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BRISK WALKING TO IMPROVE QUALITY OF LIFE OF HIGH TECHNOLOGY INDUSTRIAL WORKERS: A RANDOMISED CONTROL TRIAL

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ABSTRACT

The purpose of this study was to examine the effects of short periods of brisk walking on the quality of life (QOL) of workers in high technology industries. 86 workers were recruited from a high technology company in northern Taiwan who had not participated in regular physical activity within the last three months. They were randomly assigned to an experimental group (EG: Males=16, Females=25; mean age=33.34±6.40) and a control group (CG: Males=27, Females=18; mean age=29.40±3.59). The EG received an eight-week brisk walking intervention twice per week, each session covering the same distance (6km) with durations of 45 to 60 minutes, and maintaining the intensity at 60 to 90% of maximum heart rate (HRmax). The CG continued their normal daily routine. The Taiwanese version of the World Health Organization Quality of Life-BREF (WHOQOL-BREF) was administered pre- and post-test to both groups. The eight-week brisk walking intervention programme enhanced the physical health domain ($p<0.05$), psychological health domain ($p<0.01$), environment domain ($p<0.01$) and the overall QOL ($p<0.01$) of the workers in high technology industries. The findings may be useful for future workplace health promotions in high technology industries.

Key words: Brisk walking; Physical health; Workplace health promotions; Taiwan.

INTRODUCTION

According to the Ministry of Science and Technology (2016), the share of the gross domestic product of the manufacturing industry occupied by high technology industries in Taiwan has hit a record high. A study by Chen *et al*. (2010) identified that 72.4% of those surveyed intended to join high technology industries, clearly indicating that these industries have become the core of economic growth in Taiwan. The same study also found that the surveyed workers in high technology industries reported long working hours, work stress and regular over-time (54.81%, 47.98%, 38.89%, respectively) as the disadvantages of working in such industries (Chen *et al*., 2010). Similarly, Marcelline and Michael (2005) suggested that an intense work pace is detrimental to the psychological aspect of quality of life (QOL). Meanwhile, workers in high technology, who are exposed to highly-variable and stressful work environments for extended periods, are prone to anxiety over job performance, over-work and fatigue accumulation. These effects may subsequently lead to depression and affect QOL (Chen *et al*., 2010).

QOL is a complex concept that is evaluated on multiple dimensions. It encompasses physical health, psychological health, level of independence, social relationships, the environment and personal beliefs, while emphasising the individual's relationships to salient features of their environment (Figueira *et al*., 2010; Bowling & Iliffe, 2011; Bowling & Stenner, 2011). QOL is the level of satisfaction on an aspect of life for a person to increase work motivation (Krijthe *et al*., 2011). Physical activity is positively correlated with activeness and negatively correlated with nervousness, fatigue (Shephard, 2005) and emotion (Hogan *et al*., 2015). Physical activity has been suggested to alleviate anxiety, relieve stress, improve mood and enhance confidence, as well as increase vitality and quality of life (Biddle & Mutrie, 2001). Furthermore, Rejeski and Mihalko (2001) proposed that physical activity may moderate or mediate satisfaction with life. Specifically, a moderation effect implies that physical activity directly increases subjective perception by altering the level of health consciousness and emotion of the individual. The existence of a mediation effect indicates that physical activity indirectly increases the level of interest, improves interpersonal relationships and reduces stress and depression, thereby increasing satisfaction with life and ultimately enhancing the physical and psychological health or physical fitness aspect of QOL. According to Saxton *et al.* (2011), increased physical activity is associated with enhanced QOL. Regular physical activity is crucial for improving QOL (Hopman *et al*., 2007; Beuttenmüller *et al*., 2010).

Brisk walking originated in western countries. It is a rhythmic, aerobic activity that is simple, requires no complicated skills or expensive equipment, has a low injury risk (Adams *et al*., 2015) and can be performed anywhere and anytime (Morris & Hardman, 1997). In recent years, brisk walking has also become a fitness trend in Taiwan (THEA, 2008). The majority of the studies on brisk walking conducted in other countries have tended to focus on its physiological implications, such as body composition, blood lipids and cardiovascular disease (Kim & Yang, 2005; Tully *et al*., 2005). The duration of intervention has been varied with durations of 12 weeks, 24 weeks and 36 weeks (Baker *et al*., 2008; Chen *et al*., 2010; Woolf-May *et al.*, 2011; Pernambuco *et al.*, 2012; Liao & Shiu, 2014). Studies in Taiwan on brisk walking have been limited to its effect on chronic diseases and its application in the elderly (Lin *et al*., 2009; Lin & Wu, 2010; Lin *et al*., 2011). Among these studies, randomised control trials are absent and no studies to date have investigated the health benefits or sought to determine the duration of a brisk walking programme that is sufficient for workers in high-tech industries.

As mentioned previously, these workers are more susceptible to psychological disorders than those in other professions (Marcelline & Michael, 2005) with long working hours and regular overtime being reported as the disadvantages of such industries (Chen *et al*., 2010). As indicated by Baicker *et al*. (2010), most large workplaces worldwide are implementing workplace health promotion programmes and have introduced health-promoting organisational cultures. Workplace health promotion has been shown to reduce the risk of disease in the workplace, improve QOL, further elevate individual self-efficacy and increase the cost-effectiveness of organisations (Berry & Mirabito, 2011). Since no previous scientific research has addressed the effects of a short-duration brisk walking programme on the health of workers in high-tech industries, exploring the effects of a brisk walking programme on the QOL of workers may be beneficial to both the cost-effectiveness of organisations and the workers. The hypothesis of this study was that a short-term (8-week) brisk walking programme would significantly improve QOL among workers in high technology industries. Health authorities in Taiwan and international health care providers may use these findings to improve the health status of such workers in other countries.

METHODOLOGY

Design and participants

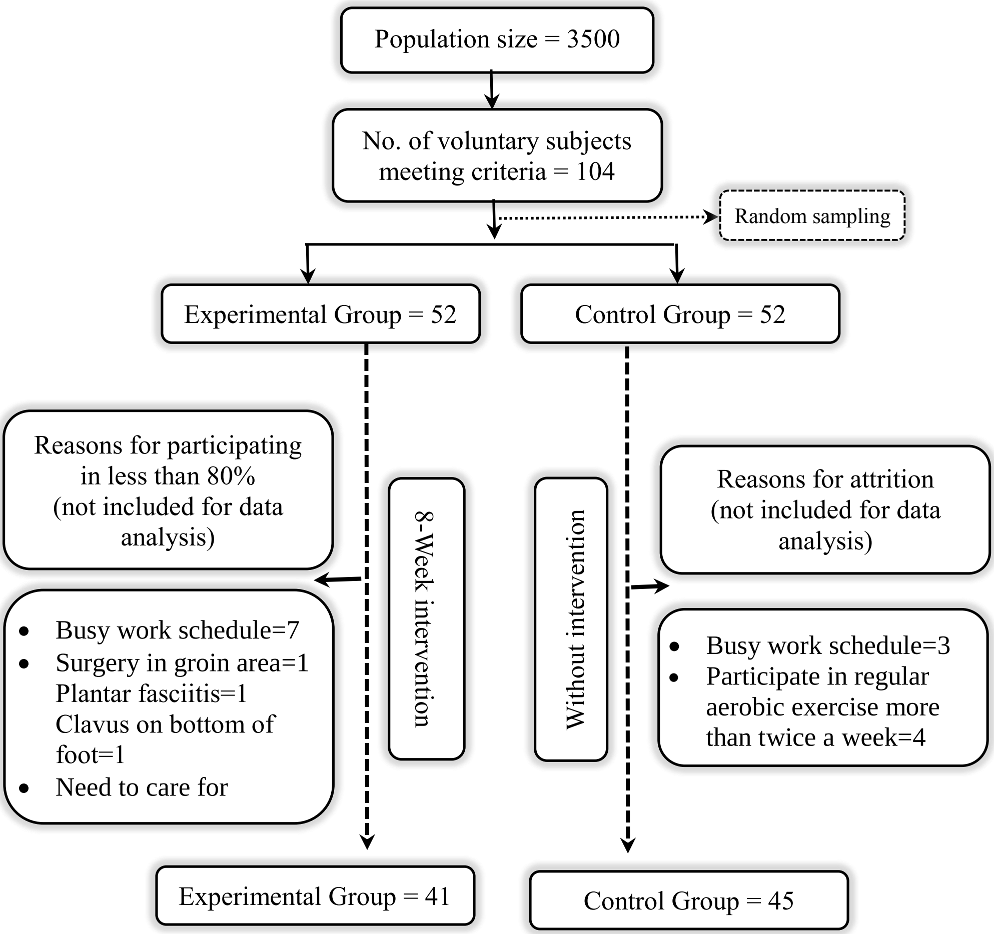

Figure 1. **SUBJECT RECRUITMENT**

A randomised control trial was used in this cross-sectional survey. Convenience sampling was used to select participants from a high technology company in northern Taiwan. Participants were asked to sign a consent form and requested not to change their exercise habits or activities of daily living during the research process. The experimental group (EG) participated in a brisk walking programme (45 to 60 minutes per session, twice a week for 8 consecutive weeks), while the control group (CG) received no exercise intervention. The inclusion criteria for this study included: No regular exercise within 3 months of study initiation (less than 2 exercise sessions per week, less than 30 minutes per session, and a heart rate during physical activity of less than 220-age x 60%); no physical disability; no severe heart disease or hypertension; and no severe knee or lower back pain. 104 voluntary participants satisfied the criteria and were recruited. The participants were randomly assigned to the EG and the CG. Each group contained 52 subjects. Subjects with participation of less than 80% were removed from the study, finally leaving a total of 41 subjects in the EG and 45 subjects in the CG (Figure 1).

Research instruments

Demographic information

This included gender, marital status, education level, occupation, years of work experience, average working hours and health history (provided by participants), and were collected.

Anthropometric measurements

Height, weight, BMI, body fat percentage and waist circumference were measured. These measurements were performed by qualified occupational health nurses with standard anthropometric tools. The body height and weight of the participants were measured simultaneously with Detecto scales (Detecto Scales, Inc., Brooklyn, NY). Standing height without shoes was measured to the nearest 0.01cm. Body weight was measured to the nearest 0.01kg. To calculate the BMI, the weight (kg) was divided by height (m^2). The InBody 230 (Body composition analyser, Biospace Co., Ltd.) was used to measure and record the body fat percentage. Waist circumference was measured at the narrowest point between the lowest rib and the uppermost lateral border of the iliac crest with a measuring tape (cm).

WHOQOL-BREF

The WHOQOL-BREF (World Health Organization Quality of Life-Bref) (WHO, 2004) Taiwan version, which is based on the brief version of the WHOQOL, was used in this study. The Taiwan version comprises 28 items divided into 4 domains: physical health (7 items: satisfaction with work capacity, self-satisfaction, etc.), psychological health (6 items: life meaning, satisfaction of personal relationships, etc.), social relationships (3 items: the feeling of being respected by others, satisfaction with social support and personal relationships), and environment (8 items: satisfaction with living place; satisfaction with access to health services, etc.). Two items measure individual perceptions of overall QOL and health status. The 26 items specified above are the same as those in the general WHOQOL-BREF used worldwide.

For the cultural adaptation of the questionnaire, 2 new items (being respected/accepted and eating/food) were included in the Taiwan version. Hence, the WHOQOL-BREF Taiwan version contains a total of 28 items. Each item is rated on a 5-point Likert-type scale. The internal consistency (Cronbach's α) coefficients are 0.70 to 0.77 at the domain level and 0.91 for the whole questionnaire. The test-retest reliability coefficients for an interval of 2 to 4 weeks are 0.76 to 0.80 at the domain level (Yao *et al*., 2002). The WHOQOL-BREF domain scores are calculated by multiplying the average scores of all items in each domain by 4. Scores range from 4 to 20, with higher scores indicating higher QOL.

Brisk walking programme

The brisk walking programme was designed and implemented by qualified trainers (trained by the Taiwan Health and Exercise Association). The basic movement for brisk walking was adopted from the guidelines provided by the Taiwan Health and Exercise Association (THEA, 2008). When walking at a quick pace, workers should take slow, long deep breaths; keep the head level, the chest slightly lifted and the lower abdomen tucked in; bend arms 90 degrees at the elbow, close the hands in relaxed fists and place them near the waist; when swinging the arms forward, keep the hands level at lower than the chest; and the knees should not be locked but remain relaxed.

The workers who participated in brisk walking were instructed to imagine that they were walking as if they were hurrying to catch a bus. This instruction has been successfully used in other studies (Taylor *et al*., 2005; Taylor & Oliver, 2009) to ensure participants walked at moderate intensity.

Intervention

Prior to the intervention, the researchers designed a standard operating procedure (SOP) to confirm that all workers in the experimental group could measure their pulse rates properly. They were asked to attend a one-on-one meeting with a qualified occupational health nurse and exercise specialist to learn how to properly measure their radial pulse rates.

The SOP to measure the pulse rates included:

1) *Measuring the resting heart rate*: They were asked to find the radial pulse, the pulse on the inside of the wrist, using the anterior surface of the index (first) and middle fingers, not the thumb. To measure the pulse rate, a timepiece with a second hand was used. The resting heart rate was calculated as the number of beats in 15 seconds multiplied by 4 (beats/min) (Yang *et al*., 2016).
2) *Confirming that all workers could measure radial pulse rates successfully each time*: Workers measured and recorded their pulse rates under the supervision of qualified occupational health nurses and exercise specialists. If anyone had difficulty measuring the pulse rate, the nurses and specialists would guide them individually to confirm that all participants could measure their pulse rates correctly.
3) *Measuring pulse rates during the intervention*: When the workers had covered half of the walking distance (3km), staff would tell the workers to begin measuring their pulse rates for 15 seconds. All workers would stop walking and measure their pulse rates in pairs for 15 seconds. Occupational health nurses and exercise specialists supervised and recorded the heart rate of each worker, calculating the rate as described above.

To maintain the quality of the intervention, the number of participants was limited to 22 per class; therefore, the 41 workers in the EG were divided into class A (19 persons) and class B (22 persons). Each class walked briskly on 2 separate days per week. Class A was scheduled for Mondays and Wednesdays, and class B was scheduled for Tuesdays and Thursdays (Appendix).

A professional trainer managed the exercise programme according to heart rates of the participants in order to maintain heart rates between 60 and 90% of the maximum heart rate (HR_{max}). Each brisk walking session covered the same distance (6km), and the duration of each session was between 45 and 60 minutes. The warm-up and cool-down sessions lasted 10 to 20 minutes. The programme continued for 8 weeks. The venues for the brisk walking programme were scheduled for the hour after work, and mainly outdoor walking tracks or sidewalks were used. When rain did not allow outdoor exercise, the indoor sport court in the office building was used. The participants in the CG continued with their normal daily activities without any aerobic exercise or continued exercising for less than two sessions per week.

During each session, after covering half the distance (3km), the workers were grouped in pairs to measure each other's pulse rates as described, supervised by occupational health nurses. The HR_{max} was then calculated with the formula (HR_{max} =220-age) and recorded after each measurement (Tanaka *et al*., 2001). Pulse rates were measured at the halfway point of the session to ensure that workers' heart rates were between 60 and 90% of HR_{max}. Each participant's brisk walking card was stamped each time to record the number of sessions they had participated in and to record the heart rate.

Data analysis

Descriptive statistical analyses were used to describe the variable distributions using means, standard deviations, frequencies and percentages. The independent t-test and Chi-square tests were used to examine the differences between the EG and the CG in terms of pre-test scores. The paired t-test was used to assess differences between the pre- and post-test of the QOL and the physiological aspects of both the EG and CG. In order to assess the effect of the 8-week brisk walking programme on QOL, analysis of covariance (ANCOVA) was used to eliminate any predominant differences between the groups (the pre-test was used as a covariate). The significance level for all statistics was set at $p<0.05$.

Ethical considerations

This study was approved by the Institutional Review Board (case no. TCHIRB-1020210-E). Before the study commenced, the objectives, risks and benefits of the study were explained to the subjects. The subjects then decided voluntarily whether to participate or withdraw from the study. All subjects signed the informed consent form. The health and safety of the subjects were prioritised throughout the study and the subjects could withdraw voluntarily from the study at any point. All data generated from this research protocol were coded to maintain confidentiality and used for academic purposes only.

RESULTS

Personal background

A total of 104 subjects complied with the inclusion criteria of the study and participated voluntarily. Data of the subjects in the EG with a participation rate of less than 80% (participation in less than 13 brisk walking sessions) were not analysed. Forty-one (41) subjects in the EG completed the brisk walking programme and examinations, while a total of 45 subjects in the CG completed the examinations (7 subjects dropped out).

The independent sample t-test and Pearson's Chi-Square test revealed no significant differences at baseline between the EG and CG with respect to gender, marital status, education level, occupation, years of work experience, average working hours, health history, height, weight, BMI, body fat percentage, or waist circumference. Only the average age was significantly different (p=0.01; Table 1).

Table 1. **DEMOGRAPHIC CHARACTERISTICS**

Variables	**EG** (n=41) **M±SD**	**CG** (n=45) **M±SD**	**p-value**	Statis-tic
Age	33.34±6.40	29.40±3.59	0.010	a
Anthropometric measures				
Height (cm)	164.39±8.76	168.62±8.76	0.280	a
Weight (kg)	64.06±13.66	66.55±14.66	0.420	a
BMI (kg/m^2)	23.59±3.89	23.25±3.93	0.690	a
Body fat %	28.08±7.07	25.08±8.00	0.070	a
Waist circumf. (cm)	78.60±10.38	79.08±11.39	0.840	a
Gender	**n (%)**	**n (%)**	0.084	b
Male	16 (39.0%)	27 (60.0%)		
Female	25 (61.0%)	18 (40.0%)		
Marital status			0.082	b
No	27 (65.9%)	37 (82.2%)		
Yes	14 (34.1%)	8 (17.8%)		
Education level			0.171	b
College	35 (85.4%)	33 (73.3%)		
Master's degree	6 (14.6%)	12 (26.7%)		
Occupation			0.090	b
Director	9 (22.0%)	2 (4.4%)		
Design engineer	21 (51.2%)	27 (60.0%)		
Engineer	2 (4.9%)	3 (6.6%)		
Support service	9 (22.0%)	13 (28.9%)		
Work experience			0.064	b
<1year	7 (17.1%)	7 (15.6%)		
2-4years	14 (34.1%)	27 (60.0%)		
5-7years	9 (22.0%)	6 (13.3%)		
>8 years	11 (26.9%)	5 (11.0%)		
Average working hours			0.300	b
<9hrs	12 (29.3%)	18 (40.0%)		
>9hrs	29 (70.7%)	27 (60.0%)		
Medical history			0.401	b
No	35 (85.4%)	36 (80.0%)		
Yes	6 (14.6%)	9 (20.0%)		

EG=Experimental Group CG=Control Group a=Independent t-test b=Chi-Square test

Differences in quality of life and physiological components between pre- and post-test

This study used the WHOQOL-BREF Taiwan version and anthropometric measurements to examine the effects of brisk walking on QOL and physiological components. The WHOQOL-BREF Taiwan version is composed of 4 domains (physical health, psychological health, social relationships and environment) and overall QOL. The anthropometric measurements included body weight, BMI, body fat percentage and waist circumference. As shown in Table 2, the pre-test scores between the 2 groups did not differ significantly.

Table 2. **PRETEST SCORES: DIFFERENCES BETWEEN GROUPS**

Domain	**EG** (n=41) **Mean±SD**	**CG** (n=45) **Mean±SD**	**95%CI Lower – Upper**	**# p-Value**
Anthropometric				
Weight (kg)	64.06±13.66	66.55±14.66	-8.58 – 3.60	0.420
BMI (kg/m^2)	23.59±3.89	23.25±3.93	-1.34 – 2.01	0.690
Body fat %	28.08±7.07	25.08±8.00	-0.26 – 6.23	0.070
Waist circumf. (cm)	78.60±10.38	79.08±11.39	-5.16 – 4.20	0.840
Items of QOL				
Physical health	13.95±1.63	14.23±1.93	-1.05 – 0.48	0.460
Psychological health	12.85±2.29	13.23±2.03	-1.31 – 0.54	0.410
Social relationships	13.53±2.54	13.92±2.55	-1.48 – 0.70	0.470
Environment	13.37±2.20	13.67±2.29	-1.27 – 0.66	0.530
Overall quality of life	53.69±7.27	55.02±6.92	-4.37 – 1.71	0.380

EG=Experimental Group CG=Control Group # Independent t-Test:

Table 3. **DIFFERENCE BETWEEN PRE- AND POST-TEST SCORES WITHIN GROUPS**

	Experimental Group (n=41)		
Domain	***Pre-Test*** Mean±SD	***Post-Test*** Mean±SD	p-Value
Anthropometric measures			
Weight(kg)	64.06±13.66	63.77±13.74	0.110
BMI(kg/m^2)	23.59±3.89	23.46±3.88	0.060
Body fat %	28.08±7.07	27.78±6.69	0.170
Waist circumf. (cm)	78.60±10.38	77.73±10.14	0.081
Items of QOL			
Physical health	13.95±1.63	14.70±1.71	0.004**
Psychological health	12.85±2.29	13.64±2.10	0.002**
Social relationships	13.53±2.54	13.76±2.47	0.001***
Environment	13.37±2.20	13.77±1.90	0.001***
Overall quality of life	53.69±7.27	55.63±6.87	0.020*

Continued

Table 3. **DIFFERENCE BETWEEN PRE- AND POST-TEST SCORES WITHIN GROUPS *(cont.)***

	Control Group (n=45)		
Domain	***Pre-Test*** Mean±SD	***Post-Test*** Mean±SD	p-Value
Anthropometric measures			
Weight(kg)	66.55±14.66	66.64±15.08	0.450
BMI(kg/m^2)	23.25±3.93	23.39±4.00	0.492
Body fat %	25.08±8.00	26.13±7.87	0.061
Waist circumf. (cm)	79.08±11.39	78.35±10.87	0.120
Items of QOL			
Physical health	14.23±1.93	14.34±1.89	0.690
Psychological health	13.23±2.03	13.11±2.22	0.560
Social relationships	13.92±2.55	13.50±2.65	0.160
Environment	13.67±2.29	12.88±2.08	0.002**
Overall quality of life	55.02±6.92	53.83±7.45	0.060

After the 8-week brisk walking programme, in terms of QOL, all the pre-test/post-test scores in the EG were statistically different ($p<0.05$), while the environment domain of the CG was negatively significantly different ($p<0.002$). In terms of anthropometric measurements, none of the pre-test/post-test scores in the EG revealed statistically significant differences ($p>0.05$, Table 3).

Effects of brisk walking on quality of life

Statistical process control was used to compare the 8-week brisk walking programme effects to eliminate any predominant differences between the groups before the intervention. Therefore, pre-test results for both groups were used as the covariate for ANCOVA when comparing the groups in terms of the effects of the exercise intervention. Before ANCOVA, the homogeneity of the within-class regression coefficient was calculated to determine if the slopes of each group were the same, a fitness determinant of the homogeneity hypothesis. At pre-test, the mean age of the EG was significantly older than that of the CG (EG: 33.34±6.40; CG: 29.40±3.59; $p=0.01$). No significant between-group differences were identified for the other demographic variables. The pre-test QOL score and age were used as covariates to remove their effects.

On the *Physical health* domain, after removal of the effects of pre-test scores and age, the post-test scores of the EG and the CG varied significantly ($F=3.62$, $p<0.05$). The adjusted score of the EG was 14.85 and that of the CG was 14.20. This suggested that the 8-week outdoor brisk walking programme had an effect on the physical health domain.

On the *Psychological health* domain, the post-test scores of the EG and the CG differed significantly ($F=8.21$, $p<0.01$). The adjusted score for the EG was 13.83, which was significantly higher than that of the CG (12.94). This indicated that the 8-week outdoor brisk walking programme benefited the psychological health of the EG.

In the *Social relationships* domain, the post-test scores of the EG and the CG did not differ significantly (F=2.60, p>0.05). The adjusted score of the EG was 13.97 and that of the CG was 13.31. These results indicated that the 8-week outdoor brisk walking programme had no effect on the social relationships domain.

On *Environment domain*, the post-test scores of the EG and the CG differed significantly (F=10.81, p<0.01). The adjusted score of the EG was 13.90, which was significantly greater than that of the CG (12.76). This indicated that the 8-week outdoor brisk walking programme had a positive effect on the environment domain.

For the *Overall QOL*, the post-test scores on overall QOL of the EG and the CG differed significantly (F=9.41, p<0.01). The adjusted score of the EG was 56.30, which was significantly higher than that of the CG (53.22). This indicated that the 8-week brisk walking programme improved the overall QOL of these workers in high technology industries (Table 4).

Table 4. **ANCOVA FOR POST-TEST SCORES USING PRETEST AND AGE AS COVARIATE**

Domain	Group	Mean±SE	95% CI	F	p-Value
Physical health	EG	14.85±0.24	14.38–15.33	3.62	0.041*
	CG	14.20±0.23	13.75–14.65		
Psychological health	EG	13.83±0.22	13.40–14.27	8.21	0.005**
	CG	12.94±0.21	12.52–13.35		
Social relationships	EG	13.97±0.29	13.40–14.55	2.60	0.110
	CG	13.31±0.28	12.76–13.85		
Environment	EG	13.90±0.24	13.42–14.38	10.81	0.002**
	CG	12.76±0.23	12.30–13.22		
Overall quality of life	EG	56.30±0.71	54.90–57.70	9.41	0.003**
	CG	53.22±0.67	51.88–54.55		

* p<0.05 ** p<0.01 SE=Standard Error EG=Experimental Group CG=Control Group

DISCUSSION AND LIMITATIONS

The hypothesis of this study was that an 8-week brisk walking programme would significantly improve the overall QOL of workers in high technology industries. The study findings supported the hypothesis and demonstrated an intervention benefit similar to those of previous studies. Chen *et al*. (2010), Pernambuco *et al*. (2012) and Liao and Shiu (2014) reported that 36 weeks or 12 weeks of physical activity or regular exercise had positive effects on the physical health domain in community elderly populations. Fisher and Li (2004), Vuillemin *et al*. (2005) and Lin *et al*. (2007) demonstrated positive correlations between physical exercise and psychological health.

Blacklock *et al*. (2007), Chen *et al*. (2010), Lin and Wu (2010) and Lin *et al*. (2011) all suggested that physical exercise provides an opportunity and location for community elderly populations to interact, thereby promoting social engagement and improving interpersonal relationships. In this study, although the brisk walking programme provided opportunities for workers from different departments to interact, the results did not indicate significant improvement of the social relationships of the workers. The reasons could be that the number of participants per group (22) was limited and that the classes were supervised by researchers in order to maintain the quality of the intervention. These factors may have limited interpersonal interactions. However, this possibility requires further investigation.

Lin *et al*. (2009) examined the effect of environment on the physical activity of community residents and indicated that the quality of the natural environment was the most important factor for the participants. Specifically, a healthy, safe, comfortable, smooth and user-friendly environment enhances people's motivation to perform physical activity. As shown in this study, an outdoor brisk walking programme has a positive influence on the environment domain of workers in stressful high technology industry jobs, for which they remain seated for extended periods. Also worthy of note is that the pre-test/post-test scores of the CG on the environment domain were significantly negative. Workers in high technology industries are exposed to a highly variable and stressful work environment for extended periods of time, thus they are prone to lower QOL due to overwork.

In this study, the effects of the brisk walking programme on physiological components were also tested, but the findings were inconsistent with those of previous studies. Woolf-May *et al.* (2011) demonstrated a positive correlation between 24 weeks of brisk walking and anthropometric components (weight, BMI and waist circumference). Baker *et al.* (2008) indicated that a 12-week walking programme significantly reduced body fat percentage. The reason could be the relatively short duration of the brisk walking programme in this study (8 weeks). It is possible that the duration was too short to produce physiological change. To the authors' knowledge, this study was the first to investigate the health benefits of a brisk walking programme among high technology workers in Taiwan. Although the 8-week brisk walking programme in this study did not appear to have an effect on physiological health, it was associated with improvement in the overall QOL of the workers.

As mentioned previously, workers in high technology industries are more susceptible to psychological disorders than those in other professions (Marcelline & Michael, 2005; Chen *et al*., 2010). Thus, exploring the short-term effects of a brisk walking programme on QOL of the workers may benefit in terms of both the cost-effectiveness of the organisations and workers. According to the findings of this study, it is recommended that an 8-week brisk walking programme is sufficient to improve the overall QOL of workers in high technology industries. Potential limitations of this study were as follows. Firstly, due to budget constraints and workforce limitations, the post-test was carried out immediately after the 8-week brisk walking programme and the participants were not followed up. As a result, it is not known whether the improvement in QOL from this period of training persisted after the study was terminated. Secondly, the authors adopted a randomised controlled trial design. It was conducted only in Taipei City and the size of the valid sample was only 86. Thus, the findings cannot be generalised to the rest of the population of Taiwan.

AVENUES FOR FUTURE RESEARCH

The authors suggest several areas that could be potential topics for further investigation. Gender differences and work experiences (working hours) may have an impact on the effects of the intervention. In this study, the ratios of the variables were not equal in the two groups, thus further research should control for these issues. Reliable instruments should be used to obtain measurements. Although the researchers confirmed that all participants measured their pulse rates accurately, by individual oversight, individual errors may have occurred. Further research should use pulse monitoring equipment to ensure objective detection of changes in pulse rates. In order to demonstrate the benefits of regular exercise on QOL among the Taiwan population, future research should focus on increasing the intervention duration, ensuring mastery of the correct technique and monitoring intensity during the intervention period.

PRACTICAL APPLICATIONS

In times of economic recession, the design of a cost effective programme to promote employee health is a challenge in the workplace. In order to prevent occupational health hazards and to improve working conditions, an employer must arrange occupational health care services for employees, using proper health care professionals and consultants. This study provides an example of a brisk walking programme for promoting the workplace health of employees.

CONCLUSION

Brisk walking is an effective form of exercise for a large proportion of the population. It does not require any formal training or special equipment and can be performed in an individual's own locality and available time slots. Previous studies have indicated that physical activities increase the overall level of satisfaction with life in various population groups. The results of this study suggest that implementing a brisk walking programme in a high technology company has positive effects on overall QOL and on the physical health, psychological health and environment domains of QOL. Therefore, brisk walking is an activity worth promoting. Workers in high technology industries are exposed to stressful work environments for extended periods. Hence, brisk walking is a simple activity that can encourage workers to exercise. Brisk walking causes minimal sport-related injuries while promoting health, making it an ideal activity to promote to the public.

REFERENCES

ADAMS, T.; BURNS, D.; FOREHAND, J.F. & SPURLOCK, A. (2015). A community-based walking program to promote physical activity among African American women. *Nursing for Women's Health*, 19(1): 26-35.

BAICKER, K.; CUTLER, D. & SONG, Z. (2010). Workplace wellness programs can generate savings. *Health Affairs*, 29(2): 304-311.

BAKER, G.; GRAY, S.R.; WRIGHT, A.; FITZSIMONS, C.; NIMMO, M.; LOWRY, R.; MUTRIE, N. & Scottish Physical Activity Research Collaboration (SPARColl) (2008). The effect of a pedometer-based community walking intervention "Walking for Wellbeing in the West" on physical activity levels and health outcomes: A 12-week randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, 5(September): 44-58.

BERRY, L.L. & MIRABITO, A.M. (2011). Partnering for prevention with workplace health promotion programs. *Mayo Clinic Proceeding*, 86(4): 335-337.

BEUTTENMÜLLER, L.; CADER, S.A.; MACENA, R.H.M.; ARAUJO, N.S.; NUNES, É.F.C. & DANTAS, E.H.M. (2010). Muscle contraction of the pelvic floor and quality of life of women with stress urinary incontinence who underwent kinesiotherapy. *Physiotherapy*, 18(1): 35-41.

BIDDLE, S.J.H. & MUTRIE, N. (2001). *Psychology of physical activity: Determinants, well-being and interventions*. New York, NY: Routledge.

BLACKLOCK, R.E.; RHODES, R.E. & BROWN, S.G. (2007). Relationship between regular walking, physical activity, and health-related quality of life. *Journal of Physical Activity and Health*, 4(2): 138-152.

BOWLING, A. & ILIFFE, S. (2011). Psychological approach to successful ageing predicts future quality of life in older adults. *Health and Quality of Life Outcomes*, 9(1): 13-22.

BOWLING, A. & STENNER, P. (2011). Which measure of quality of life performs best in older age? A comparison of the OPQOL, CASP-19 and WHOQOL-OLD. *Journal of Epidemiology and Community Health*, 65(3): 273-280.

CHEN, C.Y.; WU, C.R. & HSU, J.H. (2010). Study on the correlation between risk factors of workplace stress and burnout of the high-tech employees: Case study on a science park [In Chinese]. *Journal of International Esthetic Science*, 7(2): 5-20.

FIGUEIRA, H.A.; FIGUEIRA, O.A.; FIGUEIRA, A.A.; FIGUEIRA, J.A.; GIANI, T.S. & DANTAS, E.H.M. (2010). Elderly quality of life impacted by traditional Chinese medicine techniques. *Clinical Interventions in Aging*, 5(October): 301-305.

FISHER, K.J. & LI, F. (2004). A community-based walking trial to improve neighborhood quality of life in older adults: A multilevel analysis. *Annals of Behavioural Medicine*, 28(3): 186-194.

HOGAN, C.L.; CATALINO, L.I.; MATA, J. & FREDRICKSON, B.L. (2015). Beyond emotional benefits: Physical activity and sedentary behaviour affect psychosocial resources through emotions. *Psychology and Health*, 30(3): 345-369.

HOPMAN, W.M.; BERGER, C.; JOSEPH, L.; BARR, S.I.; GAO, Y.; PRIOR, J.C.; POLIQUIN, S.; TOWHEED, T.; ANASTASSIADES, T. & CAMOS RESEARCH GROUP (2007). The association between body mass index and health-related quality of life: Data from CaMos, a stratified population study. *Quality of Life Research*, 16(10): 1595-1603.

KIM, Y.H. & YANG, Y.O. (2005). Effects of walking exercise on metabolic syndrome risk factors and body composition in obese middle school girls. *Journal of Korean Academy of Nursing*, 35(5): 858-867.

KRIJTHE, B.P.; WALTER, S.; NEWSON, R.S.; HOFMAN, A.; HUNINK, M.G. & TIEMEIER, H. (2011). Is positive affect associated with survival? A population-based study of elderly persons. *American Journal of Epidemiology*, 178(11): 1298-1307.

LIAO, Y.H. & SHIU, J.M. (2014). Exercise attitudes and participation, and health-related quality of life (SF-36) among university students in Yunlin [In Chinese]. *Journal of Taiwan Society for Sport Management*, 13(1): 1-29.

LIN, F.T.; CHANG, C.; LEE, C.H. & YANG, T. (2011). The quality of life effects of a community exercise-walking intervention in the middle-aged and elderly [In Chinese]. *Journal of Health Science*, 13(4): 31-44.

LIN, L.J.; YEN, L.L.; HUANG, C.H.; KU, N.H. & CHANG, Y.H. (2009). Effectiveness of promoting walking behaviour for community residents [In Chinese]. *Taiwan Journal of Public Health*, 28(2): 115-123.

LIN, L.L. & WU, Z.I. (2010). Effect of brisk walking program on cardiovascular risk factors in middle-aged and older adults in the community [In Chinese]. *Sports and Exercise Research*, 12(4): 90-98.

LIN, Y.C.; WEN, C.P. & WEI, J.P. (2007). Leisure-time physical activity and its association with health behaviours, health status and health-related quality of life among Taiwanese adults [In Chinese]. *Taiwan Journal of Public Health*, 26(3): 218-228.

MARCELLINE, F. & MICHAEL, R.M. (2005). Psychosocial predictors of health status revisited. *Journal of Behavioural Medicine*, 28(4): 347-358.

MINISTRY OF SCIENCE AND TECHNOLOGY (2016). "National economic trends, Taiwan Area, the Republic of China. Executive Yuan, Republic of China". Hyperlink: [https://www.most.gov.tw/most/attachments/c63b1ebe-a732-4aca-a526-7587edb27113]. Retrieved on 19 March 2016.

MORRIS, J.N. & HARDMAN, A.E. (1997). Walking to health. *Sports Medicine*, 23(5): 306-332.

PERNAMBUCO, C.; RODRIGUES, B.; BEZERRA, J.; CARRIELO, A.; FERNANDES, A.; VALE, R. & DANTAS, E. (2012) Quality of life, elderly and physical activity. *Health*, 4(2): 88-93.

REJESKI, W.J. & MIHALKO, S.L. (2001). Physical activity and quality of life in older adults. *Journals of Gerontology (Series A, Biological Sciences and Medical Sciences)*, 56A (Special issue 2): 23-35.

SAXTON, J.M.; ZWIERSKA, I.; BLAGOJEVIC, M.; CHOKSY, S.A.; NAWAZ, S. & POCKLEY, G. (2011). Upper-versus lower-limb aerobic exercise training on health-related quality of life in patients with symptomatic peripheral arterial disease. *Journal of Vascular Surgery*, 53(5): 1265-1273.

SHEPHARD, R.J. (2005). Chronic fatigue syndrome: A brief review of functional disturbances and potential therapy. *Journal of Sports Medicine and Physical Fitness*, 45(3): 381-92.

TANAKA, H.; MONAHAN, K.D. & SEALS, D.R. (2001). Age-predicted maximal heart rate revisited. *Journal of the American College of Cardiology*, 37(1): 153-156.

TAYLOR, A.H.; KATOMERI, M. & USSHER, M. (2005). Acute effects of self-paced walking on urges to smoke during temporary smoking abstinence. *Psychopharmacology*, 181(1): 1-7.

TAYLOR, A.H. & OLIVER, A.J. (2009). Acute effects of brisk walking on urges to eat chocolate, affect, and responses to a stressor and chocolate cue: An experimental study. *Appetite*, 52(1): 155-160.

THEA (TAIWAN HEALTH AND EXERCISE ASSOCIATION) (2008). "The plan of workplace health promotion". Hyperlink: [http://www.exercise.org.tw/about.php?id=3]. Retrieved on 24 May 2015.

TULLY, M.A.; CUPPLES, M.E.; CHAN, W.S.; MCGLADE, K. & YOUNG, I.S. (2005). Brisk walking, fitness, and cardiovascular risk: A randomized controlled trial in primary care. *Preventive Medicine*, 41(2): 622-628.

VUILLEMIN, A.; BOINI, S.; BERTRAIS, S.; TESSIER, S.; OPPERT, J.M.; HERCBERG, S.; GUILLEMIN, F. & BRIANÇON, S. (2005). Leisure time physical activity and health-related quality of life. *Preventive Medicine*, 41(2): 562-569.

WHO (WORLD HEALTH ORGANIZATION) (2004). *The World Health Organization Quality of Life (WHOQOL)– BREF.* Geneva (Switzerland): World Health Organization Printers.

WOOLF-MAY, K.; SCOTT, A.; KEARNEY, E. & JONES, D. (2011). The effect of 24 weeks of moderate intensity walking upon metabolic syndrome risk factors in previously sedentary/low active men. *Journal of Exercise Physiology*, 4(4): 145-156.

YANG, H.I.; KIM, H.C. & JEON, J.Y. (2016). The association of resting heart rate with diabetes, hypertension, and metabolic syndrome in the Korean adult population: The fifth Korea National Health and Nutrition Examination Survey. *Clinica Chimica Acta*, 455(April): 195-200.

YAO, G.; CHUNG, C.W.; YU, C.F. & WANG, J.D. (2002). Development and verification of validity and reliability of the WHOQOL-BREF Taiwan version. *Journal of the Formosan Medical Association*, 101(5): 342-351.

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