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An intervention program to promote health-related physical fitness in nurses

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Aims. To assess the effects of exercise intervention on nurses' health-related physical fitness.

Background. Regular exercise that includes gymnastics or aerobics has a positive effect on fitness. In Taiwan, there are not much data which assess the effects of exercise intervention on nurses' health-related physical fitness. Many studies have reported the high incidence of musculoskeletal disorders (MSDs) in nurses However, there has been limited research on intervention programs that are designed to improve the general physical fitness of nurses.

Design. A quasi-experimental study was conducted at a medical centre in central Taiwan.

Methods. Ninety nurses from five different units of a hospital volunteered to participate in this study and participated in an experimental group and a control group. The experimental group engaged in a three-month intervention program consisting of treadmill exercise. Indicators of the health-related physical fitness of both groups were established and assessed before and after the intervention.

Results. Before intervention, the control group had significantly better grasp strength, flexibility and durability of abdominal muscles than the experimental group ($p < 0{\cdot}05$). After the intervention, logistic regression was used to adjust for marital status, work duration, regular exercise and workload and found that the experimental group performed significantly better ($p < 0{\cdot}05$) on body mass index, grasp strength, flexibility, durability of abdominal and back muscles and cardiopulmonary function.

Conclusions. This study demonstrates that the development and implementation of an intervention program can promote and improve the health-related physical fitness of nurses.

Relevance to clinical practice. It is suggested that nurses engage in an exercise program while in the workplace to lower the risk of MSDs and to promote working efficiency.

Key words: health education, health-related physical fitness, intervention, nurses, nursing

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Introduction

Nursing is a very stressful profession and has become more demanding in recent years due to an ageing population, an increase in chronic diseases and changes in health insurance policies (Tsai *et al.* 1996, Liaw *et al.* 2006). Studies have shown that musculoskeletal disorders (MSDs) are common in nurses (Lipscomb *et al.* 2004) and that the prevalence rate for

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nurses in Taiwan is 65–72%. Factors that affect MSD rates include workload, working posture and insufficient rest time (Nien & Ke 1996, Feng *et al.* 2005, Bos *et al.* 2007). A Taiwanese study (Wang *et al.* 2006) focusing on fatigue/liveliness, health-promoting lifestyle and health-related quality of life (HRQOL) in nurses found that fatigue and health-promoting lifestyle had a significant negative correlation. In other words, the better an individual's health-promoting lifestyle, the less fatigue and more liveliness the individual would experience. Of the nurses, 88·9% exercised once per week, yet none exercised more than three times per week. A study (Song *et al.* 2001) of clinical nurses and nursing students showed that exercise was their least frequent activity.

Previous studies (Lu 2002) have pointed out that exercise is beneficial to people's health by improving cardiopulmonary functions, strengthening the immune system, reducing psychological stresses and depression and improving the overall HRQOL. Research on MSDs in nurses revealed that individuals who exercised regularly experienced less mental, emotional and physical distress (Feng & Hwang 1999). One study pointed out that people who exercise frequently were better at handling stress than people who did not exercise; they were also less likely to experience frustration and anxiety [American College of Sports Medicine (ACSM) 2000]. Fitness professionals believe that, to improve aerobic fitness, people should exercise regularly since regular exercise is important for maintaining good physical fitness. Nevertheless, despite the advantages of regular exercise, people usually do not exercise due to a lack of time, energy and no place to exercise (Lin 1999). The physical fitness of a group of nurses at a medical centre was poor when compared to a similar age sampling of the general population, suggesting that nurses' physical fitness shows room for improvement (Hu *et al.* 2005).

Effective exercising consists of aerobic activity three to five times a week, 20–60 minutes each time, while maintaining a heart rate at 80–90% of the maximum heart rate (220 bpm, ACSM 2000). Aerobic exercise is an 'endurance' exercise that improves fitness, increases metabolic rates, burns more calories, increases the force of myocardial contractions, reduces vascular resistance, helps prevent hypertension and MSDs (Fang & Chen 1997, Huang 2001). Exercise increases blood flow, helps achieves maximum oxygen uptake and increases muscle tension, while reducing anxiety (Zhang & Jiang 1995). After an eight-week exercise program in Taiwan, not only did workers' muscle endurance and cardiopulmonary endurance improve but 90% of the staff felt they had better overall health, better working morale and higher efficiency (Chen 2002). It is necessary to communicate with nurses to enhance positive health, prevent diminishing ill-health and help them change their attitudes and behaviour. Because in Taiwan there is a limited amount of literature regarding how to improve the fitness of nurses in the workplace, the objective of this study was to assess the effect of an exercise intervention program.

Methods

Study design and participant selection

This quasi-experimental study was conducted using measurements taken before and after administering an intervention program. The protocol was approved by the institutional review board (IRB). After we announced we were going to conduct this experiment, nurses in a medical centre in central Taiwan volunteered to participate in this experiment and signed informed consent forms. Five separate nursing units each assigned 8–10 voluntary subjects to an experimental group and a control group. At the beginning of the study, each group consisted of 45 subjects. While all 45 subjects in the experimental group completed the study, only 41 subjects in the control group were able to finish because one fell ill and three quit their jobs. Subjects were excluded if they suffered from cardiovascular disease, chronic systemic diseases (diabetes, hypertension, renal and pulmonary diseases), severe musculoskeletal aches, or were pregnant (Lin *et al.* 2005).

Instruments

A structured questionnaire was designed for the study to record the nurses' basic information, including age, height, weight, level of education, marital status, working duration, workload, respiratory diseases, type of shift worked, time and method of commute, exercise habits and work-related MSDs. The questionnaire was given to both the experimental and control groups prior to the exercise intervention and was completed by all participants.

The standardised tool used to measure physical fitness in this study was taken from the Labour's Physical Fitness Test Method, formulated by the Taiwan Institute of Occupational Safety and Health (IOSH) in 2003 (IOSH 2003). The five indicators of fitness included body mass index (BMI), grip strength, flexibility, abdominal muscle durability, back muscle durability and cardiopulmonary durability. The method of evaluation included measuring height, weight, blood pressure, grip strength, sitting while bending forward (flexibility), bent-knee sit-ups (abdominal muscle durability), prone back bend (back muscle durability) and a three-minute stair-stepping test (cardiopulmonary durability).

The methods of fitness evaluation are described as follows: (a) BMI: BMI = weight (kg) ÷ [height (m))]^2. (b) Blood pressure was measured by the CAS (brand) 740 (model) mercurial nanometre purchased from Transmedic Ltd. (Florida, USA). (c) Grip strength was measured on the dominant hand using the grip dynamometer (T.K.K.5401) with a range of 5·0–100·0 kg purchased from Takei Scientific Instruments Co. Ltd. (Osaka, Japan). Grip strength was measured when the arm was straight, the proximal interphalangeal joints were perpendicular, eyes looking straight ahead and gripped with maximum strength when hearing the 'grip hard' command. Two measurements were made with a one-minute rest in between and only the maximum value was recorded. (d) The flexibility test used an AC696 arrow-style measuring device, purchased from Accuratus International Health Ltd (Tainan, Taiwan), placed on a flat surface or mat. The zero point on the measuring device was pointed toward the subject and the device was then secured. While the knees of the test subject were straight, a total of two measurements were made, each lasting two seconds and only the maximum value was recorded. (e) The abdominal muscle durability test had subjects lie flat on their backs, arms hugging the chest, knees bent at 90° angle and feet on the ground. The examiner secured the ankles of the subjects and sit-ups were only valid if arms touched the knees when sitting up and shoulders touched the ground when lying down. The number of sit-ups completed within 60 seconds was recorded. The mats used for sit-ups were purchased from Accuratus International Health Ltd. (f) The back muscle durability test required subjects to lie face down with arms crossed behind the back. The examiner secured the subject's thighs and the exercise was only valid if the subject's processus xiphoideus beneath the sternum left the mat and the shoulders touched the mat when lying down. The number of back bends completed within 60 seconds was recorded. (g) The cardiopulmonary durability test required the subject to step up and down from a wooden box (a height of 35 cm) at a speed of 96 steps per minute.

After three minutes, the recovered heart rate of the first 30 seconds of the first, second and third minutes were measured. If the subject was unable to complete the three-minute test, then the actual completion time and recovered heart rate were recorded. The cardiopulmonary index = exercise time (seconds) × 100/total recovered heart rate from the three times × 2. The tools used included 35 cm high height-adjustable steps and the Accu-Max three-minute Pulse Tester-1N purchased from Accuratus International Health Ltd. This study chose the easy-to-use 'animated twist stepper,' Changtian Sports Ltd. model KA-animated 200, as the aerobic exercise equipment for exercise intervention. All equipment and devices were calibrated before use.

Intervention program

The subjects were recruited from five nursing units and each unit was given a stair-stepper which was to be used daily after work by the experimental group for three months. Nurses in the control group maintained their usual work habits and did not participate in any intervention. A physical fitness exam was done in both the experimental and control groups before exercise intervention; both groups underwent another fitness exam after the experimental group completed three months of exercise. Physical fitness exams were done to evaluate and compare the effects of exercise. Proper locations were chosen for placement of the stair-steppers. The exercise was terminated for any individual in the experimental group who experienced arrhythmia, troubled breathing, dizziness or nausea. Each member of the experimental group exercised on the stair-stepper 20–30 minutes until the heart rate reached 70–85% of the 'maximum heart rate of 220-age. They exercised at least three times per week and the length of time and heart rate were recorded by the subject after exercise.

Before the experiment began, researchers visited the sites and gave detailed explanations. They also asked head nurses to encourage and assist in the experiment. Because this experiment was funded by a grant, we were able to give each of the nurses who completed the study a pedometer at the end of the third month as an incentive. Researchers visited each unit weekly to monitor progress, to encourage subject compliance with the exercise program and to collect the 'exercise record.' The 'exercise record' included the date, maximum heart rate after each exercise, length of exercise and frequency of exercise per week. Additionally, the participants were able to achieve their requirements because of the support and urging of the head nurse at each unit. At the end of the study, all of the participants were classified in two groups (improved or not improved) based on the five fitness indicators.

Data collection and analysis

After collection, the data were analysed, examined and coded. All data were filed using Microsoft Excel 2000 and analysed by SPSS version 12·0 statistical software. Before using the statistical method, the data were tested and met the assumption of statistical method. The subjects' basic information was tabulated using percentages and differences between the two groups were examined using the chi-square test. The paired t-test was used to examine data pre- and post intervention and analysis of covariance (ANCOVA) was used to assess the effects of the intervention adjusted for indicators in the preintervention. ANCOVA is a general linear model with one continuous explanatory variable and one or more factors. ANCOVA tests whether certain factors have an effect after removing the variance for which quantitative predictors (covariates) account. When five indicators of fitness were found to have 'improved', the 'fitness indicator after intervention' was greater than the 'fitness indicator before intervention'. Logistic regression is a model used for prediction of the probability of occurrence of an event by fitting data to a logistic curve and it is a technique for making predictions when the dependent variable is a dichotomy and the independent variables are continuous and/or discrete. Logistic regression was used to assess the improvement using five indicators of fitness between the two groups.

Results

Comparison of experimental group and control group demographics

Table 1 shows a comparison of the demographic information of the experimental group and control group. The average ages in the experimental group and control group were 35 and 31 years old, respectively. Over half of the nurses in both groups were university educated. However, while 64·5% of the subjects in the experimental group were married, only 36·4% of those in the control group were married. The majority of the nurses in the study had worked at their jobs for five years or fewer, followed by those with 6–10 years of work duration. Those nurses with more than 16 years of work duration were lowest in number. The types of shift worked did not differ significantly between the two groups. In the experimental group, a plurality of subjects (46·7%) primarily worked a fixed shift during the daytime. In the control group, on the other hand, a plurality (46·3%) worked an alternating shift schedule. When asked about their workload, 24·4% of the subjects in the experimental group responded that it was heavy, contrasted with 7·3% of the subjects in the control group, showing a marginal difference. The methods and durations of commute were not significantly different between the two groups. 84·4% of the subjects in the experimental group felt that the MSDs they suffered were work-related as opposed to 70·7% in the control group.

Table 1 Comparison of demographic data between the experimental group and the control group

	Experimental group $N = 45$		Control group $N = 41$		
	n	%	*n*	%	*p*
Age (years)					
≤30	18	40·0	24	58·5	0·174
31–40	16	35·6	12	29·3	
≥41	11	24·4	5	12·2	
Educational level					
< College	15	33·4	14	34·1	0·356
University	25	55·6	23	56·1	
Graduate institute	5	11·1	4	9·7	
Martial status					
No	16	35·6	26	63·4	0·010
Yes	29	64·4	15	36·6	
Work duration (years)					
< 5	19	42·2	22	53·7	0·325
6–10	13	28·9	14	34·1	
> 11	13	28·9	5	12·2	
Shift work					
No	30	55·6	19	46·4	0·529
Yes	15	44·4	22	53·6	
Workload					
No	13	28·9	17	41·5	0·085
Slightly	21	46·7	21	51·2	
Heavy	11	24·4	3	7·3	
Regular exercise					
Yes	13	28·9	12	29·3	0·969
No	32	71·1	29	70·7	
Musculoskeletal disorders					
Yes	38	84·4	29	70·7	0·246
No	7	15·6	12	29·3	

Pre- and Postintervention physical fitness measurements

The physical fitness of the two groups before and after exercise intervention is shown in Table 2. Fitness was examined using the Labour's Physical Fitness Test Method. Prior to exercise, measurements of grip strength, flexibility, abdominal muscle durability and back muscle durability, were all poorer in the experimental group than in the control group. Statistical analysis using paired *t*-test showed significant differences between pre- and postintervention BMI, flexibility, abdominal muscle durability, back muscle durability and cardiopulmonary durability ($p < 0.05$) in the experimental group. However, in the control group there was only a significant difference in gripping strength and flexibility. Unfortunately, gripping strength and flexibility values decreased in the control group. ANCOVA adjusted for indicators in the preintervention was used to determine the effects of the intervention. Improvements in the postintervention indicators were observed in the experimental group regarding grip strength, flexibility, abdominal muscle durability, back muscle durability and cardiopulmonary durability compared with the control group adjusted for preintervention baseline. However, there was no significant difference in the blood pressure of the postintervention period in the two groups.

The improvement in the fitness indicators between the experimental group and the control group are shown in Table 3 using multiple logistic regression analysis after

Table 2 Comparison of fitness indicators between pre- and postintervention periods in the experimental group and the control group

	Experimental group (N = 45)			Control group (N = 41)			
	Preintervention	Postintervention	$p1$	Preintervention	Postintervention	$p2$	$p3$
Diastolic BP (mmHg)	120·4 ± 16·0	117·8 ± 11·5	0·087	114·9 ± 14·4	113·8 ± 10·5	0·375	0·059
Systolic BP (mmHg)	77·2 ± 12·3	78·7 ± 10·6	0·426	76·8 ± 13·7	75·4 ± 11·9	0·140	0·738
Body mass index (kg/m^2)	23·65 ± 3·67	23·12 ± 3·63	0·007	23·07 ± 3·69	23·18 ± 3·71	0·850	0·002
Gripping strength	28·26 ± 7·05	28·58 ± 6·39	0·374	32·22 ± 9·42	31·44 ± 8·71	0·005	0·018
Flexibility	25·51 ± 10·2	28·96 ± 8·16	< 0·001	30·20 ± 8·96	29·15 ± 7·84	0·026	< 0·001
Abdominal muscle durability	17·22 ± 7·71	20·29 ± 6·45	< 0·001	20·63 ± 7·03	20·54 ± 6·98	0·816	< 0·001
Back muscle durability	45·09 ± 12·36	50·69 ± 10·32	< 0·001	48·20 ± 9·71	46·78 ± 9·33	0·105	< 0·001
Cardiopulmonary durability	48·82 ± 17·93	53·59 ± 14·95	< 0·001	47·04 ± 9·38	46·16 ± 6·88	0·199	< 0·001

The $p1$ was calculated by paired t-test to compare pre- and postintervention in the intervention group. The $p2$ was calculated by paired t-test to compare pre- and postintervention in the control group. The $p3$ was calculated by ANCOVA to compare the difference in the postintervention periods between the two groups after adjusted for the baseline in preintervention period.

Table 3 Improvement in physical fitness in the experimental group compared to the control group using logistic regression models adjusted for marital status, work duration, regular exercise and workload

	Crude odds ratio	95% CI	Adjusted odds ratio	95% CI
Body mass index	2·83*	1·09–7·39	3·90*	1·19–12·79
Gripping strength	1·29*	1·04–1·61	1·36*	1·05–1·76
Flexibility	1·59**	1·27–2·00	2·14**	1·46–3·14
Abdominal muscle durability	1·59**	1·25–2·02	1·68**	1·22–2·32
Back muscle durability	1·15**	1·05–1·24	1·15*	1·03–1·28
Cardiopulmonary durability	1·38**	1·14–1·67	1·64**	1·18–2·28

*p < 0·05; **p < 0·01.

adjusting for confounding variables (marriage, work duration, exercise habits and workload). Indicators were said to have improved when the fitness indicator after intervention was greater than the 'fitness indicator before intervention'. The experimental group had consistently better results than the control group in all six indicators. The experimental group was more likely than the control group to improve in BMI (OR = 3·90), grip strength (OR = 1·36), flexibility (OR = 2·14), abdominal muscle durability (OR = 1·68), back muscle durability (OR = 1·15) and cardiopulmonary durability (OR = 1·64). Six indicators of fitness were significantly higher in the experimental group.

Discussion

Evaluation of the effects of exercise intervention using the 'Labour's Physical Fitness Test Method' formulated by the IOSH in Taiwan (Taiwan IOSH 2003), found that the experimental group's physical fitness became better than that of the control group after exercise intervention, whereas it was poorer than the control group prior to intervention. After adjusting for confounding variables (marriage, work duration, exercise habits and workload), the experimental group performed better than the control group in all six fitness indicators. These results were similar to the results in a study by Lee and Fang (1998) that focused on 36 women with an average age of 38·4 years who engaged in a 60-minute fitness training class (stretching exercise, aerobic exercise and weight training) twice a week over the course of 12 weeks. The fitness training resulted in significant improvements in their BMI, flexibility, muscle strength and durability and cardiopulmonary fitness index (p < 0·05). A study by Chung (2001) on physical fitness found that female body fat, BMI and cardiopulmonary fitness all significantly improved (p < 0·05). In addition, the Workplace Staff Health Improvement Test Plan conducted by Chen (2002) and sponsored by the Taiwan DOH, found that after an eight-week fitness exercise and stair-stepping intervention, workers' muscle durability, cardiopulmonary durability and maximum oxygen uptake improved. Furthermore, close to 90% of the staff felt they were healthier; workers had higher morale and it was shown that regular exercise improved health-related physical fitness. The latter two results were similar to our findings.

Health promotion was defined as any combination of health education and related organisational, economic and environmental supports for behaviour conducive to health (Whitehead 2001, 2003). In the past, nurses educated their patients regarding health promotion. Now, we expect nurses will educate themselves regarding health promotion. If nurses want to change their behaviour, this process should include education, persuasion, manipulation and attempts to promote an environment where healthy decisions about their lifestyle can be made (Norton 1998). Although health education which enables nurses to make informed decisions and adopt behaviour which promotes health is often praised, providing information about the risks of a sedentary lifestyle will not necessarily change nurses' lifestyles or habits. This is similar to a report by Tones and Tilford (1994) stating health education was viewed as a process of critical consciousness which aims to give participants a deeper understanding of their circumstances and their capacity to influence those circumstances. However, health education and health promotion require a broad conceptualisation of theory that recognises that its knowledge-base is contingent and contextual, rather than universal, determinate and invariable (Buchanan 1998). Essentially, the several recommendations for effective behavioural-change health education practice can reflect the benefit for nurses' health by informed effective guidelines, providing accessible exercise equipment and encouraging nurses to exercise in the hospital.

The reasons given by over 70·7% of subjects in this study for not exercising regularly (three or more times per week) before the exercise intervention were 'no time', 'too tired', 'not accessible', and 'no partner'. This was similar to a study conducted in Taiwan by Wang *et al.* (2006), which found that 88·9% of nurses exercised ≤1 times per week and none exercised ≥3 times a week. It was also similar to a study by Lin (1999), which said that the reasons people give for not exercising were 'no time, too tired, not accessible, do not enjoy it, etc'. With this in mind, we installed the animated twist stepper at the hospital units in our study to make exercising more accessible, easy to do and supportable by peers. The twist stepper provided a low intensity, rhythmic and continuous aerobic exercise. At the same time, it increased metabolic rate, the number of calories burned, the force of myocardial contractions and lowered vascular resistance. The results of this study show that the 'animated twist stepper' did, in fact, improve the physical fitness of the subjects and its use should therefore be promoted. A study assessed the impact of ergonomic intervention on rates of low back pain among 1239 female nurses in two hospitals in southern England. After the intervention, the prevalence of occupational risk factors was somewhat lower, but the prevalence of symptoms increased slightly (from 27–30%). Authors suggested more effective methods of implementing changes in work systems are needed (Smedley *et al.* 2003).

Currently, the Taiwan DOH has been actively encouraging health-promotion programs in the workplace in the hope that workers' health status and working efficiency will be improved. Hospitals could provide time for nurses to exercise in the morning and in the afternoon. In addition, hospitals could also publish and distribute fitness exercise DVDs and related materials to nurses. Furthermore, hospitals should encourage the nurses to exercise. Health promotion and health education in the health services usually appeared to be preoccupied with attempting to change the behaviour of nurses and supervisors. Health education is part of health promotion and its effectiveness can surely be promoted if there is a supportive environment created by a good health policy (Cantrell 1997, Norton 1998). However, it would be hard for health workers, who are limited by the nature and environment of their work, to find time to exercise during work. Therefore, it might be a good idea for employers to provide accessible exercise equipment for health workers at their workplace. Naidoo and Coopoo (2007) suggested overall poor health and fitness profiles and a high incidence of back pain correlating with increased body fat percentages. The need for health and wellness intervention strategies in hospitals for the nurses was emphasised. Hopefully, the results of this study can serve as a reference to administrators of medical institutions to improve the physical fitness of all health workers. Positive feedback from participants was expressed in the experimental group after completion of the intervention program and it was found that their health status had improved.

Study limitations

There are some limitations in the current study. First, because the subjects were not randomised to ensure the similarity of the demographic information, the lower preintervention scores on the fitness indicators in the experimental group may indicate some bias in the process of allocation of subjects to groups and these impacts on the inference of the results to all nurses. Most of the subjects in the experimental group were married and felt they had a heavier workload than those in the control group. Because married people have both the stress of family and work responsibilities, they are at a higher risk of suffering MSDs. Therefore, married people might be more motivated than single people to exercise more regularly. Secondly, since the two groups are in the same workplace, they may imitate each other which could lead to contamination of results. Due to these uncontrollable conditions, the effects of the intervention in this study might have been underestimated. Nevertheless, no significant difference in frequency of regular exercise and work characteristic was found in the control group during the intervention period. Lastly, our study findings indicate that the intervention program has a significant improvement on fitness. Even though the intervention had a positive effect on the physical fitness of the subjects, the improvement of MSDs in those subjects was not evaluated. However, the effect of the exercise intervention in the previous study was usually evaluated through a self-reported assessment during pre- and postintervention period. No physiological measurements (such as blood or urine tests) were done, since the fitness test was able to provide concrete and measurable data. In future studies, more evaluation methods could be designed and longer study durations could be performed to monitor and understand the efficacy of fitness training in the workplace better.

Relevance to clinical practice

We suggest that nurses take part in an exercise program at the workplace that is easily accessible to lower the risk of MSDs and to improve working efficiency. When supervisors adopt the concept of the workers' health is the owner's wealth, both parties benefit. Both the general health of the nursing staff and the quality of care provided by that staff will improve.

Conclusions

Nurses engaged in regular exercise at a hospital workplace showed experimental group's scores improved in six fitness indicators (BMI, gripping strength, flexibility, abdominal and back muscle durability and cardiopulmonary durability) whilst the control group scores either stayed the same or in fact got worse on average. This does mean that intervention program would improve the fitness of some nurses (e.g. those who volunteer for such a program) is a valid one. It is important for hospitals to design an exercise area in the workplace that provides nurses with an accessible place to exercise and where they can find partners easily, which in turn should increase their willingness to exercise.

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Contributions

Study design: SCY, MCC; data collection and analysis: LJ H, YOC, WHH, HWK and manuscript preparation: SCY, HWK.

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