PHYSICAL INACTIVITY AMONG CHILDREN AND ADOLESCENTS IN SINGAPORE – A PARADOXICAL ISSUE

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Abstract
The health consequences of physical inactivity among youths are worrisome as sedentary lifestyles among youths become entrenched. Obesity rates among youths in Singapore are about 10%, but there are concerns that this rate is not sustainable over the longer term. Physical activity (PA) prevalence data in Singaporean youths are mixed as questionnaire data show adequate levels of PA engagement while HR monitoring data show very low levels of PA, in research employing single methods to capture the data. The study purpose of was to compare PA data garnered from questionnaire and HR monitoring in Singaporean youths. 280 youths aged 10-15 years, and of normal body weight, completed a Physical Activity and Exercise Questionnaire and wore HR monitors (Polar Vantage, NV) for 10 hours to gauge PA consumption over two weekdays and a weekend. Questionnaire responses revealed that 41% of primary school participants and 38% of secondary school participants experienced moderate-to-vigorous PA. HR data, over the weekday and weekend, on the contrary, showed that 86-94% of primary school participants and 94-99% of secondary school participants did not experience any moderate-to-vigorous PA (HR 140-159; HR >160 bpm). Both questionnaire and HR data showed no sex difference in PA engagement but HR data showed that younger youth were less sedentary (HR<120 bpm) than older youth. Younger youth aggregated 24 minutes and older youth aggregated 10 minutes at HR 140-159 and HR>160 bpm on the weekday. No vigorous PA (HR>160 bpm) was detected in participants on the weekend. In the best case scenario, PA engagement in Singaporean youths met only 40% of the recommended aggregation of 60 minutes of, at least moderate intensity PA, advocated by the Ministry of Health (MOH) in Singapore and others. Schools can play a significant part in discouraging sedentary behaviour and encouraging physical activity behaviours via holistic and coordinated intervention programmes targeted at all youths.

Key words*: physical activity, hearth rate, questionnaire*

Introduction

Singapore is a first-world city state with about with 500 000 school-going youths aged between 7 and 18 years. Current data suggest that the obesity levels in schools are about 10% (Chia 2007) but there are concerns that this level may not sustainable in the longer term as the lifestyles of young people become less physically active. The demerits of physical inactivity in young people, world-wide, cannot be over-emphasized. Extended periods of physical inactivity once entrenched as a daily habit may result in adult ailments like cardiovascular disease and altered glucose metabolism, which are documented to begin in infancy and childhood (Williams et al 1992). Other paediatric conditions arising from severe PA insufficiency include an earlier onset of obesity, sometimes orthopaedic problems such as joint pains in the feet, knees and hip, which are exacerbated by excessive body weight, and disrupted sleep due to obstruction of the airflow because of too much fat around the neck (Kimm and Obarzanek, 2002). Physical activity (PA), explained simply, is the result of muscular activity that increases energy expenditure substantially above resting values (Shephard 2003). The assessment of PA, however, is fraught with difficulty because PA is a complex to measure. It is a behaviour that can be explained in terms of frequency, intensity, duration, and interval between bouts (Armstrong and Welsman 1997). PA can be spontaneous or deliberate and is also contextual. For example it can be the outcome of work, of leisure or of locomotion or transport. There are many modes or types of the PA-recreational: play, exercise, game or sport- or work-related: household chores and physical labour (Chia et al in press).

Researchers have consequently devised various methods in their attempts to quantify and qualify PA. Some of these methods are subjective such as child and parent self-report, while others are objective such as direct observation, heart rate monitoring, use of digital motion sensors and doubly labelled water. All methods have their merits and demerits and no one single method can qualify, quantify and capture all aspects of PA. The choice of the measurement method is usually hypothesis-driven and the diversity of methods used to describe PA in different studies, make comparison of results across studies problematic. This explains why disparate findings about habitual PA in similar population samples are not uncommon.

In recent years, paediatric epidemiologists, PA researchers and experts have articulated consensual general activity guidelines for children and adolescents that promote positive physical health among young people (NASPE 2002; Cavill et al 2001). For example, the National Association for Sport and Physical Education (NASPE 2002) in the USA enunciated that children and adolescents should accumulate at least 60 minutes and up to several hours of age-appropriate PA on all or most days of the week. The daily accumulation should include moderate-to-vigorous PA of which the majority being intermittent in nature. These general recommendations were largely based on PA prevalence data, which are dependent on the accuracy of PA measuring methods. Andersen and colleagues (2006) reported that at least 90 minutes of daily accumulated PA of at least a moderate intensity was necessary to prevent insulin resistance and to avoid a clustering of cardiovascular risk factors in 2201 European children and adolescents aged 9 and 15 years.

In terms of classifications of activity intensity in young people, unpublished data from the Physical Education and Sports Science Laboratory in Singapore show that walking or running on the level at 4-, 6- and 8 km/hr elicited mean HR responses in 60 normal weight boys and girls aged 10, 14 and 16 years, of 106 bpm, 132 bpm and 164 bpm, respectively. Others explain moderate intensity activity as an activity usually equivalent to brisk walking, which might be expected to leave the participant feeling warm and slightly out of breath; while vigorous intensity activity is an activity that is usually equivalent to at least slow jogging, which might be expected to leave the participant out of breath and sweaty (Biddle et al 1998). In Singapore, the Ministry of Health (MOH) published New Dietary Guidelines for Children and Teenagers in 2007, which articulated the following guidelines for PA: Children and teenagers should engage in at least 60 minutes of at least moderate PA for at least 5 days of the week, echoing the general guidelines for PA emanating from the USA and UK. Data on the PA of youths in Singapore are mixed. For instance, Gilbey and Gilbey (1995) used heart rate monitoring on 50 boys and 64 girls aged nine and 10 years over three 14-hour periods and Lim (1995) reported on the HR data, derived from 12 hours of monitoring, of 120 boys and girls aged 13 to 14 years over three weekdays and one weekend day, to estimate habitual PA among young people in schools. Both sets of researchers reported that very few primary school pupils (18% of boys and 6.3% of girls) and secondary school pupils (less than 10% of boys and girls) achieved at least 10-20 minutes of sustained aerobic-type activity that resulted in a HR>140 bpm. However, in these studies, the American College of Sports Medicine (ACSM 1995) guidelines or standards (sustained 10 to 20 minute bouts of moderate to vigorous PA) that were meant for adults for the development and maintenance of cardiovascular health and fitness were applied to young people for data interpretation. It should be noted that in the early 1990s when the cited study was conducted, PA guidelines for children and youth were non-existent. Wang et al (2006), on the other hand, examined the PA and sedentary behaviours of a sample of 780 children aged between 10 and 14 years using a 7-day recall questionnaire called the Self-administered PA Checklist (Marshall et al 2002). Results showed that 60% of the participants, or 66% of boys and 57% of the girls reported a high volume of PA in the previous week that amounted to more than 300 minutes per week of moderate intensity activity and more than 120 minutes per week of vigorous intensity PA. In fact only 19% of the participants reported a low volume or no PA. The trend of the cited results is mirrored in another study on 3333 participants aged between 10 and 18 years using the 7-day recall PA questionnaire (unpublished results). In the cited studies, boys reported greater volumes of moderate and vigorous intensity than girls. However, neither of the studies classified the participants by body weight and comprised participants that represented the spread in body weight. Some data show that youths of different body mass index or levels of fatness have significantly different PA levels as assessed using pedometers (Tudor-Locke et al 2004). Overall, it seems that data on the PA of Singaporean youth are mixed and it ranges between not meeting to exceeding PA guideline recommendations. Hence the purpose of the study was to examine the PA of male and female youths of normal body weight from primary and secondary schools using a self-report questionnaire and heart-rate monitoring and to compare them to published PA recommendations for young people.

Methods

Participants

280 pupils (140 girls and 140 boys) from two primary and two secondary schools in Singapore participated in the study. 70 boys and 70 girls, aged between nine and 10 years of age (academic level – Primary 5) were recruited from two primary schools. Another 70 boys and 70 girls, aged between 14 and 15 years old (academic level – Secondary 3) were recruited from two secondary schools. The primary and secondary schools represented the typical government-funded schools in Singapore. All pupils were free from any medical ailments and were classified as within the healthy weight-height range (i.e. between 90 and 110% based upon norms of weight for height) in accordance with the criteria published by the School Health Services of the Ministry of Health in Singapore (School Health Service 2004). All participants gave informed written assent and parental consent to participate in the study, and the research procedures for the study had the required institutional ethical clearance from the National Institute of Education, Nanyang Technological University.

Self-report questionnaire on physical activity

The PA and Exercise Questionnaire (Schmidt et al 1998) was used to garner self-reported PA of the participants. Construct validity of the questionnaire has been established previously with total cholesterol ($r=0.35$, $p<0.05$), high density lipoprotein ($r=-0.38$, $p<0.05$) and triglycerides ($r=-0.27$, $p<0.05$) on an unrelated group of 745 pupils, aged 6-18 years, and the test-re-test reliability coefficient was reported as 0.67 (Schmidt et al 1998). In the questionnaire, participants were asked to describe their PA and exercise over the past 14 days. Five choices were available; inactive (sitting most of the time with no regular PA), very light PA (e.g. walk or stand for 3-4 hours daily with no regular organised leisure time PA), light PA (e.g. occasionally involved in recreational activities such as tennis, jogging, swimming, cycling, etc), moderate PA (e.g. regular involvement in stair-climbing and recreation or fitness activities such as jogging, swimming, soccer or cycling at least three times a week for 20-60 minutes per session) and vigorous PA (e.g. regular involvement in extensive PA for at least 60 minutes per session for at least 4 times a week). Participants were assured of the confidentiality of responses, were instructed that there were no right or wrong answers and were encouraged to ask questions if they were unclear about the questionnaire items. Pupils took about 10 minutes to complete the questionnaire in a quiet classroom. There was a 100% return rate for the questionnaire. The questionnaire was administered by the principal investigator on the first day of data collection of the research.

Heart rate monitoring

Heart rate (HR) data, averaged over a minute, and monitored over a mean of 10 hours (0800 hours to 1800 hours), over two weekdays and one weekend day, were collected from the participants using a HR monitoring device (Polar Vantage NV, Polar Electro Oy, Finland). Participants wore the HR monitors (HRM) that consisted of a chest strap with wireless electrodes and a waterproof wristwatch microcomputer. A leather cover was placed over the watch to help protect it from damage and to prevent pupils from tampering.

The HR data, stored in memory for each pupil were retrieved the morning after and were downloaded onto an IBM-compatible computer by means of a POLAR computer interface. The validity and reliability of ambulatory HR monitoring devices such as the Polar system have been reported elsewhere (e.g. Armstrong & Welsman 1997) and is widely accepted. Importantly, HR data using telemetric systems have been reported as valid with an error rate of only 2%. HR data were obtained from 100% of the participants. The total time spent at HR intensities described physically inactive (HR<120 bpm), lightly active (HR 120-139 bpm), moderately active (HR 140-159 bpm) and vigorously active (HR>160 bpm), over the monitored period was summed to derive the accumulated time at the HR intensity. The HR data over the two weekdays were averaged to derive a mean and median weekday value.

Statistical analyses

All data were stored in a computer and analysed using the SPSS for Windows version 16.0. Descriptive statistics (mean±standard deviation) for physical characteristics of participants, time spent at HR<120 bpm, HR 120-139 bpm, HR 140-159 bpm and HR >160 bpm, and percentages of responses to questionnaire items on PA participation were obtained. A descriptor of central tendency – the median – was also used to describe the total time spent at the four different HR ranges. A repeated-measures MANOVA was used to test the effects of academic level (primary school pupils vs. secondary school pupils) and days of the week (weekday vs. weekend day) for self-report activity levels and HR ranges (i.e. HR<120 bpm, 120-139 bpm, 140-159 bpm and HR>160 bpm). Statistical significance for all analyses was accepted at $p<0.05$.

Results

Descriptive statistics

The physical characteristics and questionnaire responses of participants organised by sex and academic level, are summarised in Table 1. In terms of self-reported PA consumption, the distribution was not significantly different between primary and secondary school participants.

Table 1 Elementary data

	Primary School		Secondary School	
Variables	Boys (N=65)	Girls (N=75)	Boys (N=72)	Girls (N=68)
Age (y)	10.6±0.3	10.5±0.3	14.8±0.6	14.7±0.6
Body mass (kg)	34.4±6.8	33.6±6.9	57.9±10.9	48.5±5.6
Stature (m)	1.42±0.08	1.45±0.06	1.69±0.07	1.58±0.05
Response to Questionnaire items on physical activity (%)				
Physical activity classification				
Inactive	8		10	
Very light	14		16	
Light	37		36	
Moderate	31		30	
Vigorous	10		8	

Eight percent of the younger participants and 10% of the older participants reported no regular PA in the previous 14 days. When the data were organised by sex, 16.3% and 31.7% of boys reported participating in very light and light PA, respectively. The corresponding values for girls were 28.4% and 45.5%. 39.4% of male boys were at least moderately active while 22.7% of girls reported being at least moderately active. However these were not significantly different between the sexes. Figures 1 and 2 show the median percentage of hours spent at the four HR ranges on two weekdays and one weekend day over an average of 10 hours for 280 primary and secondary school participants.

Figure 1a

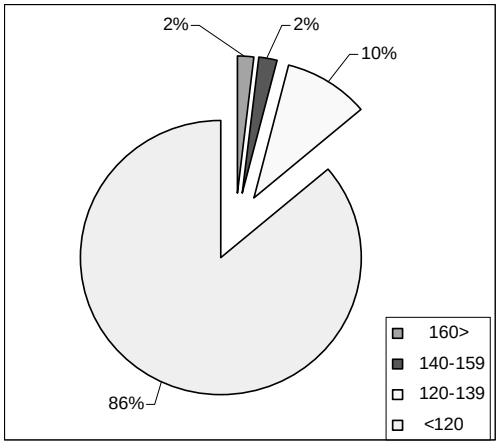
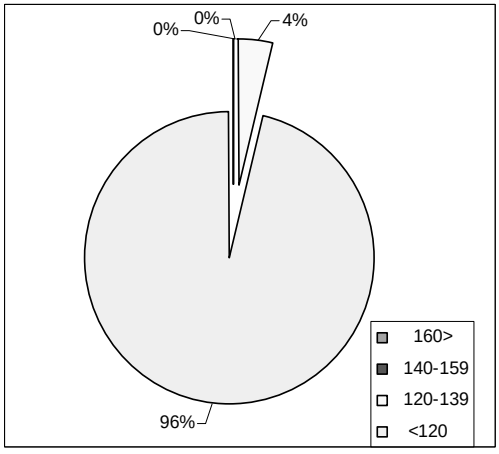


Figure 1b



Caption for Figure 1:
Median percentage of monitored time spent at the different HR intensities on weekday and weekend day for 140 primary school participants. The average time that PA was monitored was 10 hours.

Note: HR descriptions: sedentary (HR<120 bpm); lightly active (HR 120-139 bpm); moderately active (HR 140-159 bpm) and vigorously active (HR>160 bpm). Time spent at moderate PA amounted to 0.6 minutes. No vigorous PA was detected for the weekend in primary school participants.

Figure 2a

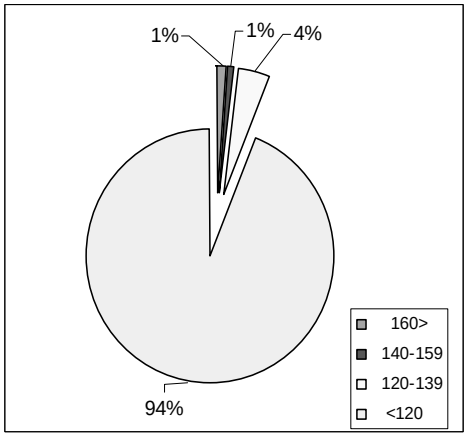
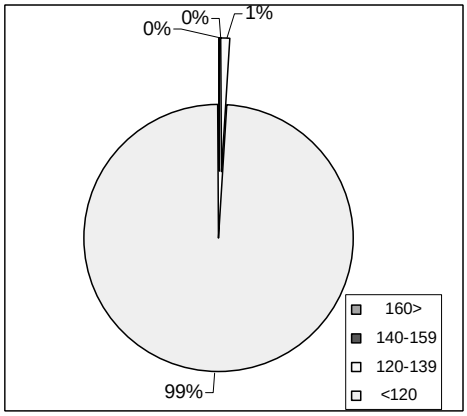


Figure 2b



Caption for Figure 2:
Median percentage of monitored time spent at the different HR intensities on weekday and weekend day for 140 secondary school participants. The average time that PA was monitored was 10 hours.

Note: HR descriptions: sedentary (HR<120 bpm); lightly active (HR 120-139 bpm); moderately active (HR 140-159 bpm) and vigorously active (HR>160 bpm). No moderate and vigorous PA was detected for the weekend in secondary school participants.

The majority of pupils were physically inactive (HR<120 bpm), more so on a weekend than on the weekday. For instance, for 98.7% of the time monitored on the weekend participants were mainly sedentary (i.e. HR<120 bpm) while for 90.2% of the time monitored on a weekday, participants had HR<120 bpm. Conversely, participants were physically more active at the light (HR 120-139 bpm), moderate (HR 140-159 bpm) and vigorous intensity (HR>160 bpm) on the weekday than on the weekend day. Results of repeated-measures MANOVA showed that there were significant differences between primary and secondary school participants at the sedentary, light, moderate and vigorous HR ranges (i.e. HR<120 bpm, 120-139 bpm, and 140-159 bpm) (Wilk's Λ=0.546, F(4,46)=9.55, p<0.05, $\eta 2$=0.45) as well as between weekday and weekend data

(Wilk's Λ=0.306, F(4,46)=26.05, p<0.05, $\eta 2$=0.69), with primary school participants significantly less sedentary than secondary school participants. However, no sex or interaction effects were detected. For the weekday, there were significant differences between primary and secondary participants for time spent at HR<120 bpm (9.14±1.99 vs. 11.99±1.47 hr, p<0.05), HR 120-139 bpm (1.23±0.72 vs. 0.64±0.49 hr, p<0.05) and HR 140-159 bpm (0.34±0.24 vs. 0.14±0.11 hr, p<0.05) but not for HR>160 bpm (0.40±0.34 hr vs. 0.30±0.31 hr, p>0.05).

For the weekend, there were significant differences between primary and secondary school participants for time spent at HR<120 bpm (6.56±3.76 vs. 9.34±3.72 hr, p<0.05) and HR 120-139 bpm (0.44±0.55 vs. 0.18±0.41 hr, p<0.05) but not for HR 140-159 bpm (0.09±0.19 vs. 0.02±0.01 hr, p>0.05) and HR>160 bpm (0.04±0.11 vs. 0.01±0.01 hr, p>0.05). None of the participants from primary or secondary school accumulated any activity that was described as vigorous (i.e. HR>160 bpm) on the weekend. Primary school participants accumulated less than one minute of PA that was described as moderate intensity (i.e. HR 140-159 bpm) for the weekend.

Discussion and conclusion

The purpose of the study was to elucidate the PA of Singaporean youth of normal body weight using subjective and objective methods and to compare the findings against published PA recommendations for youths. Previous PA data on Singaporean youth were based on youth of diverse body weights that used heart-rate monitoring (Gilbey & Gilbey 1995), pedometer step counts (Chia & Wangye 2008) or responses to questionnaire items (Wang et al 2006) but none compared PA data garnered from questionnaire and heart rate monitoring in the same sample of participants.

Results of the comparison are instructive in that single method studies used to assess PA may yield significantly different results and this may affect the efficacy of subsequent intervention programmes targeted at improving PA among young people.

Physical characteristics of the participants

The physical characteristics- age, body mass and stature – of the participants were comparable to pupils in the same age groups in schools in Singapore (School Health Service 2004). All 280 pupils were considered to be healthy in relation to body mass for age and sex, according to the weight for height norms used by the School Health Services of the Ministry of Health in Singapore (School Health Service 2004). In the present study, underweight and overweight pupils were excluded as some data show that habitual PA is influenced by body mass index or levels of fatness (Tudor-Locke et al 2004).

Questionnaire responses of the participants

The 100% response rate to the questionnaire items on the recall of PA participation over the previous 14 days is fortunate as it was conducted in a classroom setting and the majority of participants took less than 10 minutes to complete the PA and Exercise Questionnaire (Schmidt et al 1998). In the main, younger participants were just as physically active as older participants and there was no significant decline in reported PA with age, between 10 and 15 years. 41% of primary school participants and 38% of secondary school participants stated that they engaged in moderate-to-vigorous PA or exercise in the previous 14 days. If participation in moderate intensity activity is used as a reference, 59% of the younger and 62% of the older participants reported participation in activities described as light, very light or inactive. The questionnaire results are contrasted with those reported by Wang et al (2006) who polled 780 school participants aged 10 to 14 years, using a 7-day PA recall questionnaire called the PA and Exercise Checklist, where only 19% of the participants reported a low volume of PA or no PA. The reasons for the stark difference in findings are not apparent as both samples are equivalent in age, and sex distribution but the questionnaire items are not identical. Still this presents evidence that dissimilar questionnaires, measuring the PA in targeted samples can arrive at starkly difference outcomes and interpretations so researchers should be mindful about this.

HR data of the participants

Results of HR monitoring showed that a very high percentage of participants were sedentary (i.e. HR<120 bpm), and significantly more participants were sedentary on the weekend than on the weekday. Primary school participants were significantly less sedentary than secondary school pupils for the weekday and the weekend day. The reasons why PA was less for the weekend compared to the weekday need to be further investigated but the result mirrors the findings of others in studies conducted in Singapore (e.g. Gilbey & Gilbey, 1995; Lim 1995) and in the UK (Welsman & Armstrong 2000). It can be speculated that accessibility to environments that promote PA during weekdays (e.g. school) compared to the weekend (e.g. home and the community) might have a part to play in explaining the behaviours related to PA of participants. Further research is recommended to identify the barriers among normal weight young people that discourage or prevent them to be more physically active over the weekend and also on a daily basis. Previous data on participants from primary schools in Singapore has shown similar trends of physical inactivity (Gilbey & Gilbey 1995), albeit, the criterion upon which PA was classified is different between the studies. In the present study, total time accumulated at HR<120, HR 120-139, HR 140-159 and HR>160

bpm was used to describe PA whereas in the study conducted by Gilbey and Gilbey (1995), the total time that the HR was sustained at a HR>140 bpm for 5, 10 and 20' blocks was used to describe PA of the participants. There was a trend that primary school pupils were less sedentary than secondary school pupils from questionnaire and HR data, though the results did not attain statistical significance. Equivalent data, based on questionnaire responses and HR monitoring from UK (Welsman & Armstrong 2000), USA (Sallis & Owen 1999) and Europe (Van Mechelen & Kemper 1995) show trends of declining PA patterns with age during the childhood and adolescent years but this was not evident in the present study. Van Mechelen and Kemper (1995) reported that in the Netherlands, PA of young people declined steeply between the ages of 13 and 16 years in boys and girls but less steeply between the ages of 16 and 27 years. However, it is not clear whether such a decline in PA with age in the growing years is due to biology or to social influences (Sallis & Owen 1999) or is indeed a combination of the nature and nurture factors.

Self reported PA versus HR monitoring data

A key finding in the present study was that self-reported questionnaire responses on PA did not match PA data derived from heart-rate monitoring. With reference to questionnaire responses about PA, MANOVA results showed no main effects for PA. In other words, primary and secondary school participants did not differ significantly in their self-reported PA or physical inactivity. On the other hand, HR data on the weekday and weekend day showed that younger participants were significantly more active than older participants with less time spent at HR<120 bpm. Additionally, in terms of questionnaire data, 59% of primary school participants and 62% of secondary school participants did not have any moderate or vigorous PA. This contrasted with HR data, which showed that 86-96% of primary school participants and 94-99% of secondary school participants did not experience any activity that is at least of moderate intensity activity (HR 140-159 or HR >160 bpm). Sallis and Owen (1999) pointed out that PA data garnered from questionnaire response tend to be higher than that estimated from HR monitoring. In the present study, both primary and secondary participants reported engaging in vigorous PA but this was not corroborated by the HR data. For example, 30% and 31% of primary and secondary school participants, respectively, reported that they participated in moderate intensity PA; and the corresponding figures were 10% and 8% for participation in vigorous intensity activity in the last 14 days. Yet HR monitoring for 10 hours on two week days and one weekend day showed that in terms of HR data, primary school participants accumulated only 24.6 minutes of at least moderate intensity PA when the weekday and weekend data were pooled while secondary school participants aggregated 10.2 minutes of the equivalent for time spent at PA that is of at least moderate intensity. This study presents concrete evidence that both children and adolescents substantially under-report their levels of physical inactivity and concomitantly over-report their levels of PA when responding to questionnaire.

Sex and age difference in physical activity

The results of the present study showed no difference between boys and girls, and for age, for PA engagement, either from questionnaire response or HR monitoring, findings that are contrary to results of some studies, which show that girls are less active than boys between the ages of six and 18 years (Armstrong & Welsman 1997; Sallis & Owen, 1999; Trost et al 2002). For example, Trost et al (2002) investigated age- and sex-related PA using accelerometers in 375 boys and girls from grades 1-12. They reported sex differences in accelerometer-determined counts, with boys more physically active than girls at moderate and vigorous intensity, with the magnitude of the sex difference greater for vigorous than for moderate intensity activity. In the present study, both boys and girls were indistinguishable in terms of their physical inactivity and in their PA. As both boys and girls hardly experienced any vigorous PA in the weekday or weekend, any sex difference was indeterminate. These results are supported by findings of a study on 52 boys and 52 girls aged 13-14 years that used similar HR monitoring devices over three weekdays and a weekend day. Welsman and Armstrong (2000) reported that over weekdays and the weekends, girls and boys did not differ in PA in terms of the percentage of time that was spent engaged in moderate to vigorous PA. However, differences in results between studies can be due to cultural and regional and environmental differences (Sallis & Owen 1999), or might be attributed to the different methods that have been used to collect and classify PA.

Physical activity recommendations and comparison of physical activity data

For the maintenance of health among youth, the Ministry of Health (MOH) in Singapore published the recommendation in 2007 that young people should aggregate at least 60 minutes of PA of at least of a moderate intensity for at least 5 days in a week. NASPE (2002) and experts in the UK (Cavill et al, 2001), independently endorse the 60-minute guideline for daily PA. Andersen and his colleagues (2006) recommend that at least 90 minutes of daily accumulated PA of at least moderate intensity are necessary for the maintenance of metabolic health in European children. While critics argue that the 60-minute guideline is merely based on prevalence data and not dose-response benefits to youth health (Chia, 2007) others state that 60 minutes of at least moderate intensity aggregated daily, is health-enabling for youths (Strong et al, 2005).

HR data in the present study showed that neither primary nor secondary school participants satisfied the criterion of accumulating at least 60 minutes of at least moderate intensity PA on the two weekdays and the weekend day. Primary school participants managed to accumulate only 24 minutes of the equivalent PA on the weekday, while secondary school participants managed only 10 minutes at the same intensity over the same period.

The weekend data are dire, with the young participants aggregating less than one minute of the required PA and older participants having no moderate or vigorous PA. Pate, Long and Heath (1994) suggested combining durations of light, moderate and vigorous PA intensities to arrive at a more complete picture of pupils' daily PA. In their literature review of PA studies they reported that in most studies that used the combined intensity approach to describe habitual PA, the median PA time was about 60 minutes a day. Applying the same method to HR data in the present study, primary school participants accumulated 82.2 minutes on the weekday and 23.4 minutes on the weekend.

Corresponding values for secondary school participants were 36 minutes for the weekday and 3 minutes for the weekend. It appears therefore that primary and secondary school youths in Singapore had less than comparable amounts of PA on the weekday as reported in studies elsewhere (Pate et al 1994) and the PA of primary and secondary school participants on the weekend was well below the recommended 60 minutes.

Health educators caution that childhood patterns of behaviour carry over into adulthood (e.g. Biddle et al 1998; Welsman & Armstrong 2000) and that physical inactivity, especially in adolescence significantly predicts physical inactivity in adulthood (Kimm & Obarzanek 2002). It is therefore important to address the issue of high levels of physical inactivity in youth since adequate levels of PA and improvements in physical fitness, especially cardiovascular fitness are associated with lowered risks of heart disease, stroke and certain forms of cancer in adults.

These diseases are the three major causes of premature death in adults and they continue to kill and maim Singaporeans everyday (Chia et al 2002). It is noted that in present study, the majority of primary and secondary school participants were physically inactive (i.e. HR<120 bpm) for most of the time on the weekend and the weekday.

More remains to be done to encourage all participants to be physically active everyday so that sedentary behaviour among Singaporean youths does not become entrenched in the present time and also in the future.

Implications for educational institutions

It is suggested that schools give greater license to students' play and movement about in the school environment as part of informal play (before school, during recess, and after school), as part of daily PA and physical education, as part of co-curricular activities, and as part of project or team work held outside a classroom setting. At the present time, there are schools that forbid play, in some combination of before, during and after school unless it is part of organised activity. In other words, justifications for free play or access to play are not accorded their rightful priority. It is suggested that schools take action to make physical play more attractive than sedentary behaviours such as eating and excessive computer use by removing barriers for play. The Ministry of Education can ensure that schools provide safe play areas, good conditioned equipment, and ample daily opportunities for unstructured and structured play before, during and after school hours (Chia, 2007). It is suggested that schools include an additional period of free play, per week during school hours as part of physical recreation where pupils can be given choice of a sporting pursuit that they can continue to enjoy in adulthood e.g. small-sided soccer, basketball, badminton, table-tennis and dance. If the trends of reduced PA and the curtailment of physical play in daily life are allowed to continue unabated, the future health and vivacity of Singaporeans may be compromised.

Primary and secondary school youths reported similar levels of PA in questionnaire responses. However, this study showed that young people over-stated their levels of PA, especially for engagement in moderate and vigorous PA. HR data revealed no age- or sex-related differences for PA engagement for normal weight Singaporean youths. All participants were significantly less sedentary (HR<120 bpm) on the weekday than on the weekend and that primary school participants were significantly less sedentary than secondary school participants on both weekday and weekend. All participants were insufficiently active physically especially on the weekend with reference to recommendations for moderate-to-vigorous PA for children and adolescents. Schools can play a pivotal role in encouraging a daily dose of PA and provide opportunities for pupils to accumulate a sizable portion of the daily recommended volume of PA through active learning, structured physical education, play and sport and also provide a safe environment and appropriate sport equipment for spontaneous and unstructured play among youth. More can to be done to encourage youths in schools to be physically active everyday and to improve on physical fitness as the future health and vivacity of Singaporeans might well depend on that.

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TJELESNA NEAKTIVNOST MEĐU DJECOM I ADOLESCENTIMA U SINGAPURU – PARADOKSALNI NALAZ

Sažetak

Zdravstvene poslijedice tjelesne neaktivnosti među mladima su zabrinjavajuće otkako je utemeljen sedentarni životni stil mladih. Stupanj gojaznosti među djecom u Singapuru je oko 10 %, ali postoji zabrinutost da će ovaj stupanj biti dugoročno veći. Podaci o učestalosti bavljenja tjelesnim vježbanjem mladih u Singapuru su kontradiktorni pa podaci upitnika pokazuju odgovarajuću razinu angažmana dok praćenje srčanog ritma pokazuje vrlo nizak stupanj tjelesne aktivnosti, u istraživanju u kojemu je korištena individualna metoda za prikupljanje podataka. Svrha studije bila je usporedba podataka tjelesne aktivnosti prikupljenih upitnikom i podataka o srčanom ritmu (HR) kod mladih u Singapuru. Uzorak je činilo 280 mladih uzrasta 10-15 godina, standardne tjelesne mase koji su ispunili Upitnik o Tjelesnoj aktivnosti i vježbanju i koji su nosili monitor srčane frekvencije (Polar Vantage, NV) u trajanju od 10 sati kako bi se utvrdio tjelesni aktivitet kroz dva dana u tjednu i vikendom. Odgovori upitnika otkrili su da je 41 % ispitanika u osnovnoj školi i 38 % srednjoj školi iskusilo srednju do intenzivnu tjelesnu aktivnost. Međutim, suprotno tome, preko tjedna i vikenda, monitoring srčane frekvencije je pokazao da 86-94 % ispitanika u osnovnoj i 94-99 % u srednjoj školi nije bilo angažirano srednjim do visokim intenzitetom tjelesne aktivnosti (HR 140-159; HR >160 bpm). I upitnik i podaci HR monitoringa nisu pokazali razlike po spolu ali je HR monitoring pokazao da su mlađi ispitanici bili manje izloženi sedentarnom načinu života (HR<120 bpm) od starijih u uzorku. Mlađi su imali ukupno 24 minute a stariji ukupno 10 minuta na HR 140-159 i HR>160 bpm (otkucaja u minuti) kroz tjedan. Nije zabilježen veći intenzitet aktivnosti (HR>160) vikendom. U slučaju najboljeg scenarija tjelesna aktivnost kod mladih u Singapuru zadovoljava samo 40 % preporučenog 60 minutnog angažmana barem srednjeg intenziteta, podržanog od Ministarstva zdravstva u Singapuru i drugdje. Škole mogu odigrati značajnu ulogu u uklanjanju sedentarnog ponašanja i ohrabrivanju tjelesne aktivnosti kroz cjelovite kao i koordinirane interventne programe ciljane za sve mlade.

Ključne riječi: *tjelesna aktivnost, srčani otkucaji, upitnik*

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