Abstract

The purpose of this study was to examine potential correlates of objectively measured physical activity among a sample of Australian adolescents. Participants were 119 14-15 year old students from three secondary schools. Students wore pedometers for four consecutive school days and completed questionnaires assessing demographic, social, psychological and behavioural correlates of physical activity. Mean steps/day were 11,865 (± 3,997) for boys (n = 47) and 9,466 (± 3,195) for girls (n = 72). Approximately one third of boys (32%) and girls (33%) satisfied existing step recommendations (girls 11,000 steps/day and boys 13,000 steps/day). In the first instance, the relationship between factors and physical activity was assessed using bivariate correlation. Enjoyment of physical activity (r = .37, p <.05), use of self-management strategies (r = .33, p <.05) and perceived barriers (r = -.39, p <.05) were significantly related to mean steps/day among boys. Peer support (r = .26, p <.05) and the use of self-management strategies (r = .30, p <.05) were significantly associated with mean steps/day for girls. Hierarchical regression analysis revealed that gender, peer support, self-management strategies and perceived barriers accounted for 16% of the variance in mean steps/day. This study has identified a number of potentially modifiable correlates of objectively measured physical activity in sample of Australian adolescents.

Key words: Physical activity, secondary schools, factors, health promotion

Social, psychological and behavioural correlates of pedometer step counts in a sample of Australian adolescents

Despite evidence that physical activity is associated with improved social, physical and emotional health, almost half of the Australian population are not sufficiently active.[1] Estimates suggest that physical inactivity costs Australia approximately $400 million per year in health care expenses[2]. Although many of the markers of chronic diseases manifest themselves among adults, there are a number of reasons why the promotion of physical activity among youth has been identified as a global health priority.[3] Firstly, low levels of physical activity contribute to lifestyle diseases such as obesity, which is one of the leading health problems facing many developed nations, including Australia.[4] Secondly, there is some evidence to suggest that health behaviours such as physical activity track into adulthood, however, the evidence for short-term tracking is stronger.[5] Finally, physical levels generally decline during adolescence, with the most dramatic decline in physical activity occurring between the ages of 13 and 18.[6]

To help reduce the decline in physical activity associated with adolescence, it is important to examine factors associated with physical activity in specific populations. The most comprehensive review of factors associated with adolescent activity assessed 48 non-modifiable (e.g. age, gender) and modifiable (e.g. self-efficacy, beliefs) variables in 108 studies.[7] Many of the findings were conflicting and the majority of the studies were conducted in the United States. It is of additional concern that most of the evidence regarding physical activity correlates has been based on studies that have measured physical activity using self-reports.[8] The recall of physical activity is problematic and social desirability bias can lead to individuals overestimating their time spent in activity.[9]

Considering the inconsistent findings and limited data on international samples, the aim of this study was to identify correlates of objectively measured physical activity in a sample of Australian adolescents. An additional aim of this study was to identify pedometer determined levels of physical activity in the study sample.

Methods

Participants

Approval was obtained from school principals, the University of Newcastle, New South Wales (NSW), Australia and the NSW Department of Education and Training ethics committees. Two government schools and two independent schools located 15 minutes drive from the University of Newcastle were invited to participate. Three schools indicated agreement and were included in the study (two independent schools and one government school). The study aimed to recruit 50 students from years 8 and 9 (14 and 15 year olds) from each school. Participants were recruited through physical education classes and consisted of students who had selected a health and fitness school sport option delivered at the University of Newcastle. The total sample consisted of 119 students (47 boys, 72 girls) which represented a response rate of 79%.

Procedures

Students completed questionnaires which were administered by trained research assistants, who also provided students with pedometers and instructions for wearing them. Participants were asked to wear sealed pedometers for four consecutive school days (students were given the pedometers on Monday morning which were then collected on Friday morning). Previous studies have established that four days of consecutive pedometer monitoring are necessary to provide a reliable measure of habitual physical activity among youth.[10] Students were instructed on how to attach the pedometers (at the waist on the right hand side) and asked to remove the pedometers only when sleeping or when the pedometer might get wet (e.g. swimming, surfing, showering). On the Friday morning, research assistants collected the pedometers, cut the cable ties and recorded total step counts.

Measures

Physical activity. The *Yamax* SW701 pedometer was used in the present study to measure physical activity, as it has been reported to be a more reliable measure of physical activity compared to other pedometer brands.[11] Eston, Rowlands and Ingledew[12] found *Yamax* pedometers to have high correlations with oxygen consumption (r = .81) and *Caltrac* accelerometer counts (r = .99).

Self-reported variables. A number of social, psychological and behavioural variables were assessed in the current study (Table 1). Demographic variables included gender, age, country of birth and language spoken at home. Behavioural variables included hours/day watching television,

hours/day using the computer, hours/day playing electronic games and the use of physical activity self-management strategies. The following factors were included: peer support, exercise self-efficacy, outcome expectancy and perceived barriers. All scales were rated on a 5-point Likert scale, anchored by 0 (strongly disagree) and 4 (strongly agree). A higher score on each scale suggested a more positive response, except for perceived barriers, for which the opposite was true.

Statistical Analyses

The data were analysed using the SPSS software (version 12.0). Total pedometer counts were divided by the number of days worn to provide mean steps/day. Students who had completed at least two days of pedometer monitoring were included in the analysis (70% of students completed 4 days, 13% completed three days and 12% completed two days). As no daily step recommendations for Australian adolescents currently exist, proportions of students meeting the U.S. guidelines[13] (13,000 for boys and 11,000 for girls) were reported. Average scores for the various scales were calculated and if fewer than 25% of the items were missing, means of completed items were imputed (less than 2% of items had missing responses). Alpha levels were set at $p < .05$ for all calculations and marginally significant results ($.05 \leq p \leq .10$) were noted. Because physical activity levels typically vary by gender, the sample was divided into gender subgroups and data were analysed separately for each subgroup. Independent samples t-tests and Mann-Whitney U tests were used to assess hypothesized gender differences.

In the first instance, bivariate correlations were used to analyse the relationship between potential correlates and physical activity (defined as mean steps/day). Variables with at least marginally significant associations were entered into hierarchical regression models explaining mean steps/day. A number of regression models were calculated and variables were entered in three steps, with the order of entry determined by degree of individual control over factors.

Results

The average age of the students was 14.2 (± .7) years. The majority of students were born in Australia (95%) and spoke English at home (98%). There were no significant differences between boys and girls for any of the demographic variables. Boys recorded significantly higher mean steps/day compared to girls (11,865 versus 9,466, $p < .01$). Approximately one third of boys (32%)

and girls (33%) satisfied the U.S. daily step recommendations[13]. Boys and girls reported similar amounts of time spent watching television and using the computer. However, there was a statistically significant difference between boys and girls in the amount of time spent playing electronic games, with more hours/day of use reported by boys. Boys reported greater use of self-management strategies (2.70 versus 2.39, $p = .048$), higher levels of exercise self-efficacy (3.75 versus 3.33, $p = .011$) and enjoyment in physical activity (3.25 versus 2.91, $p = .013$) compared to girls. There were no statistically significant differences in peer support, outcome expectancy and perceived barriers by gender.

A number of statistically bivariate correlations were found in the current study. Among boys, enjoyment of physical activity ($r = .37$, $p < .05$), use of self-management strategies ($r = .33$, $p < .05$) and perceived barriers ($r = -.39$, $p < .05$) were associated with mean steps/day. Exercise self-efficacy, outcome expectancy and television watching were marginally significant. Only two variables were significantly associated with girls' mean steps/day. These were peer support for physical activity ($r = .26$, $p < .05$) and self-management strategies ($r = .30$, $p < .05$). When boys and girls were analysed as one group, television watching ($r = -.20$, $p < .05$), enjoyment of physical activity ($r = .24$, $p < .05$), self-management strategies ($r = .35$, $p < .01$), exercise self-efficacy ($r = .26$, $p < .01$) and perceived barriers ($r = -.20$, $p < .05$) were associated with mean steps/day.

The results of the hierarchical regression analysis are reported in Table 2. For the final model, gender was entered as the first step, peer support was entered in the second step and self-management strategies and perceived barriers were entered in the third and final step. In step one, gender explained 9% of the variance in mean steps/day [$F (1, 101) = 11.04$, $p = .001$]. In step two, peer support explained an additional 3% of the variance [$F (1, 100) = 2.8$, $p = .097$]. In the final step, an additional 4% of variance was explained by the inclusion of self-management strategies and barriers to physical activity [$F (2, 97) = 4.30$, $p = .016$]. In the final regression model gender ($ß = -.266$, $p = .005$) and self-management strategies ($ß = .239$, $p = .031$) were statistically significant predictors of mean steps/day.

Discussion

Among youth, physical activity patterns are influenced by a complex interplay of variables from multiple domains.[14] The examination of these determinants is necessary in order to understand physical activity behaviour and design appropriate interventions. The primary aim of this study was to assess the relationship between potential correlates and objectively determined physical activity in a sample of Australian adolescents. Although a number of correlates were identified in the current study, only 16% of the variance in physical activity was explained. This finding corresponds with previous studies that have assessed physical activity using objective measures, which have generally explained small amounts of variance. [15 16] It has been suggested that shared method variance between self-reported physical activity and correlates may explain inflated associations in studies using self-report.[17] As such, the results of the current study will be compared where possible to studies that have used objective measures of adolescents' physical activity (i.e. accelerometers and pedometers).

None of the demographic variables assessed in the current study were associated with physical activity in the bivariate analyses and subsequently were not included in the hierarchical regression models. There were a number of statistically significant associations between the behavioural variables and physical activity. In the bivariate analyses, hours spent watching television/day was inversely related to physical activity. While it has been suggested that time spent in sedentary pursuits (such as watching TV and playing computer games) replaces time spent in physical activity, previous studies examining this relationship have proven inconclusive.[18] Time spent watching television was not related to physical activity in any of the regression analyses and was not included in the final regression model.

In the current study, the use of self-management strategies was positively associated with physical activity among both boys and girls in the bivariate correlations and was a significant predictor in the final regression model. Physical activity self-management strategies include behaviours such as goal setting, physical activity monitoring and positive self-talk. Although there is limited research examining the relationship between the use of self-management strategies and physical activity among youth, interventions have demonstrated that the use of self-management strategies help to improve exercise adherence among adolescents.[19] The discovery of self-management strategies as a correlate of activity among both males and females is an important

finding. Physical education and school sport programs offer ideal opportunities to teach physical activity self-management strategies and adolescents interested in health and fitness activities may especially benefit from programs that teach these skills. Recent interventions using pedometers have found short-term increases in physical activity using self-management strategies among adolescents.[20]

Peer support for physical activity was the only social variable assessed in the current study. In the bivariate analysis, peer support was related to physical activity among girls but not among boys. After controlling for gender in the multivariate analysis, peer support was a marginally significant predictor of physical activity. While social support has been considered an important influence on physical activity among youth,[21] the review by Sallis and colleagues[7] concluded that the relationship between physical activity and peer support was indeterminate.

A number of psychological variables were associated with physical activity in the bivariate analyses, but none were significant predictors in the final regression model. Outcome expectancy was not related to physical activity in the study sample in any of the analyses. This finding corresponds with the review by Sallis and colleagues,[7] who concluded that the relationship between knowledge and attitudes about physical activity and the behaviour was uncertain. Among boys, enjoyment of physical activity and perceived barriers (inverse) were related to physical activity levels in the bivariate analysis. Similar to the findings in this study, physical activity (accelerometer) was associated with self-efficacy scores among a sample of U.S. adolescents.[22] In another study examining the activity patterns of U.S. adolescents, overcoming barriers was related to accelerometer counts.[15]

An additional aim of this study was to identify pedometer determined levels of physical activity in a sample of Australian adolescents. In the current study, boys recorded 11,865 (± 3,997) steps/day and girls recorded 9,466 (± 3,195) steps/day. Evidently, only 32% of boys (≥ 13,000 steps/day) and 33% of girls (≥ 11,000 steps) met the U.S. daily step recommendations.[13] The step counts recorded in the current study were lower than those reported in a recent study of Australian adolescents (CAPANS), which found boys to average 14,240 steps/day and girls to average 10,901 steps/day.[23] The higher step counts observed in the CAPANS study may be attributable, in part, to differences in the study population and the use of unsealed pedometer protocol.

There are a number of limitations in the current study. First, schools were not randomly selected and participants were adolescents who had chosen a health and fitness school sport option, which may limit the generalizability of the results. Second, the study sample was relatively small and the statistical analyses were underpowered. Third, physical activity was measured during school days and did not include weekend step monitoring. The activity patterns of adolescents differ from weekday to weekends and while some studies have found students to be more active during the week, others have found the contrary to be true. Finally, the study involved a cross-sectional design and therefore causal relationships cannot be established.

Conclusions

It has been suggested that a lack of understanding regarding the mediators of behaviour change has contributed to the ineffectiveness of previous physical activity interventions among youth.[24] While most interventions are developed with reference to a theory of behaviour change, few test the construct validity of their interventions using mediation analysis.[25] Furthermore, the few studies that have tested mediation in physical activity interventions have used self-report measures of activity. Consequently, future studies should involve longitudinal designs which assess physical activity using objective measures and attempt to identify the various components of interventions responsible for mediating behaviour change.

Practical Implications

- The majority of adolescents in the current study failed to meet the U.S. pedometer step guidelines.
- More active adolescents reported greater use of self-management strategies such as goal setting and physical activity monitoring.
- Programs to promote physical activity among adolescents may benefit from the inclusion of self-management strategies.

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Table 1: Items and scales used to measure potential correlates

	Description	Range (No. of items)	Source	Psychometric properties
Demographic				
Age, country of birth, language spoken at home	Three questions assessing age of student, country of birth and language spoken at home.	N/A	Commonly used items	Not available
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"	0 - 4 (4)	Existing scale [26]	*r* = .86 α = .59
Psychological				
Outcome expectancy	Statements regarding the benefits of physical activity. Starting with the common stem "If I participate in regular physical activity". Example item - "It would help me to control my weight"	0 - 4 (9)	Existing scale [27]	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…" Example item- "it gives me energy"	0 - 4 (16)	Existing scale [28]	Reliability scores not available α = .91
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"	0 - 4 (5)	Existing scale [27]	*r* = .89 α = .84
Perceived barriers to physical activity	Statements describing commonly cited barriers to physical activity. E.g. "I don't have a place to do physical activity"	0 - 4 (10)	Existing scale [19]	*r* = .90 α = .83
Behavioural				
Television watching	Number of hours watching television per day.	0 - 6+ (1)	Commonly used item	Not available
Non-school computer use	Number of hours spent using a computer per day.	0 - 6+ (1)	Commonly used item	Not available
Electronic games	Number of hours spent playing hand held electronic games	0 - 6+ (1)	Commonly used item	Not available
Self-management strategies	Statements regarding behavioural & cognitive strategies to increase physical activity. E.g. "I set goals to do physical activities"	0 - 4 (8)	Existing scale [19]	Reliability scores not available α = .88

r = Test-retest reliability
α = Cronbach's alpha
Note. Test-retest reliability from cited sources, Cronbach's alpha derived from study sample.

Table 2: Hierarchical regression analysis results explaining mean steps/day

Blocks of variables	Variables	Significance level (*p*)	Standardized coefficients (β)
Step 1	Adjusted R^2 = .089*		
	Gender	.001**	-.313
Step 2	Adjusted R^2 = .033		
	Peer support	.097	.156
Step 3	Adjusted R^2 = .038		
	Self-management strategies	.031	.239
	Perceived barriers	.219	-.118
	Total Adjusted R^2 = .160*		

Note. Adjusted R^2 indicates the proportion of variance attributable to the blocks of variables.

Significance, $p < .05$; ** significance, $p < .01$

Gender code: Male = 0, Female = 1