Pediatrics & Therapeutics
ISSN: 2161-0665

Alhusaini, Pediatr Ther 2017, 7:1
DOI: 10.4172/2161-0665.1000312

Research Article Open Access

Physical Activity and Sedentary Behavior Relative to Body Mass Index among School Children in Saudi Arabia

Adel Abdullah Alhusaini*

Department of Pediatric Physical Therapy, Rehabilitation Sciences, King Saud University, Saudi Arabia

***Corresponding author:** Adel Abdullah Alhusaini, Assistant Professor, Pediatric Neurorehabilitation Consultant, Department of Pediatric Physical Therapy, Rehabilitation Sciences, King Saud University, College of Applied Medical Sciences, P.O Box 10219, 11433, Riyadh, Saudi Arabia, Tel: 966-11-4693605; E-mail: aaalhusaini@ksu.edu.sa

Received date: Jan 11, 2017; **Accepted date:** Jan 25, 2017; **Published date:** Jan 27, 2017

Abstract

Background: Increased time spent on sedentary activities and decreased time spent on physical activities has been linked with lower levels of energy expenditure, overweight, obesity, and increased risk of cardiovascular and metabolic diseases. During the past few years, rapid improvements in living standards, mechanization and urbanization has a profound impact in the Kingdom of Saudi Arabia resulting in low levels of physical activity and sedentary living. Therefore the purpose of the research is to provide basic data of subjectively measured physical activity and sedentary behavior of the Saudi school children in relation with BMI.

Methods: This study used cross sectional survey of 357 school children aged 10-16 years (82 boys and 275 girls) recruited from different schools in central Riyadh between 2015 and 2016. Demographic information such as age, gender, weight, height was obtained from each participant. Sedentary behavior was recorded as time spent on activities such as TV viewing, playing video games, computer use and homework, and physical activity was assessed using Physical Activity Questionnaire for Children (PAQ-C), and Godin leisure- time exercise questionnaire.

Results: Majority of participants were girls (77%). Values of body fat expressed as percentiles of body mass index of appropriate age and height were used as criteria to stratify the sample. The sample proportion stratified based on percentile of body weight constituted of 5.3% of underweight (19), 54.6% of normal (195), 18.8% of overweight (67) and 23% of obese (76) children. A high proportion (68.3%) of Saudi school children spent more than 2 hours on screen time (TV+PC) daily. PAQ-C reported 26.3% are less active, 51.5% are moderately active and 22.1% are highly active. Using ANOVA, no significant variation was shown in PAQ-C scores in relation to BMI. PA findings by Godin leisure-time exercise questionnaire concluded that 70.3% are insufficiently active, 20.4% are moderately active and 9.2% are active. Analysis done by Kruskal-Wallis test showed significant difference observed in Godin moderate scores (P=0.01) and total scores (P=0.03) but not in other subcategories (strenuous, mild, Sweat) in relation to BMI.

Conclusion: Sedentary behaviors, physical inactivity and increased BMI among Saudi school children are the major public health concerns. There is an urgent need for national policy promoting active living and healthy eating and reducing sedentary behaviors among children in Saudi Arabia.

Keywords: Childhood obesity; Overweight; Physical activity; Sedentary behavior

Introduction

Increased time spent on sedentary activities and decreased time spent on physical activities has been linked with lower levels of energy expenditure [1,2], overweight, obesity [3,4], and increased risk of cardiovascular and metabolic diseases [5]. Physical inactivity is the fourth-leading risk factor for global mortality, accounting 6% of the death [6]. Rising trends in overweight and obesity is a major concern worldwide in both developed and developing countries [7,8]. Childhood obesity and overweight are serious problems to be addressed and may have negative outcomes on physical and psychological health [9,10].

Until recent times, the physical demands of daily life and work in Saudi Arabia were sufficient to maintain a lean body mass and an appropriate level of physical fitness among the population [11,12]. However, during the past few years' rapid developments in standards of living, mechanization, urbanization, decreased physical activity has a profound impact in the Kingdom of Saudi Arabia. As a result, great changes in physical activity and eating habits have occurred in our society and low levels of physical activity and sedentary living are becoming increasingly prevalent among the Saudi children [13]. Overweight and obesity is becoming a public health concern among Saudi population of all ages [5,14-16]. Moreover, with massive urbanization and increased reliance on computer and telecommunication technology, further reductions in physical activity are projected for the coming years [11,17]. It is estimated that different cultural beliefs influence various health outcomes. Social and cultural influences play a major role in promoting physical activity [15]. The majority of children and teen do not meet the current guidelines

suggested by experts of a minimum of 60 minutes duration of moderate to vigorous physical activity per day [18].

A strong body of empirical evidence comprising both observational and experimental research pointing rapid increase in the body mass index (BMI) of school children from different parts of the world over the past two decades [9,19-23]. Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters. In children and teens, BMI is age- and sex-specific and is often referred to as BMI-for-age. The body mass index has also been found to be related to total percentage of body fat in both boys and girls which can be influenced by genetic predisposition and environmental factors [24].

Sedentary behavior refers to any waking activity characterized by an energy expenditure ≤ 1.5 metabolic equivalent (MET) and a sitting or reclining posture [25]. TV viewing; playing video games; leisure-time computer use or sitting during school or work time constitute the sedentary behavior. Children classified as frequent television watchers are more likely to have a longitudinal association with lower self-esteem, lower perceived health status, and poorer school grades [26-28]. The American Academy of Pediatrics recommends that parents limit school-age children's total media time (watching TV or videos and playing video games) to two hours per day [9,29-31]. Data from a limited number of studies indicate that 60% of Saudi children and 71% of young people do not engage in physical activity of sufficient duration and frequency [5,11].

Physical activity (PA) and Sedentary behavior can be assessed subjectively (self-reports, survey etc.) [32-34] and objectively (pedometers and accelerometers) [35-37]. Questionnaires are feasible method of obtaining physical activity among children with relative ease, cost effective and noninvasive manner in large population. There is limited published data on PA levels and sedentary behaviors of children in Riyadh region. Therefore, the purpose of the research is to provide basic data of subjectively measured physical activity and sedentary behavior of the Saudi Arabian school children. The secondary aim is to determine the variation of sedentary time and physical activity with BMI scores. A better understanding of the sedentary behaviors, physical activity, in relation to body mass index (BMI) would provide insight for developing interventions to prevent or reduce overweight.

Materials and Methods

The present study is a part of King Abdulaziz City for Science and Technology (KACST) project, a cross sectional school based observational study. A total of 357 children (boys-82, girls-275), within an age group of 10-16 years, from different schools of central Riyadh constituted the sample. The study sample was selected by simple random sampling from different secondary private and public schools of Riyadh, Saudi Arabia. The minimum sample size was determined so that the sample proportion would be within ± 0.05 of the population proportion with a 95% confidence level. The data were collected during the period of August 2015-2016. The study protocol and procedures were approved by the Research ethics committee of College of Applied medical sciences, King Saud University (CAMS 36-43/35). We also obtained schools and parental consents as well as students' approval for conducting the study.

Demographic characteristics

Demographic data regarding the participant age, sex, grade and nationality were recorded from school records. Anthropometric variables included body weight, height were performed by trained researchers using standardized procedures. Body weight was measured to the nearest 0.05 kilogram with portable electronic scale (Omron) and height was measured by a calibrated portable measuring rod (Seca Ltd., Hamburg, Germany), with minimal clothing and without shoes. Body mass index (BMI) was calculated as body weight in kg divided by height squared in meters. The CDC growth charts are the most commonly used indicator to measure the size and growth patterns of children and teens. BMI-for-age weight status categories and the corresponding percentiles were based on expert committee recommendations. Using BMI percentiles derived from the gender-specific BMI-for-age growth charts of the Centers for Disease Control and Prevention, weight status was categorized as follows: underweight or at risk for underweight (≤ 15th percentile); normal weight (16th-84th percentile); overweight or at risk for obesity (85th-94th percentile); and obese (≥ 95th percentile) [38].

Measures for physical activity

Physical activity questionnaire for children (PAQ-C): The Physical Activity Questionnaire for Children (PAQ-C) is a self-administered, 7-day recall instrument. It was developed to assess general levels of physical activity throughout the elementary school year for students in grades 4 to 8 and approximately 8 to 14 years of age. The PAQ-C investigates moderate and intense physical activities 7 days before filling it up (therefore including the weekend). This questionnaire consists of 9 questions about sports and games, physical activities in school and leisure. Each is worth 1 (did not practice any activity) to 5 (practiced activities on all week days) and the final score is the average of the questions. In the end, the score provides a range from very sedentary to very active (from 1 to 5): 1 - very sedentary, 2 - sedentary, 3 - moderately active; 4 - active; and 5 - very active [39-41]. The physical activity level was determined according to the mean scale of the nine items as low (≤ 2), moderate (>2 and ≤ 3), and high activity (>3) [42].

Godin leisure-time exercise questionnaire: It is a simple and feasible self-report instrument which is valid and reliable PA measure [43,44]. Children were asked about the number of times/week that they spent in different activities for a period at least 15 minutes. The activities were classified in 3 categories, according to metabolic equivalent (MET): low (3 METs), moderate (5 METs), or high (9 METs). The products derived from multiplying the frequency of each category by the MET value (METs/week) were summed and a total PA (TPA) score was obtained. In reference to the score in units obtained using only moderate and strenuous physical activities, we can adopt the following rule; ≥ 24 units- Active (Substantial benefits); 14- 23 units- Moderately active (Some benefits); <14 units- Insufficiently active (Less substantial or low benefits) [45].

Sedentary behaviors

The amount of time spent on sedentary activities includes TV time and other screen times such as playing video games, computer and internet use and time spent on doing homework. The total hours spent on these activities was calculated as their sedentary time. The American Academy of Pediatrics recommends the total media time to 2 hours per day and the authors used this as criteria to describe sedentary behavior [26].

Data were then analyzed using SPSS, version 21. Descriptive statistics were presented as means, median, standard deviations and

proportions. The chi-square test was used to compare proportions and P<0.05 was considered statistically significant. To compare between different groups of BMI, Levene's test used for answering whether different groups of BMI have equal or different variances. Levene's test is often used before a comparison of means. When Levene's test shows non-significance, One-way analysis of variance (ANOVA) is used to analyze the data. Then followed by Student-Newman-Keuls test are used for all pairwise comparisons. The level of significance was set at a p value of P<0.05. When Levene's test shows significance (P<0.05) the variances in the different groups are different (the groups are not homogeneous). Then, the average ranking of Kruskal-Wallis test is used.

Results

The author hypothesized that the sedentary time and physical inactivity is high among Saudi children between the ages 10 to 16 years. Secondly, normal weight children have high physical activity levels and less screen time compared to overweight and obese groups.

	Age (years)				Height (centimeters)				Weight (kilograms)				BMI (kg/m^2)			
Percentile	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
N	19	195	67	76	19	195	67	76	19	195	67	76	19	195	67	76
Mean	12.5	12.5	12.7	12.7	148.7	152.5	154.2	156.5	32.4	44.0	56.8	72.1	14.4	18.7	23.7	29.2
SD	1.8	1.7	1.5	1.6	12.7	10	8.9	8.9	6.7	9.2	8.4	15.3	1.0	2.2	1.4	4.1
95% CI	11.6-13.4	12.3-12.8	12.4-13.2	12.4-13.2	142.5-154.8	151.8-153.9	152-158	154.6-158.6	29.2-35.7	42.7-45.3	54.8-58-9	68.6-75.6	13.9-14.9	18.4-19	23.4-24	28.2-30.1
ANOVA	p>0.05				p<0.05*				p<0.05*				p<0.05*			
Obese-4, Overweight-3, Normal-2, Underweight-1; kg/m^2-kilogram per square meter; N- sample size; SD –standard deviation; CI –confidence interval; ANOVA-Analysis of Variance; p<0.05*																

Table 1: Demographic characteristics of the participants.

	Percentile of body weight				
Gender	**1**	**2**	**3**	**4**	**Total**
Boys (n)	1	42	13	26	82 (23.0%)
Girls (n)	18	153	54	50	275 (77.0%)
Total [N (%)]	19 (5.3%)	195 (54.6%)	67 (18.8%)	76 (21.3%)	357 (100%)
Obese-4, Overweight-3, Normal-2, Underweight-1; n-sample; N-total sample					

Table 2: The proportions (%) of sample based on gender and percentile of body weight.

Table 1 presents the anthropometric characteristics of the participants, mean, standard deviation and confidence interval (95% CI) stratified based on the percentile of BMI, as underweight, normal, overweight and obese. The age of the participants ranged between 10 and 16 years. There is no significant difference in age (p>0.05) of the sample, but significant variation in regard to height, weight and BMI (p<0.05). Table 2 presents the proportion of total sample (357), with boys comprising of 82 (23%) and girls of 275 (77%). More than half of the respondents were girls. The sample proportion stratified based on percentile of body weight constituted of 5.3% of underweight (19), 54.6% of normal (195), 18.8% of overweight (67) and 23% of obese (76) children. The proportions (%) of Saudi children cutoff scores of TV, PC, and Screen time of the total sample (n=357) were presented (Table 3). Nearly one-fourth of the sample (28.9%) surpassed the cutoff scores of >2 hours in time spent on TV viewing, 20.7% on time spent on PC, and overall screen time (TV + PC) was 68.3%. There was variation in the amount of sedentary time spent on TV with relation to percentile of BMI, and was analyzed using Chi-squared test (p<0.05) (Figure 1). But no such variation in trend observed in PC and total screen time (TV+PC) (P>0.05) (Table 4).

TV (n=357)	
(≤ 2 hours)	(>2 hours)
254 (71.1%)	103 (28.9%)
PC (n=357)	
(≤ 2 hours)	(>2 hours)
283 (79.3%)	74 (20.7%)
Screen time [TV+PC] (n=357)	
(≤ 2 hours)	(>2 hours)
113 (31.7%)	244 (68.3%)
PC-Computer, TV –television, (≤ 2 hours) - Less or equal to 2 hours, (>2 hours) - More than 2 hours	

Table 3: Sedentary behavior of the participants.

The sedentary characteristics related to percentage of body weight are shown in Table 4. The obese children (2.54 h ± 1.66) and overweight (2.31 h ± 1.67) children spent more sedentary time on TV on comparison with normal (2.05 h ± 1.52) and underweight (1.57 h ± 1.03). One-way analysis of variance revealed that there is significant variation on the amount of sedentary time spent on TV (F=2.80, P=0.04). Pairwise comparison was calculated using Student-Newman-Keuls test and no significance (p>0.05). The Levene's test p Value for the sedentary time spent on computer (0.0014), homework (0.008), total time (0.014), and screen time (0.004). However, the average

ranking of Kruskal-Wallis test used for analysis showed no significant variation (p<0.05) for the sedentary time spent on computer, screen time, homework and total time in relation to percentage of body weight.

			Student-Newman-Keuls test for all pairwise comparisons					Kruskal-Wallis test			Post-hoc analysis
Variables	**Levene's test (p value)**	**ANOVA**	**Factor**	**n**	**Mean (hrs.)**	**SD**	**Different (P<0.05*) from factor nr**	**Factor**	**n**	**Rank**	**Different (P<0.05*) from factor nr**
TV	0.215	0.04*	1	19	1.57	1.03	-	-	-	-	-
			2	195	2.05	1.52	-	-	-	-	-
			3	67	2.31	1.67	-	-	-	-	-
			4	76	2.54	1.66	-	-	-	-	-
			P>0.05								
PC	0.0014*	-	-	-	-	-	-	1	19	146.53	-
		-	-	-	-	-	-	2	195	181.87	-
		-	-	-	-	-	-	3	67	189.55	-
		-	-	-	-	-	-	4	76	170.45	-
		-	-	-	-	-	-	P=0.33			
Homework	0.008*	-	-	-	-	-	-	1	19	168.21	-
		-	-	-	-	-	-	2	195	176.67	-
		-	-	-	-	-	-	3	67	191.57	-
		-	-	-	-	-	-	4	76	176.59	-
		-	-	-	-	-	-	P=0.71			
Total	0.014*	-	-	-	-	-	-	1	19	126.16	-
		-	-	-	-	-	-	2	195	176.58	-
		-	-	-	-	-	-	3	67	188.90	-
		-	-	-	-	-	-	4	76	189.70	-
		-	-	-	-	-	-	P=0.08			
Screen time (TV + PC)	0.004*	-	-	-	-	-	-	1	19	130.61	-
		-	-	-	-	-	-	2	195	175.46	-
		-	-	-	-	-	-	3	67	191.84	-
		-	-	-	-	-	-	4	76	188.87	-
		-	-	-	-	-	-	P=0.10			
Obese-4, Overweight-3, Normal-2, Underweight-1; *significant at p<0.05.											

Table 4: Sedentary characteristics related to percentage of body weight.

Table 4 shows the means of physical activity indices of Physical Activity Questionnaire for Children (PAQ-C) and Godin and Shephard questionnaire. The proportion PAQ-C scores are categorized as 26.3% students as low (≤ 2), 51.5% moderate (>2 and ≤ 3) and 22.1% and high activity (>3) (Table 5). ANOVA (F=2.336, p=0.074) revealed no significant variation in PAQ-C scores in relation to percentile of BMI (Table 6).

PA findings by Godin and Shephard questionnaire concluded that 70.3% are insufficiently active, 20.4% are moderately active and 9.2% are active (Table 5). Levene's test for Godin Strenuous, moderate and total scores were significant (p<0.05), and therefore average ranking was done by Kruskal-Wallis test. No significant variation was shown in Godin strenuous scores (P=0.08). But significant difference observed in Godin moderate scores (P=0.01) and total scores (P=0.03). Post-hoc

analysis have shown significant variation in pair wise comparison in Godin moderate and Godin total PA scores (P<0.05). In Godin moderate scores the obese group has significant difference between normal and overweight group, and variation in pairwise comparison between normal and overweight. Similarly, Godin total scores exhibited significant variation with pairwise comparison in obese group with underweight and normal group, with no much difference with the overweight group. Levene's test for Godin mild and sweat scores were not significant, therefore ANOVA (Godin mild F=0.585, P=0.625; Godin sweat F=0.201, P=1.550) showed no significant difference between the groups (P>0.05) (Table 6).

PAQ-C (n=357)		
Low N (%)	**Moderate N (%)**	**High activity N (%)**
94 (26.3%)	184 (51.5%)	79 (22.1%)
Godin and Shephard questionnaire (n=357)		
Insufficiently active (Less substantial or low benefits)	Moderately active (Some benefits)	Active (Substantial benefits)
251 (70.3%)	73 (20.4%)	33 (9.2%)

Table 5: Physical activity of the Saudi children using PAQ-C and Godin leisure-time exercise questionnaires.

			Student-Newman-Keuls test for all pairwise comparisons					**Kruskal-Wallis test**			**Post-hoc analysis**
Variables	**Levene's test (p value)**	**ANOVA (p value)**	**Factor**	**n**	**Mean**	**SD**	**Different (P<0.05*) from factor nr**	**Factor**	**n**	**Rank**	**Different (P<0.05*) from factor nr**
PAQ-C	0.729	0.074	1	19	2.72	0.71	-	-	-	-	-
			2	195	2.51	0.69	-	-	-	-	-
			3	67	2.57	0.72	-	-	-	-	-
			4	76	2.33	0.64	-	-	-	-	-
			P>0.05		-	-	-	-			
Godin Strenuous	0.0042*	-	-	-	-	-	-	1	19	211.71	-
			-	-	-	-	-	2	195	187.27	-
			-	-	-	-	-	3	67	162.23	-
			-	-	-	-	-	4	76	164.38	-
			-	-	-	-	-	P=0.08			
Godin moderate	0.0048*	-	-	-	-	-	-	1	19	188.92	-
			-	-	-	-	-	2	195	190.31	(4)
			-	-	-	-	-	3	67	180.29	(4)
			-	-	-	-	-	4	76	146.36	(2)(3)
			-	-	-	-	-	P=0.01*			
Godin mild	0.617	0.625	1	19	6.47	8.84	-	-	-	-	-
-			2	195	6.82	8.82	-	-	-	-	-
-			3	67	6.58	7.24	-	-	-	-	-
-			4	76	5.28	9.11	-	-	-	-	-
-			p>0.05				-	-	-	-	
Godin sweat	0.541	0.201	1	19	2.10	0.73	-	-	-	-	-

			2	195	2.08	0.76	-	-	-	-	-
			3	67	2.17	0.69	-	-	-	-	-
			4	76	1.92	0.72	-	-	-	-	-
			p>0.05		-	-	-	-			
Godin Total	0.0057*	-						1	19	205.45	(4)
								2	195	189.49	(4)
								3	67	169.59	-
								4	76	153.76	(1) (2)
								P=0.03*			
Obese-4, overweight-3, normal-2, underweight-1; significant at p<0.05*. paq-c: physical activity questionnaire for children.											

Table 6: Physical activity scores related to percentage of body weight.

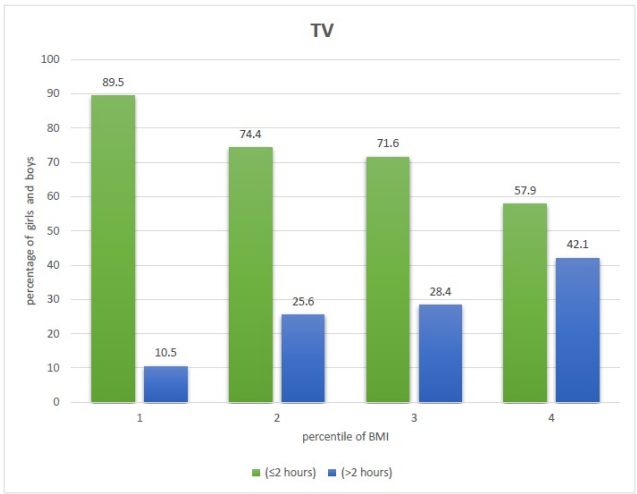

Figure 1: Sedentary time of the children spent on TV. Obese-4, overweight-3, Normal-2, Underweight-1.

Table 4 shows the means of physical activity indices of Physical Activity Questionnaire for Children (PAQ-C) and Godin and Shephard questionnaire. The proportion PAQ-C scores are categorized as 26.3% students as low (≤ 2), 51.5% moderate (>2 and ≤ 3) and 22.1% and high activity (>3) (Table 5). ANOVA (F=2.336, p=0.074) revealed no significant variation in PAQ-C scores in relation to percentile of BMI (Table 6).

PA findings by Godin and Shephard questionnaire concluded that 70.3% are insufficiently active, 20.4% are moderately active and 9.2% are active (Table 5). Levene's test for Godin Strenuous, moderate and total scores were significant (p<0.05), and therefore average ranking was done by Kruskal-Wallis test. No significant variation was shown in Godin strenuous scores (P=0.08). But significant difference observed in Godin moderate scores (P=0.01) and total scores (P=0.03). Post-hoc analysis have shown significant variation in pair wise comparison in Godin moderate and Godin total PA scores (P<0.05). In Godin moderate scores the obese group has significant difference between normal and overweight group, and variation in pairwise comparison between normal and overweight. Similarly, Godin total scores exhibited significant variation with pairwise comparison in obese group with underweight and normal group, with no much difference with the overweight group. Levene's test for Godin mild and sweat scores were not significant, therefore ANOVA (Godin mild F=0.585, P=0.625; Godin sweat F=0.201, P=1.550) showed no significant difference between the groups (P>0.05) (Table 6).

Discussion

The expanding development of predominance of obesity and physical inactivity and lower levels of daily physical activity in all age groups and in different populations around the globe justify the importance of studies analyzing the distribution of these variables and how they associate with each other, indicating the need and enabling the adoption of population-specific public health strategies to control them. Therefore, the findings of the present study presents the sedentary behavior and physical activity levels of Saudi school children of Riyadh, aged 10-16 years in relation with the percentile of BMI using standardized questionnaires.

BMI

The BMI cut off scores are done on percentile of the body weight and the current study reported combined proportion of 40.1% with 18.8% of the sample overweight and 21.3% of them are rated obese. The proportion of the sample constituted of more female participants (77%) than male (23%) amongst 357 participants. The sample was calculated based on percentile of body weight rather than gender based. The proportion of the total high BMI scores of the sample are alarming and therefore due consideration must be emphasized. According to national cross-sectional survey from 1994 to 1998 in five provinces of Saudi Arabia, overweight was defined as 10.68% and 12.7% for boys and girls, respectively (average 11.69%) and obesity was defined as 5.9% and 6.7% for boys and girls, respectively (average 6.3%) [46-48]. The latest national data revealed that the rates of overweight and obesity among school-age children have reached 23% and 9.3%, respectively. However, the rates of overweight and obesity among preschool children were reported as nearly 15% and 6%, respectively [46]. A previous study done by El Mouzan et al. reported

overall prevalence of overweight was 21%, 13.4% and 20.1%, that of obesity was 9.3%, 6% and 9.1% in the Central, Southwestern and Northern regions from an age group of 2-17 years old [47]. A similar study done by Al- Nuaim et al. revealed that the combined prevalence of overweight and obesity was 37.78% with 19.63% overweight and 18.15% obese amongst the 1270 participants [19]. The rate of overweight in children was found to be 10.5% and the rate of obesity was 8.7% by a study cross sectional study conducted by Al Shammari et al. in both children and adults of Riyadh [49]. The important findings of the study are that the significant rise in the trend of overweight and obesity over recent times in school children. Secondly there are only few studies reporting the data regarding the Riyadh region and variations can be attributed to regional and environmental context. In our study the sample frame included school based rather than population based. Generalizability of results must be interpreted with caution, because of the variability of age groups studied and different sampling frames.

Sedentary behavior characteristics

The changes in social and environmental factors that initiate sedentary behaviors may affect the body composition indices of children and adolescents leading to childhood obesity that can extend into adulthood with consequent health issues such as cardiovascular and metabolic diseases. In this study, we focused on sedentary time spent on television (TV), computer, screen time, and homework. The proportions (%) of Saudi children cutoff scores of TV, PC, and Screen time are presented in Table 3, and we found 68.3% of the total sample exceeds more than 2 hours of screen time (TV+PC). In regard to TV viewing there is variation in trend observed, where the proportion of sample portrayed a downward trend in scores of less than 2 hours and upward trend in scores of more than 2 hours in relation to BMI (Figure 1). The obese group (42.1%) spent more than 2 hrs. of watching TV followed by overweight (28.4%), healthy (25.6%) and underweight group (10.5%).

In regard to classification of percentile of BMI, the overweight, obese children spent more time on TV than, normal and underweight ($p<0.05$). In regard to the time spent on computer and homework, there is no significant variation in relation to BMI. The total time spent on all the sedentary activities also, we found no significant variation. Almost 68.3% of the sample surpassed the guidelines indicated by American academy of pediatrics of watching the TV and other screen based activity (computer) i.e., more than 2 hours. In our study we concluded, irrespective of their weight status majority of children were spending their leisure time sedentary. AlGhamdi reported significant findings association of TV watching and obesity in children of Saudi Arabia [50]. Al-Agha et al. concluded that children spending more than 2 hours of watching TV are associated with increased BMI [51]. A recent study done by Alghadir et al. reported that children with moderate and active physical scores demonstrated less sedentary behavior (TV viewing and computer usage), lower body composition values, and higher total energy expenditure than sedentary or mild activity level participants [24]. Apart from health, sedentary behavior can have a profound impact on academics, motor skills and overall quality of life. So this information can be helpful for schools to implement programs to educate children and their parents for the wellbeing of the society.

Physical activity questionnaires

Physical Activity Questionnaire for Children (PAQ-C): In our study the scores of PAQ-C, analyzed by ANOVA reported no significant variation in 7 day recall of general physical activity levels during the school year for children. The physical activity levels did not exhibit any variation in relation to weight status. As the PAQ are not designed to provide measures of time or intensity, classification relative to PA guidelines is impossible. Instead, various arbitrary PAQ-C score cut-off points have been proposed to categorize according to their self-reported PA [32]. Chen et al. assigned PAQ scores ≤ 2 as "low activity," >2 and ≤ 3 as "moderate activity," and >3 as "high activity" [42].Therefore the total proportion PAQ-C scores are categorized as 26.3% children as low (≤ 2), 51.5%moderate (>2 and ≤ 3) and 22.1% high activity (>3).

This study presents a significant finding concluding that irrespective of BMI the physical activity levels of students are mostly moderately active exhibiting an average score of 2.72 for underweight, 2.51 average score for normal or healthy, 2.57 score for overweight and 2.33 score for obese children respectively. Normative PAQ data for English youth reported cut off scores of all ages and therefore found an average mean of 3.007 (0.720) for boys and 2.695 (0.628) for girls [32]. The mean activity score for boys was 3.29 (SD=0.66), whereas the mean activity score for girls was 3.16 (SD=0.62) by a study reported by Welk et al. [52]. A pilot study regarding the effect of active video games on physical activity in children found average scores of PAQ-C score of 3.2 ± 0.5 with children participating video game play compared to the control group of scores 2.7 ± 0.8 with no intervention [53]. The average PAQ scores reported in this study are less when compared to the previous studies. The results of our study helps to form a cutoff score for Saudi children as genetic, environmental, and socio demographic variations can affect the scores of PA.

In our study there is no significant variation in the PAQ-C scores with regard to the percentile of body weight, and most of the sample is moderately active and high activity was not reported. In a previous similar study reported by Rivera et al. that physical inactivity is present in 93.5% of children and adolescents from Maceio, with no association or correlation of this variable with excess weight or body fat [54]. The low health risk (LHR) children and the high health risk (HHR) children had almost identical activity levels as assessed by the PAQ-C (M=3.01, SD=0.65 and M=3.00, SD=0.66; respectively) reported by McCargar [55].

Godin shephard leisure time physical activity questionnaire (GSLTPAQ): In reference to the score in units obtained using only moderate and strenuous physical activities, the total sample are categorized. The findings have shown that 70.3% are insufficiently active (>14 units), 20.4% moderately active (14-23 units) and 9.2% active (≤ 24 units) [45]. The findings of the study report that majority of the sample is insufficiently active, not meeting the standards of health benefits categorization (Table 5).

In regard to percentile of BMI, the subcategories of the scale i.e., Godin Strenuous, mild and sweat scores did not exhibit any significant variation ($p>0.05$). But the Godin moderate and total scores of the scale reported significant variation ($p<0.05$). Post hoc analysis shown that Obese group are having less scores in moderate leisure activities compared with overweight and healthy group children. In Godin total scores, obese group exhibited significant variation with the healthy and underweight group children ($p<0.05$), but no significant difference with overweight group ($p>0.05$). Previous studies showed that less

energy expenditure per day contribute to obesity and total energy expenditure throughout the day is important rather than small parts of the day engaged in exercise [56]. Health risk profile was worse for those who spent more time in watching TV and better for those who engaged in physical activity irrespective of their BMI [57].

The findings of our study signify that children participated in moderate leisure activities which were in congruence with the findings using Physical Activity Questionnaire for Children (PAQ-C). But significant variation in total scores of Godin in obese and overweight children, address the problem of physical inactivity among these children ($p<0.05$) (Table 6).

Strengths and limitations

The findings of the present study should be seen in the light of their strengths and limitations. This is a novel study in regard to children's physical activity and sedentary behavior in regard to percentile of BMI representing the large sample of school children of Riyadh, Saudi Arabia using validated physical-activity questionnaires. In contrast to similar studies, the present study aims to highlight the decline of physical activity levels and increase in sedentary behavior indices irrespective of weight status which is an interesting finding. The results documented that most of Saudi Arabian school children participated in moderate physical activity levels, although little variation observed in obese and overweight children. Several variables such as socio economic status, environmental and cultural factors may have contributed to moderate physical activity levels and increased sedentary behavior with no regard to their weight status. Future studies should focus on the various barriers to physical activity such as low income, health literacy especially in Saudi population.

Physical activity questionnaires (PAQs) are often the most feasible method when assessing PA in large-scale studies, because of its relatively less cost and feasibility. PAQs are prone to measurement error and bias due to misreporting, either deliberate or because of cognitive limitations related to recall or comprehension particularly in children. And an objective measure like accelerometer provides an estimate close to the truth than the self-reported data [58]. Hence the results of this study must be corroborated with more specific objective findings such VO2 max, pedometers and accelerometers. The sample constituted more of girls than boys, hence gender based variation was not examined. The findings of the study must be extrapolated with caution taking into consideration to other populations, ethnic groups, or other geographical regions.

Conclusions

The sedentary behaviors, physical inactivity and BMI among school children are the major public health concerns. A better understanding of the relationship between sedentary behaviors, physical activity, and body mass index (BMI) would provide insight for developing interventions to prevent or reduce overweight. Future research among Saudi children should focus on the assessment of physical activity and sedentary behavior using a comprehensive objective measure.

Acknowledgement

The authors thank King Abdulaziz City for Science and Technology (KACST) (Grant No: ARGP 143-35) for the support. We would also like to extend our gratitude to Mr. Ganeswara Rao and Ms. Syamala Buragadda, researchers, Rehabilitation Health Science department, King Saud University for their contribution to the study.

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