Randomized Controlled Trial of the Physical Activity Leaders (PALs) Program for
Adolescent Boys from Disadvantaged Secondary Schools

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Abstract

Objective: The aim of this study was to evaluate the efficacy and feasibility of the Physical Activity Leaders (PALs) program. PALs is an obesity prevention program for low-active adolescent boys from disadvantaged schools.

Methods: The study was conducted in the Hunter Region, New South Wales (NSW), Australia from June to December 2009. Four disadvantaged secondary schools were randomized to treatment conditions for the 6-month study period. Participants were 100 adolescent boys [mean (SD) age=14.3(.6) years; BMI = 22.1 kg/m² (4.6); BMI z-score = 0.6 (1.2)]. The primary outcome was change in BMI and secondary outcomes were body fat (bio-electrical impedance analysis), waist circumference, muscular fitness (leg dynamometer, 90-degree push-up test and 7-stage sit-up test), physical activity (5-days of pedometry) and selected dietary behaviors.

Results. Significant group-by-time interaction effects were found for BMI (mean difference = -0.8 kg/m², $p < 0.001$, $d = 0.7$), BMI z-score (mean difference = -0.2, $p < 0.001$, $d = 0.7$), and body fat (mean difference = -1.8%, $p < 0.05$, $d = 0.5$), but not for waist circumference, muscular fitness or physical activity. Participants in the intervention group reduced their consumption of sugar-containing beverages.

Conclusions: The PALs program was a feasible and efficacious approach to induce healthy weight loss in adolescent boys from disadvantaged secondary schools.

Key words: Obesity; overweight; intervention; youth; resistance training; strength training

Trial Registration: Australian New Zealand Clinical Trials Registry No: ACTRN12609000414213.

1 **Introduction**

2 While some evidence suggests that obesity rates have leveled off in recent
 3 years (Olds, et al., 2010), this has not been the case among youth from lower socio-
 4 economic strata (Stamatakis, et al., 2010). It is of additional concern that schools in
 5 disadvantaged areas may be compounding this issue and a recent nationally
 6 representative sample of US adolescents found that school socio-economic status
 7 (SES) was negatively associated with weight status, even after controlling for
 8 individual level SES (O'Malley, et al., 2007). Schools have been identified as
 9 important institutions for the prevention of obesity through the promotion of physical
 10 activity and healthy eating (Booth and Okely, 2005, Pate, et al., 2006, Wechsler, et al.,
 11 2000). School-based interventions have demonstrated potential in the prevention of
 12 obesity among youth (Brown and Summerbell, 2009, Katz, et al., 2008), but there is
 13 considerable room for improvement. One of the problems of school-based approaches
 14 is that they have shown less impact on those most at risk of obesity. Consequently, it
 15 has been recommended that interventions be designed and evaluated among those
 16 most at risk, which include youth from disadvantaged backgrounds and ethnic
 17 minorities (Cale and Harris, 2006, Cavill, et al., 2001, Thomas, 2006).

18 Evidence suggests that SES is inversely related to physical activity and healthy
 19 eating in youth (Booth, et al., 2006, Van der Horst, et al., 2007, Walters, et al., 2009),
 20 yet few obesity prevention studies have specifically targeted adolescents from
 21 disadvantaged backgrounds. The Dutch Obesity Intervention in Teenagers (DOiT)
 22 was a multi-component program for adolescents from low socio-economic
 23 backgrounds (Singh, et al., 2006). DOiT resulted in short-term improvements in body
 24 composition among adolescent boys and girls (Singh, et al., 2007). But after 20
 25 months the improvements in waist circumference observed among adolescent boys
 26 were no longer significant (Singh, et al., 2009).

27 Although adolescent girls are generally less active than boys, many adolescent
 28 boys are not sufficiently active (Centers for Disease Control & Prevention, 2006,
 29 Department of Health & Ageing, 2008). Physical activity plays an important role in
 30 preventing unhealthy weight gain during adolescence (Menschik, et al., 2008) and
 31 while there are no gender differences in the prevalence of overweight and obesity
 32 among Australian adolescents, the prevalence of obesity is high among low SES boys
 33 in particular (Booth, et al., 2006) and higher among young Australian men than
 34 women (Cameron, et al., 2003). The primary aim of this study is to report the 6-month

effects of a school-based obesity prevention program for low-active boys from disadvantaged secondary schools. The Physical Activity Leaders (PALs) program was developed in reference to Bandura's Social Cognitive Theory (SCT: 2004) and was designed to encourage adolescent boys to become physical activity leaders in their homes and at school. We hypothesized that participants in the PALs intervention, compared to those in the control group, would display more favorable changes in body mass index (BMI) and improvements in muscular fitness, physical activity and dietary behavior over the 6-month study period.

Methods

Study Design

The design, implementation and reporting of the PALs study conforms to the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomized trials (Moher, et al., 2010). The study was registered with Australia and New Zealand Clinical Trials registry (ACTRN12609000414213). Ethics approval for this study was obtained from the University of Newcastle and the NSW Department of Education & Training (DET) ethics' committees. All participants provided written informed consent and the study was conducted from June to December 2009.

Sample size

A power calculation was conducted to determine the sample size necessary to detect differences in body mass index (BMI), which is considered a better measure of change in adiposity than BMI z -score (Cole, et al., 2005). Using an alpha of .05 and power of 80%, it was determined that a sample size of approximately 120 was needed to detect a 1kg/m^{-2} ($\text{SD}=2\text{kg/m}^{-2}$) difference between groups (Robinson, et al., 2008).

Schools and participants

Six low socio-economic status (SES) co-educational secondary schools from the Hunter Region, NSW, Australia were invited to participate in the study and four schools consented. Eligible schools were identified using the NSW DET Priority Schools Program (PSP) classification. The PSP was set up in 2006 by the NSW state government to identify disadvantaged schools and provide them with additional funding, staffing and consultancy to support students from communities with the highest concentrations of low SES families. The decision to include schools in the PSP is made by the NSW DET and is based on the level of employment, education, and Indigenous status of the schools' parents. All of the schools included in the current study had a Socio-Economic Indexes for Areas (SEIFA) index of relative

socioeconomic disadvantage score of 5 or less. The SEIFA index (scale 1=lowest to 10=highest) summarizes the characteristics of people and households within an area and is developed using the following data: employment, education, financial well-being, housing stress, overcrowding, home ownership, family support, family breakdown, family type, lack of wealth (no car or telephone), low income, Indigenous status and foreign birth. Eligible participants were adolescent boys in Grade 9 attending one of the four selected study schools. Physical education (PE) teachers at the study schools were involved in identifying and recruiting low-active boys. To be eligible for the study, students were considered by the teachers to be disengaged in PE and/or not currently participating in organized team or individual sports.

Randomization

Following baseline assessments, schools were randomized to the intervention or wait list control groups. Research assistants and participants were not blinded to treatment allocation at 3- and 6-month assessments.

Intervention

The PALs program was a multi-component school-based intervention and included school sport sessions, interactive seminars, lunch-time activities, physical activity and nutrition handbooks, leadership sessions and pedometers for self-monitoring. The program was developed in reference to Bandura's SCT (2004) and the intervention components, behavior change strategies and targeted constructs are listed and described in Table 1. The intervention was focused on the promotion of lifestyle (i.e. activities that are performed as part of everyday life, such as walking to school and using the stairs) and lifetime activities (i.e. activities that may be easily carried into adulthood because they generally need one or two people, for example, resistance training) and delivered over two school terms at no cost to the school or students. In Australian secondary schools, extra-curricular/co-curricular school sport programs are often delivered off campus and may involve weekly fees. Consequently, the cost of school sport activities has been identified as a barrier to participation among some students (Lubans, et al., in press) and may be a particular issue for low SES students. Considering the importance of muscularity and physical strength to self-esteem among males from both Western and non-Western cultures (Gray and Ginsberg, 2007), resistance training (RT) was selected as the focus of the physical activity sessions for the adolescent boys. RT is rarely offered as an activity in Australian secondary schools, despite the popularity of RT for overweight youth who often experience

1 difficulty in weight bearing activity (Sothorn, et al., 2000).

2 The physical activity sessions focused on the use of elastic tubing RT devices,
3 known as Gymsticks™ (Gymstick International, Lahti, Finland) (Lubans, et al., 2010,
4 Lubans, et al., 2010). Participants completed self- and teacher-directed fitness
5 sessions. A flexible intervention delivery model was utilized to allow teachers to adapt
6 the program to the needs of their students. Teachers were encouraged to set-up fitness
7 circuits to maximize participation, but students were also given basic RT programs to
8 promote exercise independence. The RT programs included 2 sets of 8-12 repetitions
9 for 10 exercises. The RT programs were focused on all the major muscle groups and
10 included a variety of exercises, which changed over the intervention period.

11 A unique aspect of this study was that it encouraged participants to become
12 physical activity leaders in their schools and at home and provided accreditation to
13 formalize their achievements. Participants who satisfied the accreditation criteria were
14 presented with leadership certificates at school assemblies. The criteria for
15 accreditation were, (i) attendance at ≥ 6 school sport sessions, (ii) attendance at ≥ 5
16 lunch-time sessions, (iii) attendance at ≥ 5 physical activity leadership sessions and
17 (iv) submission of the physical activity and nutrition handbook. The PALs program
18 was delivered at the wait list control group schools at the completion of the 6-month
19 study.

20 *Measures*

21 All assessments were completed by trained research assistants and
22 measurements were completed at the study schools using the same instruments at each
23 time point. BMI was the primary outcome and a range of secondary measures were
24 also assessed. The one week test-retest reliability of the study measures was examined
25 among 66 adolescents not involved in the current study (Lubans, et al., in press).
26 Intra-class correlation coefficients (ICC), 95% confidence intervals (95% CI) and
27 typical error for the different measures are reported.

28 *Height and weight.* Weight was measured in light clothing without shoes using a
29 portable digital scale (Seca 770, Wedderburn) to the nearest 0.1kg and height was
30 measured to the nearest 0.1 cm using a portable stadiometer (Design No. 1013522,
31 Surgical and Medical Products, Australia). Body mass index (BMI) was calculated
32 using the standard equation ($\text{weight}[\text{kg}]/\text{height}[\text{m}]^2$). BMI-z scores were calculated
33 using the 'LMS' method using 1990 British growth reference centiles (Cole, et al.,
34 2000).

Waist circumference. Non-extendible steel tapes (KDSF10-02, KDS Corporation, Osaka, Japan) were used to assess waist circumference, which was measured level with the umbilicus to standardize the procedure [ICC =0.99 (0.99 to 1.00), typical error =1.1].

Bio-electrical impedance. Percentage body fat was determined using the ImpTM SFB7 bioelectrical impedance analyzer (Nielsen, et al., 2007), which has good reliability [ICC =0.95 (0.90 to 0.97) , typical error = 2.2].

Leg dynamometer. A leg dynamometer (TTM Muscular Meter, Gloria, Tokyo, Japan) was used to assess participants' lower body strength [ICC =0.91 (0.83 to 0.95), typical error = 9.0].

90-degree push-up test. The 90° push-up test (90PU) was used as a measure of upper body muscular endurance (Cooper Institute for Aerobics Research, 1992) [ICC =0.90 (0.80 to 0.95), typical error =3.6].

7-stage abdominal strength test. The 7-stage abdominal strength test was used to provide a measure of abdominal muscular strength [ICC =0.96 (0.74 to 0.93), typical error =0.6].

Physical activity. Yamax CW200 pedometers (Yamax Corporation, Kumamoto City, Japan) were used to provide five days (four consecutive school days and one weekend day) (Troost, et al., 2000) of objectively measured physical activity (Crouter, et al., 2003, Le Masurier, et al., 2004, Schneider, et al., 2003). Excessively high (3 participants reported >30,000) and low (1 participants reported <1000) step counts were replaced using the mean of the participant's valid days (Rowe, et al., 2004) and values were imputed for non-ambulatory activity (Miller, et al., 2006).

Dietary behaviors. Selected dietary behaviors were assessed using items from the NSW Schools Physical Activity and Nutrition Survey (NSW Centre for Obesity & Overweight, 2006). Items were used to assess students' daily consumption of fruit, vegetables, sugar containing beverages and water.

Process evaluation

A detailed process evaluation was undertaken to assess the feasibility of the PALs program. This included recruitment (achievement of target sample size), retention (retention rates at 3- and 6-month follow-up), attendance (at program sessions) and program satisfaction. At the completion of the study, participants were asked to rate their satisfaction with the PALs program by responding to the following 4 items using a 5-point Likert scale from 1 = "Strongly disagree" to 5 = "Strongly agree": (i) "I enjoyed the school sport sessions", (ii) "The physical activity and

nutrition handbook provided me with useful information”, (iii) “I found the information sessions to be useful”, (iv) “Overall I am satisfied with the PALs program”.

Analysis

Statistical analyses were completed using PASW Statistics 17 (SPSS Inc. Chicago, IL) software and alpha levels were set at $p < 0.05$. All variables were checked for normality and satisfied the criteria. Independent samples t-tests were used to compare differences between intervention and control groups at baseline and for differences between study completers and those who had dropped out of the study. Linear mixed models were fitted with an unstructured covariance structure to compare intervention and control groups for continuous variables. Mixed models were used to assess primary outcomes for the impact of group (intervention or control), time (treated as categorical with levels baseline, 3-months and 6-months) and the group-by-time interaction. To examine potential clustering of effects at the school level, treatment and treatment-by-time were nested in the school condition and included as a fixed effect. School attended did not significantly contribute to any of the models exploring the effects of primary or secondary outcomes and were removed from the final models. Cohen’s d (1988) was used to determine effect sizes and the proportion of overweight/obese participants in each group at baseline and follow-up were compared using chi square tests. Nutrition variables were recoded as dichotomous variables (e.g. less than 2 servings of fruit/day or more than 2 servings/day) and treatment effects were explored using logistic regression with treatment included as a fixed factor and baseline values entered as a covariate. Last observation carried forward was used for nutrition data missing at 3- and 6-months.

Results

Overview

The flow of participants through the study process is reported in Figure 1. One hundred students from four secondary schools (25 from each school) were recruited for the study and assessed at baseline. There were no significant differences between control and intervention groups at baseline for BMI, BMI z -score, body fat or other key variables. Participants in the control group achieved significantly more push-ups at baseline compared to the intervention group (16.0 versus 11.7, $p < 0.01$). There were no significant differences between completers and study drop-outs for any of the study variables ($p > 0.05$).

The mean (SD) age of participants was 14.3(0.6) years and all participants were born in Australia and spoke English at home (Table 2). At baseline, 22% of participants were considered overweight and 13% obese, with approximately equal numbers of overweight/obese participants in control and intervention groups.

Changes in primary outcome

There were significant group-by-time interaction effects for BMI ($p<0.001$, $d=0.7$) and BMI z-score ($p<0.001$, $d=0.7$)(Table 3). This resulted in a significant reduction in the number of participants classified as overweight or obese in the intervention group ($\chi^2=4.68$, $p=0.03$). At 6-month follow-up, 38% of control group participants were classified as overweight (20%) or obese (18%). In the intervention group, 8% of participants were overweight and 8% obese at the completion of the study (2 obese and 1 overweight participants dropped out of the intervention group).

Changes in secondary outcomes

Significant beneficial treatment effects were found from baseline to 3- and 6-months for body fat % ($p<0.05$, $d=0.5$). Small increases in upper body muscular endurance ($p=0.09$, $d=0.3$) and abdominal strength ($p=0.07$, $d=0.2$) were observed, but these were not statistically significant. There were no between group differences for lower body strength or mean steps/day. In comparison to the control group, participants in the intervention group significantly decreased their consumption of sugar-containing beverages ($\beta = -1.17$, Wald chi square = 5.67, $p=0.02$). There were no changes in the proportion of participants consuming other food and beverage items over the study period (Table 4).

Process evaluation

Teachers were asked to identify 25 to 30 low-active adolescent boys from Grade 9 at their school. All four schools successfully identified and recruited 25 boys. Retention rate at 3- and 6-months was 90% and 82%, respectively. Four participants withdrew from the intervention group. Nine from the intervention group and five from the control groups were not available for the 6-month follow-up. On average, participants in the intervention group attended 7 of 10 school sport sessions, 6 of 8 lunch-time sessions, 4 of 6 physical activity leadership sessions and 29 of the 50 participants submitted their completed physical activity and nutrition handbooks. Approximately 50% (23 participants) of the intervention group satisfied the requirements for PALs accreditation. Overall, participants were satisfied with the

program (4.0 ± 0.9). No injuries or adverse effects were reported during the activity sessions or assessments.

Discussion

This study reports the 6-month effects of a school-based obesity prevention program for low-active boys from disadvantaged secondary schools. The PALs intervention resulted in a significant beneficial intervention effect for BMI at 6-month follow-up and significantly decreased the prevalence of overweight and obesity in the intervention group. Participants in the intervention group significantly reduced their consumption of sugar-containing beverages but there were no changes in steps/day over the study period.

The PALs intervention resulted in a BMI z-score mean difference of 0.22. Ford and colleagues (Ford, et al., 2010) reported that a reduction of ≥ 0.25 BMI z-scores is associated with improved insulin sensitivity, total cholesterol/high-density lipoprotein ratio and blood pressure in obese adolescents. While the current study sample included healthy weight, overweight and obese participants, the improvements in body composition observed among participants in the PALs intervention may be associated with additional improvements in cardio-metabolic health.

A recent systematic review of school-based obesity prevention interventions found 38 studies, including 12 studies that involved adolescents in secondary schools (Brown and Summerbell, 2009). Seven studies included adolescent boys and girls, but none of the interventions specifically targeted adolescent boys. Of those that included boys, only two resulted in favorable changes in BMI for boys (Ask, et al., 2006, Sallis, et al., 2003). More recently, Singh and colleagues (Singh, et al., 2007) found significant short-term improvements in body composition in adolescent boys and girls from disadvantaged backgrounds in the DOiT program. Similar to the current study, Singh and colleagues found that the DOiT program helped adolescent boys' reduce their consumption of sugar-containing beverages.

A novel aspect of the PALs intervention was the accreditation process and participants were encouraged to become physical activity leaders in their schools and at home. To gain PALs accreditation, participants were required to deliver lunch-time physical activity sessions with Grade 7 students, under the supervision of teachers. Approximately 50% of the intervention group satisfied the predetermined criteria for accreditation. The potential sustainability of school-based interventions has been identified as a weakness of previous programs (Salmon, et al., 2007, Van Sluijs, et al.,

2008). Using students to deliver intervention components may reduce the burden on teachers to run lunch-time sessions and improve sustainability. Furthermore, this component may enhance students' sense of responsibility and promote a deeper understanding of the program content. The program successfully retained approximately 80% of participants and the attendance at sessions was relatively high (approximately 70%).

Although the practical component of the PALs program was focused on RT to improve muscular fitness, additional intervention components addressed the promotion of incidental lifestyle activity. Surprisingly, participants in the intervention group did not increase their mean steps/day over the six month study period. Recent reviews have identified self-monitoring with pedometers to be an appropriate strategy for increasing physical activity among adults (Bravata, et al., 2007) and youth (Lubans, et al., 2009). However, using pedometers in a study to both promote and measure physical activity is problematic and may explain our null findings. Evidence for reactivity among pedometer wearers in monitoring studies is conflicting and while some have identified reactivity as an issue (Clemes, et al., 2008), others have found no evidence for reactivity (Behrens and Dinger, 2007, Ozdoba, et al., 2004). Alternatively, it is plausible to suggest that adolescent boys were attracted to the RT component of the intervention but did not engage with the walking program. Muscularity and physical strength are highly valued by adolescent males (Gray and Ginsberg, 2007), while walking and other activities of low intensity may be less motivating for this group.

The recruitment of adolescents at risk of becoming obese is problematic and school-based programs specifically targeting overweight participants may result in stigmatization. Previous studies have attempted to overcome this by using fitness-based inclusion criteria (Peralta, et al., 2009, Schneider-Jamner, et al., 2004). For example, Peralta and colleagues (Peralta, et al., 2009) conducted an obesity prevention program for adolescent boys using low-levels of cardio-respiratory fitness as the inclusion criteria. Similar recruitment strategies were used in the Project FAB intervention for adolescent girls (Schneider-Jamner, et al., 2004). In the current study, low-active participants were identified and recruited by teachers at the study school. One advantage of our strategy was that it minimized the stigma associated with being involved in the program. Consequently, participant adherence and retention were both high in the PALs intervention.

Despite the novelty of this study, there are some limitations that should be noted. First, we did not assess participants' actual SES level. However, weight status has been found to be inversely associated with school SES, even after controlling for individual level SES (O'Malley, et al., 2007). Second, teachers at the study schools identified and recruited students who they considered to be disengaged in PE and/or not currently participating in organized team or individual sports. This method of recruitment was used to minimize stigmatization associated with involvement in the program but may have resulted in selection bias as we were not able to ensure uniformity between teachers. However, PE teachers are often asked to evaluate their students' engagement in physical activity. Third, pedometers were unsealed during assessments and this method of monitoring may explain our higher than expected baseline step counts. In addition, participants wore pedometers for five days at baseline and posttest. The inclusion of additional monitoring days may be necessary to provide a reliable estimate of physical activity among adolescents.

Conclusions

Targeted interventions to prevent obesity among those most at risk are urgently needed (Cale and Harris, 2006, Cavill, et al., 2001, Thomas, 2006). Based on the limited effectiveness of previous interventions (Brown and Summerbell, 2009), it is unlikely that a 'one-size fits all' intervention will appeal to, and be suitable for, everyone. The PALs program was successful in recruiting and retaining a group of adolescent boys at risk of obesity. Participants' involvement in health-related fitness activities, including resistance training, resulted in significant improvements in body composition. Although the long-term effectiveness of this program remains untested, PALs is a feasible and efficacious approach to improving weight status in low-active adolescent boys from disadvantaged secondary schools.

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Competing interests

The authors declare that they have no competing interests.

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- 1 **Table 1: Intervention components, behavior change techniques and targeted**
- 2 **constructs (Australia from June to December 2009)**
- 3

- 1 **Table 2: Baseline characteristics of boys randomized to the intervention and**
- 2 **control groups (Australia, June to December 2009)**
- 3

- 1 **Table 4: Participants consuming specific food and beverage items at baseline, 3-months and 6-**
- 2 **months follow-ups (Australia, June to December, 2009)**

Figure 1: Participant recruitment and retention