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Author(s)	C. K. John Wang, Y. H. Michael Chia, J. J. Quek and W. C. Liu
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Patterns of Physical Activity, Sedentary Behaviors, and Psychological Determinants of Physical Activity Among Singaporean School Children

C. K. John Wang, Y. H. Michael Chia, J. J. Quek, & W. C. Liu

National Institute of Education, Nanyang Technological University, Singapore

Abstract

The purpose of the research was to examine the prevalence and interrelationships between sedentary and physical activity behaviors, and psychological determinants of physical activity among Singaporean school children. A sample of 1935 children aged 10 to 14 years, took part in the study. In Study 1 (N=780), physical activity and sedentary behaviors were assessed using a 7-day physical activity recall method. Three distinct clusters were found for each sex using cluster analysis. Thirty six percent of the boys spent much of their sedentary time in technology-based entertainment (e.g., computer/internet), and 38% of them reported substantial amount of time spent studying and doing homework. The rest of the boys spent their time being physically active but they were also substantially engaged in playing video games. Among the girls, time spent socializing with friends, studying, and engaging in physical activity amounted to 57.3%. Fifteen percent of the girls reported spending much of their time studying and doing homework. A group of girls (27.8%) reported little study time, little socialization, and low engagement in physical activity compared to their peers. In Study 2 (N =1155), three clusters were found using sport ability beliefs, perceived autonomy, and perceived competence as clustering variables. The amount of physical activity that the children took part in was influenced by their perceptions of competence, sport ability, and autonomy. The findings of the research showed that physical activity and sedentary behaviors were not inversely related. In addition, the studies confirmed that certain psychological determinants were important for examining the physical activity behaviors of Singaporean school children.

Key words: clustering, psychological determinants, sedentary behaviors, physical activity, children.

Corresponding author: C.K. John Wang, PhD, Physical Education and Sports Science, National Institute of Education, Blk 5 #03-20, 1 Nanyang Walk, Singapore 637616, Tel: (65) 67903702, Fax: (65) 68969260
Email: ckjwang@nie.edu.sg

The health benefits of regular physical activity for adults have been widely studied and there is enough evidence to suggest that regular physical exercise increases the functional capacity and reduces the risk factors of many chronic diseases including coronary heart disease, hypertension, obesity, and cardiovascular diseases (Bouchard, Shephard, & Stephens, 1994; Leon, 1997; Pate et al., 1995). Moreover, current evidence indicates that physical activity of moderate intensity reduces depression and anxiety, improves mood, and enhances quality of life throughout the life span (Berger & Owen, 1992; Biddle, Fox, & Boutcher, 2000; Raglin, 1990). Therefore, in many countries, the promotion of physical activity forms part of the national agenda, and this is evidenced by a number of national initiatives, which involve the promotion of physical activity. For example, the "Healthy People 2000" in the US, "Finland on the Move" in Finland, "Strategy Statement on Physical Activity" in the United Kingdom, and "The Healthy Lifestyle Campaign" in Singapore, all aim to encourage more people to be physically active to improve their health.

Compared to the adult population, the benefits of physical activity in young people are not as clearly understood. Divergent viewpoints have been expressed about physical activity among young people in terms of its tracking into adulthood, or its long-term benefits for the prevention of chronic heart disease (Kemper, Post, Twist, & Van Mechelen, 1999; Pate et al., 1999; Williams, 1994). While further research is required to provide more conclusive evidence, there is widespread consensus among health experts that regular participation in physical activity is beneficial to children and adolescents, at least in terms of short-term health. These include areas such as cardiovascular fitness, psychological health, skeletal health, blood pressure, body composition, as well as glucose, insulin, and blood lipids (Biddle, Sallis, & Cavill, 1998; Health Education Authority, 1997; Sallis, 1994). The strong justification of the need for physical activity promotion among young people leads to prescriptions of the amount of physical activity necessary to gain maximum health benefits (Health Education Authority, 1997; Sallis, 1994; Pate et al., 1995). The current recommendation in the United Kingdom is for young people to participate in thirty to sixty minutes of moderate to vigorous physical activity on most days of the week (Biddle et al., 1998). Similarly, in the United States, the National Institutes of Health (NIH) Consensus Development Panel on Physical Activity and Cardiovascular Health recommended that "all children and adults should set a long-term goal to accumulate at least 30 minutes or more of moderate intensity physical activity, on most, or preferably all days of the week." (NIH, 1996).

A few studies have attempted to identify the factors that influence physical activity participation among young children (e.g., Bungum, Dowda, Weston, Trost, & Pate, 2000; Sallis, Prochaska, & Taylor, 2000), but none have apparently addressed the same situation in Asian populations. Identifying the factors which influence young people in physical activity participation is important for guiding intervention programmes (Sallis et al., 1992). Henceforth, the purposes of the current two studies were (i) to examine the sedentary behaviors and physical activity patterns of young people (Study 1) and (ii) to examine the psychological determinants of physical activity in young people (Study 2). The first study investigated the inter-relationships between sedentary behaviors and

physical activity, while the second study examined the psychological determinants of physical activity.

There is a common assumption that sedentary behavior has a negative relationship with physical activity. For example, the use of multimedia technology (e.g. television, video, and computer) has been related to physical inactivity among young people (Andersen, Crespo, Bartlett, Cheskin & Pratt, 1998; McGuire, Neumark-Sztainer, & Story, 2002; Pate et al., 1997; Robinson et al., 1993; Taras et al., 1989; Vandewater, Shim, & Caplovitz, 2004). Findings from these cited studies are however equivocal. For example, McGuire et al. (2002) reported no significant relationship between television viewing and physical activity while Andersen et al. (1998) suggested that television viewing resulted in decreased physical activity. A study in Singapore (Chia, Wang, Teo-Koh, Quek & Gosian, 2002) showed that the increased use of information and communications technology (e.g. computer) did not have any negative impact on self-reported physical activity among pupils of a normal body weight. Also, many of the cited studies singled out multimedia technology as the only type of sedentary behavior (e.g., Vandewater et al., 2004). It might be useful to examine sedentary behaviors in a wider context.

Some researchers (e.g., Marshall, Biddle, Sallis, McKenzie, & Conway, 2002) have suggested using multiple sedentary behavior indicators, as opposed to focusing on a single behavior for studying youth behavior as they enable a more complete examination of lifestyle behavior and provide potential for planning interventions. Indeed, Marshall et al. (2002) investigated the multiple sedentary behaviors of American and British children (N = 2494) in relation to physical activity behavior. Multiple sedentary behaviors included TV viewing, video game playing, talking on the phone, sitting and talking to friends, using the computer, reading, and doing homework. Their study results showed that physical activity and sedentary behaviors were not inversely related and that boys and girls had different patterns of sedentary behaviors. Additionally, older girls from the USA tended to be more inactive compared to the sample from the UK. Apart from the results of Marshall et al., there is apparently no relevant or equivalent study on Asian populations using the approach of multiple sedentary indicators to explain youth behavior. A comprehensive study on physical activity patterns and sedentary behaviors of Singaporean youth would help researchers to understand how young people in Singapore spend their free time. However, there is also a need to better understand the determinants of physical activity in young people at the same time.

In the related literature on the determinants of physical activity (e.g., Biddle, Wang, Chatzisarantis, & Spray, 2003; Sallis et al., 2000; Wang & Biddle, 2001), motivational variables focused on sport ability beliefs, perceived competence, and perceptions of autonomy seem to be influential in physical activity participation among young children. For example, Biddle et al. (2003) found that an incremental belief, that is, athletic ability is open to improvement and can be developed through learning predicted high enjoyment in physical activity directly, as well as indirectly through task orientation. A fixed belief (entity) that athletic ability is stable and a gift predicted self-amotivation towards physical activity. In another study, it was found that children who perceive to be more 'self-determined' tend to participate more in recreation physical activities (Wang &

Biddle, 2001). In additional, it was found that girls were overrepresented in the clusters that had lower perceived competence and higher amotivation and more boys were in the high motivational adaptive profile. This is consistent with previous findings that found girls are less active than boys between the ages of six and 18 years (Armstrong & Welsman, 1997; Gilbey & Gilbey, 1995; Sallis & Owen, 1999; WHO, 2000). Using the Self Determination Theory (SDT; Deci & Ryan, 1985) and self-theories of ability (Dweck, 1999; Dweck & Leggett, 1988) framework, these cited studies have shown that physical activity participation among children and young adolescents varies with the levels of motivation, which is conceptualized as lying along a continuum from being autonomously endorsed to more controlling in nature (for review, see Deci & Ryan, 1985; Ryan & Deci, 2000a, 2000b).

Self-determination theory (SDT) is an organismic theory of motivation that accounts for psychological needs and motives. The psychological needs include the needs of autonomy, competence, and relatedness (social needs). The need for autonomy is defined as the need to feel ownership of one's behaviour. The need for competence refers to the need for producing desired outcomes and to experience mastery and effectiveness (Deci, Vallerand, Pelletier, & Ryan, 1991). The need for relatedness is the need to feel that one can relate to others and with the social world in general (Ryan, 1993). People are motivated to satisfy these needs because it is essential for the development of self. When autonomous, people experience choice and freedom in their actions, which is characterized by an absence of external pressures (Deci & Ryan, 1987). On the other hand, when a person is compelled to do certain things, that is, when the behaviour is not self-determined, the person is controlled. In this case, autonomy is deprived and competence cannot be regulated. Therefore, if the needs for autonomy, competence, and relatedness are satisfied, intrinsic motivation will increase; if not, intrinsic motivation will be undermined.

In addition, there exists a process of internalization through which individuals satisfy their needs. This process involves a shift from external to internal locus of causality (Deci et al., 1991) as individuals try to rationalize the behavioural outcomes relevant to their need satisfaction. That is, the more internalized a behaviour regulation, the more it will be experienced as autonomous (Ryan & Connell, 1989). Ryan and Connell also suggest that there are four main types of behavioural regulations central to self-determination theory, each one reflecting a qualitatively different 'reason' for acting out the behaviour in question. They are external regulation, introjected regulation, identification, and intrinsic motivation. External regulation refers to behaviour that is controlled by external means such as rewards or external authority. Introjected regulation refers to behaviour that is internally controlling or self-imposed, such as acting out feelings of guilt avoidance, and is characterized by feeling of 'ought'. When identified, the behaviour is self-determined according to one's choice or values. It is characterized by feelings of 'want' rather than 'ought'. Finally, intrinsically motivated behaviour is behaviour that is solely for its own sake or enjoyment. These four behavioural regulations can be assessed by using the Perceived Locus of Causality scale (PLOC; Ryan & Connell, 1989). The four regulations form a continuum which characterizes the degree of internalization

of the behaviour (Deci et al., 1991). In addition, based on the study of Ryan and Connell (1989), Goudas, Biddle and Fox (1994) showed that an overall relative autonomy index (RAI) can be calculated by weighting each subscale to indicate the level of autonomy in the following way: external regulation x (-2) + introjection x (-1) + identification x (1) + intrinsic motivation x (2). This serves as an indicator of a person's motivational orientation. Positive scores indicate more autonomous regulation and negative scores indicate more controlling regulation.

Dweck (1986) presents a model of implicit theories of intelligence to explain the general conceptualization of goals in the academic domain. According to her, two clusters of beliefs underpin the adoption of achievement goals. Specifically, children with a fixed 'entity' theory of intelligence are more likely to set ego-oriented (performance) goals as a way to display that entity. In contrast, children with an 'incremental' theory of intelligence are more likely to set task-oriented (learning) goals. Here, for these children, intelligence is seen as malleable, controllable, and changeable. In addition, when faced with setbacks, children with an entity theory of intelligence set performance goals and exhibit a maladaptive motivational pattern, characterized by negative cognitions, negative affect, and show a sharp decline in performance. On the other hand, children with an incremental theory of intelligence set learning goals and demonstrate more adaptive patterns, characterized by positive thoughts, positive affect, and effective problem-solving strategies (Dweck, 1986; Dweck, 1988; Heyman & Dweck, 1992).

Adopting such notions in the physical domain, studies (Biddle, Soos, & Chatzisarantis, 1999; Lintunen, Valkonen, Leskinen, & Biddle, 1999; Sarrazin et al., 1996; Biddle et al., 2003) have found that enjoyment of physical activity in youth was predicted directly by task orientation and incremental beliefs and entity beliefs directly predicted self-reported amotivation towards physical education and sport. These studies provide support for the role of sport ability beliefs, with goal orientations and perceptions of competence, in gaining insight into motivated behaviour of young people in physical activity.

There are apparently no data on the relationships between physical activity and sedentary behaviors, as well as psychological determinants of physical activity among young people in Singapore. The purpose of the Study 1 was to examine the relationships between physical activity participation and sedentary behaviors using multiple sedentary indicators among Singaporean school children. This was a replication of the study conducted by Marshall et al. (2002). Specifically, Study 1 examines whether homogenous groupings of children could be identified based on their sedentary behaviours and physical activity patterns and determines the gender differences in sedentary behaviours and physical activity patterns. Study 2 examined the psychological determinants of physical activity among Singaporean school children using the SDT and sport ability beliefs frameworks.

Study 1: Patterns of Sedentary Behaviors and Physical Activity

Method

Participants

A sample of 780 primary school children aged 11 to 14 years took part in the study (*M* = 12.24 yrs.; *SD* = .47 yrs.). There were 285 boys and 482 girls. Thirteen participants did not indicate their gender). The children were attending Primary 6 academic level in the Singaporean school system.

Procedures

The University Ethics Review Committee granted approval for all the procedures described in the study. All school principals and participants gave their informed consent to participate in the study. Researcher assistants administered the questionnaire in a quiet classroom setting. All participants were told that their participation in the study was voluntary and they were free to withdraw at any time, without any consequence. The participants took 15 minutes to complete the questionnaire. When completing the questionnaire, participants were informed that there were no right answers or wrong answers. They were assured of the confidentiality of their responses, and were encouraged to ask questions if necessary.

Measures

Modified Self-administered Physical Activity Checklist (SAPAC). A modified SAPAC with a seven-day physical activity recall instead of a previous day recall (Sallis, Strikmiller, Harsha, & Feldman, 1996; Marshall et al., 2002) was used to measure the pupils' engagement in physical activity and sedentary behaviors. The use of the longer time frame of recall minimizes the recap of sporadic behaviors typical among young children (Sallis & Saelens, 2000). The three categories of physical activity were: sport and dance (e.g., basketball, rugby and folk dance), exercise (e.g., walking for exercise, cycling machine and weight training), general physical activity (e.g., hiking and walking as part of transport). A total of 32 physical activities were listed. Open-ended items were used to record any additional activities not listed in each category. One separate category for sedentary behaviors contained seven listed sedentary activities (e.g., TV watching, doing homework, and talking on the phone).

The participants needed to recall whether they had engaged in the activity over the last seven days. If they did, they were then asked to recall the number of times they engaged in the activity and recall the time in minutes per session spent in that activity. Each activity in the list was assigned a metabolic equivalent (MET) value (Ainsworth et al. 1993; Ainsworth et al. 2000) that characterized the amount of energy that the body expends during the activity (one MET is equivalent to 1 $kcal.kg^{-1}.hr^{-1}$). To estimate how much energy was expended for any one particular activity, the total duration in hours per week was obtained by multiplying the number of times by minutes per session and

dividing by 60. The resulting value was then multiplied by the MET value assigned for that activity (Ainsworth et al. 1993; Ainsworth et al. 2000). A total MET value was obtained when all the MET expenditure of all the activities were summed.

The seven-day recall SAPAC's test-retest reliability was 0.42 for USA youth (N = 100) and the mean interclass correlation coefficient across the seven sedentary items was 0.70 (Marshall et al., 2002). In this study, the mean intraclass correlation coefficient was 0.60. The physical activity items were also shown to have acceptable levels of test-retest reliability and validity among fifth grade boys and girls in relation to accelerometer and heart rate monitor measures (Sallis et al., 1996).

Results

Preliminary Analyses

Initial analyses showed that the univariate distribution of each sedentary behavior was positively skewed and leptokurtic. In order to reduce the skewness and kurtosis, each sedentary behavior was polychotomised with cut-off points based on Marshall et al.'s (2002) study. That is, time spent on computer/internet, playing video games, doing homework, reading (not for school), sitting and talking/ listening to music, and talking on the telephone were categorized into 4 categories: None (0 hour/week), Low (0.1 to 2.9 hour/week), Moderate (3.0 to 6.9 hour/week), and High ($\geq$ 7 hour/week). Television watching was classified into 5 categories: None (0 hour/week), Low (0.1 to 6.9 hour/week), Moderate (7.0 to 13.9 hour/week), High (14.0 to 27.9 hour/week), and Very High ($\geq$ 28 hour/week). In addition, the levels of physical activity participation was recoded into four categories: No Activity (0 min/week), Low Activity (> 0 but either $\leq$ 150 mins of moderate activity (4 to 6 METs) or $\leq$ 60 mins/week of vigorous activity ($\geq$ 6 METs), Moderate Activity (either > 150 and $\geq$ 300 mins/week of moderate activity or > 60 and $\leq$ 120 mins/week of vigorous activity), and High Activity (either > 300 mins/weeks of moderate activity or > 120 mins/week of vigorous activity).

Descriptive Statistics and Gender Differences

Table 1 shows the prevalence of sedentary and physical activity behaviors among the overall sample and for gender in the eight types of activity. The results showed that majority of Singaporean children (68.8%) spent more than seven hours per week doing homework. More than 65% of them spent little or no time in the use of the computer, playing video games, reading, sitting and talking, telephone and watching television. In terms of physical activity participation, 60% of the children reported a high amount of physical activity (> 300 mins/wk of moderate activity or > 120 mins/wk of vigorous activity). Only 19% of them reported low or no physical activity.

Table 1. Prevalence (%) of Sedentary and Physical Activity Behaviors for the Overall Sample and among Boys and Girls.

Engaged Activity	None (0 hr/wk)	Low (0.1-2.9 hr/wk)	Moderate (3-6.9 hr/wk)	High (≥ 7 hr/wk)
COMPUTER/INTERNET				
Overall	22.7	42.1	19.1	16.2
Boys	25.3	38.9	21.8	14.0
Girls	21.2	44.2	17.8	16.8
VIDEO GAMES				
Overall	72.7	16.2	6.4	4.7
Boys	56.1	28.1	7.4	8.4
Girls	82.6	9.3	5.6	2.5
HOMEWORK				
Overall	11.7	6.9	12.6	68.8
Boys	11.9	10.9	14.0	63.2
Girls	11.6	4.8	11.8	71.8
READING				
Overall	34.9	34.9	17.1	13.2
Boys	42.1	35.8	11.9	10.2
Girls	30.5	34.9	20.1	14.5
SIT & TALK				
Overall	29.9	34.1	16.7	19.4
Boys	41.8	34.4	12.6	11.2
Girls	22.8	34.6	18.7	23.9
TELEPHONE				
Overall	31.9	49.7	9.0	9.4
Boys	42.8	46.0	7.4	3.9
Girls	25.5	52.1	9.8	12.7

TV Watching	None (0 hr/wk)	Low (0.1-6.9 hr/wk)	Moderate (7-13.9 hr/wk)	High (14-27.9 hr/wk)	Very High (≥ 28 hr/wk)
Overall	17.3	37.8	22.4	17.1	5.4
Boys	17.9	40.0	22.1	14.0	6.0
Girls	17.0	36.9	22.2	18.9	5.0

Physical Activity	Inactive (0 hr/wk)	Low (≤ 150 mins/wk of MOD or ≤ 60 mins/wk of VIG)	Moderate (> 150 and ≤ 300 mins/wk of MOD or > 60 and ≤ 120 mins/wk of VIG)	High (> 300 mins/wk of MOD or > 120 mins/wk of VIG)
Overall	3.2	15.8	20.9	60.1
Boys	3.9	13.3	16.8	66.0
Girls	2.5	16.8	23.4	57.3

Table 2. Polychoric Correlation Matrix for the Sedentary Behaviors and Physical Activity

Variables	1	2	3	4	5	6	7	8
1. Computer / Internet	1.00							
2. Video Games	.26**	1.00						
3. Homework	.16**	-.04	1.00					
4. Reading	.12**	-.01	.23**	1.00				
5. Sit & Talk	.21**	.04	.21**	.26**	1.00			
6. Telephone	.27**	.10**	.15**	.15**	.31**	1.00		
7. TV Watching	.23**	.22**	.18**	.08*	.20**	.17**	1.00	
8. Physical Activity	.11**	.12**	.06	.06	.10**	.12**	.03	1.00

Note. * $p < .05$, ** $p < .01$.

Results from the polychoric correlations (See Table 2) showed that use of computer / internet had small but significant positive relationships with playing video games, sitting and talking, and telephone and television watching. The relationships between reading, sitting and talking, using the telephone, and watching the television were positive (all $p < .01$). Finally, the results did not show any negative relationship between physical activity and any of the sedentary behaviors.

Chi-square analyses were conducted to determine differences between boys and girls in terms of their patterns of physical activity and sedentary behaviors. The results showed significant differences between genders in six out of the eight activities. Specifically, boys spent significantly more time playing video games [$\chi^2(3, N = 767) = 70.09$, $p < .05$] and doing physical activity [χ^2 (3, N = 767) = 8.47, $p < .05$] than girls. On the other hand, girls spent more time in study [χ^2 (3, N = 767) = 12.13, $p < .05$], reading [χ^2 (3, N = 767) = 16.64, $p < .05$], sitting/talking with friends [χ^2 (3, N = 767) = 40.39, $p < .05$], and using the telephone [χ^2 (3, N = 767) = 34.01, $p < .05$] than their male counterpart. Subsequent analyses were conducted separately for both genders.

Cluster Analysis

To examine the patterns of sedentary and physical activity behaviors among Singaporean children, two cluster analyses were performed separately for each gender. The objective of the cluster analysis was to identify homogenous groups of children with similar sedentary behaviors and physical activity patterns.

Using the hierarchical methods with agglomerative clustering, each observation starts out as its own cluster (Anderberg, 1973). New clusters are formed by the combination of the most similar cluster until all clusters are grouped into one cluster. The agglomeration schedule and dendrogram were used to identify the number of clusters. Greater increase in distant or coefficient indicated two dissimilar clusters are combined together.

Before clustering, the polychotomised scores for all the seven sedentary and physical activity behaviors for the boys and girls collectively were standardized using *Z* scores (mean of 0 and a standard deviation of 1). This procedure allows comparison across all the variables at the same level. Distinguishing characteristics of each cluster are indicated by high or low z-scores of ±0.5. The agglomeration schedule and dendrogram suggested a three-cluster solution to be suitable for both genders. Figures 1 and 2 show the cluster profiles in standardized scores for boys and girls, respectively.

Boys. In Cluster 1, 75 boys (26.3%) were grouped together with similar sedentary behaviors and physical activity patterns. The characteristics of this group of boys were very low level of study and reading time and socialization activities, such as talking and use of the telephone. They tended to spend their time in playing video games and engaged in an above average amount of physical activity among children of the same age (86.7% of them met or exceeded recommendations for physical activity engagement). This cluster was labeled as "Non-academically-inclined" cluster.

Cluster 2 consisted of 37.9% of the boys (N = 108). This cluster was labeled as "Academically-inclined" as they had highest time spent studying compared to the other two groups and lowest for time spent on the computer/internet, playing video games, and television watching. They participated in above average amount of physical activity (78.7% of them met or exceeded recommendations for physical activity engagement).

In Cluster 3, 35.8% of the boys (N = 102) spent much of their sedentary time in technology-based entertainment (e.g., computer/internet, video games, TV watching). However, they also spent a high amount of time in study, reading, and physical activity (84.3% of them met or exceeded recommendations for physical activity engagement) compared to their peers. This cluster was labeled as "Techno Actives".

Girls. Among the girls, three homogenous groupings were also found. The first cluster was identical to the boys' "Academically-inclined" cluster (Cluster 2). A high amount of their time was spent in studying and a low amount of time was spent on use of computer/internet, video games, reading, and socialization. In contrast to their male counterparts, they did not participate much in physical activity. This cluster consisted of 27.8% (N = 134) of the sample of girls.

The second cluster of girls was unique in that they scored the highest for the use of the computer/internet, TV watching, socializing with friends, studying, and reading. They also scored the highest for physical activity participation. There were 276 girls in this cluster (57.3%). This cluster was labeled as "Active Socialisers".

In Cluster 3, 15% of the girls (N = 72) reported spending the least amount of time spent studying, reading, socializing with friends, TV watching, and physical activity compared to their peers. This cluster was labeled as "Inactive and Non-Academically-inclined" cluster.

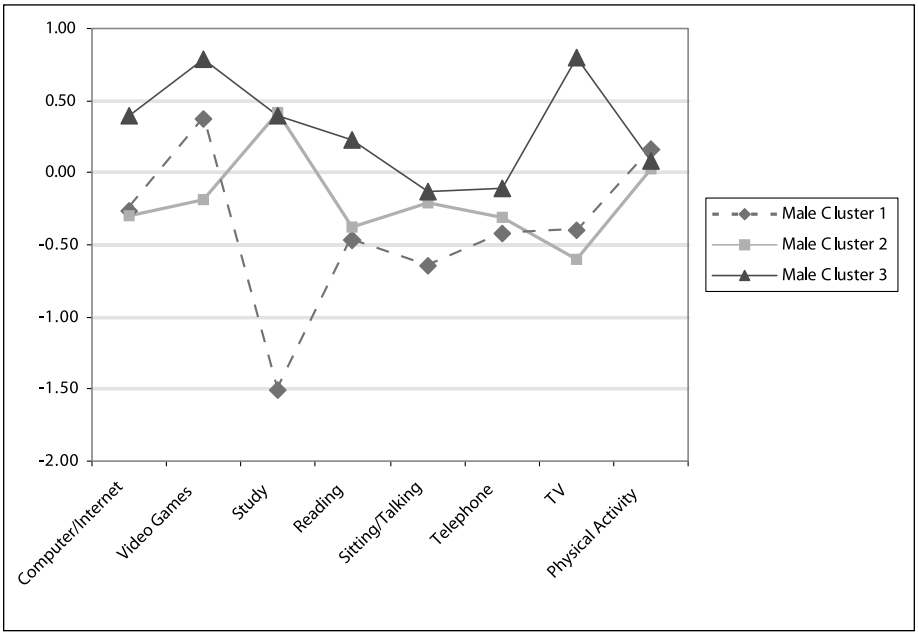

Figure 1. The cluster profiles of sedentary behaviors and physical activity for boys.

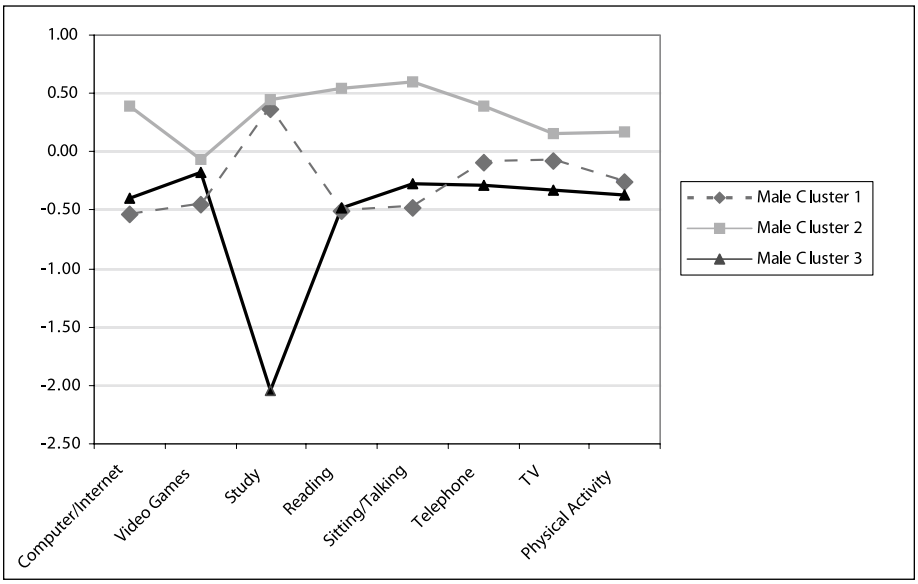

Figure 2. The cluster profiles of sedentary behaviors and physical activity for girls.

Discussion

The main purpose of Study 1 was to examine the prevalence and inter-relationships between sedentary behaviors and physical activity patterns among Singaporean school children. One pertinent result from this study was that Singaporean school children spent most of their time in doing homework or studying. Specifically, the average amount of time spent doing homework or studying was 2.3 hour per day (about 70% of the sample spent more than 7 hours per week in study). This is higher than the 64% and 36% reported for children in the USA and UK, respectively (Marshall et al., 2002; Sharp, Keys, & Benfield, 2001).

Another interesting finding of the present study was that Singaporean school children spent little time in TV watching. Only 5% of the boys and 6% of the girls watched more than four hours per day in TV watching, this is in stark contrast with previous research that reported that about one-third of children in the USA and UK watched TV for more than four hours per day (Andersen et al., 1998; Marshall et al., 2002; Taras et al., 1989). Indeed more than 50% of the school children in Singapore do not spend more than an hour per day watching TV.

The cluster profiles identified in this study were very different from those found among the USA and UK samples in a previous study (Marshall et al., 2002). Apart from the "Techno Actives" among the boys and "Active Socializers" among the girls, all other clusters were unique to the Singaporean sample. The "Non-Socialising Actives" and "Uninvolved Inactives" found in Marshall et al.'s (2002) study were not found in the Singaporean sample. The differences in their activity patterns could be due to the different educational systems. In Singapore, there is a strong emphasis on academic achievement. For example, in a recent study conducted by the International Association for Evaluation of Educational Achievement (IEA) based in Boston, USA, Singapore has emerged first in both Mathematics and Science in a 49-country study of Grade 4 (Primary 4) and Grade 8 (Secondary 2) students (National Center for Education Statistics, 2005). This study affirms the high quality of Mathematics and Science education in Singapore. Thus, the Singaporean children may need to spend more time in doing homework and study and less time in television watching. There is a need to examine the congruency of this claim in future studies.

The present findings showed that physical activity was not negatively correlated with most of the sedentary behavior indicators (r ranged from .03 to .12; mean r = .08). This is consistent with the findings reported in previous studies (e.g., Andersen et al., 1998; Katzmarzyk, Malina, Song, & Bouchard, 1998; Marshall et al., 2002; Myers, Strikmiller, & Webber, 1996; Owen, Leslie, Salmon, & Fotheringham, 2000). Some clusters showed that high levels of sedentary behaviors and physical activity could coexist (e.g., Cluster 3 for boys and Cluster 2 for girls). Therefore, sedentary behaviors and physical activity patterns were not competing activities, at least in the present study. There is a need to use different methods to collect and classify sedentary and physical activities and to validate the self-report instruments in future studies.

In terms of physical activity participation, the majority of the children in Singapore

(66% of boys and 57% of girls) were spending more than 300 minutes per week in moderate intensity physical activity or more than 120 minutes per week of vigorous intensity physical activity. These exceeded the current physical activity recommendations for youth by two times. However, the physical activity reported was still lower when compared to children in the USA (81% for boys and 76% for girls) and in UK (79% for boys and 61% for girls), respectively in Marshall et al.'s study (2002). Boys were more physically active than girls, in agreement with the findings of others (e.g., Biddle, et al., 1998; Pratt, Macera, & Blanton, 1999; Sallis et al., 2000).

In summary, the findings of Study 1 showed that physical activity and sedentary behaviors were not inversely related. Therefore, interventions that focus on reducing sedentary behaviors may not be effective. There is a need to examine further the determinants of physical activity so as to guide any future physical activity interventions.

Study 2: Psychological Determinants of Physical Activity

The findings from Study 1 suggested that sedentary behaviours and physical activity are not two sides of the same coin. Therefore, research focusing on determinants of physical activity could be conducted independently of sedentary behaviours. A recent review by Sallis et al. (2000) suggested that psychological variables focusing on perceived competence, perceived support and beliefs are consistently associated with physical activity of children. Wang and Biddle (2001) showed that five homogenous groups of children with different levels of perceived competence, goal orientations, sport ability beliefs, and perceptions of autonomy were found in a large sample of UK young adolescents (N = 2510). These clusters differed significantly in their perceived self-worth and physical activity participation. However, whether these findings are universal to all children outside of the USA and UK is in need of investigation.

The aim of the present study was to examine the relationships between sport ability beliefs, perceived competence, and autonomy using a separate sample. In this study, the physical activity participation measured by the modified SAPAC was used to validate the clusters. This is considered a strength because Wang and Biddle (2001) used a very crude measure of physical activity (one item) in the validation procedure in their study. The use of the modified SAPAC was more accurate and complete with the different categories of sedentary behaviors and physical activity. Specifically, it was hypothesized that there are subgroups of children with distinct profiles based on sport ability beliefs, perceptions of competence, and autonomy. The clusters characterized by higher incremental beliefs, more self-determined motivation, and higher perceived competence will be involved in greater levels of physical activity compared to clusters with higher entity beliefs, less self-determination, and lower perceived competence.

Method

Participants

In the present study, 1155 pupils from three primary schools in Singapore were involved. This sample is completely separate from the sample for Study 1. The children were mainly aged between 10 and 12 years (M = 11.27; SD = .84) and attending Primary 4 to 6 academic levels. These were 595 boys and 533 girls, spread across the academic levels.

Procedures

The procedure used was similar to the first study except that the participants took a longer time (20 to 30 minutes) to complete the questionnaire in a quiet classroom setting. Participants were informed that there were no right or wrong answers and that they were free to withdraw at any time.

Measures

Modified Self-administered Physical Activity Checklist (SAPAC). The modified SAPAC used in the first study was used to measure the frequency and duration of sedentary behaviors and physical activity. A sedentary activity score was obtained by multiplying the frequency and duration of each sedentary behaviour and summing up all the seven sedentary activities. Similarly, a physical activity score was tabulated by summing up the duration of all types of physical activities. Both variables were not polychotomised as this will restrict the statistical methods used in the present study.

Sport ability beliefs. The English version of the 'Conceptions of the Nature of Athletic Ability Questionnaire, Version 2' (CNAAQ-2; Biddle et al., 2003) was used to assess incremental and entity sport beliefs. There were six items for each subscale. Two examples of items for Incremental Beliefs were "to be successful in sport you need to learn techniques and skills, and practice them regularly" and "how good you are at sport will always improve if you work at it". Two examples of items for Entity Beliefs were "it is difficult to change how good you are in sport" and "to be good in sport you need to be naturally gifted". Responses were made on 5-point scales ranging from "strongly disagree" (1) to "strongly agree" (5).

Relative Autonomy Index (RAI). The perceived autonomy in exercise context was measured using the Exercise Self-Regulation Questionnaire (SRQ-E) scale developed by Ryan and Connell (1989). There are four subscales: External regulation (4 items, e.g., "because I worry that I would get into trouble with others if I did not"), Introjection (4 items, e.g., "because I'll feel bad about myself if I didn't"), Identification (4 items, e.g., "because it feels important to me personally to accomplish this goal"), and intrinsic motivation (4 items, e.g., "because I enjoy exercising"). Responses were also made on 5-point scales similar to the CNAAQ-2. An overall Relative Autonomy Index (RAI) was calculated by weighting each subscale to indicate the level of autonomy in the following way: External Regulation x (-2) + Introjection x (-1) + Identification x (1) + Intrinsic motivation x (2). This serves as an indicator of a person's motivational orientation with positive

scores indicating a more autonomous regulation and negative scores representing a more controlling regulation.

Perceived competence. Perceived competence was assessed using the Sport Competence subscale of the Children's version of the Physical Self-Perception Profile (PSPP-C; Fox & Corbin, 1989; Whitehead, 1995). This subscale contains six items. Two examples of items were 'some people feel that they are good when it comes to playing sport' and 'some people are quite confident when it comes to taking part in sports activities'. Responses were given on 5-point scales ranging from 1 (this is not at all like me) to 5 (this is very much like me).

Demographic information. Participants' personal information such as gender, athletic status, height, weight, and age were also collected.

Results

Descriptive Statistics and Correlations

Table 3 shows the descriptive statistics, internal consistency coefficients, and correlations for the whole sample and for both genders. Cronbach's alphas for all the scales were satisfactory ($\alpha > .70$). The participants had high incremental beliefs about sport ability, relatively high scores on perception of autonomy and perceived competence. They also engaged in relatively high levels of physical activity. Table 3 also shows the inter-correlations between the variables. Physical activity was positively correlated with perceived competence, incremental beliefs, and RAI. No relationship existed between entity beliefs and physical activity. Sedentary behaviors were not correlated with physical activity.

Table 3. Descriptive Statistics, Correlation and Internal Consistency Coefficients for the Overall Sample

Variables	α	Overall Mean	SD	Boys Mean	SD	Girls Mean	SD	1	2	3	4	5
1. Incremental	.84	3.96	0.84	3.92	0.93	4.00	0.72	1.00				
2. Entity	.79	2.79	0.92	2.78	0.99	2.80	0.84	.17**	1.00			
3. Perc. Competence	.78	3.81	0.73	3.87	0.74	3.75	0.71	.34**	-.02	1.00		
4. RAI	---	5.34	3.20	5.42	3.25	5.30	3.13	.21**	-.29**	.31**	1.00	
5. Physical Activity	---	2720	1968	2758	1973	2679	1963	.18**	.03	.22**	.14**	1.00
6. Sedentary Activity	---	1843	1243	1870	1172	2059	1230	.02	-.09**	.12**	.12**	.24**

Note. ** $p < .01$., Perc. Competence = perceived competence, RAI = Relative Autonomy Index (Alpha coefficients for external regulation = .72, introjection = .71, identification = .73, and intrinsic motivation = .72)

RAI was positively associated with incremental beliefs and perceived competence but negatively correlated with entity beliefs.

Gender Differences

Two one-way MANOVAs were conducted to examine differences between the two genders in the four psychological determinants (incremental and entity beliefs, perceived competence, and RAI) and physical and sedentary activities. For the first MAONVA, results revealed that significant differences were found between the two genders and the four psychological determinants, Wilk's Λ = .987, $F(4, 1123) = 3.76$, $p = .005$, $\eta^2 = .01$. Follow-up ANOVAs showed that only perceived competence differed significantly between boys and girls, $F(1, 1128) = 4.15$, $p = .005$, $\eta^2 = .01$. However, the effect size was small. In terms of physical activities and sedentary activities, no significant differences were found between the genders (Wilk's Λ = .990, F(2, 456) = 2.35, p = .10, ?2 = .01). In view of the small differences, the cluster analysis was conducted with the whole sample.

Cluster Analysis

The cluster analysis was conducted with incremental and entity beliefs, Relative Autonomy Index (RAI), and perceived sport competence. The procedure and methods used were similar to that used in the first study. To enhance the power of the procedure, physical activity and sedentary behaviors were not included in the cluster analysis but were used later to check if the clusters identified differed significantly in these two measures. This was considered as a validation procedure for the cluster analysis (see Hair, Anderson, Tatham, & Black, 1998).

After examining the dendrogram and agglomeration schedule, it was found that a three-cluster solution was suitable to describe the sample. Figure 3 shows the profiles of the three clusters.

The first cluster composed a majority of the sample (N = 669, 58%). The characteristic of this group was low incremental beliefs and low perceived competence. This cluster group was comprised of 50.8% of boys and 49.2% of girls. This cluster consisted mainly of older children (51.3% from Primary 6, 25.2% from Primary 5 and 22.5% from Primary 4). 14.1% of them represented their schools in various sports and games. This cluster also had a similar profile as Wang and Biddle's (2001) "Poorly Motivated" cluster.

The second cluster was represented by 301 children with high incremental beliefs, RAI and perceived competence, and they had very low entity beliefs. A slightly higher percentage of them were boys (55.6%). Very few Primary 4 children were found in this cluster (18.6% Primary 4, 32.6% from Primary 5 and 48.8% from Primary 6). A high proportion was school athletes (25.7%). This cluster profile was similar to the "Self-Determined" children in Wang and Biddle's (2001) study.

The final cluster comprised of 186 children, of which 55.2% were boys. The unique characteristics of the cluster were high incremental beliefs, extremely high entity beliefs, and high perceived competence. They had moderately low RAI. A majority of them were lower primary children (34.9% from Primary 4, 37.6% from Primary 5 and 27.4%

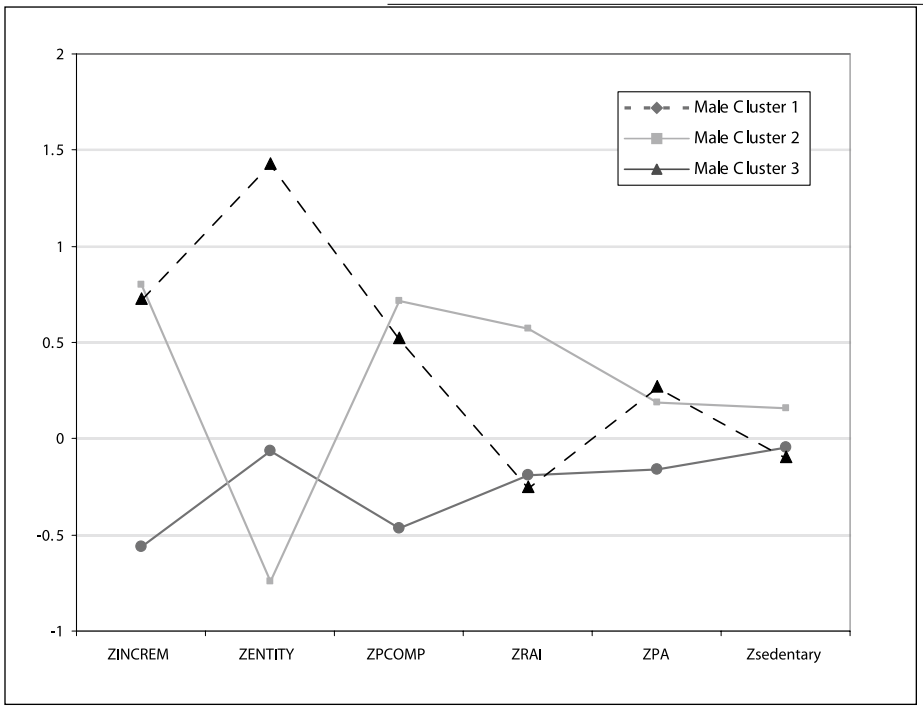

Figure 3. Profiles for the 3 clusters with sedentary behaviors and physical activity patterns.
(Note. PA and Sedentary behaviours were not included in the cluster analysis)

Table 4. Cluster Means, Standard Deviations and Z Scores for the Three Clusters

	Cluster 1 N = 669			Cluster 2 N = 301			Cluster 3 N = 186		
	Mean	**SD**	**Z**	**Mean**	**SD**	**Z**	**Mean**	**SD**	**Z**
Clustering Variables									
1. Incremental	3.49	.76	-.56	4.63	.36	.80	4.56	.40	.72
2. Entity	2.73	.69	-.06	2.11	.70	-.74	4.10	.51	1.43
3. Perceived Competence	3.47	.71	-.47	4.33	.40	.71	4.19	.46	.52
4. RAI	4.74	3.18	-.19	7.18	2.43	.57	4.55	3.24	-.25
Cluster Characteristics									
5. Physical Activity	2398	1891	-.16	3080	2018	.19	3238	1999	.27
6. Sedentary Activity	1788	1226	-.04	2039	1223	.16	1722	1308	-.10

from Primary 6). The "Highly Motivated" cluster of Wang and Biddle's (2001) study also display similar characteristics. Although in their study, the RAI score was much higher.

Cluster Differences in Physical and Sedentary Activities

In order to examine whether the three clusters identified were meaningful in differentiating levels of physical and sedentary activities, two separate one-way ANOVAs were conducted using physical activity and sedentary activity as dependent variables and the clusters as the independent variables. Both ANOVAs showed significant differences between the three clusters on the dependent measures ($F(2, 1152) = 20.89$, $p < .001$, $\eta^2 = .04$, for physical activity, and $F(2, 1152) = 5.31$, $p = .005$, $\eta^2 = .010$, for sedentary activity, respectively). Post-hoc Tukey's tests indicated that Cluster 1 had significantly lower physical activity compared to Clusters 2 and 3 ($p < .001$), but there were no differences between Clusters 2 and 3. In terms of sedentary activity, the children in Cluster 2 had significantly higher levels of sedentary activity compared to Clusters 1 and 3 (both $p < .05$). No differences were found between clusters 1 and 3.

Discussion

Understanding the determinants of physical activity has been identified as a research priority (Sallis et al., 1992). The main aim of the second study was to examine the relationships between sport ability beliefs, perceived competence and autonomy, and sedentary and physical activity patterns. Three clusters of children were found to have distinctive patterns of beliefs and perceptions of competence and autonomy, similar to a previous study (Wang & Biddle, 2001). This provides the evidence that sport ability beliefs, perceived competence, and RAI contribute to participation in physical activity among children.

Results confirmed that young people with a combination of high incremental beliefs, low entity beliefs, high perceived competence, and high RAI tended to be involved in high levels of physical activity (Cluster 2). Therefore, the hypothesis was supported. Moreover a high proportion of school athletes was found in the cluster implied that many of the physical activities involved were competitive sport and games. Wang and Biddle (2001) showed that young people from this cluster had high perceived physical self-worth. These suggested that cultivating a belief that athletic ability is changeable through learning and effort, and promoting a task mastery and autonomy supportive environment are keys to promoting physical activity (Ames, 1992; Dweck, 1999; Ryan & Deci, 2000a).

The children from the Cluster 2 also reported the highest amount of sedentary activity. This supported the findings of the first study where physical activity and sedentary behaviors were not inversely related. In fact, they coexisted. In addition, almost 50% of them were older children. In the Singaporean context, it may be that older children have more freedom to socialize; they may also spend more time for studying in preparation of the Primary School Leaving Examination (PSLE).

A high proportion of the sample (58%), particularly the older children from Primary 6 (51.3%), was found in the least favorable cluster (Cluster 1). This cluster had low incremental beliefs and low perceptions of competence. Dweck (1999) posits that incremental beliefs lead to the adoption of learning goals and thus reflect the goal of developing one's competence. A low incremental belief may lead to low persistence, especially when faced with obstacles. It has been shown that ability beliefs had a direct impact on individuals' motivational patterns. Biddle and his colleagues (Biddle et al., 2003) found that incremental beliefs, through task orientation, predicted intentions to be physically active in their first study, and negatively predicted amotivation in the second study. This study highlighted that interventions are urgently needed to help this group of young people in Singapore to foster their incremental beliefs.

Another important finding from the present study is that the Cluster 3 had exceptionally high entity beliefs. This profile has been shown to be motivationally maladaptive because they may exhibit characteristics such as high amotivation and low self-esteem (Biddle et al., 2003; Wang & Biddle, 2001). It could be that entity beliefs do not allow feelings of confidence and control over future outcomes, especially when perceived competence is low, thus resulting in less motivationally adaptive responses. One factor that could contribute to this may be because physical fitness is highly valued in the Singaporean school system. Singaporean schools are ranked annually based on the physical fitness tests results and obesity rate. As a result, school physical education programmes may focus more on achievement and fitness training rather than fun and enjoyment. Within this competitive and evaluative context, it is likely that children may have developed a belief that their athletic ability was difficult to change. The highly structured PE curriculum could also send a message that they do not have much autonomy in the decision-making process. There is a need for further studies to examine the factors influencing children's entity beliefs and perceptions of autonomy in the Singapore context.

Conclusions

The present study examined the relationship between physical activity and sedentary behaviors using multiple sedentary indicators and investigated the psychological determinants of physical activity.

The results of the first study showed that boys and girls had different physical and sedentary behavioral patterns. While boys tended to spend more time in technology-related activities, girls had the tendency to socialize and read more in their leisure time. Physical activity participation seemed to be high among the Singaporean children but still much lower than their counterparts in the USA and UK (Marshall et al., 2002). In addition, physical activity and sedentary behaviors were not inversely related. These findings supported the outcomes of previous research that reducing sedentary behaviors among young people as a strategy to improve physical activity may not as effective as previously thought.

The second study provided insight about the psychological variables that influence physical activity. The results showed that children with high incremental beliefs, high perceived competence, and perceived autonomy tended to be more physically activity.

Thus, fostering incremental beliefs, providing successful experiences and an autonomy-supportive environment are essential for achieving the desired results.

One weakness of the present investigation was that most of the constructs under study were examined through self-reported measures. It is known that younger children may not be able to make accurate self-reports due to their level of cognitive maturation. In addition, they may respond to the questionnaire in a socially desirable way, especially with regard to incremental beliefs or perceived competence because of their appealing nature. Although the participants have been assured of confidentiality of their responses, they were told that the only person who would see their responses would be the researcher. In addition, they were informed that the aim of the questionnaire was to solicit their opinions and there were no 'correct' answers. These steps taken would have reduced the tendency for social desirability but it might not have eradicated it.

Future studies need to consider using more objective measurement procedures such as the use of direct observations or pedometers. Another possibility is to consider garnering information from other sources, such as from parents, teachers, or coaches to triangulate the physical activity results.

In summary, both studies mark the first attempts to examine the physical and sedentary activities among Singaporean young children. Results have provided a comprehensive description of physical activity and sedentary behaviors among young people in Singapore and confirmed the conceptual coherent relationships between key psychological variables and physical activity participation.

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