Using Environmental Stimuli in Physical Activity Intervention for School Teachers: A Pilot Study

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Abstract

The purpose of the present study was to examine the effectiveness of a six-week intervention that aimed to promote teachers' physical activity level during working hours. Thirty-eight teachers from three intervention schools (schools randomly assigned as intervention group) received intervention prompts: SMS messages, leaflets and posters promoting walking, and a pedometer. Fourteen teachers were from a control school (school randomly assigned as control group). All participants reported pedometer readings and rated their Stage of Change scores before and after intervention. Differences in step counts per minute between groups were examined using ANCOVA adjusted by time duration for step counts. The intervention group had a higher increase in steps-at-work (t=3.61, P<0.001) than the control group and type of commuter affected the increase in steps-at-work for the intervention group ($F_{2,34}=4.95$, $P<0.01$, $\eta_p^2=.23$). The study concluded that an intervention utilizing environmental stimuli as the strategy can be successfully applied in the school setting for the promotion of school teachers' physical activity.

Key words: *Physical activity, Worksite Intervention, Pedometer, School Teachers*

Introduction

Surveys indicate that the majority of adults in developed countries fail to meet the recommended physical activity (PA) levels for health benefits and highlight the need to promote PA.[1,2] The statistics are similar in Hong Kong. The Hong Kong Behavioral Risk Factor Survey revealed that over half (56.5%) of the adults in Hong Kong aged 18 to 64 failed to complete at least 10 minutes of moderate PA during the day.[3] Although the benefits of regular PA have been well-documented,[4,5] most adults in Hong Kong still adopt a sedentary life style.

Intervention programs with different approaches have been implemented in various studies for promoting PA. Dishman and Buckworth [6] stressed that the efficacy of an intervention program design depended on the support from a theoretical basis and the strategy applied. The Transtheoretical model (TTM) is one of the widely applied theories to guide the promotion of individual's exercise behavior and its effectiveness has been reported in previous research.[7,8] The model suggests that individuals adopting a new behavior progress through five stages (i.e., precontemplation, contemplation, preparation, action and maintenance).[9] The "processes of change" (e.g., consciousness raising, dramatic relief, stimulus control) are activities suggested to assist progress through the stages of the TTM and provide important guides for intervention program design.

Apart from a theoretical basis, appropriate and practical strategies applied on the intervention are essential for implementation and success. Different strategies have been implemented in worksite intervention studies for promoting PA. These have included posters in prominent positions to encourage the use of stairs and increase PA,[10] as well as the use of web-based material, email and fliers.[11] Marshall[12] reviewed the worksite intervention studies conducted since 1997 and reported that less 'organized' programs would tend to be more effective for influencing the overall workforce. For example, simple strategies of promoting incidental activity (e.g., stair use) could impact on a greater number of inactive employees as these individuals would not typically join an 'organized' exercise program. Environmental cues or prompts, that minimally interrupt the normal setting, have been found to facilitate adoption and maintenance of PA.[13] Lombard, Lombard, and Winett[14] designed a phone call based intervention for university staff. Staff who received frequent calls recorded more walking activity than those who received infrequent calls. Long working hours, in sedentary jobs, possibly impacts upon the amount of PA.[15] Teachers in Hong Kong have long working hours with heavy teaching and administrative workloads.[16] Few studies have targeted teachers' PA. The design of the present study was theoretically based on the activities suggested in the "processes of changes" of the TTM and aimed to add stimuli that encourage active PA. The contents of the design utilized environmental prompts that focused on the teachers' working (i.e., school) environment. Another distinct characteristic of the present study's intervention strategy was to capitalize on mobile phone technology by sending out short message services (SMS) to the intervention participants to prompt them to be more physically active. Finally, in order to identify the precise impact of the intervention strategy, the present study included the breakdown of the time spent in PA on the way to work, at work and after work.

Pedometer recorded steps counts were utilized to assess the intervention effect. Past researchers have shown that pedometers are both valid[17] and reliable.[18] Pedometer has also been used as an outcome measure for PA intervention studies or as a motivational tool to increase PA in intervention studies.[19,20] Since the amount of steps taken to work might be related to individuals' PA pattern at work and off work, participants were further categorized into different groups of commuters based on the amount of time and steps taken to work. Furthermore, the Stage of Change construct [21] was used to categorize participants into one of the five stages of readiness of PA participation as a differential intervention effect was assumed for participants at different stages of change. Specifically, the objectives of the study were to (1) examine the intervention effect on the steps taken at work and off work between the intervention and control groups; and (2) examine the intervention effect on the steps taken at work and off work of the intervention group broken down by commuter travelling speed, distance, as well as different stages of change status.

Methods

Measurements

Pedometer. PA level, in terms of the amount of steps taken was measured by a pedometer (SW-700, Japan). Participants followed these sequential procedures for pedometer recordings on each day: first, record the time and set pedometer to zero before leaving home; and then record the time and pedometer reading (a) on arrival at school; (b) when leaving school; and (c) when removing it to go to bed. These pedometer data were self-recorded for 5 consecutive weekdays in the first week and again in the post-intervention week. The steps taken at different segments of a day were obtained from a self-report log.

Stage of Change Questionnaire. The Stage of Change Questionnaire[7] was adopted to assess the participants' stages of readiness to participate in PA and has been used in Chinese.[22] The operational definition of regular PA for the questionnaire was described as more than 4 times per week with daily accumulated activity time being 30 min or above. Each respondent chooses one statement out of five that best describes his/her regular PA participation pattern and the Stage of Change score ranges from 1 to 5: (1) yes, for more than 6 months, (2) yes, for less than 6 months, (3) no, but intend to in the next 30 days, (4) no, but intend to in the next 6 months, (5) no, do not intend to in the next 6 months. The baseline and post-intervention scores for Stage of Change were collected at the beginning and at the end of the project.

Schools and Participating Teachers

Participating schools were recruited through convenience sample based on three criteria: (a) 8-h school day (8:00 a.m. to 3:00 p.m.), (b) only one six-floor building and (c) one lift/elevator for teachers' access to different floors. Principals from four primary schools gave consent to conduct the study in their schools. The study was quasi-experimental and involved the assignment of three schools to the intervention group and one school to the control group. All teachers in each of the schools (number of teachers ranged from 39 to 48) were invited to participate in the study voluntarily. Ethical approval for using human participants was obtained from the Research Committee of the second author's university.

Design and Procedure

Baseline. In the first visit to participants, the lead researcher gave a briefing session on the procedures of the pedometer recordings and collected the participants' Stage of Change data and anthropometric measures (i.e., height, weight, waist and hip circumferences and percent body fat).

After completion of five days of baseline pedometer recordings, participants in the intervention group sent their PA log data back to the researcher through facsimile machine and kept the pedometer for daily use during the following intervention period. The control group participants submitted their pedometers and baseline recordings to the researcher.

Intervention. The intervention content included: (a) sending messages through the short message service (SMS) about exercise benefits, (b) distributing information leaflets to the participants, (c) putting up posters in the school environment, and (d) providing participants with a pedometer.

The intervention group participants received different SMS messages on their mobile phones once, on alternate days of the week (Monday, Wednesday, Friday), during the intervention period within school hours. They included 12 text messages about the benefits of being active and the drawbacks of a sedentary lifestyle; for example, using stairs at work can help increase regular PA, a sedentary lifestyle increases the risk of cardiovascular diseases. Participants were given leaflets about walking trails and facilities for active walking, which were printed by the local government's leisure department. On the first day of the intervention, posters were put up on the walls in eye-catching areas. These included the notice board inside the staff room (1 poster), the walls near the stairways of each floor (6 posters) and next to the elevator doors (6 posters). The posters comprised of slogans and graphics to urge teachers to use the stairs instead of the lift. The last strategy was to provide the intervention group with pedometers as they can be used as a motivation tool[18]. Participants were told they could use it to monitor their steps if they wished to, but they were not asked to achieve specific step goals. Participants in the control group were not given any prompts during the 6-week intervention. They were told to conduct their normal lifestyle.

Post-intervention. After the intervention, pedometers were redistributed to the control group participants. Both groups then followed the procedures employed during the baseline for the PA log. Final school visits enabled participants' PA and Stage of Change data, and anthropometric measures to be collected. Participants in the intervention groups were also asked to evaluate their perceived awareness and the effectiveness of the strategies at post-intervention.

Data Analysis

The goal of the intervention was to increase PA during at-work and off-work periods by comparing the average post-intervention walk-rate against baseline levels. Descriptive statistics of participants' baseline and post-intervention measures of anthropometric, Stage of Change, and PA data in terms of walk-rate (steps/min) averaged over 5 days for steps-to-work, steps-at-work , steps-off-work, and time duration (min) averaged over 5 days for time-to-work, time-at-work, time-off-work were computed. Two dependent variables were used to reflect the change in PA. They were the change scores for steps-at-work (△steps-at-work) and steps-off-work (△steps-off-work), which were computed as the difference scores between post-intervention and baseline scores for the dependent variables.

The independent variables were group (intervention or control), commuter group and stage of change. The latter two independent variables only applied to the intervention group participants due to the small number of participants in the control group.

Groups of Commuters. Because the participants varied in their traveling time and mode of transportation taken to work, we hypothesized commuting distance and speed might have differential intervention effect on the activity patterns of teachers. Therefore, an independent factor was created by categorizing participants into four groups of commuters according to their steps-to work (long distance vs. short distance) and speed to work (slow-walking vs. fast-walking) at baseline. The cut-off points for this categorization were the means of each variable.

Stage of Change Status Groups. Because actions to maintain or commence an active lifestyle require individual determination, we hypothesized participants that had the intentions to start or maintain regular PA would increase their steps during and after the intervention. Following Titze et al.'s[8] design, participants were allocated to groups based on changes in their stage of change scores from baseline to post-intervention. These were labeled 'progress' (progressed one or more stages), 'regress' (regressed one or more stages), 'maintain active' (active group at baseline) and 'maintain inactive' (inactive at baseline). These latter two categories were a modification of Titze et al.'s [8] stable group.

Control Variable: Variations in Time Duration for Step Counts. We expected large variations in time at-work and off-work, to account for this we added change scores in time-at-work (△time-at-work) and time-off-work (△time-off-work) separately as a covariate to △steps-at-work and △steps-off-work.

Statistical Analysis. Independent-samples T-tests were computed to determine any intervention effect in △steps-at-work and △steps-off-work between participants of the intervention and control groups. If there was a significant intervention effect, subsequent analyses were then conducted to explore the other independent variables (commuting time/distance and Stage of change status group). These were analyses of covariance (ANCOVA) for the significant dependent variable, using the time change score as the covariate. The level of significance was set at $P < 0.05$. The effect-size calculations for all ANCOVAs are reported as partial eta squared (η_p^2).

Results

Descriptive Information at Baseline and Post-intervention

Fifty-two participants (38 in the intervention group, 14 in the control group) from four primary schools volunteered to be participants of the study. The average percentages of participating teachers from each school were 29% in the intervention group and 30% in the control group. The total sample comprised of 11 males (intervention=9, control=2) and 41 females (intervention=29, control=12).

Regarding participants' readiness for action represented by the stage of change score, the same percentage was obtained for both the intervention and control group (i.e., action group: 25%; preparation group:12.5%; inactive group: 62.5%). We believe that the choice of not participating in the study was more likely due to personal reasons rather than their stage of readiness nor PA level.

Table 1 contains a breakdown of the participants' anthropometric and PA data by baseline and post-intervention. Analyses indicated that there were significant differences ($p<0.05$) between the intervention group and control group at baseline. The intervention group were older (intervention: 38.9±10.8 y, control: 26.5±1.9 y) and had a higher BMI than the control group (intervention: 22.05 kg/m^2, control: 20.59 kg/m^2).

The baseline mean daily steps for all participants ranged from 7,784 to 18,472 steps per day with a mean of 11,399 steps per day (*SD*=2,450) in an average of 15±1.73 h per day for data recording. Participant spent on average 10 h (*SD*=1) at work with a mean of 7,223 steps (*SD*=2,179) at work at baseline. The control group (*n*=14) had significantly higher PA measures in terms of steps-at work and steps-off-work than the intervention group (*n*=38) at baseline, but they were not significantly different at post-intervention (see Table 1). The control group spent longer time-at-work than the intervention group both at baseline and post-intervention, and they had shorter time-off-work than the intervention group at post-intervention (see Table 1).

We correlated steps-to-work and time-to-work at baseline for all participants. The scatterplot depicted three distinct groups of commuters (Figure 1). Therefore, three groups of commuters were treated as an independent variable: (1) fast-walking commuters: ≧ 32 steps/min (mean steps-to-work) and ≦60 min (mean time-to-work), (2) slow-walking commuters: □ 32 steps/min and ≦ 60 min, and (3) long-distance commuters: □32 steps/min and >60 min. The percentages in the three commuter groups were 24% (*n*=9), 34% (*n*=13) and 42% (*n*=16), respectively.

Another independent variable was the status groups. The percentages of intervention participants in the stage of change status groups were 'progress' 22% (*n*= 8), 'maintain active' 39% (*n*=15), and 'maintain inactive/regress' 39% (*n*=15).

In the steps-at-work and steps-off-work data, we observed moderate variations in time-at-work (51.51±21.80 min) and large variations in time-off-work (213.42±92.13 min) at baseline (Table 1) and found these variations in time correlated highly with change in steps. Specifically, the correlations between △time-at-work and △steps-at-work was *r*=-.42 and for △time-off-work and △steps-off-work was *r*=-.58. Therefore, △time-at-work and △time-off-work were treated separately as covariates in the ANOVA analyses.

In order to remove the age difference effect for the intervention and control groups, we used age as a covariate to explain change scores in steps-to-work, steps-at-work, and steps-off-work. We found age was not a significant covariate; therefore, age was not considered as a covariate in subsequent inferential statistical tests.

Preliminary ANOVA analyses of sex by group were conducted for △steps-at-work and △steps-off-work separately. Because there were no sex differences for the dependent variables and the number of males recruited in this study was small, sex was not treated as an independent factor.

Independent-Samples T Test for Intervention Effect

Results showed that there was a significant difference in △steps-at-work (*t*=3.61, *P*<0.001) between the intervention (mean △steps-at-work=1.35, *SD*=2.78, *n*=38) and control groups (mean △steps-at-work=-1.72, *SD*=2.55, *n*=14). However, there was no significant difference in △steps-off-work (*t*=1.11, *P*=0.27; intervention mean △steps-off-work=4.09, *SD*=11.07 and control groups mean △steps-off-work=0.38, *SD*=9.22). Therefore, subsequent statistical analyses were conducted only on the △steps-at-work dependent variable.

ANCOVA Results

The commuting time/distance ANCOVA for △steps-at-work after adjusting △time-at-work was significant ($F_{2,34}$=4.95, *P*=0.013, η_p^2=.23). Pairwise comparisons indicated that fast-walking commuters had a greater positive increase in steps-at-work (mean △steps-at-work=3.25, *n*=10) than short-distance commuters (mean △steps-at-work =0.22, *n*=14) and long-distance commuters (mean △steps-at-work=1.13, *n*=14). There was no difference between short-distance and long-distance commuters. The ANCOVA for stage of change for status groups was non significant ($F_{2,48}$=0.40, *P*=0.68).

Discussion

The present study was designed to evaluate the effectiveness of an intervention, which made use of environmental stimuli to promote the PA of school teachers. Results supported an increase in the change in steps taken at work in the intervention group compared to the control group.

In the present study, school teachers' mean daily steps counts recorded at baseline (11,399 steps for 14.8 h) and after the intervention (11,524 steps for 14.5 h) were above the recommended 10,000 steps per day.[23] Indeed, all the control group (both at baseline and post-intervention) and 49% (at baseline) and 66% (at postintervention) of the intervention group exceeded 10,000 steps per day. This activity level was comparable to a large population study which reported step counts ranging from 6,700 to 11,900.[24] These figures exceed the levels reported in other intervention studies.[19,20] However, while the step counts can serve as an indicator of the PA level of the participants,[25] wearing a pedometer to collect baseline activity level may influence the PA of the participants. This is a limitation of the current study and may explain why the step counts were high at baseline in the control group and then went down post-intervention.

The intervention strategy in the present study was customized to school teachers, who work long hours (over 8 h) in school. Given that 68% of school teachers report that they spend over 11 h a day on school work, the long working hours could prevent them from having time available to be physically active. Based on the behavioral management approach, participants were inspired to be more active during the school day. The present findings supported that the manipulation of cues (i.e., the pedometer, SMS messages, posters and information leaflets) were effective in modifying participants' activity behavior at work. Similar results have been found in previous studies. Rooney, Smalley, Larson and Havens[26] found the wearing of pedometer to be a simple, noninvasive way to increase women's awareness of daily activity and lead to an increase in PA. Moreover, environmental stimuli with "point of decision prompts" (i.e., the location of posters in the intervention group school environment) has been shown to be effective[10,27] and was another strategy adopted.

As the design of the present study does not allow for the differentiation of the effectiveness of the various strategies, they are collectively effective in arousing the teachers' alertness and prompting them to be physically active. The respondents' perceived awareness on the effectiveness of the strategies at post-intervention revealed that pedometer was most effective (mean=3.29, *SD*=1.39) on a 1 to 5 (strongly disagree to strongly agree) scale, although both the SMS messages and posters scored above 3.2 for awareness and 2.5 for effectiveness.

Analyses of step counts data by different segments of a day failed to demonstrate significant changes other than during the working day when the steps increased from baseline to post-intervention in the intervention group but declined in the control group. Although there was a mean change of 4 steps/min in the intervention group compared to .38 steps/min in the control group in steps-off-work, this did not reach significance. The time of the post-intervention step counts was in late May, which was close to the final examination period. This might be another reason for the decline in the control group's step counts although the present results would suggest that the intervention strategy more than compensated for this decline in the intervention group participants.

The cross-tabulation of steps taken to work with traveling time-to-work revealed three distinct groups of commuters. As in other cosmopolitan cities like London, New York City, or Tokyo, Hong Kong has an extensive and efficient public transportation system; people often walk to stations for public transport and some take more than 1 hour commuting to work. Because participants took 50 min on average commuting to work, this would be an opportunity for the teachers to increase their PA. For instance, individuals are encouraged to get off one stop before their destination and walk. Future studies could be conducted to evaluate the feasibility of promoting "walk to work" especially for those with jobs occupying long working hours that have limited time for exercise or sport after work.

Of the three groups of commuters identified, those that were classified as fast-walking (≧32 steps/min and ≦60 min) were most receptive to the intervention. It is not clear why this would be the case, although it could be linked to the participants' preparedness and/or ability to walk at a higher intensity. The other two commuting groups both walked at a slower pace.

In terms of stage of change scores, although a higher percentage of the intervention group (baseline 45%; post-intervention 37%) self-rated themselves in the maintenance stage than American adults from the national sample (36%),[28] we did not find any differences in changes in steps after the intervention among teachers of different status groups (i.e., active, maintain active, maintain inactive) based on their intentions to change in their PA behavior. Although Marcus, Bock and Pinto[29] suggested that cognitive aspects of behavior change would be favorable for precontemplators and contemplators, the findings of this study could not substantiate this claim.

There are a number of limitations to this pilot study that future research should attempt to alleviate. As the present research design involved step recordings at different segments of a day, a blinded protocol using sealed pedometers could not be adopted in this study. The use of sealed pedometers has been shown to remove reactivity in step counts [30]and monitoring for more than 2 days also minimizes the impact of reactivity. Because this was a pilot study, the design involved only one school as control. Future study should select more than one school as control so that the unit of statistical analysis could be based on school. Additional information about participants' PA behavior, mode of transportation and activity patterns (i.e., walking distance and time) to work and off work might have allowed clearer distinction between the different groups of commuters as well as stage of change status. The utility of a self-report activity inventory such as the 7-day PA recall would help to address these limitations.

In conclusion, the present study demonstrated that an intervention applying the strategy of environmental stimuli was effective in assisting teachers to increase their PA levels at work following a 6-week intervention period. Future research could be conducted to assess the long term effect of this kind of intervention.

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Table 1 Baseline (by Gender) and Postintevention Anthropometric[a] and Physical Activity Data Between Intervention and Control Participants (*M*±*SD)*

Variable	Baseline Values		Intervention (*n* =38)		Control (*n* = 14)	
	Males (*n* = 11)	Females (*n* = 41)	Baseline	Post-Intervention	Baseline	Post-Intervention
Anthropometric:						
Height (cm)	171.9±7.7	156.6±6.0	159.4±9.2	---	161.1±8.5	---
Weight (kg)	67.5±8.9	52.2±7.54	56.1±10.8	56.4±10.3	53.7±7.6	52.8±7.7
BMI[b c] (kg/m^2)	22.9±3.3	21.3±3.1	22.0±3.5	22.3±3.5	20.6±1.6	20.2±1.6
Waist-to-hip ratio	0.9±0.0	0.8±0.1	0.8±0.1	0.8±0.1	0.7±0.1	0.8±0.1
% Body Fat	19.9±5.1	26.7±0.6	26.0±7.4	24.4±6.8	23.2±4.8	22.8±4.1
Physical Activity (Daily):						
Steps-to-work (steps/min)	---	---	28.1±14.0	26.6±14.4	34.8±18.7	36.0±17.0
Steps-at-work[b] (steps/min)	---	---	10.5±2.5	11.8±3.0	14.4±2.5	12.6±2.3
Steps-off-work[b] (steps/min)	---	---	13.4±6.6	17.4±11.8	18.8±8.4	19.2±8.9
Time-to-work (min)	---	---	50.8±20.3	52.5±22.0	53.3±18.7	50.3±29.3
Time-at-work[b c] (min)	---	---	602.3±54.4	611.6±48.0	683.9±42.7	708.9±72.6
Time-off-work[c] (min)	---	---	225.1±99.2	201.8±122.2	183.4±64.4	131.5±60.1

Notes:

[a] No significant difference between baseline and post-intervention for all anthropometric measures

[b] Significant difference between intervention and control group at baseline ($P<0.05$)

[c] Significant difference between intervention and control group at post-intervention ($P<0.05$)

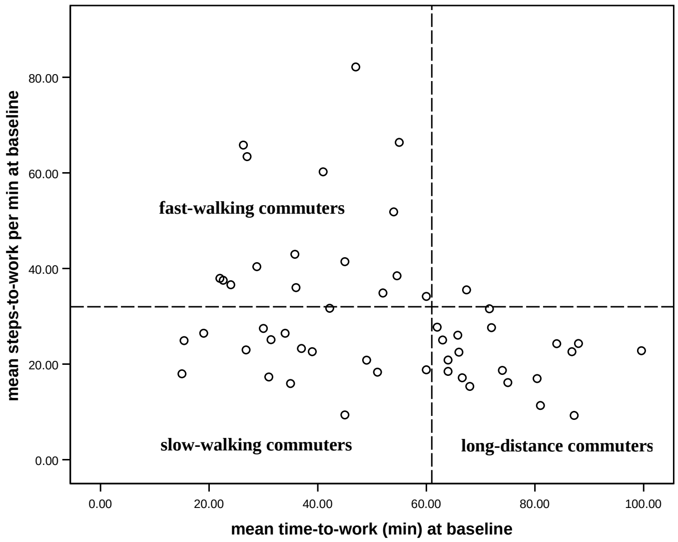

Figure 1 Scatterplot showing three groups of commuters categorized by mean steps-to-work (steps per min) at baseline with mean time-to-work (min) at baseline