Abstract

It has been suggested that the low level of effectiveness of youth interventions is due to a lack of knowledge regarding the mechanisms responsible for behaviour change. The identification of behaviour mediators is necessary for the progression of physical activity research, as it allows researchers to determine which components of an intervention are responsible for mediating behaviour change. The purpose of this study was to identify mediators of behaviour change in a physical activity intervention for senior school students. Participants ($n = 78$) were randomly allocated to control or intervention conditions for a period of 10 weeks. Moderate-to-vigorous physical activity (MVPA) and potential mediators were assessed at baseline and post-intervention (10 weeks). Hypothesized mediators were derived from Bandura's Social Cognitive Theory and included: peer support, exercise self-efficacy and outcome expectancy. Mediation was assessed using the product-of-coefficients test described by MacKinnon and colleagues, based on the criteria for mediation identified by Baron and Kenny. While none of the variables satisfied all four criteria for mediation among males or females, self-efficacy was able to satisfy the first three criteria among females in the study. Exercise self-efficacy may be a mediator of physical activity behaviour in adolescent girls.

Interventions to increase physical activity should be guided by a behavioural science model (e.g. Theory of Planned Behavior, Transtheoretical Model, Social Cognitive Theory) which is predictive of behaviour and identifies mechanisms responsible for behaviour change[1]. Measurement of these change mechanisms is necessary for the systematic progression of physical activity research[2] as it allows researchers to determine which components of an intervention are responsible for mediating behaviour change. While it is common for physical activity interventions to describe their theoretical framework, few studies test the validity of these models[1]. In a review of physical activity mediation studies, only three studies testing mediation among youth populations were found[3]. More recently, a number of studies have examined mediation pathways in youth physical activity interventions using structural equation modelling[4-6].

To identify a statistically significant mediational effect, an intervention must result in large changes in hypothesized mediators and outcomes, involve a suitably large sample size and use a statistical method appropriate for the sample size[7]. Although traditional methods to evaluate mediation, such as the Baron-Kenny method[8] have low statistical power and require large samples, simulation studies have demonstrated that various other tests can establish mediation effects in smaller samples[7 9].

This study describes potential mechanisms for behaviour change in a previously published intervention study[10]. The Lifetime Activity Program (LAP) was developed with reference to Bandura's Social Cognitive Theory (SCT), which proposes that behaviour change is influenced by environmental factors, personal factors and attributes of the behaviour itself[11]. Social-cognitive variables (outcome expectancy, perceived barriers, self-efficacy etc.) have been identified as important for understanding and intervening in health behaviour[12]. The purpose of this study was to examine whether constructs derived from Bandura's Social Cognitive Theory (SCT) mediated changes in moderate-to-vigorous physical activity (MVPA) within the context of a conceptual physical education program for senior school students.

Method

Participants were 30 male and 48 female students (aged 16-18) from one private co-educational school, who had chosen a health and fitness school sport option. As reported elsewhere [10], the majority of students came from English speaking households and like others in the school were from predominantly high socio-economic backgrounds. From the target population of 105 students, 78 students volunteered to be involved in the LAP.

The LAP was a conceptual physical education program developed with reference to Bandura's SCT[13] and Self-Efficacy Theory (SET)[14]. The ten-week program consisted of weekly information sessions and exercise training in a health and fitness centre. Self-efficacy, outcome expectancy and peer support were identified as potential mediators of behaviour and the intervention involved a number of strategies to impact upon these mediators (Figure 1).

Self-efficacy. According to Bandura[13] there are four main sources which provide individuals with information regarding self-efficacy beliefs; prior success and performance attainment, imitation and modelling, verbal and social persuasion and judgments of physiological states. These were incorporated into the LAP to facilitate the development of exercise self-efficacy. Firstly, students were organized into training pairs which enabled them to observe each other engaging in exercise tasks. Observing others succeed or fail can affect efficacy beliefs, especially if the individual has little experience in the activity[15]. Secondly, behavioural skill instruction was included to encourage self-regulatory behaviour (e.g. goal setting strategies and activity monitoring). Goals act as a point of reference for individuals and may be an important source of exercise self-efficacy[16]. Thirdly, students were provided with partner training guidelines which encouraged students to support each other with positive reinforcement and motivation. Finally, students learnt to identify physical activity intensity through the use of heart rate and rate of perceived exertion (RPE). A greater awareness of physiological symptoms of effort and pain may contribute in a positive way to exercise adherence[15].

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[17]. The LAP information sessions included content describing the short-term and long-term benefits of physical activity. More specifically, enjoyment was an important outcome and the intervention included

strategies to make exercise activity more enjoyable (e.g. exercising with friends and working out with music).

Peer support. Previous interventions have demonstrated the impact of social support in physical activity interventions among youth[18][19]. Students in the LAP intervention were provided with guidelines to increase their social support from peers. The guidelines included information regarding the selection of training partners, the planning of training sessions, the identification of perceived barriers, and the importance of motivation and feedback. These guidelines were revisited at the start of each LAP session and students were given an opportunity to record the number of completed sessions and evaluate the relationship with their training partner.

Those in the treatment group met twice a week for the duration of the term (10 weeks). One session per week involved a researcher-led work-out, for the other session, students completed their own training. Students in the control group were required by the school to attend the same health centre and complete their own activity for two sessions of 90 minutes each week. Students registered their attendance at each session but were not monitored by teachers. All students were provided with unlimited access to weight training equipment and cardiovascular training equipment (i.e. treadmills, ergometers & stationary bikes).

Physical activity. The study involved the assessment of MVPA and a number of psychosocial factors. MVPA behaviour was measured using the *Oxford Physical Activity Questionnaire* (OPAQ), which is a self-administered, seven-day questionnaire designed to assess the MVPA of adolescent school students. The OPAQ is a time-based questionnaire presented in a time-table format. The psychometric properties of the OPAQ were evaluated among an independent sample of 94 students with mean ages of 12.2 (year 7) and 13.8 (year 9). The OPAQ displayed strong 1-week test-retest reliability (ICC = .76 - .91) and moderate convergent validity ($r = .32$, $p = .02$) through its relation to *Caltrac* accelerometer movement counts.

Self-efficacy. Self-efficacy was assessed using a 5-item scale developed by Taylor and colleagues[20]. The measure uses a 5-point Likert scale anchored by 1 (*Strongly disagree*) and 5 *(Strongly agree)*. The scale has good test-retest reliability ($r = .88$)[20] and the internal consistency of the scale with baseline data from the study sample was $\alpha = .75$.

Outcome expectancy. Outcome expectancy of physical activity was assessed using a 13-item scale[20]. The scale was anchored by 1 (*Strongly disagree*) and 5 (*Strongly agree*). It was found to have acceptable test-retest reliability $r = .65$ [20] and good internal consistency ($\alpha = .83$).

Peer support. Peer support was assessed using a scale developed by Prochaska, Rodgers and Sallis[21]. The test-retest reliability of the peer support scale (4 items) was $r = .86$. Using baseline data from the study sample the internal consistency of the scale was $\alpha = .73$.

The study involved an experimental design, with students randomly allocated to control or intervention conditions for a period of ten weeks. The effects of the intervention have been reported elsewhere[10] and therefore, the current paper describes the mediating effects of variables derived from the SCT on MVPA. The study methodology was approved by the University of Oxford's Department of Educational Studies Ethics Committee and all students and parents/guardians provided informed consent.

The data were analysed with SPSS version 14.0 (SPSS Inc., Chicago, IL). Minutes spent in MVPA were calculated for each student along with totals for the various psychosocial scales. To control for group differences at baseline, change scores (follow-up score minus baseline score) were used in all analyses and separate analyses were conducted for males and females. Alpha levels were set at $p < .05$ and marginally significant results are also reported ($.05 \leq p \leq .10$). The product-of-coefficients (POC) test was used to assess mediation in the LAP intervention because it has good statistical power in small samples[22]. The POC test is based on the criteria identified by Baron and Kenny [8]:

- Criterion 1: The treatment condition is significantly related to the outcome, minutes spent in moderate-to-vigorous physical activity (MVPA), controlling for baseline (τ).

- Criterion 2: The treatment condition is significantly related to the hypothesized mediator score, controlling for baseline (α).

- Criterion 3: The hypothesized mediator score is significantly related to MVPA, controlling for baseline (β).

- Criterion 4: The relationship between the treatment condition and MVPA is substantially reduced when controlling for the hypothesized mediators. Treatment condition and hypothesized mediators were entered into regression models explaining MVPA. To determine whether the reduction could be considered 'substantial', the Sobel test was used[23]. The Sobel test uses a formula (z-value = $ab/\sqrt{(b^2 s_a^2 + a^2 s_b^2)}$) in which a = the path from treatment condition to the mediator; s_a = the standard error of a, b = path from the mediator to physical activity; s_b = standard error of b), to examine the indirect effect of the intervention on MVPA change scores via the hypothesized mediators (τ').

Results

A total of 78 students participated in the study; this included 48 females and 30 males distributed approximately equally across treatment and control conditions. There were no statistically significant differences between participants in the intervention and control groups on any of the demographic or outcome variables at baseline. The average age of the students was 16.7 years and the majority of students (83.3%) came from English-speaking households.

Criterion 1: Effect of treatment condition on MVPA (τ)

The effect of the treatment condition on MVPA is presented in Table 1. Treatment condition was significantly related to MVPA among females, τ = .31 (CI = 5.44 to 165.81, p = .04) and there was a marginally significant association between treatment condition and MVPA among males, τ = .32 (CI = -9.53 to 131.53, p = .09).

Criterion 2: Effect of treatment condition on hypothesized mediators (α)

The effect of treatment condition on the hypothesized mediators is reported in Table 1. Regression analysis indicated that females from the intervention group perceived significantly more support from their peers after involvement in the program α = .36 (CI = .09 to .76, p = .01). Changes in peer support were not significantly related to treatment condition among males α = -.17 (CI = -.73 to .28, p = .36). While changes in self-efficacy were not significantly associated with treatment condition among males (α = .22, CI = -.13 to .47, p = .35), there was a significant difference for self-efficacy among females in the study α = .35 (CI = -.08 to .83, p = .02), suggesting that females in the

intervention group increased their self-efficacy over the study period. The intervention and control group did not differ on outcome expectancy among females or males.

Criterion 3: Effect of hypothesized mediators on MVPA (ß)

The effect of the hypothesized mediators on MVPA is also reported in Table 1. None of the hypothesized mediators were significantly associated with MVPA among males in the study sample. Among females, increases in self-efficacy from baseline to post-test were related to changes in MVPA over the study period, $ß = .34$ (CI = 10.48 to 137.35, $p = .02$). Changes in peer support were not associated with MVPA ($ß = .04$, CI = -.61.05 to 80.47). However, there was a marginally significant association between changes in outcome expectancy and changes in MVPA $ß = .27$ (CI = -.30 to 10.72, $p = .06$).

Criterion 4: Relationship between condition and MVPA is reduced when controlling for hypothesized mediator (τ′).

None of the variables satisfied the first three criteria for mediation in the male subgroup and therefore no further analyses were conducted for this group. As peer support and outcome expectancy could not satisfy the first three criteria for mediation among females, self-efficacy was the only variable assessed. To test the fourth criterion, treatment condition and self-efficacy were entered into a regression model predicting changes in MVPA. Once self-efficacy was included in the model, treatment condition was no longer a significant predictor ($τ′ = .21$, $p = .18$). In this model self-efficacy ($ß = .27$, $p = .09$) was a marginally significant predictor of MVPA. The pathway between treatment condition and MVPA was reduced from $τ = .31$ when only treatment condition was included in the model, to $τ′ = .27$ when self-efficacy was added to the regression model. To assess whether this reduction was substantial, the Sobel test was used. The Sobel test was non-significant ($z = 1.42$, $p = .16$), suggesting that self-efficacy could not satisfy the fourth criterion for mediation.

Discussion

Mediation analysis is an important part of physical activity research because it has the potential to reveal the processes responsible for changes in health behaviour[24]. The primary objective of this study was to identify if constructs derived from Bandura's SCT mediated changes in MVPA in the context of the LAP. The product-of-coefficients test was used to explore this relationship

because simulation studies have demonstrated that this method has good statistical power in small samples[9]. While none of the variables satisfied all four criteria for mediation among males or females, self-efficacy was able to satisfy the first three criteria among females in the study.

Although there is a lack of studies that have tested mediation in youth physical activity interventions[3], two previous studies have found evidence for the mediating influence of self-efficacy on activity behaviour among youth [5 18]. Using structural equation modelling, Dishman and colleagues [5] found self-efficacy to mediate increases in physical activity in the Lifestyle Education for Activity Program (LEAP) for adolescent females. Similarly, Sallis and colleagues[18] found that self-efficacy mediated physical activity changes in Project GRAD; an intervention targeting university students. While the LEAP program was a year long intensive intervention, Project GRAD was evaluated over one semester, suggesting that shorter interventions can be successful by targeting social cognitive mechanisms of behaviour change.

Outcome expectancy did not satisfy any of the criteria for mediation in the LAP intervention among males or females and regression coefficients revealed a weak relationship between treatment condition and changes in the outcome expectancy. All students in the study reported moderate-to-high levels of outcome expectancy in relation to physical activity and the study did not appear to impact upon students' perceptions regarding the outcomes of physical activity. Among females, peer support satisfied the second criteria for mediation but did not satisfy the third and fourth criteria. Treatment condition was related to changes in peer support; however, these changes were not associated with changes in MVPA among females in the sample. This finding illustrates the importance of mediation analyses in intervention research. Mediation analyses help to determine which aspects of an intervention were responsible for behaviour change. Without a mediation analysis, researchers may conclude that changes in peer support in the current study were responsible for increases in MVPA in the intervention group. However, the increases in peer support indicated by females in the intervention group were not related to changes in MVPA.

Findings from the current study suggest that an increase in self-efficacy among girls in the intervention group contributed to MVPA behaviour change in the LAP intervention. This finding combined with results from previous mediation analyses, suggest that self-efficacy may be a

mediator of physical activity behaviour change among adolescent females. Although changes in peer support were not related in the changes in MVPA in the current study, the importance of peer support cannot be discounted. Evidence from previous interventions[18 19] and cross-sectional research[21 25] have highlighted the potential of social support to impact upon behaviour. While self-efficacy beliefs about overcoming barriers should predict exercise adoption, beliefs about behaviour self-regulation should predict long term exercise adherence[4 14]. It may also be true that support from significant others will support long-term physical activity behaviours, as demonstrated by a recent longitudinal study of adolescents in the United States[26]. As such, future interventions should include methods to increase adolescent exercise self-efficacy and social support.

Limitations of this study include: the use of physical activity self-report, the possibility of treatment diffusion, the small sample size, the homogenous nature of the participants who came from one school only and the lack of a long-term follow-up. The current study would have benefited from the use of a more objective measure of physical activity, as recalling activity is a complex cognitive task[27]. The small sample size may have contributed to the study's failure to identify mediation among males in the study sample. The authors' suggest that self-efficacy may have satisfied the fourth criteria for mediation in a larger sample. As the study sample was not representative of British adolescents, future studies should evaluate the LAP and similar programs in larger samples with longer-term follow-ups.

Despite these limitations, the information from this study may be useful in the design of interventions for older female adolescents. Few studies have attempted to intervene in the senior years at school and fewer have attempted to establish mediation in such interventions. The need for such research has been clearly noted in the literature.

Conclusions

- Understanding the mediators of behavioural change is important for identifying the most successful components of interventions.

- Interventions aimed at increasing self-efficacy can be successful in increasing short-term physical activity among adolescents.

Acknowledgements

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Tables

Table 1: Summary of mediation criteria 1, 2 and 3

Variable	Males (*n* = 30)		Females (*n* =47)	
	Beta[1]	Confidence Interval [2]	Beta	Confidence Interval
Effect of treatment condition on moderate-to-vigorous physical activity (τ)				
Moderate-to-vigorous physical activity	.32	-9.53 to 131.53	.31	5.44 to 165.81*
Effect of treatment condition on hypothesized mediator variables (α)				
Peer support	-.17	-.73 to .28	.36	.09 to .76*
Outcome expectancy	.05	-2.96 to 3.80	.08	-.3.26 to 5.54
Self-efficacy	.22	-.13 to .47	.35	.08 to .83*
Effect of mediator variables on moderate-to-vigorous physical activity (β)				
Peer support	.22	-25.32 to 89.49	.04	-61.05 to 80.47
Outcome expectancy	.01	-8.33 to 8.53	.27	-.30 to 10.72
Self-efficacy	.19	-36.40 to 149.18	.34	10.48 to 137.35*

Note. Change scores (post-test minus baseline) were used in all analyses.

[1] Standardized regression coefficients calculated from linear regression models.

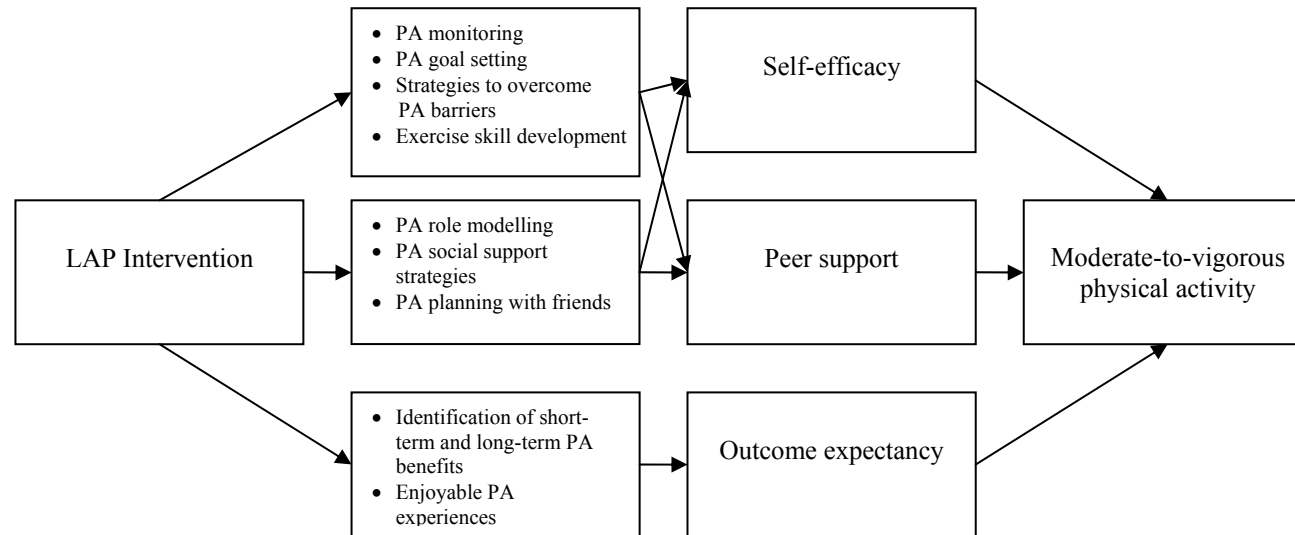[2] 95% confidence intervals for standardised regression coefficients.

*$p < .05$

Supplemental Table: Means and standard deviations for mediator change scores

Variable	Males M (SD)		Females M (SD)	
	Intervention *n* = **15**	**Control** *n* = **15**	**Intervention** *n* = **23**	**Control** *n* = **24**
Moderate-to-vigorous physical activity (mins/week)	3.00 (107.35)	-58.00 (79.10)	100.00 (112.84)	14.38 (155.71)
Peer support	.05 (.56)	.28 (.75)	.49 (.62)	.06 (.51)
Outcome expectancy	.13 (.30)	.10 (.40)	.18 (.51)	.90 (.63)
Self–efficacy	.23 (.38)	.07 (.38)	.45 (.56)	-.01 (.68)

Note. Change scores (post-test minus baseline) reported.

M = Mean, SD = Standard deviation.

1   **Figure 1: Intervention strategies and proposed mediation pathways**

2