BMJ open

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Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000721
Article Type:	Research
Date Submitted by the Author:	05-Dec-2011
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Primary Subject Heading:	Nutrition and metabolism
Secondary Subject Heading:	Global health, Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Nutrition < TROPICAL MEDICINE

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

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Key words: peer, intervention, physical activity, sedentary, adolescent

Word count: 3701

ABSTRACT

Objectives: To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in urban Beijing, China.

Design: Four junior high schools were matched by school size and randomized to intervention (n = 346) and control group (n = 336).

Intervention: Trained peer leaders from grade 7 by research staff delivered weekly 40-minute lessons to their classmates over four consecutive weeks. Students in control schools received no intervention.

Outcome measures: A validated 7-day youth physical activity questionnaire was used to evaluate physical activity and sedentary behaviors at baseline (September 2010), 3(December 2010) and 7 months (May 2011). Generalized linear mixed models were applied to evaluate the effect.

Results: In boys, time in total moderate-to-vigorous physical activity (MVPA) was 7.3 min/d higher at 3 months and 2.2 min/d higher at 7 months in intervention schools compared with control schools. Similar differences were found for out-of-school MVPA. However, a 4.0 min/d less increase for in-school MVPA was found in the intervention group at 3 months but no difference at 7 months. In girls, time in total MVPA was 4.9 min/d lower, and in-school MVPA was 4.4 min/d lower at 3 months in intervention schools compared to control schools. In boys and girls, time in sedentary behavior in intervention schools decreased more (15.6 min/d for boys and 15.8 min/d for girls) at 3 months and was sustained to 7 months (23.8 min/d for boys and 20.2 min/d for girls). This reduction was mainly due to reduction in computer usage.

Conclusion: Peer education appears to be an effective intervention to reduce sedentary behaviors in both boys and girls in China. These results need confirmation in a larger study.

ARTICLE SUMMARY

Article focus

- To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in grade 7 students in urban Beijing, China.

Key messages

- Peer education is an effective intervention to reduce sedentary behaviors in adolescents.
- Peer education is effective in increasing moderate-to-vigorous physical activity in boys.
- Peer education is a promising public health measure in promoting active lifestyles.

Strengths and limitations of this study

Strengths

Our intervention is innovative because the peer education program is theory-based and easy to run by following the peer leader's manual. Peer leaders are trained in a short period of time and then educate their classmates. These features ensure the program minimally interrupt school activities, cost-effective and feasible for larger-scale implementation.

Limitations

This pilot study lacked power to detect statistical significance of the intervention effects. In addition, with only two schools in each arm, potential confounders may not have been balanced across treatment groups. Also, physical activity was not objectively measured.

INTRODUCTION

Adolescents in China have become increasingly sedentary with a decrease in physical activity[1] and an increase in sedentary behavior[2] over the last decade, concurrently with the rapid socioeconomic development, especially in urban areas. This tendency to increasing sedentariness may be associated with an array of health problems including overweight and obesity[3, 4] that can track into adults[5]. The prevalence of overweight and obesity has increased from 3.6% to 9.1% in adolescents in China in the last decade[6]. Therefore, there is an urgent need for cost-effective interventions to increase physical activity and to reduce sedentary behavior in adolescents when they are establishing long-term lifestyle patterns.

Peers are a key component of the social network of adolescents who are transiting from childhood to adulthood. During the transition, youth move away from dependence on the family, to closer ties with their peers who give them the social support they need, especially with their schoolmates. Peer education programs offer a powerful approach to educate youth and change their health behaviors[7]. There is growing support for the use of student peer leaders to disseminate health information and to serve as role models in schools[8]. Health education programs in drug and alcohol issues have successfully employed peer teaching as an intervention strategy and appear to have a greater effect on health behavior than adult-led interventions[9-12]. Recent studies have shown peer education programs can significantly improve a range of health behaviors, including increasing fruit intake and reducing the risk of eating disorders in primary school students[13].

However, little is known about whether this premise holds for motivating junior high school students to increase physical activity and to reduce sedentary behavior. In the US, one study using a combined peer-led and teacher-led education[14] in a high school found favorable

impacts on physical activity in girls but not in boys. This study was evaluated with an internal control of classes in the same school that did not receive the intervention. Another study in elementary school students implemented a peer education program to prevent obesity. However, the effect on physical activity was not reported[15].

Few studies have examined the effect of an intervention on physical activity in adolescents in China. Only one study[16] has been identified in two recent systematic reviews of studies of school-based and community-based prevention of childhood obesity in China[17, 18] with a physical activity intervention. This study implemented a teacher-led organized physical activity but did not report its effects on physical activity and sedentary behavior. In China, peer education has been effective in promoting knowledge, attitudes and intention to change behavior in AIDS prevention[19]. However, no studies have evaluated the effect of peer education on physical activity and sedentary behaviors. Therefore, we conducted a pilot study from September 2010 to May 2011in four junior high schools in urban Beijing, China to test the feasibility of a peer-led education program in changing obesity-related behaviors. The present study aims to examine the effects of peer education on physical activity and sedentary behavior.

METHODS

Study design

A convenience sample of two small-sized and two large-sized junior high schools in Dongcheng District, Beijing were selected by the Dongcheng District Institute for Student Healthcare from schools with more than 160 students in grade 7. These schools were matched by school population size, and in each matched pair, one school was randomly allocated by research staff by throwing a coin to intervention or the control group. In the large-sized schools, four classes

were randomly drawn to participate in the study. In the small schools, all classes participated in the study. Peer education was implemented in classrooms in the first 2 months in intervention schools. No intervention was implemented in the control schools during the study. Assessments were conducted at baseline (September 2010), 3 months (December 2010) and 7 months (April/May 2011).

Survey protocols, instruments, and processes for obtaining informed consent for this study were approved by institutional review committees of the University of Sydney, Sydney, Australia and the Peking University Health Science Center, Beijing, China.

Start-up of the study

Before the baseline assessment, a start-up conference was conducted with the attendance of officers from the Dongcheng District Institute for Student Healthcare, school principals and doctors, and research staff. The research plan and the responsibilities of participating institutions were introduced and discussed. The principal and participant information and consent forms were distributed to attendees from schools. After that, the principal and the school doctor in each intervention school held a meeting with all class teachers in participating classes in grade 7 to explain the research plan and to develop the school's work plan.

The information and consent forms were distributed to students in participating classes by class teachers in the four schools. Consent forms signed by both students and one of their guardians were collected before the baseline data collection. Only the students with consent forms signed by both themselves and their guardian were allowed to participate in the assessment. School consent forms signed by principals were collected as well.

Intervention

The four-component intervention was adapted, from a peer-led health promotion program in Australia[20] that was based on social cognitive theory[21] and an empowerment educational approach[22], to ensure it was culturally appropriate for Chinese students and fitted with our research objectives. The key modification was that peer leaders from grade 7 were selected to educate students in their own grade 7 instead of recruiting older peer leaders from grade 10. This change was made because junior and senior high school are separate schools in China, and grade 9 children were too busy with exams for entrance to senior high school to act as peer leaders. In addition, the component to increase awareness about local healthcare services was replaced by that to reduce consumption of carbonated drinks.

Therefore, our intervention covered four components: food choice, physical activity and sedentary behavior, carbonated drinks, and goal setting, which directly aimed at behavior change. Learning activities were designed to be conducted in a variety of ways including presentation, video watching, group discussion, games, experiments, lifestyle practice, skit playing and quizzes. Each component was designed to be taught at a 40-minute lesson: a 2-minute discipline maintenance activity, 2-3 topic-specific activities and 2-3 minutes of conclusion to the lesson. A peer leader's manual was developed to describe these structured activities.

To provide basic knowledge in healthy lifestyles and behavioral change and to encourage parents to support their children's behavioral changes, an 8-page pamphlet with knowledge supplemental to the four lessons was distributed to students and their parents in the intervention schools right after the baseline assessment.

Our intervention consisted of a three-step process including peer leaders recruitment and training, peer-led education and student action.

Peer leaders recruitment and training

After the baseline assessment, four to eight peer leaders balanced by gender in each intervention class were selected by the class teacher from volunteer students based on their organization and oral expression ability, influence among students and sense of responsibility.

Then peer leaders in each intervention school were trained by research staff in three after-school 90-minute workshops over 3 consecutive days at school. We explained and practiced all the four components, with the aim of enabling peer leaders to successfully deliver the lessons to their classmates. In the whole training process, peer leaders were encouraged to learn the skills as a peer leader to actively interact with peers and to facilitate interaction between peers.

Peer education

Before each peer education lesson, school doctors or class teachers had a meeting with peer leaders to clarify each peer leader's responsibility. Peer leaders prepared and practiced their lessons.

Peer leaders then delivered four 40-minute peer education lessons to their classmates over four consecutive weeks in their classrooms, following the peer leader's manual. The four peer education activities were integrated into the existing health education courses and class meetings.

The students (29 – 42 students per class) sat either in one large or several small circles. Given the heavy academic pressure of peer leaders and to ensure feasibility, we used a different pair of peer leaders to deliver the lessons.

During the peer education, a school teacher was present to help maintain classroom order. Research staff and staff from Dongcheng District Institute for Student Healthcare observed the peer education classes in both intervention schools.

Student action

Students were encouraged to maintain a healthy lifestyle based on the personal goals set in the fourth peer education lesson.

Assessment

A validated 7-day youth physical activity questionnaire[23] was modified to collect information on moderate-to-vigorous physical activity (MVPA) and sedentary behavior in the previous week. Trained medical students, who were blinded to the assignment of the intervention, explained the questionnaire to students in the classroom. In the questionnaire, in-school and out-of-school MVPA were recorded with a 12-item and 18-item scale to collect information on days, frequency per day, and duration per time, respectively. Commuting to and from school was recorded using a 4-item scale including walking, cycling, public transportation and picking up by parents. For those who walk or cycle, frequency and time of travelling were collected separately by to and from school. For those who take public transportation (bus, subway and taxi), frequency and time of walking between public transportation station/stop and home (or school) were collected. Whether or not they were picked up from school by their guardians was also collected. Sedentary behavior was assessed by an 8-item scale including TV viewing, DVD and video tape viewing, computer usage for entertainment, electronically game playing, extracurricular reading,

drawing/writing/listening to music, sitting to phone call or chat, and playing musical instruments on week days and weekends.

Adverse events (injury) related to the intervention were reported by the intervention schools to the Dongcheng District Institute for Student Healthcare.

Statistical analysis

Given that only two schools were included in each arm, the baseline characteristics in the two arms may not be comparable although schools were matched. Thus intention to treat analysis was not applied in the present analysis and the students who were lost to follow-up (6.2%) were excluded from the analysis. The baseline characteristics of students with all three measurements were compared with those of students who were lost to follow-up.

The effect of the intervention on physical activity was evaluated by the relative changes in time (or MET × time) for in-school and out-of-school MVPA, active commuting to and from school (walking or cycling) and total MVPA between intervention and control groups compared to baseline. The effect of the intervention on sedentary behavior was evaluated by the relative changes in time in individual activities and the total activity.

With 682 student available for analysis, the detectable relative changes between pre- and post-intervention between groups was 37.5 min/d for MVPA, 83.3 min/d for time on total sedentary behavior, 36.6 min/d for TV viewing, and 34.2 min/d for computer usage. Due to the limited statistical power in this pilot study, we were not aiming to examine for statistical significance but rather look for the direction and magnitude of changes.

Generalized linear mixed models was applied to evaluate the relative changes of physical activity and sedentary behaviors at 3 and 7 months after adjustment for baseline measures of the dependent variable, body mass index (BMI) and age, and the cluster effect of matched pairs[24], school and class[25] using SAS 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

Participants

A total of 758 students were eligible for the study in the four schools (Figure 1). Signed consent forms were obtained from 738 students (97.4%). Nine students (1.2%) missed the baseline assessment and 47 students (6.2%) were lost to follow-up, which led to a total of 682 (90.0%) participants with 336 in the control arm and 346 in the intervention arm available for the analysis. There were no significant differences in gender, age, weight status and mean BMI between students with all measurements and those lost to follow-up across research arms at baseline (data not shown).

Baseline characteristics between the control and intervention groups were compared separately in boys and girls as shown in Table 1. For boys, mean BMI ($p = 0.038$) and prevalence of overweight and obesity ($p = 0.016$) were significantly lower in the control group than those in the intervention group. No significant differences were found in MVPA and sedentary behaviors between groups by gender at baseline as seen in Tables 2 – 5.

Table 1 Baseline characteristics of participants[†]

Variable	Intervention[‡]		Control[‡]	
	Boys (n=176)	Girls (n=170)	Boys (n=177)	Girls (n=159)
Age, mean ± SD, years	12.7 ± 0.5	12.6 ± 0.5	12.8 ± 0.5	12.6 ± 0.4
Weight status, %				
Normal weight	51.1	76.5	64.4[*]	76.7
Overweight	34.1	17.6	25.4	15.7
Obesity	14.8	5.9	10.2	7.5
BMI, kg/m^2	21.7 ± 4.6	20.2 ± 3.8	20.6 ± 4.2[*]	19.9 ± 4.6

[†] P values were adjusted for cluster effect in matched pair, school and class.
[‡] Unadjusted values.
[*] P < 0.05 in boys between intervention and control group by gender.

Adjusted effect on MVPA

Time in total MVPA in the intervention group was 7.3 min/d higher at 3 months, and 2.2 min/d higher at 7 months (Table 2) than those in the control group in boys. Similar differences were found for out-of-school MVPA and active commuting to school. However, in-school MVPA was 4.0 min/d less in the intervention than in the control group at 3 months, but there was no difference (0.3 min/d more increase) at 7 months.

Table 2 Daily time (min/d) and MET* × time and changes of MVPA† at baseline‡ and 7 months in boys

	n	7 months §	Unadjusted change	Adjusted difference (95% CI) ¶	P
Total MVPA, min/d					
Control	153	203.0	-28.3		
Intervention	162	196.8	-13.3	2.2 (-24.1,28.5)	0.87
Total MVPA, MET × min/d					
Control	153	1058.7	-140.8		
Intervention	162	1018.4	-61.7	9.4 (-212.7,231.5)	0.93
MVPA in school, min/d					
Control	168	108.7	-5.8		
Intervention	169	103.5	-0.8	0.3 (-34.4,35.0)	0.99
MVPA in school, MET × min/d					
Control	168	612.5	-21.5		
Intervention	169	566.3	6.6	-6.6 (-244.9,231.7)	0.96
MVPA out school, min/d					
Control	164	108.8	-19.6		
Intervention	164	103.3	-8.5	-1.2 (-18.4,15.9)	0.89
MVPA out school, MET × min/d					
Control	164	555.0	-102.7		
Intervention	164	515.7	-49.2	-13.8 (-106.8,79.3)	0.77
Active commuting to school, MET × min/d					
Control	167	122.0	-18.9		
Intervention	174	130.5	-19.5	5.5 (-14.4,25.4)	0.59

* MET denotes 1 kcal ×·kg body weight^{-1} × h^{-1}.

† Moderate and vigorous physical activity (MVPA) is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.

‡ Comparison between control group and intervention group in each variable at baseline is not significant.

§ Data are unadjusted means. Results at 3 months were described in text in result section.

¶Differences between the intervention and control groups were adjusted for age, BMI at baseline, and baseline measures of the dependent variable, and cluster effect in matched pair, school and class.

A worse picture was found in girls although differences in the changes in MVPA were also not significant as seen in Table 3. Time in total MVPA in the intervention group was 4.9 min/d lower than the control group at 3 months, and similar differences were found for in-school MVPA. There were no differences for out-of-school MVPA at 3 month (0.4 min/d less decrease).

Table3 Daily time (min/d) and MET* × time and changes of MVPA† at baseline‡ and 7 months in girls

	n	Baseline§	7 months§	Unadjusted change	Adjusted difference (95% CI)¶	P
Total MVPA, min/d						
Control	142	158.5	138.4	-20.2		
Intervention	161	172.4	146.0	-26.4	1.3 (-46.9,49.5)	0.96
Total MVPA, MET × min/d						
Control	142	781.5	690.9	-90.6		
Intervention	161	866.5	722.9	-143.6	-5.6 (-258.5,247.3)	0.97
MVPA in school, min/d						
Control	153	74.3	71.3	-3.0		
Intervention	168	82.5	81.1	-1.5	9.9 (-17.1,36.9)	0.47
MVPA in school, MET × min/d						
Control	153	381.7	379.1	-2.6		
Intervention	168	446.4	424.9	-21.5	39.0 (-108.7,186.8)	0.60
MVPA out school, min/d						
Control	150	86.4	67.7	-18.7		
Intervention	165	95.8	75.6	-20.2	3.9 (-21.8,29.6)	0.76
MVPA out school, MET × min/d						
Control	150	428.5	333.9	-94.6		
Intervention	165	470.9	368.4	-102.5	17.8 (-117.9,153.6)	0.80
Active commuting to school, MET × min/d						
Control	153	122.6	118.0	-4.6		
Intervention	167	123.3	104.2	-19.1	-15.7 (-35.6,4.2)	0.12

* MET denotes 1 kcal ×·kg body weight^{-1} × h^{-1}.

† Moderate and vigorous physical activity (MVPA) is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.

‡ Comparison between control group and intervention group in each variable at baseline is not significant.

§ Data are unadjusted means. Results at 3 months were described in text in result section.

¶Differences between the intervention and control groups were adjusted for age, BMI at baseline, and baseline measures of the dependent variable, and cluster effect in matched pair, school and class.

Adjusted effect on sedentary behaviors

Table 4 shows favorable adjusted differences in sedentary behaviors especially in total sedentary activity and computer usage, on weekdays and weekends, in boys and girls. Compared to those in control schools, time on computer usage decreased on weekdays (6.9 min/d) and weekends (18.7 min/d, p = 0.071) in boys in the intervention group at 3 months, and decreased further at 7 months (16.1 min/d on weekdays, p = 0.031; 27.7 min/d on weekends, p = 0.16). As a result, the daily time for computer usage decreased by 10.2 min/d (p = 0.14) at 3 months and by 19.6 min/d (p = 0.053) at 7 months. However, the relative decrease was not sustained in watching television with a decline of 9.2 min/d less at 3 months but no difference at 7 months. Time in total sedentary behavior relatively decreased 15.6 min/d at 3 months and 23.9 min/d at 7 months in the intervention compared to the control group. The decreases in time in sedentary behaviors were 8.0 min/d more at 3 months and 16.1 min/d more at 7 months on weekdays, and 37.2 min/d at 3 months followed by a significant decline at 7 months (49.5 min/d more, p = 0.042) on weekends. No major changes in other sedentary activities were observed.

In girls, daily time in total sedentary behaviors during the week relatively decreased at 3 months, and this decline was sustained at 7 months (Table 5). Similar results were found on weekdays, while the reduction was less sustained on weekends. In each specific sedentary behavior, the greatest decrease was found in computer usage (11.0 min/d at 3 months and 10.9 min/d 7 months). The decrease was sustained on weekdays (8.3 min/d at 3 months and 12.9 min/d at 7 months) but less sustained on weekends (17.7 min/d at 3 months and 5.3 min/d at 7 months). As in boys, time watching television decreased at 3 months (8.7 min/d) but this effect was not sustained at 7 months (0.9 min/d).

Table 4 Daily minutes and changes of sedentary behaviors[†] at baseline[‡] and 7 months in boys[*]

	Baseline [§]	7 months [§]	Unadjusted change	Adjusted difference (95% CI) [¶]	P
Total sedentary behaviors					
Control	256.3	255.5	-0.9		
Intervention	248.9	225.0	-23.9	-23.8 (-54.3,6.8)	0.13
Total sedentary behaviors, on weekdays					
Control	196.5	195.8	-0.8		
Intervention	179.6	172.2	-7.4	-16.1 (-48.6,16.5)	0.33
Total sedentary behaviors, on weekend					
Control	405.8	407.1	1.3		
Intervention	423.8	358.2	-65.6	-49.5(-97.1,-1.8)	0.042
Computer					
Control	49.7	66.5	16.8		
Intervention	51.5	45.6	-6.0	-19.6 (-39.5,0.3)	0.053
Computer, on weekdays					
Control	30.4	43.2	12.8		
Intervention	27.0	24.9	-2.1	-16.1(-30.6,-1.5)	0.031
Computer, on weekend					
Control	97.8	124.8	27.0		
Intervention	112.8	97.3	-15.5	-27.7 (-66.6,11.2)	0.16
Television and DVD					
Control	76.2	75.0	-1.2		
Intervention	69.8	70.9	1.1	0.4 (-13.3,14.0)	0.96
Video game					
Control	8.7	16.1	7.5		
Intervention	11.4	13.3	1.8	-3.4 (-10.6,3.7)	0.35
Extracurricular reading, writing, drawing and listening to music					
Control	72.2	64.7	-7.5		
Intervention	74.2	58.1	-16.1	-7.8 (-21.7,6.1)	0.27
Passive commuting					
Control	32.0	23.3	-8.7		
Intervention	24.3	30.1	5.8	7.4 (-0.2,15.0)	0.056
Sitting and talking					
Control	18.4	12.8	-5.6		
Intervention	21.9	11.7	-10.3	-0.9 (-6.9,5.0)	0.76

[†] Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

[‡]Comparison between control group and intervention group in each variable at baseline is not significant.

[*] Sample size in control group = 177, in intervention group = 176.

[§] Data are unadjusted means. Results at 3 months were described in text in result section.

[¶]Differences between the intervention and control groups were adjusted for age, weight status at baseline, and baseline measures of the dependent variable, and cluster effect in matched pair, school and class.

Table 5 Daily time and changes of sedentary behaviors [†] at baseline[‡] and 7 months in girls[*]

	Baseline[§]	7 months[§]	unadjusted change	adjusted difference (95% CI)[¶]	P
Total sedentary behaviors					
Control	253.5	254.5	1.0		
Intervention	251.7	237.0	-14.6	-20.2 (-59.5,19.2)	0.31
Total sedentary behaviors, on weekdays					
Control	197.1	199.2	2.1		
Intervention	185.6	172.7	-12.9	-25.2 (-58.8,8.4)	0.14
Total sedentary behaviors, on weekend					
Control	396.4	394.6	-1.7		
Intervention	418.8	399.8	-19.0	-7.5 (-59.3,44.4)	0.78
Computer					
Control	36.8	48.7	11.8		
Intervention	41.2	41.4	0.2	-10.9 (-28.9,7.1)	0.24
Computer, on weekdays					
Control	22.6	33.7	11.1		
Intervention	24.1	22.8	-1.4	-12.9 (-29.0,3.3)	0.12
Computer, on weekend					
Control	72.3	86.1	13.8		
Intervention	83.9	87.9	4.0	-5.3 (-28.3,17.7)	0.65
Television and DVD					
Control	63.7	61.1	-2.6		
Intervention	62.0	60.6	-1.4	-0.9 (-17.6,15.9)	0.92
Video game					
Control	3.4	7.2	3.8		
Intervention	4.0	3.7	-0.3	-3.6 (-8.2,1.0)	0.12
Extracurricular reading, writing, drawing and listening to music					
Control	94.7	91.7	-3.0		
Intervention	88.9	88.2	-0.7	-3.3 (-23.7,17.0)	0.75
Passive commuting					
Control	30.9	28.0	-2.9		
Intervention	31.0	29.0	-2.0	1.4 (-11.8,14.5)	0.84
Sitting and talking					
Control	26.5	21.0	-5.6		
Intervention	25.9	16.7	-9.2	-4.3 (-11.1,2.6)	0.22

[†] Information on daily time spent on sedentary behaviors was collected with a 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

[‡] Comparison between control group and intervention group in each variable at baseline is not significant.

[*] Sample size in control group = 177, in intervention group = 176.

[§] Data are unadjusted means. Results at 3 months were described in text in result section.

[¶]Differences between the intervention and control groups were adjusted for age, weight status at baseline, and baseline measures of the dependent variable, and cluster effect in matched pair, school and class.

Adverse events

No adverse events were reported during the intervention.

DISCUSSION

This pilot study based on 682 students in 4 schools (2 intervention and 2 control schools) indicated that the adapted peer education program from Australia was feasible and acceptable in schools in Beijing and it showed potential for promoting physical activity in male adolescents (although the results did not achieve statistical significance) and reducing sedentary behaviors in adolescents of both genders, especially computer time.

Our intervention was innovative for a number of reasons. Firstly, the peer education program was well-designed, structured and easy to run by following the manual. The training of peer leaders was shorter compared to other peer education studies in China that had a four-day to four-week training[19, 26], which is an attractive feature in reducing costs and increasing feasibility for larger-scale implementation.

Secondly, the peer education program directly aimed at behavior change. Our program delivered health information by a variety of participatory activities to motivate students to be more active. Also, students actively interacted with each other and to find out the most realistic solutions to their barriers to engage in more physical activity.

Thirdly, our program results in minimal interruption to school activities. Peer leaders were the classmates of the peers they educated, which reduced interruption to the regular education programs in the schools compared to programs that used senior students as peer leaders. The use

of senior students is complicated in China because the schools need to adjust their curriculum to make both peer leaders and their "peers" available at specific times, especially when senior peer leaders come from senior high schools that are separate from junior high schools. The use of senior peer leaders has been driven by concerns about the ability of younger students to educate and influence their immediate peers. However, the Healthy Buddies program indicated that younger peer educators (students in 4th through 7th grade) are effective in delivering the messages to students in kindergarten through 3rd grade[15]. In addition, peer leaders from the same class stayed in contact longer with their peers in future school life, which may contribute to the sustainability of the intervention. The minimal interruption to school also featured by the shorter training of peer leaders in our study[15]. High school students in China have long school hours (5.4 days in school per week and 7.6 lessons/day[27]) and heavy pressure for academic achievement (2 hours/day on homework[27]), thus, minimal interruption to school is critical to ensure the sustainability of a school-based health promotion program in this context.

Fourthly, students were educated in groups regarded as small in China, which was associated with greater increases in knowledge, altered attitudes and intentions to change behavior than those in larger groups in the peer education study[19] because small groups facilitate cooperative learning, discussion and communication[28].

Comparison with studies in China was limited because there has been only one study that used a teacher-led organized exercise to prevent obesity in adolescents and physical activity outcome was not reported in this study[17]. Limited studies have used peer education to promote physical activity in high-income countries. Healthy Buddies[15], that used students in 4th to 7th grade trained by a teacher in a weekly 45-minute lesson to promote physical activity in students from kindergarten to 3rd grade over 21 weeks, and reported no significant effects on physical

activity[15]. Using teachers to train peer leaders may increase the feasibility of our program to be implemented at a larger scale. Another 10 session peer-led program reported physical activity increased in girls but not in boys[14]. In contrast, our study found that out-of-school MVPA increased in boys but was not sustained, while there was no effect for girls. Previous studies suggest girls had fewer tendencies to engage in physical activity than boys. The 2002 China Nutrition and Health Surveys (CNHS) reported that the prevalence of regular leisure-time exercise in girls (5.4%) was half of that in boys (10.5%)[27]. In our study, girls participated far less in MVPA (165 minutes/day) than did boys (220 minutes/day) at baseline. Additionally, female peer leaders should be trained to be active models to convince female students to be more active. Also, messages should aim to address psychosocial barriers for girls to engage in more physical activity such as self-efficacy of girls, and perceived safety of neighborhood environment by girls and their parents.

Several lessons have been learnt from our pilot study. Firstly, future intervention studies should focus not only on TV viewing but also emerging computer usage in large cities in China. The 2002 CNHS reported 25% of adolescent used computers and spent an average of 1.2 hours/day on the computer[27]. An average of 40-50 min/d of computer usage in our study suggests that computer usage accounted for a substantial amount of sedentary time in children in large cities in China. Further, the decrease in sedentary time was mainly from the reduction in computer usage, which might partly be due to parental limits on the accessibility to computers for their children. In our study, time on TV viewing was reduced but not sustained. This might be because TV viewing is a traditional family activity. A stronger message on TV viewing in our study should be delivered to modify this family norm of watching TV and to inform parents of specific measures they could take to limit their children's TV viewing, such as parental role models[2].

In-school MVPA slightly decreased in both boys and girls. The possible explanation is the Sunny Sport Policy issued by the Department of Education in China. This program has been implemented nationally and requires schools to ensure students have daily one hour of physical activity in school. With this policy in place, it may be difficult for any school-based intervention to increase in-school non-organized physical activity. Therefore, organized physical activity may potentilly increase in-school physical activity in large cities in China, for example, to increase the intensity of physical education.

Conclusion

Our pilot study of a peer counseling intervention was effective in reducing sedentary behaviors in adolescents in China. These results need to be confirmed in a larger study.

Acknowledgements

We are very grateful to the participating schools, children and their families. We also thank the Australian Agency for International Development (AusAID) for funding Zhaohui Cui's doctoral scholarship in International Public Health at the University of Sydney, Australia, and this analysis, which is part of the requirements for his PhD studies. We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention for the provision the physical activity questionnaire.

Funding

This work was supported by the Nestle Foundation.

Competing interests

None

Contributors

MD, SS and ZC formulated the idea and study design. ZC modified the intervention materials, implemented the intervention, collected and cleaned the data, and carried out the data analyses, drafted the manuscript. SS, LLY, YW, YP, AG and MD contributed to the implementation of the intervention. SS, LLY and MD contributed to the interpretations of the results.

Data sharing statement

No additional data is available

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[Legend of Figure 1]

Figure 1 Flow of the participants through the trial

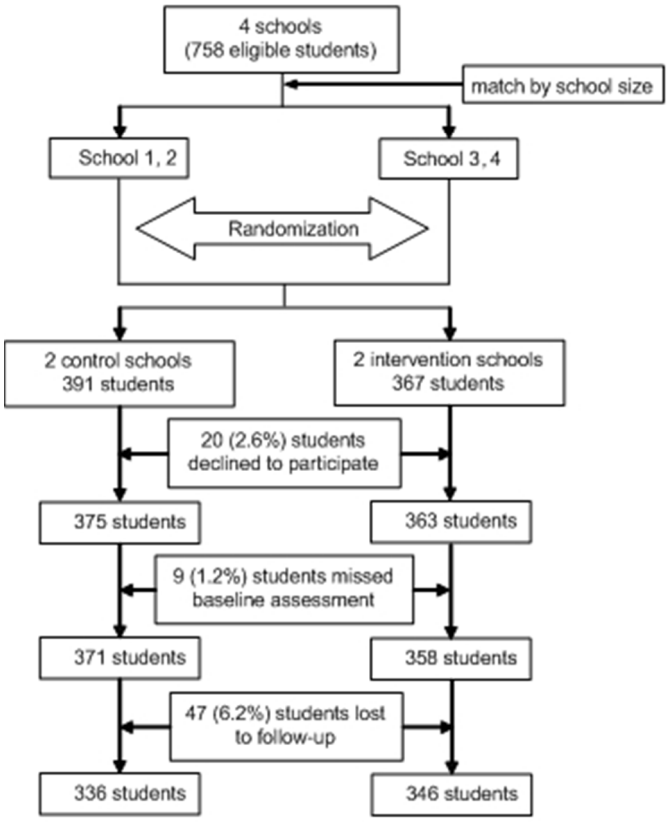

Figure 1 Flow of the participants through the trial
89x110mm (96 x 96 DPI)

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Not applicable
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Yes
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Yes
	2b	Specific objectives or hypotheses	Yes
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Yes
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Yes
Participants	4a	Eligibility criteria for participants	Yes
	4b	Settings and locations where the data were collected	Yes
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Yes
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Yes
	6b	Any changes to trial outcomes after the trial commenced, with reasons	Not applicable
Sample size	7a	How sample size was determined	Yes
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Not applicable
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Yes
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Yes
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Yes
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Yes
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	Yes

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	Not applicable
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Yes
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Not applicable
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Yes
	13b	For each group, losses and exclusions after randomisation, together with reasons	Yes
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Yes
	14b	Why the trial ended or was stopped	Not applicable
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Yes
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Yes
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Yes
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Not applicable
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Yes
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Yes
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Yes
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Yes
Other information			
Registration	23	Registration number and name of trial registry	Not applicable
Protocol	24	Where the full trial protocol can be accessed, if available	Not applicable
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Yes

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

BMJ open

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000721.R1
Article Type:	Research
Date Submitted by the Author:	19-Feb-2012
Complete List of Authors:	Cui, Zhaohui; University of Sydney, School of Public Health Shah, Smita Yan, Lijing Pan, Yongping Gao, Aiyu Shi, Xiaoyan Wu, Yangfeng Dibley, Michael
Primary Subject Heading:	Nutrition and metabolism
Secondary Subject Heading:	Global health, Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Nutrition < TROPICAL MEDICINE

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

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Key words: peer, intervention, physical activity, sedentary, adolescent

Word count: 3713

ABSTRACT

Objectives: To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in urban Beijing, China.

Design: Four junior high schools were matched by school size and randomized to intervention (n = 346) and control group (n = 336).

Intervention: Trained peer leaders from grade 7 by research staff delivered weekly 40-minute lessons to their classmates over four consecutive weeks. Students in control schools received no intervention.

Outcome measures: A validated 7-day youth physical activity questionnaire was used to evaluate physical activity and sedentary behaviors at baseline (September 2010), 3(December 2010) and 7 months (May 2011). Generalized linear mixed models were applied to evaluate the effect.

Results: There was a significant decrease in time in sedentary behavior on weekdays, 20 min/d at 7 months (P = 0.020) reported by students in the intervention schools compared to control schools. This reduction was mainly due to a reduction of 14 min/d in computer usage on weekdays (P = 0.0009). There were no significant differences in time on other sedentary behaviors including television and DVD, video game, extracurricular reading, writing, drawing and listening to music, passive commuting and sitting to talk. There was also no significant difference in time in moderate-to-vigorous physical activity between intervention and control group.

Conclusion: Peer education appears to be a promising intervention in reducing sedentary behaviors in adolescents in China. These results need confirmation in a larger study.

ARTICLE SUMMARY

Article focus

- To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in grade 7 students in urban Beijing, China.

Key messages

- Peer education is a promising intervention to reduce sedentary behaviors in adolescents.

Strengths and limitations of this study

Strengths

Our intervention is innovative because the peer education program is theory-based and easy to run by following the peer leader's manual. Peer leaders are trained in a short period of time and then educate their classmates. These features ensure the program minimally interrupt school activities, cost-effective and feasible for larger-scale implementation.

Limitations

This pilot study lacked power to detect statistical significance of the intervention effects. In addition, with only two schools in each arm, potential confounders may not have been balanced across treatment groups. Also, physical activity was not objectively measured.

INTRODUCTION

Adolescents in China have become increasingly sedentary with a decrease in physical activity[1] and an increase in sedentary behavior[2] over the last decade, concurrently with the rapid socioeconomic development, especially in urban areas. This tendency to increasing sedentariness may be associated with an array of health problems including overweight and obesity[3, 4] that can track into adults[5]. The prevalence of overweight and obesity has increased from 3.6% to 9.1% in adolescents in China in the last decade[6]. Therefore, there is an urgent need for cost-effective interventions to increase physical activity and to reduce sedentary behavior in adolescents when they are establishing long-term lifestyle patterns.

Peers are a key component of the social network of adolescents who are transiting from childhood to adulthood. During the transition, youth move away from dependence on the family, to closer ties with their peers who give them the social support they need, especially with their schoolmates. Peer education programs offer a powerful approach to educate youth and change their health behaviors[7]. There is growing support for the use of student peer leaders to disseminate health information and to serve as role models in schools[8]. Health education programs in drug and alcohol issues have successfully employed peer teaching as an intervention strategy and appear to have a greater effect on health behavior than adult-led interventions[9-12]. Recent studies have shown peer education programs can significantly improve a range of health behaviors, including increasing fruit intake and reducing the risk of eating disorders in primary school students[13].

However, little is known about whether this premise holds for motivating junior high school students to increase physical activity and to reduce sedentary behavior. In the US, one study using a combined peer-led and teacher-led education[14] in a high school found favorable

impacts on physical activity in girls but not in boys. This study was evaluated with an internal control of classes in the same school that did not receive the intervention. Another study in elementary school students implemented a peer education program to prevent obesity. However, the effect on physical activity was not reported[15].

Few studies have examined the effect of an intervention on physical activity in adolescents in China. Only one study[16] has been identified in two recent systematic reviews of studies of school-based and community-based prevention of childhood obesity in China[17, 18] with a physical activity intervention. This study implemented a teacher-led organized physical activity but did not report its effects on physical activity and sedentary behavior. In China, peer education has been effective in promoting knowledge, attitudes and intention to change behavior in AIDS prevention[19]. However, no studies have evaluated the effect of peer education on physical activity and sedentary behaviors. Therefore, we conducted a pilot study from September 2010 to May 2011in four junior high schools in urban Beijing, China to test the feasibility of a peer-led education program in changing obesity-related behaviors. The present study aims to examine the effects of peer education on physical activity and sedentary behavior.

METHODS

Study design

A convenience sample of two small-sized and two large-sized junior high schools in Dongcheng District, Beijing were selected by the Dongcheng District Institute for Student Healthcare from schools with more than 160 students in grade 7. These schools were matched by school population size, and in each matched pair, one school was randomly allocated by research staff by throwing a coin to intervention or the control group. In the large-sized schools, four classes

were randomly drawn to participate in the study. In the small schools, all classes participated in the study. Peer education was implemented in classrooms in the first 2 months in intervention schools. No intervention was implemented in the control schools during the study. Assessments were conducted at baseline (September 2010), 3 months (December 2010) and 7 months (April/May 2011).

Survey protocols, instruments, and processes for obtaining informed consent for this study were approved by institutional review committees of the University of Sydney, Sydney, Australia and the Peking University Health Science Center, Beijing, China.

Start-up of the study

Before the baseline assessment, a start-up conference was conducted with the attendance of officers from the Dongcheng District Institute for Student Healthcare, school principals and doctors, and research staff. The research plan and the responsibilities of participating institutions were introduced and discussed. The principal and participant information and consent forms were distributed to attendees from schools. After that, the principal and the school doctor in each intervention school held a meeting with all class teachers in participating classes in grade 7 to explain the research plan and to develop the school's work plan.

The information and consent forms were distributed to students in participating classes by class teachers in the four schools. Consent forms signed by both students and one of their guardians were collected before the baseline data collection. Only the students with consent forms signed by both themselves and their guardian were allowed to participate in the assessment. School consent forms signed by principals were collected as well.

Intervention

The four-component intervention was adapted, from a peer-led health promotion program in Australia[20] that was based on social cognitive theory[21] and an empowerment educational approach[22], to ensure it was culturally appropriate for Chinese students and fitted with our research objectives. The key modification was that peer leaders from grade 7 were selected to educate students in their own grade 7 instead of recruiting older peer leaders from grade 10. This change was made because junior and senior high school are separate schools in China, and grade 9 children were too busy with exams for entrance to senior high school to act as peer leaders. In addition, the component to increase awareness about local healthcare services was replaced by that to reduce consumption of carbonated drinks.

Therefore, our intervention covered four components: food choice, physical activity and sedentary behavior, carbonated drinks, and goal setting, which directly aimed at behavior change. Learning activities were designed to be conducted in a variety of ways including presentation, video watching, group discussion, games, experiments, lifestyle practice, skit playing and quiz show. Each component was designed to be taught at a 40-minute lesson. A peer leader's manual was developed to describe these structured activities.

To provide basic knowledge in healthy lifestyles and behavioral change and to encourage parents to support their children's behavioral changes, an 8-page pamphlet with knowledge supplemental to the four lessons was distributed to students and their parents in the intervention schools right after the baseline assessment.

Our intervention consisted of a three-step process including peer leaders recruitment and training, peer-led education and student action.

Peer leaders recruitment and training

After the baseline assessment, four to eight peer leaders balanced by gender in each intervention class were selected by the class teacher from volunteer students based on their organization and oral expression ability, influence among students and sense of responsibility.

Then peer leaders in each intervention school were trained by research staff in three after-school 90-minute workshops over 3 consecutive days at school. We explained and practiced all the four components, with the aim of enabling peer leaders to successfully deliver the lessons to their classmates. In the whole training process, peer leaders were encouraged to learn the skills as a peer leader to actively interact with peers and to facilitate interaction between peers.

Peer education

Before each peer education lesson, school doctors or class teachers had a meeting with peer leaders to clarify each peer leader's responsibility. Peer leaders prepared and practiced their lessons.

Peer leaders then delivered four 40-minute peer education lessons to their classmates over four consecutive weeks in their classrooms, following the peer leader's manual. The four peer education activities were integrated into the existing health education courses and class meetings.

The students (29 – 42 students per class) sat either in one large or several small circles. Given the heavy academic pressure of peer leaders and to ensure feasibility, we used a different pair of peer leaders to deliver the lessons.

During the peer education, a school teacher was present to help maintain classroom order.

Student action

Students were encouraged to maintain a healthy lifestyle based on the personal goals set in the fourth peer education lesson. The peer leaders were encouraged to be role models and to facilitate other students to maintain healthy lifestyles.

Assessment

Physical activity

A validated 7-day youth physical activity questionnaire[23] was modified to collect information on moderate-to-vigorous physical activity (MVPA) and sedentary behavior in the previous week. Trained medical students, who were blinded to the assignment of the intervention, explained the questionnaire to students in the classroom. In the questionnaire, in-school and out-of-school MVPA were recorded with a 12-item and 18-item scale to collect information on days, frequency per day, and duration per time, respectively. Commuting to and from school was recorded using a 4-item scale including walking, cycling, public transportation and picking up by parents. For those who walk or cycle, frequency and time of travelling were collected separately by to and from school. For those who take public transportation (bus, subway and taxi), frequency and time of walking between public transportation station/stop and home (or school) were collected. Whether or not they were picked up from school by their guardians was also collected. Sedentary behavior was assessed by an 8-item scale including TV viewing, DVD and video tape viewing, computer usage for entertainment, electronically game playing, extracurricular reading, drawing/writing/listening to music, sitting to phone call or chat, and playing musical instruments on week days and weekends.

Body mass index

Height was measured to the nearest 0.1 cm without shoes with a portable stadiometer and weight in lightweight clothing was measured to the nearest 0.1 kg on a calibrated beam scale. Body mass index (BMI) was calculated as weight in kilograms / (height in meters) ^{2}. Overweight and obesity were defined using the age- and sex-specific BMI cut-offs recommended by the International Obesity Task Force [24].

Process evaluation and adverse events

Process evaluation was conducted by direct observation and focus group discussion in each intervention school. Research staff (CZ) and an officer from Dongcheng District Institute for Student Healthcare observed the peer education classes in the two intervention schools. In addition, immediately after the intervention, two focus group discussions were conducted among peer leaders and their peers to obtain feedback about the program in each intervention school. Stratified by participating class, twelve students were randomly invited to participate for each focus group discussion. The discussion chaired by a trained research staff was recorded. Also in-depth interviews were held with a principal, class teacher, school doctor and physical education teacher from each intervention school.

Adverse events (injury) related to the intervention were reported by the intervention schools to the Dongcheng District Institute for Student Healthcare.

Statistical analysis

Given that only two schools were included in each arm, the baseline characteristics in the two arms may not be comparable although schools were matched. Thus intention to treat analysis

was not applied in the present analysis and the students who were lost to follow-up (6.2%) were excluded from the analysis. The baseline characteristics of students with all three measurements were compared with those of students who were lost to follow-up.

The effect of the intervention on physical activity was evaluated by the relative changes in time (or MET × time) for in-school and out-of-school MVPA, active commuting to and from school (walking or cycling) and total MVPA between intervention and control groups compared to baseline. The effect of the intervention on sedentary behavior was evaluated by the relative changes in time in individual activities and the total activity.

Generalized linear mixed models was applied to obtain means by group and to evaluate the effect of the intervention on physical activity and sedentary behaviors at 3 and 7 months after adjustment for age, sex and BMI at baseline, with school, class[25] and within-subject correlation as random effect and with a covariance structure of simple diagonal using SAS 9.2 (SAS Institute, Cary, NC, USA). In the analysis to evaluate the effect of the intervention, the cluster effect of matched school pairs [26] was also treated as random effect. In addition, two interaction terms (sex by group, and group by time points of data collection) were added to evaluate that whether intervention effect was modified by sex or time.

RESULTS

Participants

A total of 758 students were eligible for the study in the four schools (Figure 1). Signed consent forms were obtained from 738 students (97.4%). Nine students (1.2%) missed the baseline assessment and 47 students (6.2%) were lost to follow-up, which led to a total of 682 (90.0%) participants with 336 in the control arm and 346 in the intervention arm available for the analysis.

There were no significant differences in gender, age, weight status and mean BMI between students with all measurements and those lost to follow-up across research arms at baseline (data not shown).

Baseline characteristics between the control and intervention groups were compared separately in boys and girls as shown in Table 1. For boys, mean BMI (p = 0.038) and prevalence of overweight and obesity (p = 0.016) were significantly lower in the control group than those in the intervention group. No significant differences were found in MVPA and sedentary behaviors between groups by gender at baseline as seen in Tables 2 – 3.

Table 1 Baseline characteristics of participants[†]

Variable	Intervention[‡]		Control[‡]	
	Boys (n=176)	Girls (n=170)	Boys (n=177)	Girls (n=159)
Age, mean ± SD, years	12.7 ± 0.5	12.6 ± 0.5	12.8 ± 0.5	12.6 ± 0.4
Weight status, %				
Normal weight	51.1	76.5	64.4[*]	76.7
Overweight	34.1	17.6	25.4	15.7
Obesity	14.8	5.9	10.2	7.5
BMI, kg/m^2	21.7 ± 4.6	20.2 ± 3.8	20.6 ± 4.2[*]	19.9 ± 4.6

[†] P values were adjusted for cluster effect in matched pair, school and class.
[‡] Unadjusted values.
[*] P < 0.05 in boys between intervention and control group by gender.

Adjusted effect on MVPA

There was no significant difference between groups in time in total MVPA, in- and out-of-school MVPA and active commuting to school at 3 and 7 months, after adjustment for age, gender, body mass index at baseline (Table 2).

Table 2 Daily time and MET* ×time on MVPA† at baseline‡, 3 months and 7 months

	Sample, n	Baseline§ Mean	Baseline§ SE	3 months§ Mean	3 months§ SE	P¶	7 months§ Mean	7 months§ SE	P¶
Total MVPA, min/d									
Control	295	196.7	11.1	183.3	12.6		171.3	11.4	
Intervention	323	190.1	10.8	179.6	12.4	0.83	171.6	11.2	0.94
Total MVPA, MET*min/d									
Control	295	998.6	58.4	957.6	90.6		874.3	73.8	
Intervention	323	967.8	57.0	917.0	89.9	0.66	869.2	73.0	0.88
MVPA in school, min/d									
Control	321	95.6	4.8	105.5	8.7		88.8	9.4	
Intervention	337	92.6	4.7	99.2	8.7	0.52	92.8	9.3	0.77
MVPA in school, MET*min/d									
Control	321	513.9	26.0	593.2	67.6		488.0	62.2	
Intervention	337	498.9	25.4	533.2	67.4	0.38	497.8	61.9	0.99
MVPA out school, min/d									
Control	314	108.7	10.0	90.8	5.5		89.5	7.8	
Intervention	329	103.2	9.9	91.1	5.4	0.97	88.9	7.8	0.94
MVPA out school, MET*min/d									
Control	314	549.4	53.3	462.1	36.1		449.4	38.7	
Intervention	329	514.6	53.0	456.0	35.6	0.91	438.9	38.4	0.81
Active commuting to school, MET * min/d									
Control	320	131.6	13.1	115.1	17.2		120.6	11.4	
Intervention	341	135.4	13.0	118.5	17.2	0.82	116.4	11.3	0.79

* MET denotes 1 kcal ×·kg body weight^{-1} × h^{-1}.
† MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.
‡ Comparison between control group and intervention group in each variable at baseline is not significant.
§ Data was adjusted for age, gender and body mass index at baseline.
¶Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Adjusted effect on sedentary behaviors

As shown in Table 3, there was no significant difference between groups in time on sedentary behaviors at 3 months. At 7 months, time on computer usage on week days in the intervention group was 15min/d (data not shown) lower (p = 0.0009) than that in control schools. As a result, the daily time for computer usage in the intervention group was significant lower than that in control group (p = 0.016). Also, there was a significant decrease in time in sedentary behavior on weekdays, 20 min/d (data not shown) at 7 months (P = 0.020) reported by students in the

intervention schools compared to control schools. Time on total sedentary behaviors in intervention group was 22 min/d (data not shown) lower than that in control group, but the difference was not significant (p = 0.06). There were no significant differences between groups in time on other sedentary behaviors at 7 months.

Table 3 Daily minutes spent on sedentary behaviors* at baseline†, 3 months and 7 months‡

	Baseline§		3 months§			7 months§		
	Mean	SE	Mean	SE	P¶	Mean	SE	P¶
Sedentary behaviors								
Control	256.3	26.5	256.8	25.4		258.8	25.5	
Intervention	248.7	26.5	237.2	25.4	0.21	229.0	25.5	0.060
Sedentary behaviors, on weekdays								
Control	197.7	24.8	188.4	26.6		201.1	28.8	
Intervention	181.3	24.8	172.2	26.6	0.21	169.8	28.8	0.02
Sedentary behaviors, on weekend								
Control	403.8	31.5	428.2	23.8		405.1	19.9	
Intervention	419.7	31.4	399.3	23.7	0.25	377.5	19.7	0.25
Computer								
Control	43.6	11.4	52.0	11.9		59.2	11.0	
Intervention	45.6	11.4	42.2	11.9	0.13	43.0	11.0	0.016
Computer, on weekdays								
Control	26.7	8.9	31.2	9.1		39.7	8.8	
Intervention	25.1	8.9	22.8	9.1	0.07	23.3	8.8	0.0009
Computer, on weekend								
Control	85.9	17.7	104.1	19.0		107.7	16.7	
Intervention	97.1	17.7	90.7	19.0	0.27	91.9	16.7	0.18
Television and DVD								
Control	70.7	12.5	72.2	9.5		69.0	11.2	
Intervention	65.6	12.5	60.9	9.5	0.13	65.1	11.2	0.56
Video game								
Control	6.0	1.3	10.3	1.8		11.9	1.9	
Intervention	7.8	1.2	7.6	1.8	0.26	8.5	1.9	0.21
Extracurricular reading, writing, drawing and listening to music								
Control	83.6	4.1	74.1	5.0		79.4	4.8	
Intervention	81.3	4.1	79.6	4.9	0.4	72.6	4.8	0.29
Passive commuting								
Control	31.6	2.6	27.8	2.7		25.6	2.5	
Intervention	27.4	2.6	32.4	2.6	0.22	29.3	2.5	0.32
Sitting and talking								
Control	22.3	3.0	21.4	1.8		16.8	1.7	

Intervention	24.2	2.9	17.0	1.8	0.16	14.2	1.6	0.34

* Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

† Comparison between control group and intervention group in each variable at baseline is not significant.

‡ Sample size in control group = 336, in intervention group = 345.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Comparison between peer leaders and other students

Selected variables were selected to evaluate the differences in the effect of the peer education program on peer leaders and other participating students in intervention schools (Table 4). There were no significant differences between peer leaders and other students in time on MVPA, sedentary behaviors and computer usage at both 3 and 7 months. By comparing the magnitudes of adjusted mean time through baseline to 7 months, we found that time on MVPA decreased more among peer leaders than other students, while time on sedentary behaviors decreased in other students, while slightly increased in peer leaders.

Table 4 Comparison of daily minutes spent on total MVPA* and selected sedentary behaviors† between peer leaders and other students‡

	Baseline§		3 months§		P‡	7 months §		P‡
	Mean	SE	Mean	SE		Mean	SE	
Total MVPA, min/d								
peers	195.7	10.0	181.4	9.0		173.1	17.4	
peer leaders	192.1	18.3	197.9	17.5	0.42	182.5	21.9	0.50
Sedentary behaviors								
peers	256.9	24.9	241.1	11.8		234.5	15.2	
peer leaders	210.4	30.8	231.2	21.5	0.75	217.1	22.7	0.46
Sedentary behaviors, on weekdays								
peers	188.7	24.9	174.8	15.2		174.6	20.4	
peer leaders	145.1	30.3	167.7	22.6	0.80	157.5	25.6	0.41
Sedentary behaviors, on weekend								
peers	429.7	24.9	402.8	17.2		383.1	16.8	
peer leaders	373.6	39.2	388.4	35.9	0.75	364.5	32.0	0.65
Computer								
peers	47.6	12.4	42.8	5.7		45.6	4.1	
peer leaders	34.7	13.9	41.6	7.9	0.97	36.0	6.6	0.2
Computer, on weekdays								
peers	26.6	9.8	23.4	4.8		25.1	3.9	
peer leaders	16.5	11.2	21.4	6.7	0.82	18.8	6.0	0.34
Computer, on weekend								
peers	100.5	19.1	91.4	7.9		96.0	6.7	
peer leaders	80.1	22.7	92.1	13.8	0.86	78.2	12.8	0.23

* MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.

† Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

‡ Number of peer leaders = 59, of other students = 286.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Process evaluation and adverse events

Research staff and education officer observed that the delivery of the four lessons by the peer leaders followed the peer leader's manual. From the focus group discussions we found that the

peer leaders performed well according to their peers and were able to involve the students in the activities. The teachers and students demonstrated that the peer education program is feasible and is acceptable because of it is innovative, easy and includes a range of activities.

No adverse events were reported during the intervention.

DISCUSSION

This pilot study based on 682 students in 4 schools (2 intervention and 2 control schools) indicated that the adapted peer education program from Australia was feasible and acceptable in schools in Beijing and it showed potential for reducing sedentary behaviors in adolescents, especially computer time.

Our intervention was innovative for a number of reasons. Firstly, the peer education program was well-designed, structured and easy to run by following the manual. The training of peer leaders was shorter compared to other peer education studies in China that had a four-day to four-week training[19, 27], which is an attractive feature in reducing costs and increasing feasibility for larger-scale implementation.

Secondly, the peer education program directly aimed at behavior change. Our program delivered health information by a variety of participatory activities to motivate students to be more active. Also, students actively interacted with each other and to find out the most realistic solutions to their barriers to engage in more physical activity.

Thirdly, our program results in minimal interruption to school activities. Peer leaders were the classmates of the peers they educated, which reduced interruption to the regular education

programs in the schools compared to programs that used senior students as peer leaders. The use of senior students is complicated in China because the schools need to adjust their curriculum to make both peer leaders and their "peers" available at specific times, especially when senior peer leaders come from senior high schools that are separate from junior high schools. The use of senior peer leaders has been driven by concerns about the ability of younger students to educate and influence their immediate peers. However, the Healthy Buddies program indicated that younger peer educators (students in 4th through 7th grade) are effective in delivering the messages to students in kindergarten through 3rd grade[15]. In addition, peer leaders from the same class stayed in contact longer with their peers in future school life, which may contribute to the sustainability of the intervention. The minimal interruption to school also featured by the shorter training of peer leaders in our study[15]. High school students in China have long school hours (5.4 days in school per week and 7.6 lessons/day[28]) and heavy pressure for academic achievement (2 hours/day on homework[28]), thus, minimal interruption to school is critical to ensure the sustainability of a school-based health promotion program in this context.

Fourthly, students were educated in groups regarded as small in China, which was associated with greater increases in knowledge, altered attitudes and intentions to change behavior than those in larger groups in the peer education study[19] because small groups facilitate cooperative learning, discussion and communication[29].

Comparison with studies in China was limited because there has been only one study that used a teacher-led organized exercise to prevent obesity in adolescents and physical activity outcome was not reported in this study[17]. Limited studies have used peer education to promote physical activity in high-income countries. Consistent with our findings, Healthy Buddies[15], that used students in 4th to 7th grade trained by a teacher in a weekly 45-minute lesson to promote physical

activity in students from kindergarten to 3rd grade over 21 weeks, and reported no significant effects on physical activity[15]. The possible explanation is the Sunny Sport Policy issued by the Department of Education in China. This program has been implemented nationally and requires schools to ensure students have daily one hour of physical activity in school. With this policy in place, it may be difficult for any school-based intervention to increase in-school non-organized physical activity. Therefore, organized physical activity may potentially increase in-school physical activity in large cities in China, for example, to increase the intensity of physical education. For out-of-school physical activity, an intervention component at family and neighborhood level involving environmental modification may be useful. Like Healthy Buddies, using teachers to train peer leaders may increase the feasibility of our program to be implemented at a larger scale.

Several lessons have been learnt from our pilot study. Firstly, future intervention studies should focus not only on TV viewing but also emerging computer usage in large cities in China. The 2002 CNHS reported 25% of adolescent used computers and spent an average of 1.2 hours/day on the computer[28]. An average of 40-50 min/d of computer usage in our study suggests that computer usage accounted for a substantial amount of sedentary time in children in large cities in China. Further, the decrease in sedentary time was mainly from the reduction in computer usage, which might partly be due to parental limits on the accessibility to computers for their children.

Conclusion

Our pilot study of a peer counseling intervention was promising in reducing sedentary behaviors in adolescents in China. These results need to be confirmed in a larger study.

Acknowledgements

We are very grateful to the participating schools, children and their families. We also thank the Australian Agency for International Development (AusAID) for funding Zhaohui Cui's doctoral scholarship in International Public Health at the University of Sydney, Australia, and this analysis, which is part of the requirements for his PhD studies. We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention for the provision the physical activity questionnaire.

Funding

This work was supported by the Nestle Foundation. The funders of the research had no role in the analysis nor the decision to publish.

Competing interests

None

Contributors

MD, SS and ZC formulated the idea and study design. ZC modified the intervention materials, implemented the intervention, collected and cleaned the data, and carried out the data analyses, drafted the manuscript. SS, LLY, YW, YP, AG and MD contributed to the implementation of the intervention. SS, LLY and MD contributed to the interpretations of the results. All authors contributed to revising the paper and approved the final version.

Data sharing statement

No additional data is available

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[Legend of Figure 1]

Figure 1 Flow of the participants through the trial

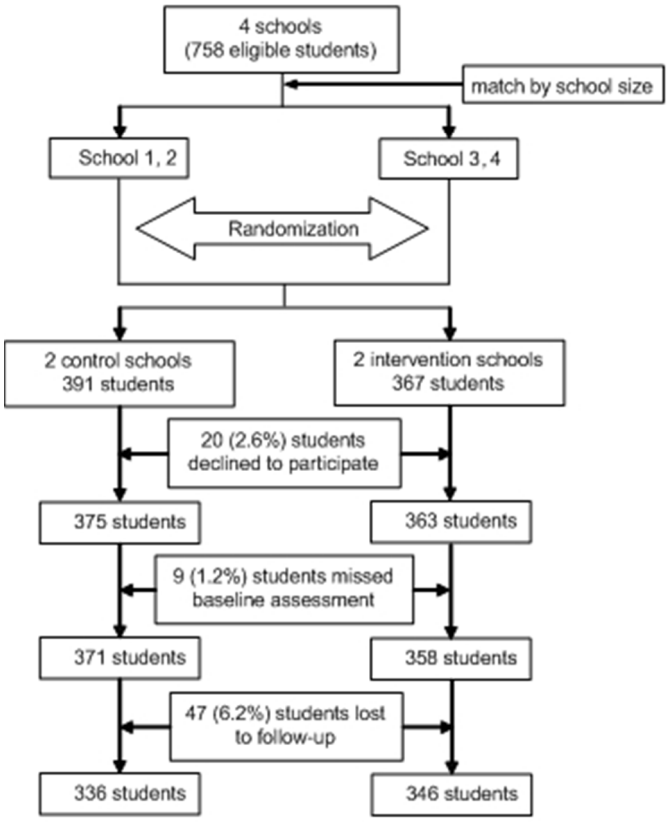

Figure 1 Flow of the participants through the trial
89x110mm (96 x 96 DPI)

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Not applicable
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Yes
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Yes
	2b	Specific objectives or hypotheses	Yes
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Yes
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Yes
Participants	4a	Eligibility criteria for participants	Yes
	4b	Settings and locations where the data were collected	Yes
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Yes
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Yes
	6b	Any changes to trial outcomes after the trial commenced, with reasons	Not applicable
Sample size	7a	How sample size was determined	Yes
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Not applicable
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Yes
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Yes
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Yes
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Yes
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	Yes

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	Not applicable
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Yes
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Not applicable
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Yes
	13b	For each group, losses and exclusions after randomisation, together with reasons	Yes
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Yes
	14b	Why the trial ended or was stopped	Not applicable
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Yes
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Yes
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Yes
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Not applicable
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Yes
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Yes
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Yes
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Yes
Other information			
Registration	23	Registration number and name of trial registry	Not applicable
Protocol	24	Where the full trial protocol can be accessed, if available	Not applicable
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Yes

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

BMJ open

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000721.R2
Article Type:	Research
Date Submitted by the Author:	28-Feb-2012
Complete List of Authors:	Cui, Zhaohui; University of Sydney, School of Public Health Shah, Smita Yan, Lijing Pan, Yongping Gao, Aiyu Shi, Xiaoyan Wu, Yangfeng Dibley, Michael
Primary Subject Heading:	Nutrition and metabolism
Secondary Subject Heading:	Global health, Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Nutrition < TROPICAL MEDICINE

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

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Key words: peer, intervention, physical activity, sedentary, adolescent

Word count: 3698

ABSTRACT

Objectives: To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in urban Beijing, China.

Design: Four junior high schools were matched by school size and randomized to intervention (n = 346) and control group (n = 336).

Intervention: Trained peer leaders from grade 7 by research staff delivered weekly 40-minute lessons to their classmates over four consecutive weeks. Students in control schools received no intervention.

Outcome measures: A validated 7-day youth physical activity questionnaire was used to evaluate physical activity and sedentary behaviors at baseline (September 2010), 3(December 2010) and 7 months (May 2011). Generalized linear mixed models were applied to evaluate the effect.

Results: There was a significant decrease in time in sedentary behavior on weekdays, 20 min/d at 7 months (P = 0.020) reported by students in the intervention schools compared to control schools. This reduction was mainly due to a reduction of 14 min/d in computer usage on weekdays (P = 0.0009). There were no significant differences in time on other sedentary behaviors including television and DVD, video game, extracurricular reading, writing, drawing and listening to music, passive commuting and sitting to talk. There was also no significant difference in time in moderate-to-vigorous physical activity between intervention and control group.

Conclusion: Peer education appears to be a promising intervention in reducing sedentary behaviors in adolescents in China. These results need confirmation in a larger study.

ARTICLE SUMMARY

Article focus

- To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in grade 7 students in urban Beijing, China.

Key messages

- Peer education is a promising intervention to reduce sedentary behaviors in adolescents.

Strengths and limitations of this study

Strengths

Our intervention is innovative because the peer education program is theory-based and easy to run by following the peer leader's manual. Peer leaders are trained in a short period of time and then educate their classmates. These features ensure the program minimally interrupt school activities, cost-effective and feasible for larger-scale implementation.

Limitations

With only two schools in each arm, potential confounders may not have been balanced across treatment groups. Also, physical activity was not objectively measured.

INTRODUCTION

Adolescents in China have become increasingly sedentary with a decrease in physical activity[1] and an increase in sedentary behavior[2] over the last decade, concurrently with the rapid socioeconomic development, especially in urban areas. This tendency to increasing sedentariness may be associated with an array of health problems including overweight and obesity[3, 4] that can track into adults[5]. The prevalence of overweight and obesity has increased from 3.6% to 9.1% in adolescents in China in the last decade[6]. Therefore, there is an urgent need for cost-effective interventions to increase physical activity and to reduce sedentary behavior in adolescents when they are establishing long-term lifestyle patterns.

Peers are a key component of the social network of adolescents who are transiting from childhood to adulthood. During the transition, youth move away from dependence on the family, to closer ties with their peers who give them the social support they need, especially with their schoolmates. Peer education programs offer a powerful approach to educate youth and change their health behaviors[7]. There is growing support for the use of student peer leaders to disseminate health information and to serve as role models in schools[8]. Health education programs in drug and alcohol issues have successfully employed peer teaching as an intervention strategy and appear to have a greater effect on health behavior than adult-led interventions[9-12]. Recent studies have shown peer education programs can significantly improve a range of health behaviors, including increasing fruit intake and reducing the risk of eating disorders in primary school students[13].

However, little is known about whether this premise holds for motivating junior high school students to increase physical activity and to reduce sedentary behavior. In the US, one study using a combined peer-led and teacher-led education[14] in a high school found favorable

impacts on physical activity in girls but not in boys. This study was evaluated with an internal control of classes in the same school that did not receive the intervention. Another study in elementary school students implemented a peer education program to prevent obesity. However, the effect on physical activity was not reported[15].

Few studies have examined the effect of an intervention on physical activity in adolescents in China. Only one study[16] has been identified in two recent systematic reviews of studies of school-based and community-based prevention of childhood obesity in China[17, 18] with a physical activity intervention. This study implemented a teacher-led organized physical activity but did not report its effects on physical activity and sedentary behavior. In China, peer education has been effective in promoting knowledge, attitudes and intention to change behavior in AIDS prevention[19]. However, no studies have evaluated the effect of peer education on physical activity and sedentary behaviors. Therefore, we conducted a pilot study from September 2010 to May 2011in four junior high schools in urban Beijing, China to test the feasibility of a peer-led education program in changing obesity-related behaviors. The present study aims to examine the effects of peer education on physical activity and sedentary behavior.

METHODS

Study design

A convenience sample of two small-sized and two large-sized junior high schools in Dongcheng District, Beijing were selected by the Dongcheng District Institute for Student Healthcare from schools with more than 160 students in grade 7. These schools were matched by school population size, and in each matched pair, one school was randomly allocated by research staff by throwing a coin to intervention or the control group. In the large-sized schools, four classes

were randomly drawn to participate in the study. In the small schools, all classes participated in the study. Peer education was implemented in classrooms in the first 2 months in intervention schools. No intervention was implemented in the control schools during the study. Assessments were conducted at baseline (September 2010), 3 months (December 2010) and 7 months (April/May 2011).

Survey protocols, instruments, and processes for obtaining informed consent for this study were approved by institutional review committees of the University of Sydney, Sydney, Australia and the Peking University Health Science Center, Beijing, China.

Start-up of the study

Before the baseline assessment, a start-up conference was conducted with the attendance of officers from the Dongcheng District Institute for Student Healthcare, school principals and doctors, and research staff. The research plan and the responsibilities of participating institutions were introduced and discussed. The principal and participant information and consent forms were distributed to attendees from schools. After that, the principal and the school doctor in each intervention school held a meeting with all class teachers in participating classes in grade 7 to explain the research plan and to develop the school's work plan.

The information and consent forms were distributed to students in participating classes by class teachers in the four schools. Consent forms signed by both students and one of their guardians were collected before the baseline data collection. Only the students with consent forms signed by both themselves and their guardian were allowed to participate in the assessment. School consent forms signed by principals were collected as well.

Intervention

The four-component intervention was adapted, from a peer-led health promotion program in Australia[20] that was based on social cognitive theory[21] and an empowerment educational approach[22], to ensure it was culturally appropriate for Chinese students and fitted with our research objectives. The key modification was that peer leaders from grade 7 were selected to educate students in their own grade 7 instead of recruiting older peer leaders from grade 10. This change was made because junior and senior high school are separate schools in China, and grade 9 children were too busy with exams for entrance to senior high school to act as peer leaders. In addition, the component to increase awareness about local healthcare services was replaced by that to reduce consumption of carbonated drinks.

Therefore, our intervention covered four components: food choice, physical activity and sedentary behavior, carbonated drinks, and goal setting, which directly aimed at behavior change. Learning activities were designed to be conducted in a variety of ways including presentation, video watching, group discussion, games, experiments, lifestyle practice, skit playing and quiz show. Each component was designed to be taught at a 40-minute lesson. A peer leader's manual was developed to describe these structured activities.

To provide basic knowledge in healthy lifestyles and behavioral change and to encourage parents to support their children's behavioral changes, an 8-page pamphlet with knowledge supplemental to the four lessons was distributed to students and their parents in the intervention schools right after the baseline assessment.

Our intervention consisted of a three-step process including peer leaders recruitment and training, peer-led education and student action.

Peer leaders recruitment and training

After the baseline assessment, four to eight peer leaders balanced by gender in each intervention class were selected by the class teacher from volunteer students based on their organization and oral expression ability, influence among students and sense of responsibility.

Then peer leaders in each intervention school were trained by research staff in three after-school 90-minute workshops over 3 consecutive days at school. We explained and practiced all the four components, with the aim of enabling peer leaders to successfully deliver the lessons to their classmates. In the whole training process, peer leaders were encouraged to learn the skills as a peer leader to actively interact with peers and to facilitate interaction between peers.

Peer education

Before each peer education lesson, school doctors or class teachers had a meeting with peer leaders to clarify each peer leader's responsibility. Peer leaders prepared and practiced their lessons.

Peer leaders then delivered four 40-minute peer education lessons to their classmates over four consecutive weeks in their classrooms, following the peer leader's manual. The four peer education activities were integrated into the existing health education courses and class meetings.

The students (29 – 42 students per class) sat either in one large or several small circles. Given the heavy academic pressure of peer leaders and to ensure feasibility, we used a different pair of peer leaders to deliver the lessons.

During the peer education, a school teacher was present to help maintain classroom order.

Student action

Students were encouraged to maintain a healthy lifestyle based on the personal goals set in the fourth peer education lesson. The peer leaders were encouraged to be role models and to facilitate other students to maintain healthy lifestyles.

Assessment

Physical activity

A validated 7-day youth physical activity questionnaire[23] was modified to collect information on moderate-to-vigorous physical activity (MVPA) and sedentary behavior in the previous week. Trained medical students, who were blinded to the assignment of the intervention, explained the questionnaire to students in the classroom. In the questionnaire, in-school and out-of-school MVPA were recorded with a 12-item and 18-item scale to collect information on days, frequency per day, and duration per time, respectively. Commuting to and from school was recorded using a 4-item scale including walking, cycling, public transportation and picking up by parents. For those who walk or cycle, frequency and time of travelling were collected separately by to and from school. For those who take public transportation (bus, subway and taxi), frequency and time of walking between public transportation station/stop and home (or school) were collected. Whether or not they were picked up from school by their guardians was also collected. Sedentary behavior was assessed by an 8-item scale including TV viewing, DVD and video tape viewing, computer usage for entertainment, electronically game playing, extracurricular reading, drawing/writing/listening to music, sitting to phone call or chat, and playing musical instruments on week days and weekends.

Body mass index

Height was measured to the nearest 0.1 cm without shoes with a portable stadiometer and weight in lightweight clothing was measured to the nearest 0.1 kg on a calibrated beam scale. Body mass index (BMI) was calculated as weight in kilograms / (height in meters) ^{2}. Overweight and obesity were defined using the age- and sex-specific BMI cut-offs recommended by the International Obesity Task Force [24].

Process evaluation and adverse events

Process evaluation was conducted by direct observation and focus group discussion in each intervention school. Research staff (CZ) and an officer from Dongcheng District Institute for Student Healthcare observed the peer education classes in the two intervention schools. In addition, immediately after the intervention, two focus group discussions were conducted among peer leaders and their peers to obtain feedback about the program in each intervention school. Stratified by participating class, twelve students were randomly invited to participate for each focus group discussion. The discussion chaired by a trained research staff was recorded. Also in-depth interviews were held with a principal, class teacher, school doctor and physical education teacher from each intervention school.

Adverse events (injury) related to the intervention were reported by the intervention schools to the Dongcheng District Institute for Student Healthcare.

Statistical analysis

Given that only two schools were included in each arm, the baseline characteristics in the two arms may not be comparable although schools were matched. Thus intention to treat analysis

was not applied in the present analysis and the students who were lost to follow-up (6.2%) were excluded from the analysis. The baseline characteristics of students with all three measurements were compared with those of students who were lost to follow-up.

The effect of the intervention on physical activity was evaluated by the relative changes in time (or MET × time) for in-school and out-of-school MVPA, active commuting to and from school (walking or cycling) and total MVPA between intervention and control groups compared to baseline. The effect of the intervention on sedentary behavior was evaluated by the relative changes in time in individual activities and the total activity.

Generalized linear mixed models was applied to obtain means by group and to evaluate the effect of the intervention on physical activity and sedentary behaviors at 3 and 7 months after adjustment for age, sex and BMI at baseline, with school, class[25] and within-subject correlation as random effect and with a covariance structure of simple diagonal using SAS 9.2 (SAS Institute, Cary, NC, USA). In the analysis to evaluate the effect of the intervention, the cluster effect of matched school pairs [26] was also treated as random effect. In addition, two interaction terms (sex by group, and group by time points of data collection) were added to evaluate that whether intervention effect was modified by sex or time.

RESULTS

Participants

A total of 758 students were eligible for the study in the four schools (Figure 1). Signed consent forms were obtained from 738 students (97.4%). Nine students (1.2%) missed the baseline assessment and 47 students (6.2%) were lost to follow-up, which led to a total of 682 (90.0%) participants with 336 in the control arm and 346 in the intervention arm available for the analysis.

There were no significant differences in gender, age, weight status and mean BMI between students with all measurements and those lost to follow-up across research arms at baseline (data not shown).

Baseline characteristics between the control and intervention groups were compared separately in boys and girls as shown in Table 1. For boys, mean BMI (p = 0.038) and prevalence of overweight and obesity (p = 0.016) were significantly lower in the control group than those in the intervention group. No significant differences were found in MVPA and sedentary behaviors between groups by gender at baseline as seen in Tables 2 – 3.

Table 1 Baseline characteristics of participants[†]

Variable	Intervention[‡]		Control[‡]	
	Boys (n=176)	Girls (n=170)	Boys (n=177)	Girls (n=159)
Age, mean ± SD, years	12.7 ± 0.5	12.6 ± 0.5	12.8 ± 0.5	12.6 ± 0.4
Weight status, %				
Normal weight	51.1	76.5	64.4[*]	76.7
Overweight	34.1	17.6	25.4	15.7
Obesity	14.8	5.9	10.2	7.5
BMI, kg/m^2	21.7 ± 4.6	20.2 ± 3.8	20.6 ± 4.2[*]	19.9 ± 4.6

[†] P values were adjusted for cluster effect in matched pair, school and class.
[‡] Unadjusted values.
[*] P < 0.05 in boys between intervention and control group by gender.

Adjusted effect on MVPA

There was no significant difference between groups in time in total MVPA, in- and out-of-school MVPA and active commuting to school at 3 and 7 months, after adjustment for age, gender, body mass index at baseline (Table 2).

Table 2 Daily time and MET* ×time on MVPA† at baseline‡, 3 months and 7 months

	Sample, n	Baseline§ Mean	Baseline§ SE	3 months§ Mean	3 months§ SE	P¶	7 months§ Mean	7 months§ SE	P¶
Total MVPA, min/d									
Control	295	196.7	11.1	183.3	12.6		171.3	11.4	
Intervention	323	190.1	10.8	179.6	12.4	0.83	171.6	11.2	0.94
Total MVPA, MET*min/d									
Control	295	998.6	58.4	957.6	90.6		874.3	73.8	
Intervention	323	967.8	57.0	917.0	89.9	0.66	869.2	73.0	0.88
MVPA in school, min/d									
Control	321	95.6	4.8	105.5	8.7		88.8	9.4	
Intervention	337	92.6	4.7	99.2	8.7	0.52	92.8	9.3	0.77
MVPA in school, MET*min/d									
Control	321	513.9	26.0	593.2	67.6		488.0	62.2	
Intervention	337	498.9	25.4	533.2	67.4	0.38	497.8	61.9	0.99
MVPA out school, min/d									
Control	314	108.7	10.0	90.8	5.5		89.5	7.8	
Intervention	329	103.2	9.9	91.1	5.4	0.97	88.9	7.8	0.94
MVPA out school, MET*min/d									
Control	314	549.4	53.3	462.1	36.1		449.4	38.7	
Intervention	329	514.6	53.0	456.0	35.6	0.91	438.9	38.4	0.81
Active commuting to school, MET * min/d									
Control	320	131.6	13.1	115.1	17.2		120.6	11.4	
Intervention	341	135.4	13.0	118.5	17.2	0.82	116.4	11.3	0.79

* MET denotes 1 kcal ×·kg body weight^{-1} × h^{-1}.
† MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.
‡ Comparison between control group and intervention group in each variable at baseline is not significant.
§ Data was adjusted for age, gender and body mass index at baseline.
¶Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Adjusted effect on sedentary behaviors

As shown in Table 3, there was no significant difference between groups in time on sedentary behaviors at 3 months. At 7 months, time on computer usage on week days in the intervention group was 15min/d (data not shown) lower (p = 0.0009) than that in control schools. As a result, the daily time for computer usage in the intervention group was significant lower than that in control group (p = 0.016). Also, there was a significant decrease in time in sedentary behavior on weekdays, 20 min/d (data not shown) at 7 months (P = 0.020) reported by students in the

intervention schools compared to control schools. Time on total sedentary behaviors in intervention group was 22 min/d (data not shown) lower than that in control group, but the difference was not significant (p = 0.06). There were no significant differences between groups in time on other sedentary behaviors at 7 months.

Table 3 Daily minutes spent on sedentary behaviors* at baseline†, 3 months and 7 months‡

	Baseline§		3 months§			7 months§		
	Mean	SE	Mean	SE	P¶	Mean	SE	P¶
Sedentary behaviors								
Control	256.3	26.5	256.8	25.4		258.8	25.5	
Intervention	248.7	26.5	237.2	25.4	0.21	229.0	25.5	0.060
Sedentary behaviors, on weekdays								
Control	197.7	24.8	188.4	26.6		201.1	28.8	
Intervention	181.3	24.8	172.2	26.6	0.21	169.8	28.8	0.02
Sedentary behaviors, on weekend								
Control	403.8	31.5	428.2	23.8		405.1	19.9	
Intervention	419.7	31.4	399.3	23.7	0.25	377.5	19.7	0.25
Computer								
Control	43.6	11.4	52.0	11.9		59.2	11.0	
Intervention	45.6	11.4	42.2	11.9	0.13	43.0	11.0	0.016
Computer, on weekdays								
Control	26.7	8.9	31.2	9.1		39.7	8.8	
Intervention	25.1	8.9	22.8	9.1	0.07	23.3	8.8	0.0009
Computer, on weekend								
Control	85.9	17.7	104.1	19.0		107.7	16.7	
Intervention	97.1	17.7	90.7	19.0	0.27	91.9	16.7	0.18
Television and DVD								
Control	70.7	12.5	72.2	9.5		69.0	11.2	
Intervention	65.6	12.5	60.9	9.5	0.13	65.1	11.2	0.56
Video game								
Control	6.0	1.3	10.3	1.8		11.9	1.9	
Intervention	7.8	1.2	7.6	1.8	0.26	8.5	1.9	0.21
Extracurricular reading, writing, drawing and listening to music								
Control	83.6	4.1	74.1	5.0		79.4	4.8	
Intervention	81.3	4.1	79.6	4.9	0.4	72.6	4.8	0.29
Passive commuting								
Control	31.6	2.6	27.8	2.7		25.6	2.5	
Intervention	27.4	2.6	32.4	2.6	0.22	29.3	2.5	0.32
Sitting and talking								
Control	22.3	3.0	21.4	1.8		16.8	1.7	

Intervention	24.2	2.9	17.0	1.8	0.16	14.2	1.6	0.34

* Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

† Comparison between control group and intervention group in each variable at baseline is not significant.

‡ Sample size in control group = 336, in intervention group = 345.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Comparison between peer leaders and other students

Selected variables were selected to evaluate the differences in the effect of the peer education program on peer leaders and other participating students in intervention schools (Table 4). There were no significant differences between peer leaders and other students in time on MVPA, sedentary behaviors and computer usage at both 3 and 7 months. By comparing the magnitudes of adjusted mean time through baseline to 7 months, we found that time on MVPA decreased more among peer leaders than other students, while time on sedentary behaviors decreased in other students, while slightly increased in peer leaders.

Table 4 Comparison of daily minutes spent on total MVPA* and selected sedentary behaviors† between peer leaders and other students‡

	Baseline§		3 months§		P‡	7 months §		P‡
	Mean	SE	Mean	SE		Mean	SE	
Total MVPA, min/d								
peers	195.7	10.0	181.4	9.0		173.1	17.4	
peer leaders	192.1	18.3	197.9	17.5	0.42	182.5	21.9	0.50
Sedentary behaviors								
peers	256.9	24.9	241.1	11.8		234.5	15.2	
peer leaders	210.4	30.8	231.2	21.5	0.75	217.1	22.7	0.46
Sedentary behaviors, on weekdays								
peers	188.7	24.9	174.8	15.2		174.6	20.4	
peer leaders	145.1	30.3	167.7	22.6	0.80	157.5	25.6	0.41
Sedentary behaviors, on weekend								
peers	429.7	24.9	402.8	17.2		383.1	16.8	
peer leaders	373.6	39.2	388.4	35.9	0.75	364.5	32.0	0.65
Computer								
peers	47.6	12.4	42.8	5.7		45.6	4.1	
peer leaders	34.7	13.9	41.6	7.9	0.97	36.0	6.6	0.2
Computer, on weekdays								
peers	26.6	9.8	23.4	4.8		25.1	3.9	
peer leaders	16.5	11.2	21.4	6.7	0.82	18.8	6.0	0.34
Computer, on weekend								
peers	100.5	19.1	91.4	7.9		96.0	6.7	
peer leaders	80.1	22.7	92.1	13.8	0.86	78.2	12.8	0.23

* MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.

† Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

‡ Number of peer leaders = 59, of other students = 286.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Process evaluation and adverse events

Research staff and education officer observed that the delivery of the four lessons by the peer leaders followed the peer leader's manual. From the focus group discussions we found that the

peer leaders performed well according to their peers and were able to involve the students in the activities. The teachers and students demonstrated that the peer education program is feasible and is acceptable because of it is innovative, easy and includes a range of activities.

No adverse events were reported during the intervention.

DISCUSSION

This pilot study based on 682 students in 4 schools (2 intervention and 2 control schools) indicated that the adapted peer education program from Australia was feasible and acceptable in schools in Beijing and it showed potential for reducing sedentary behaviors in adolescents, especially computer time.

Our intervention was innovative for a number of reasons. Firstly, the peer education program was well-designed, structured and easy to run by following the manual. The training of peer leaders was shorter compared to other peer education studies in China that had a four-day to four-week training[19, 27], which is an attractive feature in reducing costs and increasing feasibility for larger-scale implementation.

Secondly, the peer education program directly aimed at behavior change. Our program delivered health information by a variety of participatory activities to motivate students to be more active. Also, students actively interacted with each other and to find out the most realistic solutions to their barriers to engage in more physical activity.

Thirdly, our program results in minimal interruption to school activities. Peer leaders were the classmates of the peers they educated, which reduced interruption to the regular education

programs in the schools compared to programs that used senior students as peer leaders. The use of senior students is complicated in China because the schools need to adjust their curriculum to make both peer leaders and their "peers" available at specific times, especially when senior peer leaders come from senior high schools that are separate from junior high schools. The use of senior peer leaders has been driven by concerns about the ability of younger students to educate and influence their immediate peers. However, the Healthy Buddies program indicated that younger peer educators (students in 4th through 7th grade) are effective in delivering the messages to students in kindergarten through 3rd grade[15]. In addition, peer leaders from the same class stayed in contact longer with their peers in future school life, which may contribute to the sustainability of the intervention. The minimal interruption to school also featured by the shorter training of peer leaders in our study[15]. High school students in China have long school hours (5.4 days in school per week and 7.6 lessons/day[28]) and heavy pressure for academic achievement (2 hours/day on homework[28]), thus, minimal interruption to school is critical to ensure the sustainability of a school-based health promotion program in this context.

Fourthly, students were educated in groups regarded as small in China, which was associated with greater increases in knowledge, altered attitudes and intentions to change behavior than those in larger groups in the peer education study[19] because small groups facilitate cooperative learning, discussion and communication[29].

Comparison with studies in China was limited because there has been only one study that used a teacher-led organized exercise to prevent obesity in adolescents and physical activity outcome was not reported in this study[17]. Limited studies have used peer education to promote physical activity in high-income countries. Consistent with our findings, Healthy Buddies[15], that used students in 4th to 7th grade trained by a teacher in a weekly 45-minute lesson to promote physical

activity in students from kindergarten to 3rd grade over 21 weeks, and reported no significant effects on physical activity[15]. The possible explanation is the Sunny Sport Policy issued by the Department of Education in China. This program has been implemented nationally and requires schools to ensure students have daily one hour of physical activity in school. With this policy in place, it may be difficult for any school-based intervention to increase in-school non-organized physical activity. Therefore, organized physical activity may potentially increase in-school physical activity in large cities in China, for example, to increase the intensity of physical education. For out-of-school physical activity, an intervention component at family and neighborhood level involving environmental modification may be useful. Like Healthy Buddies, using teachers to train peer leaders may increase the feasibility of our program to be implemented at a larger scale.

Several lessons have been learnt from our pilot study. Firstly, future intervention studies should focus not only on TV viewing but also emerging computer usage in large cities in China. The 2002 CNHS reported 25% of adolescent used computers and spent an average of 1.2 hours/day on the computer[28]. An average of 40-50 min/d of computer usage in our study suggests that computer usage accounted for a substantial amount of sedentary time in children in large cities in China. Further, the decrease in sedentary time was mainly from the reduction in computer usage, which might partly be due to parental limits on the accessibility to computers for their children.

Conclusion

Our pilot study of a peer counseling intervention was promising in reducing sedentary behaviors in adolescents in China. These results need to be confirmed in a larger study.

Acknowledgements

We are very grateful to the participating schools, children and their families. We also thank the Australian Agency for International Development (AusAID) for funding Zhaohui Cui's doctoral scholarship in International Public Health at the University of Sydney, Australia, and this analysis, which is part of the requirements for his PhD studies. We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention for the provision the physical activity questionnaire.

Funding

This work was supported by the Nestle Foundation. The funders of the research had no role in the analysis nor the decision to publish.

Competing interests

None

Contributors

MD, SS and ZC formulated the idea and study design. ZC modified the intervention materials, implemented the intervention, collected and cleaned the data, and carried out the data analyses, drafted the manuscript. SS, LLY, YW, YP, AG and MD contributed to the implementation of the intervention. SS, LLY and MD contributed to the interpretations of the results. All authors contributed to revising the paper and approved the final version.

Data sharing statement

No additional data is available

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[Legend of Figure 1]

Figure 1 Flow of the participants through the trial

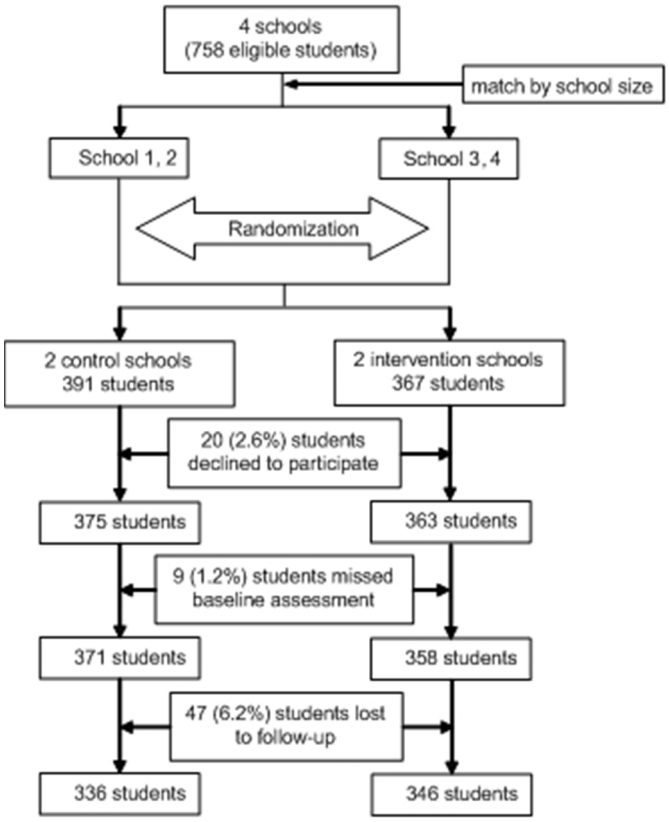

Figure 1 Flow of the participants through the trial
89x110mm (96 x 96 DPI)

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Not applicable
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Yes
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Yes
	2b	Specific objectives or hypotheses	Yes
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Yes
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Yes
Participants	4a	Eligibility criteria for participants	Yes
	4b	Settings and locations where the data were collected	Yes
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Yes
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Yes
	6b	Any changes to trial outcomes after the trial commenced, with reasons	Not applicable
Sample size	7a	How sample size was determined	Yes
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Not applicable
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Yes
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Yes
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Yes
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Yes
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	Yes

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	Not applicable
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Yes
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Not applicable
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Yes
	13b	For each group, losses and exclusions after randomisation, together with reasons	Yes
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Yes
	14b	Why the trial ended or was stopped	Not applicable
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Yes
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Yes
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Yes
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Not applicable
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Yes
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Yes
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Yes
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Yes
Other information			
Registration	23	Registration number and name of trial registry	Not applicable
Protocol	24	Where the full trial protocol can be accessed, if available	Not applicable
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Yes

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000721.R3
Article Type:	Research
Date Submitted by the Author:	13-Apr-2012
Complete List of Authors:	Cui, Zhaohui; University of Sydney, School of Public Health Shah, Smita Yan, Lijing Pan, Yongping Gao, Aiyu Shi, Xiaoyan Wu, Yangfeng Dibley, Michael
Primary Subject Heading:	Nutrition and metabolism
Secondary Subject Heading:	Global health, Epidemiology, Paediatrics, Sports and exercise medicine
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Nutrition < TROPICAL MEDICINE

Effect of a school-based peer education intervention on physical activity and sedentary behavior in Chinese adolescents: a pilot study

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Key words: peer, intervention, physical activity, sedentary, adolescent

Word count: 3722

ABSTRACT

Objectives: To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in urban Beijing, China.

Design: Four junior high schools were matched by school size and randomized to intervention (n = 346) and control group (n = 336).

Intervention: Trained peer leaders from grade 7 by research staff delivered weekly 40-minute lessons to their classmates over four consecutive weeks. Students in control schools received no intervention.

Outcome measures: A validated 7-day youth physical activity questionnaire was used to evaluate physical activity and sedentary behaviors at baseline (September 2010), 3(December 2010) and 7 months (May 2011). Generalized linear mixed models were applied to evaluate the effect.

Results: There was a significant decrease in time in sedentary behavior on weekdays, 20 min/d at 7 months (P = 0.020) reported by students in the intervention schools compared to control schools. This reduction was mainly due to a reduction of 14 min/d in computer usage on weekdays (P = 0.0009). There were no significant differences in time on other sedentary behaviors including television and DVD, video game, extracurricular reading, writing, drawing and listening to music, passive commuting and sitting to talk. There was also no significant difference in time in moderate-to-vigorous physical activity between intervention and control group.

Conclusion: Peer education appears to be a promising intervention in reducing sedentary behaviors in adolescents in China. These results need confirmation in a larger study.

Clinical trial registration number: ACTRN12612000417886 at ANZCTR.org.au.

ARTICLE SUMMARY

Article focus

- To evaluate the effect on physical activity and sedentary behavior of a pilot school-based peer education program in grade 7 students in urban Beijing, China.

Key messages

- Peer education is a promising intervention to reduce sedentary behaviors in adolescents.

Strengths and limitations of this study

Strengths

Our intervention is innovative because the peer education program is theory-based and easy to run by following the peer leader's manual. Peer leaders are trained in a short period of time and then educate their classmates. These features ensure the program minimally interrupt school activities, cost-effective and feasible for larger-scale implementation.

Limitations

With only two schools in each arm, potential confounders may not have been balanced across treatment groups. Also, physical activity was not objectively measured.

INTRODUCTION

Adolescents in China have become increasingly sedentary with a decrease in physical activity[1] and an increase in sedentary behavior[2] over the last decade, concurrently with the rapid socioeconomic development, especially in urban areas. This tendency to increasing sedentariness may be associated with an array of health problems including overweight and obesity[3, 4] that can track into adults[5]. The prevalence of overweight and obesity has increased from 3.6% to 9.1% in adolescents in China in the last decade[6]. Therefore, there is an urgent need for cost-effective interventions to increase physical activity and to reduce sedentary behavior in adolescents when they are establishing long-term lifestyle patterns.

Peers are a key component of the social network of adolescents who are transiting from childhood to adulthood. During the transition, youth move away from dependence on the family, to closer ties with their peers who give them the social support they need, especially with their schoolmates. Peer education programs offer a powerful approach to educate youth and change their health behaviors[7]. There is growing support for the use of student peer leaders to disseminate health information and to serve as role models in schools[8]. Health education programs in drug and alcohol issues have successfully employed peer teaching as an intervention strategy and appear to have a greater effect on health behavior than adult-led interventions[9-12]. Recent studies have shown peer education programs can significantly improve a range of health behaviors, including increasing fruit intake and reducing the risk of eating disorders in primary school students[13].

However, little is known about whether this premise holds for motivating junior high school students to increase physical activity and to reduce sedentary behavior. In the US, one study using a combined peer-led and teacher-led education[14] in a high school found favorable

impacts on physical activity in girls but not in boys. This study was evaluated with an internal control of classes in the same school that did not receive the intervention. Another study in elementary school students implemented a peer education program to prevent obesity. However, the effect on physical activity was not reported[15].

Few studies have examined the effect of an intervention on physical activity in adolescents in China. Only one study[16] has been identified in two recent systematic reviews of studies of school-based and community-based prevention of childhood obesity in China[17, 18] with a physical activity intervention. This study implemented a teacher-led organized physical activity but did not report its effects on physical activity and sedentary behavior. In China, peer education has been effective in promoting knowledge, attitudes and intention to change behavior in AIDS prevention[19]. However, no studies have evaluated the effect of peer education on physical activity and sedentary behaviors. Therefore, we conducted a pilot study from September 2010 to May 2011in four junior high schools in urban Beijing, China to test the feasibility of a peer-led education program in changing obesity-related behaviors. The present study aims to examine the effects of peer education on physical activity and sedentary behavior.

METHODS

Study design

A convenience sample of two small-sized and two large-sized junior high schools in Dongcheng District, Beijing were selected by the Dongcheng District Institute for Student Healthcare from schools with more than 160 students in grade 7. These schools were matched by school population size, and in each matched pair, one school was randomly allocated by research staff by throwing a coin to intervention or the control group. In the large-sized schools, four classes

were randomly drawn to participate in the study. In the small schools, all classes participated in the study. Peer education was implemented in classrooms in the first 2 months in intervention schools. No intervention was implemented in the control schools during the study. Assessments were conducted at baseline (September 2010), 3 months (December 2010) and 7 months (April/May 2011).

Survey protocols, instruments, and processes for obtaining informed consent for this study were approved by institutional review committees of the University of Sydney, Sydney, Australia and the Peking University Health Science Center, Beijing, China. The study was retrospectively registered because we were unaware of the ICMJE's policy to include pilot studies.

Start-up of the study

Before the baseline assessment, a start-up conference was conducted with the attendance of officers from the Dongcheng District Institute for Student Healthcare, school principals and doctors, and research staff. The research plan and the responsibilities of participating institutions were introduced and discussed. The principal and participant information and consent forms were distributed to attendees from schools. After that, the principal and the school doctor in each intervention school held a meeting with all class teachers in participating classes in grade 7 to explain the research plan and to develop the school's work plan.

The information and consent forms were distributed to students in participating classes by class teachers in the four schools. Consent forms signed by both students and one of their guardians were collected before the baseline data collection. Only the students with consent forms signed by both themselves and their guardian were allowed to participate in the assessment. School consent forms signed by principals were collected as well.

Intervention

The four-component intervention was adapted, from a peer-led health promotion program in Australia[20] that was based on social cognitive theory[21] and an empowerment educational approach[22], to ensure it was culturally appropriate for Chinese students and fitted with our research objectives. The key modification was that peer leaders from grade 7 were selected to educate students in their own grade 7 instead of recruiting older peer leaders from grade 10. This change was made because junior and senior high school are separate schools in China, and grade 9 children were too busy with exams for entrance to senior high school to act as peer leaders. In addition, the component to increase awareness about local healthcare services was replaced by that to reduce consumption of carbonated drinks.

Therefore, our intervention covered four components: food choice, physical activity and sedentary behavior, carbonated drinks, and goal setting, which directly aimed at behavior change. Learning activities were designed to be conducted in a variety of ways including presentation, video watching, group discussion, games, experiments, lifestyle practice, skit playing and quiz show. Each component was designed to be taught at a 40-minute lesson. A peer leader's manual was developed to describe these structured activities.

To provide basic knowledge in healthy lifestyles and behavioral change and to encourage parents to support their children's behavioral changes, an 8-page pamphlet with knowledge supplemental to the four lessons was distributed to students and their parents in the intervention schools right after the baseline assessment.

Our intervention consisted of a three-step process including peer leaders recruitment and training, peer-led education and student action.

Peer leaders recruitment and training

After the baseline assessment, four to eight peer leaders balanced by gender in each intervention class were selected by the class teacher from volunteer students based on their organization and oral expression ability, influence among students and sense of responsibility.

Then peer leaders in each intervention school were trained by research staff in three after-school 90-minute workshops over 3 consecutive days at school. We explained and practiced all the four components, with the aim of enabling peer leaders to successfully deliver the lessons to their classmates. In the whole training process, peer leaders were encouraged to learn the skills as a peer leader to actively interact with peers and to facilitate interaction between peers.

Peer education

Before each peer education lesson, school doctors or class teachers had a meeting with peer leaders to clarify each peer leader's responsibility. Peer leaders prepared and practiced their lessons.

Peer leaders then delivered four 40-minute peer education lessons to their classmates over four consecutive weeks in their classrooms, following the peer leader's manual. The four peer education activities were integrated into the existing health education courses and class meetings.

The students (29 – 42 students per class) sat either in one large or several small circles. Given the heavy academic pressure of peer leaders and to ensure feasibility, we used a different pair of peer leaders to deliver the lessons.

During the peer education, a school teacher was present to help maintain classroom order.

Student action

Students were encouraged to maintain a healthy lifestyle based on the personal goals set in the fourth peer education lesson. The peer leaders were encouraged to be role models and to facilitate other students to maintain healthy lifestyles.

Assessment

Physical activity

A validated 7-day youth physical activity questionnaire[23] was modified to collect information on moderate-to-vigorous physical activity (MVPA) and sedentary behavior in the previous week. Trained medical students, who were blinded to the assignment of the intervention, explained the questionnaire to students in the classroom. In the questionnaire, in-school and out-of-school MVPA were recorded with a 12-item and 18-item scale to collect information on days, frequency per day, and duration per time, respectively. Commuting to and from school was recorded using a 4-item scale including walking, cycling, public transportation and picking up by parents. For those who walk or cycle, frequency and time of travelling were collected separately by to and from school. For those who take public transportation (bus, subway and taxi), frequency and time of walking between public transportation station/stop and home (or school) were collected. Whether or not they were picked up from school by their guardians was also collected. Sedentary behavior was assessed by an 8-item scale including TV viewing, DVD and video tape viewing, computer usage for entertainment, electronically game playing, extracurricular reading,

drawing/writing/listening to music, sitting to phone call or chat, and playing musical instruments on week days and weekends.

Body mass index

Height was measured to the nearest 0.1 cm without shoes with a portable stadiometer and weight in lightweight clothing was measured to the nearest 0.1 kg on a calibrated beam scale. Body mass index (BMI) was calculated as weight in kilograms / (height in meters) ^{2}. Overweight and obesity were defined using the age- and sex-specific BMI cut-offs recommended by the International Obesity Task Force [24].

Process evaluation and adverse events

Process evaluation was conducted by direct observation and focus group discussion in each intervention school. Research staff (CZ) and an officer from Dongcheng District Institute for Student Healthcare observed the peer education classes in the two intervention schools. In addition, immediately after the intervention, two focus group discussions were conducted among peer leaders and their peers to obtain feedback about the program in each intervention school. Stratified by participating class, twelve students were randomly invited to participate for each focus group discussion. The discussion chaired by a trained research staff was recorded. Also in-depth interviews were held with a principal, class teacher, school doctor and physical education teacher from each intervention school.

Adverse events (injury) related to the intervention were reported by the intervention schools to the Dongcheng District Institute for Student Healthcare.

Statistical analysis

Given that only two schools were included in each arm, the baseline characteristics in the two arms may not be comparable although schools were matched. Thus intention to treat analysis was not applied in the present analysis and the students who were lost to follow-up (6.2%) were excluded from the analysis. The baseline characteristics of students with all three measurements were compared with those of students who were lost to follow-up.

The effect of the intervention on physical activity was evaluated by the relative changes in time (or MET × time) for in-school and out-of-school MVPA, active commuting to and from school (walking or cycling) and total MVPA between intervention and control groups compared to baseline. The effect of the intervention on sedentary behavior was evaluated by the relative changes in time in individual activities and the total activity.

Generalized linear mixed models was applied to obtain means by group and to evaluate the effect of the intervention on physical activity and sedentary behaviors at 3 and 7 months after adjustment for age, sex and BMI at baseline, with school, class[25] and within-subject correlation as random effect and with a covariance structure of simple diagonal using SAS 9.2 (SAS Institute, Cary, NC, USA). In the analysis to evaluate the effect of the intervention, the cluster effect of matched school pairs [26] was also treated as random effect. In addition, two interaction terms (sex by group, and group by time points of data collection) were added to evaluate that whether intervention effect was modified by sex or time.

RESULTS

Participants

A total of 758 students were eligible for the study in the four schools (Figure 1). Signed consent forms were obtained from 738 students (97.4%). Nine students (1.2%) missed the baseline

assessment and 47 students (6.2%) were lost to follow-up, which led to a total of 682 (90.0%) participants with 336 in the control arm and 346 in the intervention arm available for the analysis. There were no significant differences in gender, age, weight status and mean BMI between students with all measurements and those lost to follow-up across research arms at baseline (data not shown).

Baseline characteristics between the control and intervention groups were compared separately in boys and girls as shown in Table 1. For boys, mean BMI (p = 0.038) and prevalence of overweight and obesity (p = 0.016) were significantly lower in the control group than those in the intervention group. No significant differences were found in MVPA and sedentary behaviors between groups by gender at baseline as seen in Tables 2 – 3.

Table 1 Baseline characteristics of participants[†]

Variable	Intervention[‡]		Control[‡]	
	Boys (n=176)	Girls (n=170)	Boys (n=177)	Girls (n=159)
Age, mean ± SD, years	12.7 ± 0.5	12.6 ± 0.5	12.8 ± 0.5	12.6 ± 0.4
Weight status, %				
Normal weight	51.1	76.5	64.4[*]	76.7
Overweight	34.1	17.6	25.4	15.7
Obesity	14.8	5.9	10.2	7.5
BMI, kg/m^2	21.7 ± 4.6	20.2 ± 3.8	20.6 ± 4.2[*]	19.9 ± 4.6

[†] P values were adjusted for cluster effect in matched pair, school and class.
[‡] Unadjusted values.
[*] P < 0.05 in boys between intervention and control group by gender.

Adjusted effect on MVPA

There was no significant difference between groups in time in total MVPA, in- and out-of-school MVPA and active commuting to school at 3 and 7 months, after adjustment for age, gender, body mass index at baseline (Table 2).

Table 2 Daily time and MET* ×time on MVPA† at baseline‡, 3 months and 7 months

	Sample, n	Baseline§ Mean	Baseline§ SE	3 months§ Mean	3 months§ SE	P¶	7 months§ Mean	7 months§ SE	P¶
Total MVPA, min/d									
Control	295	196.7	11.1	183.3	12.6		171.3	11.4	
Intervention	323	190.1	10.8	179.6	12.4	0.83	171.6	11.2	0.94
Total MVPA, MET*min/d									
Control	295	998.6	58.4	957.6	90.6		874.3	73.8	
Intervention	323	967.8	57.0	917.0	89.9	0.66	869.2	73.0	0.88
MVPA in school, min/d									
Control	321	95.6	4.8	105.5	8.7		88.8	9.4	
Intervention	337	92.6	4.7	99.2	8.7	0.52	92.8	9.3	0.77
MVPA in school, MET*min/d									
Control	321	513.9	26.0	593.2	67.6		488.0	62.2	
Intervention	337	498.9	25.4	533.2	67.4	0.38	497.8	61.9	0.99
MVPA out school, min/d									
Control	314	108.7	10.0	90.8	5.5		89.5	7.8	
Intervention	329	103.2	9.9	91.1	5.4	0.97	88.9	7.8	0.94
MVPA out school, MET*min/d									
Control	314	549.4	53.3	462.1	36.1		449.4	38.7	
Intervention	329	514.6	53.0	456.0	35.6	0.91	438.9	38.4	0.81
Active commuting to school, MET * min/d									
Control	320	131.6	13.1	115.1	17.2		120.6	11.4	
Intervention	341	135.4	13.0	118.5	17.2	0.82	116.4	11.3	0.79

* MET denotes 1 kcal ×·kg body weight^{-1} × h^{-1}.
† MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.
‡ Comparison between control group and intervention group in each variable at baseline is not significant.
§ Data was adjusted for age, gender and body mass index at baseline.
¶Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Adjusted effect on sedentary behaviors

As shown in Table 3, there was no significant difference between groups in time on sedentary behaviors at 3 months. At 7 months, time on computer usage on week days in the intervention group was 15min/d (data not shown) lower (p = 0.0009) than that in control schools. As a result, the daily time for computer usage in the intervention group was significant lower than that in control group (p = 0.016). Also, there was a significant decrease in time in sedentary behavior on weekdays, 20 min/d (data not shown) at 7 months (P = 0.020) reported by students in the

intervention schools compared to control schools. Time on total sedentary behaviors in intervention group was 22 min/d (data not shown) lower than that in control group, but the difference was not significant (p = 0.06). There were no significant differences between groups in time on other sedentary behaviors at 7 months.

Table 3 Daily minutes spent on sedentary behaviors* at baseline†, 3 months and 7 months‡

	Baseline§		3 months§			7 months§		
	Mean	SE	Mean	SE	P¶	Mean	SE	P¶
Sedentary behaviors								
Control	256.3	26.5	256.8	25.4		258.8	25.5	
Intervention	248.7	26.5	237.2	25.4	0.21	229.0	25.5	0.060
Sedentary behaviors, on weekdays								
Control	197.7	24.8	188.4	26.6		201.1	28.8	
Intervention	181.3	24.8	172.2	26.6	0.21	169.8	28.8	0.02
Sedentary behaviors, on weekend								
Control	403.8	31.5	428.2	23.8		405.1	19.9	
Intervention	419.7	31.4	399.3	23.7	0.25	377.5	19.7	0.25
Computer								
Control	43.6	11.4	52.0	11.9		59.2	11.0	
Intervention	45.6	11.4	42.2	11.9	0.13	43.0	11.0	0.016
Computer, on weekdays								
Control	26.7	8.9	31.2	9.1		39.7	8.8	
Intervention	25.1	8.9	22.8	9.1	0.07	23.3	8.8	0.0009
Computer, on weekend								
Control	85.9	17.7	104.1	19.0		107.7	16.7	
Intervention	97.1	17.7	90.7	19.0	0.27	91.9	16.7	0.18
Television and DVD								
Control	70.7	12.5	72.2	9.5		69.0	11.2	
Intervention	65.6	12.5	60.9	9.5	0.13	65.1	11.2	0.56
Video game								
Control	6.0	1.3	10.3	1.8		11.9	1.9	
Intervention	7.8	1.2	7.6	1.8	0.26	8.5	1.9	0.21
Extracurricular reading, writing, drawing and listening to music								
Control	83.6	4.1	74.1	5.0		79.4	4.8	
Intervention	81.3	4.1	79.6	4.9	0.4	72.6	4.8	0.29
Passive commuting								
Control	31.6	2.6	27.8	2.7		25.6	2.5	
Intervention	27.4	2.6	32.4	2.6	0.22	29.3	2.5	0.32
Sitting and talking								
Control	22.3	3.0	21.4	1.8		16.8	1.7	

Intervention	24.2	2.9	17.0	1.8	0.16	14.2	1.6	0.34

* Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

† Comparison between control group and intervention group in each variable at baseline is not significant.

‡ Sample size in control group = 336, in intervention group = 345.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in randomization pair, school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Comparison between peer leaders and other students

Selected variables were selected to evaluate the differences in the effect of the peer education program on peer leaders and other participating students in intervention schools (Table 4). There were no significant differences between peer leaders and other students in time on MVPA, sedentary behaviors and computer usage at both 3 and 7 months. By comparing the magnitudes of adjusted mean time through baseline to 7 months, we found that time on MVPA decreased more among peer leaders than other students, while time on sedentary behaviors decreased in other students, while slightly increased in peer leaders.

Table 4 Comparison of daily minutes spent on total MVPA* and selected sedentary behaviors† between peer leaders and other students‡

	Baseline§		3 months§		P‡	7 months §		P‡
	Mean	SE	Mean	SE		Mean	SE	
Total MVPA, min/d								
peers	195.7	10.0	181.4	9.0		173.1	17.4	
peer leaders	192.1	18.3	197.9	17.5	0.42	182.5	21.9	0.50
Sedentary behaviors								
peers	256.9	24.9	241.1	11.8		234.5	15.2	
peer leaders	210.4	30.8	231.2	21.5	0.75	217.1	22.7	0.46
Sedentary behaviors, on weekdays								
peers	188.7	24.9	174.8	15.2		174.6	20.4	
peer leaders	145.1	30.3	167.7	22.6	0.80	157.5	25.6	0.41
Sedentary behaviors, on weekend								
peers	429.7	24.9	402.8	17.2		383.1	16.8	
peer leaders	373.6	39.2	388.4	35.9	0.75	364.5	32.0	0.65
Computer								
peers	47.6	12.4	42.8	5.7		45.6	4.1	
peer leaders	34.7	13.9	41.6	7.9	0.97	36.0	6.6	0.2
Computer, on weekdays								
peers	26.6	9.8	23.4	4.8		25.1	3.9	
peer leaders	16.5	11.2	21.4	6.7	0.82	18.8	6.0	0.34
Computer, on weekend								
peers	100.5	19.1	91.4	7.9		96.0	6.7	
peer leaders	80.1	22.7	92.1	13.8	0.86	78.2	12.8	0.23

* MVPA denotes moderate and vigorous physical activity that is activities with a MET ≥ 3. Total MVPA is the sum of in-school and out-of-school MVPA and active commuting to school.

† Information on daily time spent on sedentary behaviors was collected with an 8-item scale by weekdays and weekend, including TV viewing; DVD viewing; computer usage; playing video games; extracurricular reading; extracurricular writing, drawing and listening to music; Being a passenger in a bicycle, a subway, a bus or a car; sitting and talking (face-to-face or by phone). Total sedentary behaviors are the sum of the 8 items.

‡ Number of peer leaders = 59, of other students = 286.

§ Data was adjusted for age, gender and body mass index at baseline.

‡ Comparison between intervention and control groups were adjusted for age, gender, body mass index at baseline, interaction between measurement time and groups, and cluster effect in school and class level, within-subject correlation using PROC GLIMMIX procedure in SAS 9.2.

Process evaluation and adverse events

Research staff and education officer observed that the delivery of the four lessons by the peer leaders followed the peer leader's manual. From the focus group discussions we found that the

peer leaders performed well according to their peers and were able to involve the students in the activities. The teachers and students demonstrated that the peer education program is feasible and is acceptable because of it is innovative, easy and includes a range of activities.

No adverse events were reported during the intervention.

DISCUSSION

This pilot study based on 682 students in 4 schools (2 intervention and 2 control schools) indicated that the adapted peer education program from Australia was feasible and acceptable in schools in Beijing and it showed potential for reducing sedentary behaviors in adolescents, especially computer time.

Our intervention was innovative for a number of reasons. Firstly, the peer education program was well-designed, structured and easy to run by following the manual. The training of peer leaders was shorter compared to other peer education studies in China that had a four-day to four-week training[19, 27], which is an attractive feature in reducing costs and increasing feasibility for larger-scale implementation.

Secondly, the peer education program directly aimed at behavior change. Our program delivered health information by a variety of participatory activities to motivate students to be more active. Also, students actively interacted with each other and to find out the most realistic solutions to their barriers to engage in more physical activity.

Thirdly, our program results in minimal interruption to school activities. Peer leaders were the classmates of the peers they educated, which reduced interruption to the regular education

programs in the schools compared to programs that used senior students as peer leaders. The use of senior students is complicated in China because the schools need to adjust their curriculum to make both peer leaders and their "peers" available at specific times, especially when senior peer leaders come from senior high schools that are separate from junior high schools. The use of senior peer leaders has been driven by concerns about the ability of younger students to educate and influence their immediate peers. However, the Healthy Buddies program indicated that younger peer educators (students in 4th through 7th grade) are effective in delivering the messages to students in kindergarten through 3rd grade[15]. In addition, peer leaders from the same class stayed in contact longer with their peers in future school life, which may contribute to the sustainability of the intervention. The minimal interruption to school also featured by the shorter training of peer leaders in our study[15]. High school students in China have long school hours (5.4 days in school per week and 7.6 lessons/day[28]) and heavy pressure for academic achievement (2 hours/day on homework[28]), thus, minimal interruption to school is critical to ensure the sustainability of a school-based health promotion program in this context.

Fourthly, students were educated in groups regarded as small in China, which was associated with greater increases in knowledge, altered attitudes and intentions to change behavior than those in larger groups in the peer education study[19] because small groups facilitate cooperative learning, discussion and communication[29].

Comparison with studies in China was limited because there has been only one study that used a teacher-led organized exercise to prevent obesity in adolescents and physical activity outcome was not reported in this study[17]. Limited studies have used peer education to promote physical activity in high-income countries. Consistent with our findings, Healthy Buddies[15], that used students in 4th to 7th grade trained by a teacher in a weekly 45-minute lesson to promote physical

activity in students from kindergarten to 3rd grade over 21 weeks, and reported no significant effects on physical activity[15]. The possible explanation is the Sunny Sport Policy issued by the Department of Education in China. This program has been implemented nationally and requires schools to ensure students have daily one hour of physical activity in school. With this policy in place, it may be difficult for any school-based intervention to increase in-school non-organized physical activity. Therefore, organized physical activity may potentially increase in-school physical activity in large cities in China, for example, to increase the intensity of physical education. For out-of-school physical activity, an intervention component at family and neighborhood level involving environmental modification may be useful. Like Healthy Buddies, using teachers to train peer leaders may increase the feasibility of our program to be implemented at a larger scale.

Several lessons have been learnt from our pilot study. Firstly, future intervention studies should focus not only on TV viewing but also emerging computer usage in large cities in China. The 2002 CNHS reported 25% of adolescent used computers and spent an average of 1.2 hours/day on the computer[28]. An average of 40-50 min/d of computer usage in our study suggests that computer usage accounted for a substantial amount of sedentary time in children in large cities in China. Further, the decrease in sedentary time was mainly from the reduction in computer usage, which might partly be due to parental limits on the accessibility to computers for their children.

Conclusion

Our pilot study of a peer counseling intervention was promising in reducing sedentary behaviors in adolescents in China. These results need to be confirmed in a larger study.

Acknowledgements

We are very grateful to the participating schools, children and their families. We also thank the Australian Agency for International Development (AusAID) for funding Zhaohui Cui's doctoral scholarship in International Public Health at the University of Sydney, Australia, and this analysis, which is part of the requirements for his PhD studies. We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention for the provision the physical activity questionnaire.

Funding

This work was supported by the Nestle Foundation. The funders of the research had no role in the analysis nor the decision to publish.

Competing interests

None

Contributors

MD, SS and ZC formulated the idea and study design. ZC modified the intervention materials, implemented the intervention, collected and cleaned the data, and carried out the data analyses, drafted the manuscript. SS, LLY, YW, YP, AG and MD contributed to the implementation of the intervention. SS, LLY and MD contributed to the interpretations of the results. All authors contributed to revising the paper and approved the final version.

Data sharing statement

No additional data is available

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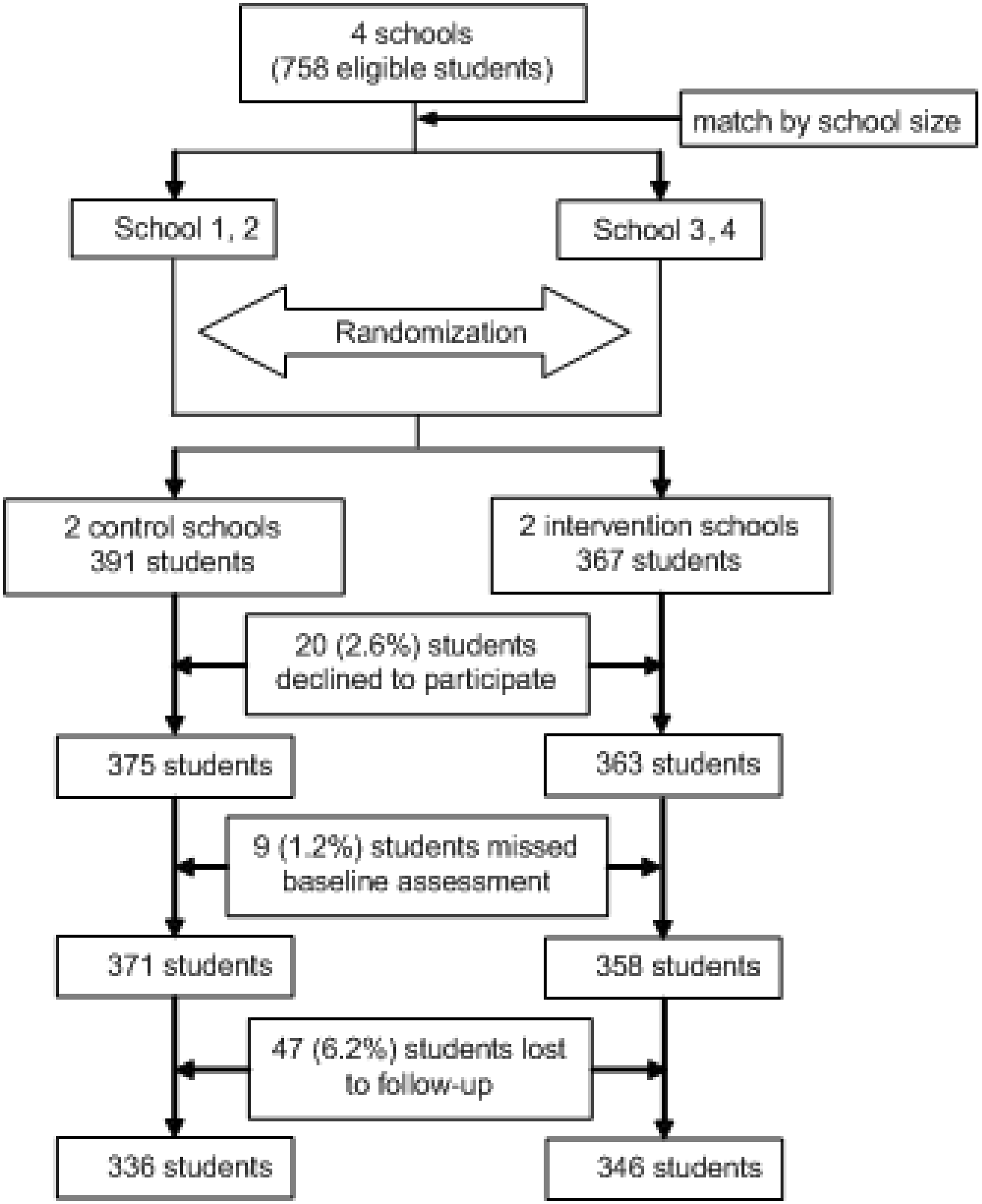
[Legend of Figure 1]

Figure 1 Flow of the participants through the trial


4 schools
(758 eligible students)
match by school size
School 1, 2
School 3, 4
Randomization
2 control schools
391 students
2 intervention schools
367 students
20 (2.6%) students
declined to participate
375 students
363 students
9 (1.2%) students missed
baseline assessment
371 students
358 students
47 (6.2%) students lost
to follow-up
336 students
346 students

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Not applicable
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Yes
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Yes
	2b	Specific objectives or hypotheses	Yes
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Yes
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Yes
Participants	4a	Eligibility criteria for participants	Yes
	4b	Settings and locations where the data were collected	Yes
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Yes
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Yes
	6b	Any changes to trial outcomes after the trial commenced, with reasons	Not applicable
Sample size	7a	How sample size was determined	Yes
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Not applicable
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Yes
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Yes
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Yes
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Yes
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	Yes

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	Not applicable
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Yes
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Not applicable
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Yes
	13b	For each group, losses and exclusions after randomisation, together with reasons	Yes
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Yes
	14b	Why the trial ended or was stopped	Not applicable
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Yes
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Yes
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Yes
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Not applicable
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Yes
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Yes
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Yes
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Yes
Other information			
Registration	23	Registration number and name of trial registry	Not applicable
Protocol	24	Where the full trial protocol can be accessed, if available	Not applicable
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Yes

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.