Impact of an extra-curricular school sport program on determinants of objectively measured physical activity among adolescents

Abstract

Objective: The purpose of this study was to identify potential determinants of objectively measured physical activity in the *Learning to Enjoy Activity with Friends* (LEAF) study.

Design: This study involved a quasi-experimental design and students (N =116) were assigned to an intervention group (n = 50) or a comparison group (n = 66) for a period of eight weeks.

Setting: Three secondary schools (grades 7-12) in New South Wales (NSW), Australia were involved in the study.

Method: At baseline and immediately following the intervention, students wore pedometers for four consecutive days and completed questionnaires assessing potential determinants of physical activity. At baseline, participants were classified using existing step recommendations, as low-active (girls < 11,000, boys < 13,000) or active (girls ≥ 11,000, boys ≥ 13,000) and the effects of the intervention on potential determinants were assessed using these subgroups. Subgroups were compared at baseline using independent samples t-tests and intervention effects were compared at posttest using linear regression (controlling for baseline measures).

Results: Although the intervention had a statistically significant effect on physical activity among individuals classified as low-active at baseline, the intervention did not impact upon potential determinants of physical activity.

Conclusion: Short-term changes in physical activity identified in the LEAF intervention were not mediated by changes in hypothesized determinants and may be due to the novelty of wearing pedometers.

Impact of an extra-curricular school sport program on determinants of objectively measured physical activity among adolescents

In the last two decades, consistent epidemiological evidence has recognized physical inactivity as a significant modifiable risk factor in the reduction of mortality and morbidity from chronic diseases [1 2]. The influence of physical activity on reducing all-cause mortality is clearly evident across studies and populations [3 4].

Researchers have demonstrated the importance of childhood and adolescence as key periods for the acquisition of health-related behaviours [5 6]. The *United States Surgeon General's Report on Physical Activity and Health* [2] described childhood and adolescence as pivotal times for preventing sedentary behaviours among adults. As they provide access to most of the target population and possess the necessary facilities and personnel, schools have been extensively recognized as important institutions for promoting physical activity for children and youth [7], Given the importance of the promotion of physical activity among adolescents and the convenience of the school setting, numerous physical activity interventions have been evaluated in schools. Physical education, health education, break periods, active transportation to school and extra-curricular school sport have all been recognized as opportunities for physical activity intervention in the school setting [8]. However, the majority of school-based physical activity interventions have evaluated the impact of enhanced physical education classes [9]. The contribution of school sport to physical activity behaviour change has not been studied extensively [7].

The *Learning to Enjoy Activity with Friends* (LEAF) program was a physical activity intervention for adolescents delivered as an extra-curricular school sport option. The LEAF program was developed with reference to Social Cognitive Theory (SCT) [10] and combined health-related fitness (HRF) activity with

behaviour modification strategies including goal setting with pedometers. The intervention aimed to increase lifestyle (e.g. walking/riding a bicycle to school) and lifetime (e.g. strength training, aerobics) physical activity by targeting several psychosocial and behavioural determinants of health behaviour change.

It has been argued that interventions should assess the determinants of physical activity along with the behaviour itself [11 12], as they are thought to mediate the targeted behaviour change [13]. It is therefore important that physical activity interventions be grounded in a behavioural science theory. While it is common for intervention studies to cite a theoretical framework, few studies test the value of these models [11]. Previous studies that have examined the effects of interventions on potential determinants of behaviour change have produced equivocal results, with the most consistent results for the behavioural processes of change [13]. The Lifestyle Education for Activity Program (LEAP) was a large scale high school physical activity intervention for adolescent girls [14] which resulted in significant increases in physical activity. Dishman and colleagues demonstrated that behaviour change in the LEAP study was mediated by self-efficacy [15] and enjoyment [16]. Similarly, the Trial of Activity for Adolescent girls (TAAG) found that the use of self-management strategies mediated self-efficacy and physical activity [17].

The LEAF intervention was found to have a statistically significant effect on adolescents classified as low-active (girls < 11,000 steps/day, boys < 13,000 steps/day) at baseline, but not on individuals classified as active (girls ≥ 11,000 steps/day, boys ≥ 13,000 steps/day) [18]. The aim of this paper is to describe potential determinants of physical activity responsible for behaviour change among low-active adolescents in the LEAF intervention.

Method

Participants

Six secondary schools (grades 7-12) in New South Wales (NSW), Australia met the eligibility criteria and were invited to participate in the study. Three schools indicated agreement and were accepted into the study. The program was made available as an extra-curricular, weekly school sport option for secondary school students (N = 116, mean age = 14.18 ± .71).

Design

The LEAF study involved a quasi-experimental design. The study design and sample flow is presented in Figure 1. Two 8-week programs (LEAF intervention [exercise and information sessions] versus comparison [exercise only]) were offered to each school as extra-curricular school sport options. To avoid treatment contamination, the allocation of condition occurred at the year level. At Schools 1 and 2, students in Year 8 were allocated to the treatment group and students in Year 9 acted as the comparison groups. At School 3, students in Year 9 were assigned to the intervention group and Year 8 students acted as the comparison group. The intervention was evaluated over a ten-week term (the school year consists of 4 terms). The baseline assessment was administered in the second last week of term 3 in each of the schools. The posttest was completed following the intervention, in the final week of term 4. The intervention was delivered at the University of Newcastle health and fitness centre. The practical components for all students were delivered by trained instructors from the health and fitness centre. A training day was provided for instructors before the commencement of the program and the researchers met regularly with the instructors to ensure program fidelity. The information component for the intervention group was delivered by a member of the research team in a university

classroom adjacent to the health and fitness centre.

Intervention

The major aim of the LEAF program was to promote lifestyle and lifetime physical activity among secondary school students and the program was guided by Bandura's SCT. The SCT purports that behaviour change is influenced by a number of personal factors, environmental factors, and attributes of the behaviour itself. Notably, each of these factors may affect or be affected by the others. This interrelationship between factors is known as 'reciprocal determinism'[10].

Students in the intervention group participated in an 8-week HRF program comprising both information and exercise sessions (Table 1). Each session lasted approximately 70 minutes (15 minutes information component, 55 minutes exercise component). The information component focused on health/fitness concepts and behaviour modification strategies relating to physical activity (e.g. identifying barriers to physical activity). Intervention students were also provided with training handbooks and pedometers for the study period. The handbooks and pedometers enabled students to record and monitor their physical activity related goals. Students used their own baseline step counts to set developmentally appropriate physical activity goals [19] for the study period and beyond.

It was hypothesized that behaviour change could be achieved by targeting the following physical activity mediators: physical activity self-management, exercise self-efficacy, outcome expectancy and peer support.

Physical activity self-management: Goal setting and physical activity monitoring were the primary behaviour modification strategies espoused by the intervention and these were reinforced at the start of each weekly session. Individual barriers were discussed and specific strategies for increasing steps (e.g. taking a walking

break at recess and lunch) were identified and promoted every week.

Exercise self-efficacy: To enhance exercise self-efficacy students were taught practical exercise skills (e.g. weight lifting technique) and behavioural self-management skills (e.g. goal setting). In addition to these skills, students learnt about exercise intensity and judgments of physiological states. It has been suggested that a greater understanding of exercise intensity and physiological symptoms of activity contribute to exercise self-efficacy [20].

Outcome expectancy: Outcome expectancy is the primary motivational variable in SCT and refers to an individual's desire to achieve positive outcomes and avoid negative consequences [21]. Information regarding the benefits of physical activity was reinforced at the start of each session and strategies to make activity more enjoyable were explored. Enjoyment was a key aim of the LEAF program and students were encouraged to consider ways to make lifestyle and lifetime more enjoyable (e.g. exercising with music and/or with friends).

Peer support: Students were encouraged to set physical activity goals with their friends and identify potential barriers. Strategies to increase social support for physical activity from family and friends were discussed. For example, students were encouraged to compare their physical activity levels with their parents by having them wear a pedometer for a day.

Students in the comparison group participated in a modified 8-week HRF program designed by the research team and included only the exercise component. The structured exercise sessions were identical to the practical sessions for the intervention students and lasted a similar duration. While students in the comparison group were not given pedometers to monitor their activity throughout the intervention, they were provided with training booklets which provided an

outline of all sessions with suggested intensities and descriptions of techniques involved. The comparison group students were not involved in any information sessions which focused on health/fitness concepts and behaviour modification strategies.

Measures

Physical activity: To provide an objective measure of physical activity *Yamax* were used. Previous studies have examined the convergent validity of *Yamax* pedometers by comparing them to a variety of existing measures of physical activity. Previous studies have found *Yamax* pedometers to have high correlations with oxygen consumption (r = .81), *Caltrac* accelerometer counts (r = .99) [22] and *Tritrac* accelerometer counts (r = .99) [23]. The accuracy of the pedometers was assessed using a brief walking test [24].

Hypothesized determinants: The potential determinants assessed in the current study were derived from SCT (Bandura, 1977;1986) and included behavioural (self-management strategies), social (peer support) and psychological (exercise self-efficacy, outcome expectancy, enjoyment of physical activity) variables. These determinants were chosen because they have been found to mediate changes in physical activity behaviour in previous adolescent interventions [15-17]. Table 2 displays scale description and source, example items and psychometric properties. For all scales, a higher score indicated a more positive result.

Procedure

Students wore sealed pedometers for four consecutive school days, as this is considered a reliable monitoring period for the measurement of habitual physical activity among adolescents [25]. Research assistants demonstrated to students how to wear the pedometers and students were told to remove the pedometers only when

sleeping or when entering water (e.g. showering, swimming). Students were asked to complete their usual day-to-day activity and refrain from tampering with the devices. When the research assistants collected the pedometers, the cable ties were cut and the number of steps was recorded. Students were asked to record any days they had forgotten to wear their pedometers.

Data Analysis

The data were analyzed using the SPSS software (version 12.0). Mean steps/day were calculated for all students at baseline and immediately following the intervention. Students who had completed at least two days of pedometer monitoring were included in the analysis (at baseline, 70% of students completed four days of monitoring, 13% completed three days and 12% completed two days, similar patterns were noted at posttest). To determine a score for each psychosocial factor, total number of points scored was divided by the number of items answered. If fewer than 25% of the items were missing, means of completed items were imputed.

As the intervention had a statistically significant effect on low-active adolescents, the data file was split and the effects of potential determinants were assessed using these subgroups (low active = girls < 11,000 steps/day & boys < 13,000 steps/day, active = girls ≥ 11,000 steps/day & boys ≥ 13,000 steps/day). Groups were compared at baseline using independent samples t-tests. Linear multiple regression analysis was used to estimate the effect of the intervention on potential determinants. For all outcome measures, baseline values were used as covariates. For all calculations alpha levels were set at $p < .05$ and marginally significant results ($p \leq .10$) were also noted.

Results

The majority of students were born in Australia (95%) and were from English

speaking households (98%). Students in the comparison (14.1 ± .7 years) and intervention (14.3 ± .7 years) groups were similar in age. Of the students who completed at least two days of pedometer monitoring at baseline, 62 adolescents (29 intervention group versus 33 comparison group) were classified as low-active (girls < 11,000, boys < 13,000) and 35 (16 intervention group versus 19 comparison group) were classified as active (girls ≥ 11,000, boys ≥ 13,000).

There were no significant differences between comparison and intervention groups at baseline for any of the hypothesized determinants among low-active and active adolescent subgroups. The mean scores at baseline and posttest for each of the determinants in each treatment group are listed in Table 2 for low-active adolescents. Scores for active adolescents are listed in Table 3. Adolescents (low-active and active) in the intervention and comparison reported high levels of exercise self-efficacy, outcome expectancy and enjoyment in physical activity at baseline and posttest. Similarly, both groups reported moderate levels of peer support for physical activity and use of self-management strategies at baseline and posttest.

The effect of the LEAF intervention on hypothesized determinants of physical activity is reported in Table 4 for low-active and Table 5 for active. Linear regression was used to examine the relationship between hypothesized determinants and the LEAF intervention, controlling for baseline measurements of each respective variable. There were no changes in peer support and exercise self-efficacy among low-active and active adolescents and the intervention did not have an effect on these mediators. Among low-active adolescents, there were small changes for self-management strategies (*ß* =.068, $p = .566$, outcome expectancy *(ß* = -.116, $p = .387$) and enjoyment *(ß* = .112, $p < .447$), but none of these were statistically significant. Similarly, the intervention did not have a statistically

significant impact on any of the potential determinants among adolescents classified as active at baseline.

Discussion

Despite considerable effort and attention, intervention programs to promote physical activity among youth often have little impact on behaviour [26]. It has been suggested that the low efficacy and effectiveness of interventions may be due to a lack of knowledge regarding the mechanisms responsible for behaviour change [27]. Thus, this study sought to identify the mechanisms responsible for physical activity behaviour change for adolescents. While the LEAF intervention had a statistically significant effect on physical activity among low-active adolescents [18], the intervention did not impact upon the hypothesized determinants of physical activity. A number of possible explanations are offered for this finding.

First, the intervention may not have been long enough to impact upon potential determinants of physical activity behaviour, which are thought to remain relatively stable over time [28]. Unlike physical activity and other health behaviours which track at a modest level during childhood and adolescence [29], existing evidence suggests that cognitions related to physical activity may be more stable than the behaviour itself [28]. While the premise of behavioural science theories is that cognitions and constructs regarding behaviour can be changed through various mechanisms, previous interventions that have impacted upon determinants of physical activity have been evaluated over a longer time period. For example, the LEAP program was evaluated over a one year period and established that enjoyment [16] and self efficacy [15] mediated increases in adolescent physical activity in the intervention group. The TAAG intervention which identified the use of self-management strategies as a mediator of activity was evaluated over a similar time

period [17]. Unlike these interventions, the LEAF program was delivered as an 8 week extra-curricular school sport option, with posttest occurring immediately after the intervention. Although many interventions have impacted positively on determinants of physical activity, others have failed to establish an effect on self-reported variables [30]. Conversely, changes in self-reported variables do not always accompany changes in physical activity [31].

Second, participants in the study were young adolescents who are less cognitively developed than older adolescents and adults. The cognitive, behavioural and affective processes developed from Bandura's SCT require individuals to reflect on their thoughts, feelings and strategies related to physical activity. It is possible that the information component of the LEAF program was not comprehensive enough to impact adequately on adolescents. Adolescents may have a poor capacity to think abstractly [32] and may not possess the cognitive abilities to accurately reflect on their internal states. Subsequently, they may require greater levels of support to affect behaviour change. This could involve strategies such as longer information sessions, more targeted and meaningful learning experiences, internet support and engagement of parents through newsletters.

Finally, it may be that the novelty of being provided with a pedometer over the study period was enough to impact on the physical activity behaviour of the intervention students. Previous studies have found that physical activity goal setting with pedometers can impact positively on the activity behaviour of children [33] and adolescents [34]. For example, Schofield and colleagues [34] found that a simple 12-week physical activity self-monitoring and educative program using pedometers was efficacious in increasing mean steps/day among a sample of low-active

adolescent girls. However, the study did not assess potential determinants of behaviour change and potential mechanisms for behaviour change were not examined. One study that did assess potential determinants of behaviour change in a pedometer intervention trial was only three weeks long and failed to impact upon physical activity or potential determinants [35].

There are several limitations to the current study that should be noted. The study involved a quasi-experimental design with students allocated to conditions by year group at each school. The original study design involved four schools randomly allocated to control and intervention conditions. Unfortunately, one school withdrew with little notice, creating an unequal distribution of students in treatment arms. In an attempt to overcome this, both treatment and control conditions were offered at all three schools with students allocated by year group to different conditions.

As mentioned previously, the short duration of the study with the posttest occurring immediately following the 8-week intervention was a limitation. Psychosocial correlates of physical activity appear to be relatively stable. The results of this study have indicated that an intervention may need to be longer or more intensive to impact upon potential determinants of behaviour. While this may be the case, programs delivered in the school setting via school sport may not have the luxury of an extended year long program.

Overall, an understanding of the mechanisms responsible for behaviour change in physical activity interventions, especially pedometer trials, is clearly lacking. While this study was unsuccessful in establishing determinants of behaviour change in mean steps/day, it has provided worthwhile information regarding intervention design and evaluation. The findings from this study suggest

that extra-curricular school sport offers a unique potential for the promotion of physical activity among youth populations. However, multi-component interventions designed to engage and support adolescent physical activity behaviour more comprehensively are needed to identify potential mechanisms of physical activity behaviour change.

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Tables

Table 1 LEAF program components

Session	Information component	Practical component
1	Introduction to program Physical activity guidelines for adolescents *LEAF strategy: Setting goals for physical activity*	Circuit training class
2	Exercise myths *LEAF strategy: Being active with friends*	Body Combat fitness class
3	Physical activity intensity and heart rate (HR) Frequency, intensity, time, type (FITT) for cardio-respiratory fitness (CRF) *LEAF strategy: Keeping a physical activity diary*	Cardio-respiratory fitness (CRF) session (rower, stepper, cross-country skier, treadmill & bike)
4	Incorporating lifestyle activity into daily lives *LEAF strategy: Physical activity contract*	CRF session - gym-based triathlon (row, run, cycle) & core stability
5	FITT for flexibility *LEAF strategy: Ways to make physical activity fun*	Spinning cycle session & flexibility session
6	Introduction to strength training techniques FITT for strength training *LEAF strategy: Identifying barriers to physical activity*	Strength training- introduction to machine weights & abdominal exercises
7	Strength training (continued) *LEAF strategy: Encouragement and rewards*	Strength training- introduction to basic free weights exercises
8	Reducing sedentary behaviour Conclusion of program *Review of LEAF strategies*	Cardio-resistance training- combination of machine weights & CRF exercises

Table 2: Items and scales used to measure potential determinants of physical activity

Variable	Description	Range (No. of items)	Source	Psychometric properties
Behavioural				
Self-management strategies	Statements regarding behavioural & cognitive strategies to increase physical activity. E.g. "I set goals to do physical activities".	8-40 (8)	Existing scale [17]	r = N/A α = .88
Social				
Peer support	Questions regarding social support for physical activity participation offered by friends. E.g. "Do your friends encourage you to do physical activities or play sport"	5-20 (4)	Existing scale [36]	*r* = .86 α = .59
Psychological				
Exercise self-efficacy	Students are asked to indicate their confidence to complete physical activity in certain adverse circumstances. E.g. "Get up early, even on weekends to exercise".	1-25 (5)	Existing scale [37]	*r* = .89 α = .84
Outcome expectancy	Statements regarding the benefits of physical activity. Starting with the common stem "If I participate in regular physical activity".	9-45 (9)	Existing scale [37]	r = .63 α = .89
Enjoyment of physical activity	Students are asked to respond to a number of statements about the effects of physical activity starting with the common stem; "When I am active…"	16-80 (16)	Existing scale [38]	r = N/A α = .91

r = test-retest reliability.
α = Cronbach's alpha.
N/A = Reliability coefficient not available.

Table 2: Baseline and posttest scores for hypothesized determinants among low-active adolescents

	Baseline		*P* value[1]	Posttest	
	C	**I**		**C**	**I**
Behavioural					
Self-management strategies	2.35 ± .88	2.36 ± .76	.948	2.39 ± .92	2.39 ± .93
Social					
Peer support	2.22 ± .77	2.27 ± .73	.780	2.22 ± .76	2.27 ± .73
Psychological					
Exercise self-efficacy	3.31 ± 1.14	3.43 ± .64	.634	3.31 ± 1.12	3.43 ± .62
Outcome expectancy	2.78 ± .90	3.00 ± .54	.265	2.97 ± .79	2.83 ± .79
Enjoyment	2.84 ± .84	3.00 ± .47	.357	2.85 ± .88	3.00 ± .45

Note: C = Comparison group, I = Intervention group.
[1] Independent sample t-tests used to compare groups at baseline

Table 3: Baseline and posttest scores for hypothesized determinants among active adolescents

	Baseline		*P* value[1]	Posttest	
	C	**I**		**C**	**I**
Behavioural					
Self-management strategies	2.63 ± .79	2.89 ± .59	.211	2.44 ± .59	2.74 ± .77
Social					
Peer support	2.63 ± .68	2.63 ± .71	.939	2.63 ± .68	2.61 ± .69
Psychological					
Exercise self-efficacy	3.64 ± .80	3.89 ± .58	.349	3.64 ± .80	3.87 ± .56
Outcome expectancy	3.16 ± .55	2.98 ± .88	.096	2.83 ± .77	3.24 ± .58
Enjoyment	3.32 ± .38	3.22 ± .86	.955	3.21 ± .43	3.19 ± .78

Note: C = Comparison group, I = Intervention group.
[1] Independent sample t-tests used to compare groups at baseline

Table 4: Results of linear regression analysis examining the effects of the LEAF intervention on potential determinants among low-active adolescents

	N	Beta (95% CI)	*p* value
Behavioural			
Self-management strategies	47	.068 (-.303 to .548)	.566
Social			
Peer support	60	No change	
Psychological			
Exercise self-efficacy	59	No change	
Outcome expectancy	59	-.116 (-.600 to .233)	.387
Enjoyment	47	.112 (-.259 to .579)	.447

Note: Model included variable for group allocation and adjusted baseline value of outcome measure.
N = number of subjects included in analysis.
CI = Confidence interval.

Table 5: Results of linear regression analysis examining the effects of the LEAF intervention on potential determinants among active adolescents

	N	Beta (95% CI)	*p* value
Behavioural			
Self-management strategies	30	.149 (-.215 to .634)	.321
Social			
Peer support	33	No change	
Psychological			
Exercise self-efficacy	33	No change	
Outcome expectancy	32	.255 (-.152 to .874)	.161
Enjoyment	30	.060 (-.365 to .504)	.739

Note: Model included variable for group allocation and adjusted baseline value of outcome measure.
N = number of subjects included in analysis.
CI = Confidence interval.

Figure 1: Participant Study Flow Diagram