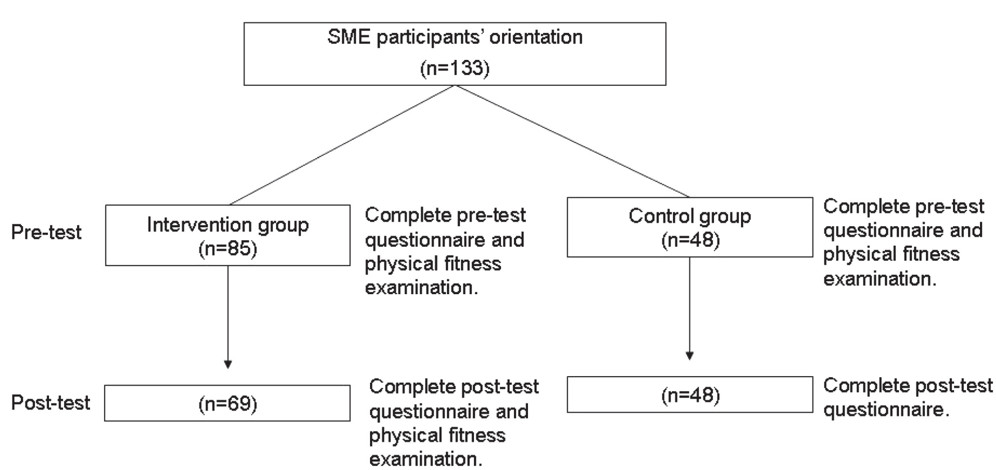

Fig. 1. The flow of SME workers' participation in the study.

and stretching (15 min). The physical fitness exercise was designed by Taiwan's Institute of Occupational Safety and Health[30] for the purpose of preventing musculoskeletal diseases in worksite environments, and also for use in musculoskeletal disorder studies. A 30-min. Hi-Lo impact aerobic class was led by a professional trainer who used music with a rhythm of 130–140 beats per minute to increase participants' cardiopulmonary endurance. Stretch training consisted of using Yoga and Pilates to improve body flexibility. Each member of the exercise group was given a physical fitness examination before and after taking the exercise program in order to determine differences in pre and post intervention health status. The exercise program was implemented for a period of 12 wk, with one hour of exercise three times a week. Data on frequency of class participation was collected to compare the effects for each participation level.

Measurement scales

Self-reported health status

The structured questionnaire was designed to collect demographic data, including age, sex, marital status, level of education, sleep quality, work load, and other lifestyle information. Part of the questionnaire consisted of a Chinese version of the SF-36 Health Survey, which was used to evaluate physical health components[31]. The questionnaire was developed to measure improvement of physical health status among study participants. This study selected three indicators representing physical health: general health perception (1 item), physical functioning (10 items) and role-emotional health (4 items). In addition, a sleep quality assessment was conducted. A higher score indicated better physical health and sleep quality. We used the Nordic Musculoskeletal Questionnaire (NMQ), which evaluates the weekly prevalence of musculoskeletal disorders, to measure body pain. The NMQ includes nine body parts: neck, shoulders, elbows, wrists, upper back, lower back, thighs/buttocks, knees, and ankles/feet[32]. Both the exercise and control groups completed the questionnaire before and after intervention.

Physical fitness examination

The physical fitness examination was designed by Taiwan's Institute of Occupational Safety and Health (IOSH) in 2003 using the Laborer Physical Fitness Test Method[30]. In this study, body composition and physical fitness test scores were used as indicators of health status. Body composition was evaluated by 1) Body Mass Index: BMI = (kg/m^2); 2) resting blood systolic/diastolic pressure and resting heart rate, measured with a digital sphygmomanometer (OMRON-HEM70000); 3) waistline, measured using a tape measure at the smallest circumference of the subject's natural waist, usually just above the belly button.

The fitness test score consisted of measurements of flexibility and abdominal muscle durability. Both measurements used trunk flexion meters (AC696 arrow-style device and T.K.K. 5404) as the measurement tool. Flexibility was measured by sit-and-reach and trunk extension tests to measure front and back trunk flexibility. In the sit-and-reach test, the subject was seated on the floor and stretched his or her arms forward along a ruler. The score was taken by measuring the maximum reach of the fingertips (in cm). For the trunk extension test, the subject reclined face-down on the floor and was asked to raise the upper body off the floor to a maximum height. The score was taken as the most distant point to which the body could be raised (in cm). Abdominal muscle durability was evaluated with a sit-up test based on the number of sit-ups achieved in a one-minute period. The back muscle test used a digital back muscle dynamometer (T.K.K. 5402) to measure the weight (kg) that the subject could lift.

Cardiopulmonary durability was measured using the three-minute step test to evaluate the heart recovery rate. The subject was asked to step up and down on a 12-inch (30 cm) bench for a total of three minutes and his or her heartbeat was then measured using the Accu-Max Three-minute Pulse Tester-1N; the result was converted to the Harvard Step Test Fitness Index, in which less than 55 is considered poor, 55–64 is low average, 65–79 is high average, 80–89 is good and over 90 is excellent. The physical fitness examination was performed within one week of completion of the program.

Statistical analysis

Baseline demographic data was collected for the exercise and control groups, and analyzed using *t*-testing and χ^2 testing. The self-reported variables for comparing intervention effects were analyzed using several methods. The comparison of musculoskeletal disorder improvement was analyzed by the χ^2 test. This study divided the exercise group into three sub-groups by frequency of participation (number of times): 1 to 12, 13 to 24 and 25 to 36. The paired *t*-test was conducted to determine the effects of the exercise program on the three groups. Analysis of covariance (ANCOVA) with repeated measurements was conducted to evaluate the statistical significance of effects of the exercise program on self-reported health status. In addition, the ANCOVA measurement was adjusted for the variables of age, sex, smoking status and coffee drinking to avoid confounding effects. Moreover, the relationship between cardiovascular risk factors and frequency of participation in the exercise program was analyzed using multiple linear regression. Data collection used Microsoft Excel software and all analyses were done with SPSS statistical software (version 17.0).

Results

Comparison of baseline demographic variables

In Table 1, the average age of the exercise and control groups was 36 and 34 yr, respectively. The average daily working time for both groups exceeded eight hours. Average daily physical activity was 32.97 min for the exercise group and 34.06 min for the control group. In the baseline, most of demographic, health status, and musculoskeletal disorder variables evidenced no significant differences between the two groups. The variables showed a different distribution for only sex (p=0.001) job category (p=0.001), and sleeping quality (p=0.035). More female participated in the exercise group than the male subjects; the control group has more physical labor than exercise group; and the exercise group has better score of sleeping quality than control group.

Intervention effects on exercise groups

In Table 2, the study divided the exercise subjects into three groups by frequency of participation to evaluate the effects of cardiovascular and physical fitness factors. After completing the 12-wk exercise program, the result showed that there were no significant changes of cardiovascular variables in the lowest frequency group (1–12). Only physical fitness factors had significant improvement, in front and back trunk flexibility and abdominal muscle durability ($p<0.05$). However, cardiovascular factors showed improvement in higher frequency groups. The present study also found that as the frequency of participation increased, the more cardiovascular and physical fitness factors improved among the three groups. Diastolic and systolic blood pressure, waistline, and back muscle strength showed additional improvement in the 13–24 frequency group ($p<0.05$). Furthermore, the evidence showed that most cardiovascular and physical fitness factors were significantly improved in the 25–36 frequency group, and the variables of weight, diastolic and systolic blood pressure, resting heart rate, waistline, BMI, front and back trunk flexibility, abdominal muscle durability, and back muscle strength were significantly different after intervention. Table 3 indicates improvements in musculoskeletal disorders in both the intervention and control groups. 'Yes' indicates the improvement from a pain condition. 'No' indicates the 3 conditions of no difference in pain, exercise-incurred pain, and no prior or post pain symptom. After intervention, the exercise group had greater improvement in musculoskeletal conditions, with reductions in neck pain (18.8%), wrist pain (17.4%), and upper/lower back pain (8.7% and 21.7%) after 12 wk of the physical fitness program. Furthermore, the present study found that the intervention effects on cardiovascular factors of BMI and resting heart rate were significantly related to the frequency of program participation. Lifestyle variables were also incorporated into this model. No significant relation was found to the variables of age, sex, smoking status, and coffee drinking. The adjusted R^2 values of the BMI and resting heart rate were 0.101 and 0.100, respectively (Table 4).

Effects on self-reported health status

Self-reported health status was analyzed statistically using ANCOVA, with repeated measurements to compare the exercise and control groups after intervention. The general health, physical functioning, role-emotional, and sleeping quality scores showed improvement after the intervention. However, there was a significant difference only in the general health score ($p<0.05$), by adjusting the variables of age, sex, smoking status, and coffee drinking (Table 5).

Discussion

Several studies have demonstrated cardiovascular and physical fitness improvement in different populations following exercise training[23, 24, 27–29]. Our results point to the same effects specifically among SME workers. Previous 12-wk exercise training study has shown improvements in muscle strength and endurance[27], as have most other studies[33, 34]. The present study additionally found improvement in more physical fitness indicators, including front/back flexibility and back muscle strength. The additional physical fitness improvement may be attributed to the exercise protocols in this intervention. Our exercise program included physical fitness training (15 min) and stretch training (15 min) to improve body flexibility and strength. Physical fitness training was designed to increase muscle strength and durability in terms of stabilizing the spine and optimizing other functions of the human body. Fifteen minutes of stretch training helped the subjects to improve their joint range of motion and flexibility, and keep a better body posture. Our exercise protocols not only improved muscle strength and durability, but also added flexibility to the subjects' bodies.

In the exercise group, cardiopulmonary durability improved slightly, but not to the level of statistical significance. As with the result of previous study, significant improvement in cardiopulmonary durability was absent[27]. However, our results are different from those of most of previous studies in suggesting that cardio-

Table 1. Baseline data of participants

Variables		Exercise group (n=85)				Within group p-value	Control group (n=48)		Between group p-value
		Complete (n=69)		Dropout (n=16)					
		number	%	number	%		number	%	
Demographic									
Sex	male	12	17.4	3	18.8	0.898	28	58.3	0.000*
	female	57	82.6	13	81.3		20	41.7	
Age		36.46 ± 6.9#		39.56 ± 11.1		0.161	34.19 ± 5.6		0.064
Marital status	married	45	65.2	9	56.3	0.097	27	56.3	0.615
	unmarried	23	33.3	5	31.3		20	41.7	
	divorce	1	1.4	2	3.5		1	2.1	
Job category	office administration	69	100	15	93.8	0.037*	38	79.2	0.000*
	physical labor	0	0	1	6.3		10	20.8	
Smoking status	yes	6	8.7	1	93.8	0.748	10	20.8	0.060
	no	63	91.3	15	8.2		38	79.2	
Daily alcohol drinking	yes	4	5.8	0	0	0.324	2	4.2	0.694
	no	65	94.2	16	100		46	95.8	
Daily coffee drinking	yes	31	44.9	7	43.8	0.414	13	27.1	0.050*
	no	38	55.4	9	56.3		35	72.9	
Daily working hours		8.79 ± 0.8		8.81 ± 1.2		0.929	8.67 ± 1.0		0.482
Daily physical activity (walk time)		32.97 ± 37.0		31.56 ± 36.3		0.891	34.06 ± 39.8		0.879
Health status									
General Health (GH)		35.5 ± 22.8		43.7 ± 19.3		0.186	38.0 ± 20.6		0.544
Physical Functioning (PF)		89.5 ± 13.1		87.1 ± 14.1		0.522	91.8 ± 11.9		0.334
Role-Emotional (RE)		76.3 ± 34.8		83.3 ± 27.2		0.454	66.6 ± 42.3		0.180
Sleeping Quality (SQ)		63.1 ± 20.7		58.75 ± 13.6		0.418	55.4 ± 17.1		0.035*
Musculoskeletal syndrome									
Neck	yes	18	26.1	1	6.3	0.086	11	22.9	0.696
	no	51	73.9	15	93.7		37	77.1	
Shoulder	yes	24	34.8	5	31.3	0.788	12	25	0.259
	no	45	65.2	11	68.8		36	75	
Elbow	yes	5	7.2	2	12.5	0.491	1	2.1	0.213
	no	64	92.8	14	87.5		47	97.9	
Wrist	yes	13	18.8	3	18.8	0.993	5	10.4	0.214
	no	56	81.2	13	81.3		43	89.6	
Upper back	yes	7	10.1	2	12.5	0.783	4	8.3	0.741
	no	62	89.9	14	87.5		44	91.7	
Lower back	yes	21	30.4	2	12.5	0.146	10	20.8	0.247
	no	48	69.6	14	87.5		38	79.2	
Thigh/Buttock	yes	8	11.6	3	18.8	0.442	2	4.2	0.158
	no	61	88.4	13	81.3		46	95.8	
Knee	yes	8	11.6	1	6.3	0.531	3	6.3	0.330
	no	61	88.4	15	93.7		45	93.8	
Ankle/Feet	yes	8	11.6	2	12.5	0.919	1	2.1	0.058
	no	61	88.4	14	87.5		47	97.9	

#Mean ± SD
Within group: complete group vs. dropout group
Between group: exercise group vs. control group
*p<0.05.

Table 2. Determinants of intervention effects among three frequency groups

Variables	1~12 (n=13)			13~24 (n=24)			25~36 (n=32)		
	Pre	Post		Pre	Post		Pre	Post	
	Mean ± SD	Mean ± SD	*p*	Mean ± SD	Mean ± SD	*p*	Mean ± SD	Mean ± SD	*p*
Cardiovascular Factor									
Weight (kg)	57.63 ± 3.51	58.05 ± 3.66	0.221	60.09 ± 2.39	59.80 ± 2.40	0.351	59.00 ± 2.23	58.47 ± 2.16	0.047*
Waistline (cm)	74.98 ± 2.17	72.96 ± 2.41	0.113	73.90 ± 1.80	71.50 ± 1.72	0.002*	74.83 ± 1.91	72.11 ± 1.74	0.000*
BMI (kg/m^2)	21.95 ± 0.74	22.10 ± 0.081	0.248	22.32 ± 0.54	22.21 ± 0.55	0.361	22.40 ± 0.55	22.21 ± 0.54	0.046*
Systolic blood pressure (mmHg)	117.92 ± 2.95	114.54 ± 2.27	0.347	124.00 ± 3.08	117.00 ± 2.61	0.001*	126.47 ± 2.33	121.47 ± 1.95	0.008*
Diastolic blood pressure (mmHg)	72.77 ± 3.73	67.46 ± 1.88	0.156	72.33 ± 2.42	66.83 ± 1.97	0.001*	76.47 ± 1.59	71.78 ± 2.01	0.013*
Resting heart rate (bpm)	76.46 ± 2.53	74.38 ± 2.15	0.268	75.25 ± 1.89	74.79 ± 1.52	0.768	83.28 ± 1.94	76.84 ± 1.27	0.000*
Physical Examination									
Front trunk flexibility (cm)	24.15 ± 3.12	29.88 ± 2.84	0.017*	25.02 ± 2.41	30.85 ± 2.08	0.000*	24.19 ± 1.82	31.55 ± 1.66	0.000*
Back trunk flexibility (cm)	24.00 ± 1.47	25.84 ± 1.40	0.023*	26.73 ± 1.07	29.11 ± 1.16	0.005*	24.31 ± 1.02	25.43 ± 0.89	0.034*
Abdominal muscle durability (freq/min)	21.31 ± 2.20	27.00 ± 2.53	0.018*	26.96 ± 2.26	31.25 ± 2.54	0.020*	21.34 ± 1.54	29.14 ± 1.71	0.000*
Back muscle Strength (kg)	51.65 ± 3.91	57.56 ± 5.21	0.077	57.92 ± 5.88	70.11 ± 7.70	0.004*	46.99 ± 3.27	55.25 ± 3.31	0.000*
Cardiopulmonary durability	50.97 ± 2.72	56.83 ± 4.25	0.247	54.54 ± 9.09	55.75 ± 10.98	0.368	55.23 ± 10.69	57.65 ± 16.39	0.268

$^*p<0.05$.

Table 3. Comparison of musculoskeletal syndromes improvement after intervention

Variables	Exercise (n=69)	Control (n=48)	χ^2
	n (%)	n (%)	*p*-value
Neck pain			
yes	13 (18.8)	1 (2.1)	0.006*
no	56 (81.2)	47 (97.9)	
Shoulder pain			
yes	14 (20.3)	4 (8.3)	0.078
no	55 (79.7)	44 (91.7)	
Elbow pain			
yes	4 (5.8)	1 (2.1)	0.329
no	65 (94.2)	47 (97.9)	
Wrist pain			
yes	12 (17.4)	2 (4.2)	0.030*
no	57 (82.6)	46 (95.8)	
Upper back pain			
yes	6 (8.7)	0 (0.0)	0.036*
no	63 (91.3)	48 (100)	
Lower back pain			
yes	15 (21.7)	3 (6.3)	0.022*
no	54 (78.3)	45 (93.8)	
Thigh/Buttock pain			
yes	6 (8.7)	1 (2.1)	0.138
no	63 (91.3)	47 (97.9)	
Knee pain			
yes	3 (4.3)	2 (4.2)	0.962
no	66 (95.7)	46 (95.8)	
Ankles/Feet pain			
yes	5 (7.2)	0 (0.0)	0.057
no	64 (92.8)	48 (100)	

$^*p<0.05$.

pulmonary durability improved following the exercising program[28]. The small number of subjects in the exercise group may explain the greater variation of results among different participants.

In the present study, cardiovascular factors were significantly improved after exercise intervention (Table 2). In addition, this study divided subjects from SMEs into three groups by frequency of participation, and found that the all cardiovascular factors were significantly improved in the highest-frequency group. Indicators such as diastolic and systolic blood pressure, resting heart rate, waistline, and BMI were reduced after completion of the exercise program. The present study also found that the significant improvements of cardiovascular factors were surprisingly absent in the lowest-frequency group. It is suggested that there is threshold frequency or intensity, and perhaps the training had a greater effect on cardiovascular factors for those subjects who participated in more than 12 exercise sessions. Furthermore, the present study found that pre- and post-intervention differences in BMI and resting heart rate were significantly associated with frequency of participation in the program. Combined with other cardiovascular risk factors (lifestyle), more participation in the exercise program produced positive effects on BMI and resting heart rate. A slow resting heart rate is often used as a measure of fitness, and many findings show that resting heat rate is associated with hypertension[35, 36]. For this reason, the present study used resting heat rate as a cardiovascular factor. The results were similar to previous studies in suggesting that low or moderate physical activity has less effect on

Table 4. Relationship between cardiovascular risk factors, frequency of program participation and lifestyle (n=69)

	BMI difference			Heart rate difference		
Variables	B	Beta	*p*-value	B	Beta	*p*-value
Frequency of program participation	0.02	0.30	0.02*	0.30	0.28	0.02*
Age	–0.01	–0.15	0.22	–0.25	–0.21	0.08
Sex	–0.15	–0.11	0.42	4.03	0.19	0.16
Smoking stuts	0.19	0.10	0.44	–3.06	–0.11	0.43
Coffee drinking	–0.07	–0.07	0.58	3.02	0.18	0.14
Adjusted R^2		0.101			0.100	

*p<0.05.

Table 5. Intervention effects on self-reported health status

	Exercise group (n=69)			Control group (n=48)			Intervention Effect (adjusted)	
	Pre	Post	Difference	Pre	Post	Difference		
Variables	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	F-value	*p*-value
General Health(GH)	35.5 ± 22.8	50.7 ± 21.8	–15.2 ± 24.3	38.0 ± 20.6	40.6 ± 22.2	–2.6 ± 18.0	5.648	0.019*
Physical Functioning (PF)	89.5 ± 13.1	92.2 ± 9.6	–2.7 ± 10.5	91.8 ± 11.9	93.96 ± 8.3	–2.1 ± 7.1	0.022	0.883
Role-Emotional (RE)	76.3 ± 34.8	78.7 ± 32.7	–2.4 ± 35.8	66.6 ± 42.3	77.7 ± 38.4	–11.1 ± 32.4	1.401	0.239
Sleeping Quality (SQ)	63.1 ± 20.7	63.4 ± 16.4	–0.3 ± 16.2	55.4 ± 17.1	57.0 ± 17.9	–1.6 ± 14.1	0.375	0.551

ANCOVA was adjusted for age, sex, smoking status, and coffee drinking.
*p<0.05.

cardiovascular disease[37)]; at the same time, other study also show improvement in cardiovascular risk factors after long (the subjects exercised more than 24 times) exercise programs[29)]. However, several studies have showed beneficial cardiovascular effects for non-vigorous physical activity[38)], and other study has indicated that the duration of physical activity does not correlate with cardiovascular factors[23)]. The mechanism behind the inconsistency of effects is not clear; differences in the population used in the studies, and the frequency or intensity of the physical activity, might also have affected the results. On the other hand, food intake factors should have been included in this study; the subjects were instructed to continue their normal daily intake, and no measurement of nutrition was taken. Further research is needed to combine exercise and nutrition factors in determining the effects of intervention on cardiovascular risk.

Physical exercise is recommended to prevent musculoskeletal disorders (MSD), especially neck and back pain. Many physicians believe that increased muscle strength can stabilize the spine and optimize other functions of the human body, and also reduce the incidence of musculoskeletal disorder. Previous findings have showed that exercise programs were related to recovery from lower back and neck pain among workers[24)]. Those results were consistent with our present study, which additionally found significant improvement of wrist and upper back pain in the SME exercise group. Subjects who suffered musculoskeletal pain before intervention were relieved of the pain following intervention. However, conflicting results in regard to neck and lower back pain recovery have been reported for different exercise intervention programs. Some studies have indicated that physical exercise of any intensity was not associated with a higher rate of recovery from MSD[39)]. These equivocal results may be due to different exercise guidelines and durations. In our 12-wk exercise program, MSD was improved significantly when compared with the control group.

A previous study showed that a physical exercise intervention program can also affect psychological health indicators[29)]. An exercise group of middle-aged Taiwanese women reported better mood compared with the control group. In the present study, mental/physical health (SF-36) and sleeping quality were tested pre- and post-intervention in a population of SME workers. All self-reported scores reported by both groups showed improvement after intervention, but only the general health indicator evidenced statistically significant change in the exercise group after adjustment for age, sex, smoking, and coffee drinking. These results can be explained by the fact that all of the SME subjects participated in a course promoting the importance of lifestyle and exercise before the initial study, so both the exercise and control groups might have adjusted their lifestyle behavior during the intervention period. For this reason, both the exercise and control groups reported better health after intervention. However, the results were inconsistent with other studies; the self-reporting of health status (SF-36) did not reveal significant changes after a six-month Tai-Chi exercise program for older adults from Taiwan[40]. A possible reason for this is that for older people, who are generally in poorer health than their younger counterparts, a longer period of exercise is required for any significant change to become apparent. The effects of a six-month exercise program may be limited in this case. Since the average age of the subjects used in the present study was younger, it is perhaps not surprising that their self-reported health status should show better results.

One of the purposes in this study was to encourage SMEs to establish wellness programs to benefit their employee's health. Therefore, the study invited only SME workers to volunteer; thus the study was conducted according to a non-randomized self-selective experimental design, which may have led to selection bias. Since the SME subjects were recruited on a voluntary basis, there were non-random patterns in the composition of the participants that may have induced confounding factors. To some extent, the findings of the present study might not represent a generalization of the SME population. The results should be interpreted with a few limitations, as follows: **Limitation 1:** Some individuals probably chose to be a part of the control group because of their poor health, physical or mental disability, or diseases for which they were receiving treatment, and these conditions might have prevented them from exercising regularly. However, most of demographic variables evidenced no significant differences between the exercise and control groups in the initial study population. With the exception of sleep quality, there was no difference in the distribution of health indicators among the two groups. Although it cannot be denied that differences between the groups affected the study results, the possibility of selection bias might be limited in the analytical data. It is suggested that randomized intervention testing will be necessary in the future. **Limitation 2:** Of the original 85 subjects in the exercise group, 16 failed to follow through with the entire program. There is a possibility that the health status of the dropouts was worse than that of the other subjects, but health status was not the reason for incompletion in the current study. The reasons were: (1) 10 workers quit their jobs, (2) 5 workers were too occupied with their jobs, and (3) 1 worker suddenly fell ill (with a common cold) to miss the post physical fitness examination. The dropouts' baseline data showed no significant difference compared with the rest of the exercise group, so the health status of the dropouts would not have had any significant influence on the exercise groups' results. **Limitation 3:** The study showed that improvement in physical fitness and cardiovascular indicators increased with the number of exercise sessions attended. Each subject decided on the number of sessions that he/she would attend; those who chose to attend more sessions may have been exercise enthusiasts, and may have exercised even outside the workplace. Such workouts could have contributed to the improvement in physical fitness and cardiovascular indicators. However, most of our exercise subjects were reported to have less exercising routine (<1 time/wk). The irregularly exercise subjects might take our exercise program as a starting habit to attend more exercise sessions. The exercise enthusiasts who chose to attend more sessions or exercised even outside the workplace might have limited influence on the post-intervention effects.

SME are commonly characterized as lacking sufficient resources for worksite health promotion. The financing of the present study was supported by the Bureau of Labor Insurance, Council of Labor Affairs, Executive Yuan, Taiwan. The exercise program was cost-free for the participating SMEs and their workers. The purpose of this study was to develop a practicable physical fitness program model for SMEs. Our community-based exercise program was conducted with a low-cost approach. Since exercise intervention requires a professional trainer and suitable location, the costs involved could be shared equally by participating SMEs and a cost-free public venue could be found near the workplace. This type of model is applicable to SMEs in densely populated area in many countries. The shared cost of trainers, equipment, and venues among the SMEs can be reduced to minimum, but with the maximum benefit of worksite health promotion.

Further, the present exercise training was conducted after working hours, so the negative effect on productivity was limited. Our findings suggested that 3 out of 6 cardiovascular risk factors improved significantly when participated more than 12 exercise sessions; when participated more than 25 sessions, all cardiovascular risk factors improved significantly. The SME workers could easily attend exercise sessions because they were able to exercise with familiar colleagues, exercise near their worksites, and spend less time in traffic. Most of the subjects (46%) attended more than 25 sessions, and only 13 (19%) attended fewer than 12 sessions.

In summary, the present study has demonstrated an approach to a community-based exercise program, through SMEs, to promote physical fitness. In the study, the effects of a community-based exercise program were shown to be significant in several areas, with improvements in cardiovascular risk factors, musculoskeletal disorders, and physical fitness being documented. This approach can solve the problems of lack of physical fitness knowledge, skills, and resources for workers at SMEs, and our exercise program may serve as a model for the design of community-based physical fitness programs for SMEs in the future.

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