

RESEARCH

Differences in Physical Behaviour between Obese and Normal Weight Saudi Arabian Boys and Girls: What is Worth Noting?

Hmidan Alturki^{1,2}, Denise Brookes³ and Peter Davies¹

¹ Child Health Research Centre, Centre for Children's Health Research, University of Queensland, South Brisbane, QLD, AU

² King Abdulaziz City for Science and Technology, Riyadh, SA

³ Queensland University of Technology, AU

Corresponding author: Hmidan Alturki (hmidan.alturki@uqconnect.edu.au)

Objectives: As there still insufficient evidence on the physical behaviours of children who gain weight.

Purpose: We aimed to gather data and investigate if any variability in physical behaviours determines whether an urban Saudi school child will be of normal weight or obese.

Methods: A multicentre cross-sectional study of 1023 child, aged 9.00 to 11.99 years, who divided into two groups (normal weight and obese, as classified by their BMI), and further stratified by sex. Participants in each group were randomly selected using a multistage stratified cluster-sampling technique. A self-paced questionnaire was used to collect data relating to physical activities (PA) and behaviours. Weight, height and waist circumference were measured, and bioelectrical impedance analysis was assessed in all children.

Results: Children being "active" during physical education (PE) significantly differed between groups ($p = 0.000$), and this difference remained after being stratified by sex (boys, $p = 0.000$; girls, $p = 0.039$). Regular child activities frequency/week, i.e. jogging or running ($p = 0.020$), bicycling ($p = 0.000$), moderate-to-vigorous physical activity (MVPA) ($p = 0.021$), vigorous physical activity (VPA) ($p = 0.000$), and household work ($p = 0.009$), were significantly different between groups, and particularly for the boys. The best places for all children to undertake PA were at home and school. Public parks and schools were highly preferred by normal weight boys and girls, respectively. Normal weight children, especially boys, clearly indicated being very active during most recess breaks; the difference was significant ($p = 0.000$). Sleeping hours were not significantly different between the normal weight and obese groups, or for both genders.

Conclusion: Lower levels of physical activities are common behaviours among obese children, and especially boys. There poses an increased risk of obesity that's needs to be addressed.

Keywords: Physical behaviour; Differences; Obesity; Saudi Arabia; Schoolchildren

1. Introduction

Current urban lifestyles have encouraged sedentary activities in which physical activity is minimal, especially among children, adolescents, and young adults (Özgür & Aslan, 2015). Consequently, there is increased incidence of adverse health outcomes such as obesity. Globally, a low percentage of children and adolescent are meeting the set guidelines for physical activity (PA) (Hallal et al.

2012). For instance, in Australia, only 23% of primary school children meet the recommended level of PA (Hardy et al. 2016). There is a direct relationship between the healthy weight status of a child and PA measured by the levels of energy expenditure (Hills, Andersen & Byrne, 2011). Therefore, encouraging overweight, and even normal weight children, to increase their participation in PA and reducing sedentary time, will help minimise weight gain and associated health risks.

However, one meta-analysis showed that PA interventions had no impact on the overall PA of obese children, neither directly post-intervention nor even follow up on a long-term basis (Nooijen et al. 2017). Therefore, we can consider inadequate levels of PA as one of the leading reasons for rising children's obesity levels globally. These must be overcome by implementing an effective intervention regime among children. Of particular concern is that by the age of 9 years, a longitudinal US study of the 1032 children conducted in 9 different states, children's engagement in PA starts to decline during the period of transition from childhood to adolescence (Nader et al. 2008). Therefore, a better understanding of the differences between normal weight boys and girls, with reference to PA behaviors will help us to develop a strategy that can improve children's weight status.

In recent years, due to the country's astonishing economic growth, Saudi Arabian households have undergone dramatic changes in their daily lifestyles (Al-Hazzaa, 2007). It is increasingly recognised that contemporary life in Saudi Arabia now involves significant amounts of time sitting down or being sedentary. This trait has risen dramatically in recent decades (Denicola et al. 2015). Insufficient research has been documented in Saudi Arabia on this topic, resulting in a lack of evidence on potential differences in PA between normal weight and obese children. This includes external or internal factors that affect these behaviors, such as subjective, family, or building environment. With this in mind, our study examines in-depth if there are differences between obese and normal weight Saudi Arabian school-aged boys and girls. Specifically, the physical activities and other factors that may be affecting differences between these behaviors are investigated. To the best of our knowledge, there is very limited literature available on the cross-cultural aspects of PA and their relationship to weight status in school children in the Middle East.

2. Methods

The details concerning the methodology have been documented elsewhere (Alturki, Brookes & Davies, 2018). Briefly, the study is a cross-sectional one that is conducted in Riyadh, Saudi Arabia. This city is organised into five major geographical areas, and in each area, two primary schools (one for boys and one for girls) plus two private schools were randomly chosen. Students in classes from grades 4, 5, and 6 were specifically selected according to their BMI percentile based on CDC data (CDC, 2000). They were organised into two cohorts: (a) obese group (BMI > 95th percentile); and (b) normal weight group (BMI between the 25th and 75th percentiles). The complete sample obtained that met this study's eligibility criteria were 1023 students between 9.00–11.99 years of age (497 obese and 526 normal weight children). Data were collected from December 2015 to March 2016.

2.1. Anthropometric measurements

The anthropometric variables of height, weight, and waist circumference (WC) were measured. Height and weight were measured using a combined instrument, weight was recorded to the nearest 100 grams, not including excess outer clothing and shoes. Height was measured to the nearest centimeter (cm). Waist circumference was recorded to the nearest 0.5 cm at the level of the umbilicus, and then classified according the CDC anthropometric reference percentile data for children (Fryar, Gu & Ogden, 2012). BMI (kg/m^2) was calculated. Assessment of body composition was done by bioelectrical impedance analysis (BIA) and classified based on the method employed by McCarthy et al. (2006).

2.2. Statistical Analysis

Descriptive statistics were presented as means \pm standard deviations (SD), or proportions. The *t* test served to determine age distribution in the obese and normal-weight groups. For determining any significant relationships or associations between the obese or normal weight groups and the dependent variables,

Chi square was utilised. Finally, logistic regression was undertaken to assess dependent variables' impact on the likelihood that children would be categorised as obese. $p < 0.05$ was set as the level of significance.

2.3. Activities data

A widely accepted, valid and reliable (Al-Hazzaa & Musaiger 2011; Telford et al. 2004; Kowalski, Crocker & Donen, 2004; Cancela, Ayán & Castro, 2013) self-report method involving questionnaires on participants' PA behaviour was used in our study. This included a questionnaire to gather the data on children's regular PA behaviours/week, covering all the mode of PA. Specific queries focused on collecting data for frequency of walking, jogging, running, bicycling (common activities). Other types of activities of PA classified as either moderate-to-vigorous physical activity (MVPA), or vigorous physical activity (VPA). Factors that affect the aforementioned PA habits were also investigated. They included usual places where a child usually prefers to do PA, reasons for not doing PA, active level of child during physical education classes, and standard child situation at recess time. In addition, details concerning daily sleeping hours (during weekdays and weekends) were included. The questionnaires and written informed consent were given to the parents/guardian to be filled out at home and returned once completed.

3. Results

The number of children in each age bracket and the mean and standard deviation of anthropometric data for children are shown in **Table 1**. The data are classified according to obese or normal weight, and stratified by gender. There was no significant difference in age distribution for boys and girls in obese and normal weight groups. Waist circumference (WC) and body fat percentages for normal and obese groups reflected normal range perimeters for the respective groups. The study cohort was clearly identified and selected and, therefore, as expected, differences in weight, height, WC, percentage of fat, and BMI between the groups, and stratified by gender, were statistically significant ($p = 0.000$).

A comparison of the weekly PA frequency, between obese and normal weight, is summarised in **Table 2**. The analysis revealed that, among all activities except walking, obese children did PA less frequently than children of normal weight, particularly among boys. The differences were significant: jogging or running ($p = 0.020$); bicycling ($p = 0.000$); MVPA ($p = 0.021$); VPA ($p = 0.000$); and household work ($p = 0.009$). In general, and with reference to all activities, the percentage of obese children who did not do any PA was higher than the normal weight children.

Factors affecting children's PA behaviors are summarised in **Table 3**, along with the odds ratio of children categorised as obese. The most popular places for all children to do physical activities or sports were the home and/or school. For both groups, parks and school were preferred by normal weight children, and this difference was significant. Specifically, public parks were preferred by the normal weight boys group (OR = 0.46, 95% CI = 0.03–0.07, $p = 0.000$), while school was preferred by the normal weight girls group (OR = 0.65, 95% CI = 0.45–0.94, $p = 0.023$). No statistical differences emerged between genders or groups and weight status for "reasons" why children did not do any PA, and for the length of daily sleeping hours.

Children's "active" characteristics are presented in **Table 4**, including the odds ratios of variables that may determine them being classified as obese. Level of activity for a child during PE was found to be "hardly ever" among obese children in both groups and genders. "Quite often active" (OR = 0.61, 95% CI = 0.41–0.89), and "always active" (OR = 0.48, 95% CI = 0.32–0.71) were characteristic traits of normal weight children. These differences were significant ($p = 0.000$) between the groups, and especially boys. Regularly, during most recess breaks, normal weight children were found to be active; they "ran and played". This difference was significant ($p = 0.000$), especially amongst the boys. Conversely, obese children just "stood around or walked around" during most of recess time (OR = 1.79, 95% CI = 1.22–2.61, $p = 0.000$). In general, for all groups and both genders, obese children reported to "sit down" during most recesses more often than normal weight group.

Table 1: Anthropometric measurements of sample children categorised as normal weight (≥ 25 th & ≤ 75 th P) and obese (≥ 95 th P) of BMI for age percentile.

Measurements	Boys		Girls		p value Odd ratio (95%CI)	Normal weight Group		Obese Group		p value Odd ratio (95%CI)
	Normal weight Total (n = 236)	Obese Total (n = 232)	Normal weight Total (n = 290)	Obese Total (n = 265)		Normal weight Total (n = 526)	Obese Total (n = 497)			
Children					$p = 0.394$					$p = 0.578$
Age groups (years)										$p = 0.262$
09-<10	81 34.3%	79 34.1%	92 31.8%	88 33.2%	Ref	173 32.9%	167 33.6%	Ref		
10-<11	89 37.9%	76 32.8%	104 35.9%	84 31.7%	1.14(0.73-1.76)	193 36.7%	160 32.2%	1.18(0.78-1.78)	1.16(0.86-1.56)	
11-<12	66 28.0%	77 33.2%	94 32.0%	93 35.1%	0.83(0.53-1.31)	160 30.4%	170 34.2%	0.96(0.64-1.45)	0.90(0.67-1.23)	
Age in years (mean \pm SD)	9.94 \pm 0.79	9.99 \pm 0.82	10.01 \pm 0.80	10.02 \pm 0.82	$p = 0.461^\dagger$	9.98 \pm 0.79	10.01 \pm 0.82	$p = 0.863^\dagger$	$p = 0.544^\dagger$	
Weight (kg)	33.7 \pm 6.2	55.8 \pm 10.4	34.8 \pm 7.0	53.0 \pm 11.5	0.000	34.3 \pm 6.6	54.3 \pm 11.1	0.000	0.000	
Height (cm)	138.7 \pm 7.1	141.4 \pm 7.6	139.3 \pm 8.4	139.9 \pm 7.9	0.011	139.0 \pm 7.8	140.9 \pm 7.8	0.011	0.022	
Waist circumference (cm)	67.9 \pm 6.7	86.3 \pm 9.4	65.8 \pm 7.0	78.9 \pm 8.4	0.000	66.8 \pm 6.9	82.3 \pm 9.6	0.000	0.000	
Body fat (%)	20.1 \pm 6.4	35.5 \pm 3.4	22.8 \pm 6.0	35.9 \pm 3.6	0.000	21.6 \pm 6.3	35.7 \pm 3.5	0.000	0.000	
BMI (kg/m ²)	17.4 \pm 2.0	27.7 \pm 3.3	17.8 \pm 2.1	26.5 \pm 2.8	0.000	17.6 \pm 2.0	27.1 \pm 3.1	0.000	0.000	

 $^\dagger = t$ test.

Table 2: Regular weekly physical activities of Saudi Arabian children categorised as normal weight (≥ 25 th & ≤ 75 th P) and obese (≥ 95 th P) of BMI for age percentile.

Child regular PA Habits/Week	Boys		Girls		p value	OR 95%CI	Normal Weight	Obese	p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI				
	Normal Weight	Obese	Normal Weight	Obese														
Walk																		
None	97	41.1%	80	34.5%	0.000	Ref	107	36.9%	94	35.5%	0.190	Ref	204	38.8%	174	35.0%	0.001	Ref
Once	55	23.3%	103	44.4%	2.27(1.46-3.53)	Ref	72	24.8%	79	29.8%	1.24(0.81-1.90)	Ref	127	24.1%	182	36.6%	1.68(1.24-2.27)	Ref
Twice	37	15.7%	22	9.5%	0.72(0.39-1.32)	Ref	48	16.6%	39	14.7%	0.92(0.55-1.53)	Ref	85	16.2%	61	12.3%	0.84(0.57-1.23)	Ref
3 times	20	8.5%	11	4.7%	0.66(0.30-1.47)	Ref	21	7.2%	26	9.8%	1.40(0.74-2.66)	Ref	41	7.8%	37	7.4%	1.05(0.64-1.72)	Ref
4 times	11	4.7%	4	1.7%	0.44(0.13-1.43)	Ref	15	5.2%	9	3.4%	0.56(0.24-1.32)	Ref	26	4.9%	13	2.6%	0.52(0.26-1.04)	Ref
5 times	5	2.1%	5	2.2%	1.21(0.33-4.33)	Ref	11	3.8%	7	2.6%	0.72(0.27-1.94)	Ref	16	3.0%	12	2.4%	0.87(0.40-1.90)	Ref
6 times	3	1.3%	2	0.9%	0.80(0.13-4.95)	Ref	4	1.4%	0	0	.000	Ref	6	1.1%	2	0.4%	0.33(0.06-1.63)	Ref
>6 times	7	3.0%	5	2.2%	0.86(0.26-2.83)	Ref	8	2.8%	11	4.2%	1.56(0.60-4.05)	Ref	15	2.9%	16	3.2%	1.25(0.60-2.60)	Ref
Jog or run																		
None	127	53.8%	155	66.8%	0.019	Ref	157	54.1%	136	51.3%	0.269	Ref	284	54.0%	291	58.6%	0.020	Ref
Once	53	22.5%	39	16.8%	0.59(0.37-0.96)	Ref	46	15.9%	54	20.4%	1.33(0.84-2.10)	Ref	99	18.8%	93	18.7%	0.91(0.65-1.26)	Ref
Twice	15	6.4%	14	6.0%	0.76(0.35-1.63)	Ref	36	12.4%	31	11.7%	0.98(0.57-1.66)	Ref	51	9.7%	45	9.1%	0.85(0.55-1.31)	Ref
3 times	11	4.7%	9	3.9%	0.66(0.26-1.65)	Ref	17	5.9%	13	4.9%	0.87(0.40-1.85)	Ref	28	5.3%	22	4.4%	0.76(0.42-1.36)	Ref
4 times	5	2.1%	7	3.0%	1.14(0.35-3.67)	Ref	6	2.1%	13	4.9%	2.46(0.91-6.66)	Ref	11	2.1%	20	4.0%	1.76(0.82-3.74)	Ref
5 times	10	4.2%	4	1.7%	0.32(0.10-1.06)	Ref	13	4.5%	11	4.2%	0.96(0.41-2.21)	Ref	23	4.4%	15	3.0%	0.63(0.32-1.23)	Ref
6 times	7	3.0%	0	0	.000	Ref	2	0.7%	2	0.8%	0.45(0.08-2.38)	Ref	6	1.1%	2	0.4%	0.16(0.03-0.72)	Ref
>6 times	7	3.0%	3	1.3%	0.34(0.08-1.37)	Ref	9	3.1%	3	1.1%	0.37(0.10-1.42)	Ref	16	3.0%	6	1.2%	0.36(0.14-0.94)	Ref
Bicycling																		
None	90	38.1%	114	49.1%	0.000	Ref	146	50.3%	157	59.2%	0.079	Ref	236	44.9%	271	54.5%	0.000	Ref
Once	49	20.8%	82	35.3%	1.28(0.82-2.01)	Ref	64	22.1%	48	18.1%	0.67(0.43-1.04)	Ref	113	21.5%	130	26.2%	0.97(0.71-1.32)	Ref
Twice	32	13.6%	15	6.5%	0.36(0.18-0.70)	Ref	23	7.9%	22	8.3%	0.86(0.46-1.61)	Ref	55	10.5%	37	7.4%	0.56(0.36-0.89)	Ref

(Contd.)

Child regular PA Frequency Habits/Week	Boys		Girls		p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI
	Normal Weight	Obese	Normal Weight	Obese										
3 times	24 10.2%	9 3.9%	17 5.9%	13 4.9%		0.28(0.12-0.65)	41	22	4.4%	0.68(0.32-1.46)	41	22	4.4%	0.45(0.26-0.78)
4 times	13 5.5%	4 1.7%	8 2.8%	8 3.0%		0.23(0.07-0.75)	21	12	2.4%	0.90(0.33-2.46)	21	12	2.4%	0.48(0.23-1.00)
5 times	16 6.8%	2 0.9%	11 3.8%	3 1.1%		0.09(0.02-0.42)	21	5	1.0%	0.18(0.05-0.63)	21	5	1.0%	0.13(0.05-0.35)
6 times	2 0.8%	2 0.9%	7 2.4%	5 1.9%		0.76(0.10-5.56)	9	7	1.4%	0.45(0.15-1.34)	9	7	1.4%	0.49(0.19-1.27)
>6 times	9 3.8%	1 0.4%	6 2.1%	4 1.5%		0.08(0.01-0.68)	15	5	1.0%	0.60(0.16-2.17)	15	5	1.0%	0.28(0.10-0.78)
MVPA														
None	96 40.7%	112 48.3%	Ref	142 49.0%	136 51.3%	0.997	Ref	238	45.2%	248	49.9%	0.021	Ref	Ref
Once	61 25.8%	78 33.6%	1.07(0.70-1.65)	75 25.9%	66 24.9%		0.91(0.60-1.36)	136	25.9%	144	29.0%		1.00(0.74-1.34)	
Twice	28 11.9%	15 6.5%	0.45(0.22-0.89)	35 12.1%	28 10.6%		0.82(0.47-1.43)	63	12.0%	43	8.7%		0.64(0.42-0.99)	
3 times	18 7.6%	15 6.5%	0.70(0.33-1.46)	19 6.6%	16 6.0%		0.87(0.43-1.76)	37	7.0%	31	6.2%		0.79(0.47-1.32)	
4 times	8 3.4%	9 3.9%	0.94(0.35-2.55)	5 1.7%	7 2.6%		1.20(0.39-3.68)	13	2.5%	16	3.2%		1.08(0.51-2.26)	
5 times	11 4.7%	0	0.000	4 1.4%	4 1.5%		1.03(0.25-4.22)	15	2.9%	4	0.8%		0.25(0.08-0.77)	
6 times	4 1.7%	0	0.000	4 1.4%	3 1.1%		0.77(0.17-3.53)	8	1.5%	3	0.6%		0.35(0.09-1.35)	
>6 times	9 3.8%	1 0.4%	0.09(0.01-0.75)	4 1.4%	4 1.5%		1.03(0.25-4.22)	13	2.5%	5	1.0%		0.36(0.12-1.03)	
VPA														
None	27 11.4%	83 35.8%	Ref	146 50.3%	143 54.0%	0.925	Ref	173	32.9%	226	45.5%	0.000	Ref	Ref
Once	40 16.9%	53 22.8%	0.43(0.23-0.78)	73 25.2%	71 26.8%		0.99(0.66-1.48)	113	21.5%	124	24.9%		0.84(0.60-1.16)	
Twice	49 20.8%	30 12.9%	0.19(0.10-0.37)	25 8.6%	20 7.5%		0.81(0.43-1.53)	74	14.1%	50	10.1%		0.51(0.34-0.77)	
3 times	25 10.6%	22 9.5%	0.28(0.13-0.58)	19 6.6%	11 4.2%		0.59(0.27-1.28)	44	8.4%	33	6.6%		0.57(0.35-0.94)	
4 times	23 9.7%	7 3.0%	0.09(0.03-0.25)	10 3.4%	8 3.0%		0.81(0.31-2.12)	33	6.3%	15	3.0%		0.34(0.18-0.66)	
5 times	25 10.6%	10 4.3%	0.13(0.05-0.30)	5 1.7%	5 1.9%		0.72(0.22-2.35)	30	5.7%	15	3.0%		0.35(0.18-0.68)	
6 times	15 6.4%	12 5.2%	0.26(0.10-0.62)	4 1.4%	3 1.1%		0.76(0.16-3.48)	19	3.6%	15	3.0%		0.60(0.29-1.22)	

(Contd.)

Child regular PA Frequency Habits/Week	Boys		Girls		OR 95%CI	p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI	
	Normal Weight	Obese	Normal Weight	Obese								
>6 times	31 13.1%	15 6.5%	5 1.7%	4 1.5%	0.15(0.07-0.33)	0.81	0.81(0.21-3.10)	34	19	3.8%	0.40(0.22-0.72)	
Household works												
None	133 56.4%	169 72.8%	56 19.3%	61 23.0%	Ref	0.249	Ref	189	230	46.3%	0.009	
Once	53 22.5%	37 15.9%	53 18.3%	63 23.8%	0.54(0.34-0.88)		1.07(0.64-1.79)	106	100	20.1%	0.77(0.55-1.07)	
Twice	18 7.6%	5 2.2%	48 16.6%	42 15.8%	0.21(0.07-0.60)		0.79(0.45-1.36)	66	47	9.5%	0.58(0.38-0.88)	
3 times	16 6.8%	8 3.4%	34 11.7%	33 12.5%	0.39(0.16-0.94)		0.87(0.48-1.59)	50	41	8.2%	0.67(0.42-1.05)	
4 times	4 1.7%	6 2.6%	26 9.0%	23 8.7%	1.18(0.32-4.26)		0.79(0.41-1.55)	30	29	5.8%	0.79(0.45-1.36)	
5 times	8 3.4%	1 0.4%	30 10.3%	15 5.7%	0.09(0.01-0.79)		0.45(0.22-0.92)	36	16	3.2%	0.34(0.18-0.63)	
6 times	1 0.4%	3 1.3%	16 5.5%	11 4.2%	2.36(0.24-22.95)		0.62(0.26-1.45)	17	14	2.8%	0.67(0.32-1.40)	
>6 times	2 0.8%	3 1.3%	26 9.0%	16 6.0%	1.18(0.19-7.16)		0.55(0.27-1.14)	28	19	3.8%	0.55(0.30-1.02)	

Table 3: Factors Affect Child PA of Saudi Arabian children categorized as normal weight ($\geq 25^{\text{th}}$ & $\leq 75^{\text{th}}$ P) and obese ($\geq 95^{\text{th}}$ P) of BMI for age percentile.

Factors Affect Child PA Habits	Boys		Girls		p value	OR 95%CI	Normal Weight	Obese	p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI				
	Normal Weight	Obese	Normal Weight	Obese														
Places that normally child do PA or sports																		
Don't do any PA*	8	3.4%	22	9.5%	0.007	2.98(1.30–6.85)	59	20.3%	64	24.2%	0.291	1.24(0.83–1.85)	67	12.7%	86	17.3%	0.042	1.43(1.01–2.02)
Home	143	60.6%	152	65.5%	0.270	1.23(0.84–1.80)	179	61.7%	151	57.0%	0.235	0.81(0.57–1.14)	322	61.2%	303	61.0%	0.904	0.98(0.76–1.26)
School	166	70.3%	149	64.2%	0.159	0.75(0.51–1.11)	101	34.8%	69	26.0%	0.023	0.65(0.45–0.94)	267	50.8%	218	43.9%	0.025	0.75(0.59–0.96)
Park or public area	82	34.7%	46	19.8%	0.000	0.46(0.30–0.70)	66	22.8%	66	24.9%	0.568	1.12(0.75–1.65)	148	28.1%	112	22.5%	0.038	0.74(0.55–0.98)
Sports or recreation center	1	0.4%	3	1.3%	0.307	3.07(0.31–29.81)	1	0.3%	2	0.8%	0.513	2.19(0.19–24.29)	2	0.4%	5	1.0%	0.226	2.65(0.51–13.76)
Health/Fitness Club	35	14.8%	25	10.8%	0.178	0.68(0.39–1.18)	3	1.0%	7	2.6%	0.157	2.58(0.66–10.10)	38	7.2%	32	6.4%	0.601	0.87(0.54–1.43)
Other places	15	6.9%	13	5.2%	–	–	11	3.3%	6	2.4%	–	–	26	5.2%	19	3.8%	–	–
* Main reasons for not doing any PA																		
No time	1	0.4%	11	4.7%	0.051	7.70(0.80–74.05)	20	6.9%	25	9.4%	0.554	1.25(0.59–2.62)	21	4.0%	36	7.2%	0.167	1.60(0.81–3.15)
Not important	3	1.3%	6	2.6%	0.642	0.66(0.12–3.70)	11	3.8%	14	5.3%	0.658	0.81(0.33–1.98)	14	2.7%	20	4.0%	0.706	1.16(0.53–2.51)
No suitable facilities	2	0.8%	12	5.2%	0.122	4.00(0.64–24.65)	24	8.3%	21	7.9%	0.360	0.70(0.33–1.48)	26	4.9%	33	6.6%	0.989	0.99(0.51–1.92)
Health reasons	0	0	0	0	–	–	0	0	0	0	–	–	0	0	0	0	–	–
Afraid of criticism	2	0.8%	5	2.2%	0.502	2.18(0.21–22.33)	1	0.3%	0	0	0.295	–	3	0.6%	5	1.0%	0.400	2.02(0.38–10.78)
Other reasons	1	0.4%	5	2.2%	–	–	6	1.8%	8	3.2%	–	–	7	1.4%	13	2.6%	–	–
Sleeping Hours week days																		
<5 hours	8	3.4%	11	4.7%	0.566	Ref	17	5.9%	24	9.1%	0.558	Ref	25	4.8%	35	7.0%	0.507	Ref
5–6 hours	12	5.1%	11	4.7%	–	0.66(0.19–2.26)	32	11.0%	35	13.2%	–	0.74(0.34–1.62)	45	8.4%	46	9.3%	–	0.72(0.37–1.40)
6–7 hours	35	14.8%	31	13.4%	–	0.64(0.23–1.80)	57	19.7%	53	20.0%	–	0.63(0.30–1.30)	92	17.5%	84	16.9%	–	0.63(0.35–1.14)
7–8 hours	74	31.4%	80	34.5%	–	0.78(0.30–2.06)	82	28.3%	66	24.9%	–	0.54(0.27–1.09)	156	29.7%	146	29.4%	–	0.65(0.37–1.13)
8–9 hours	74	31.4%	59	25.4%	–	0.58(0.21–1.53)	73	25.2%	59	22.3%	–	0.55(0.27–1.11)	147	27.9%	118	23.7%	–	0.55(0.31–0.98)

(Contd.)

Factors Affect Child PA Habits	Boys		Girls		p value	OR 95%CI	Normal Weight Group	Obese Group	p value	OR 95%CI
	Normal Weight	Obese	Normal Weight	Obese						
9–10 hours	30 12.7%	39 16.8%	27 9.3%	23 8.7%		0.94(0.33–2.64)	57 10.8%	62 12.5%		0.57(0.25–1.32)
≥11 hours	3 1.3%	1 0.4%	2 0.7%	4 1.5%		0.24(0.02–2.78)	5 1.0%	5 1.0%		1.36(0.22–8.27)
Sleeping Hours weekend										
<5 hours	5 2.1%	4 1.7%	6 2.1%	13 4.9%	0.465	Ref	11 2.1%	17 3.4%	0.341	Ref
5–6 hours	5 2.1%	7 3.0%	17 5.9%	13 4.9%		1.75(0.30–10.02)	22 4.2%	20 4.0%		0.32(0.09–1.08)
6–7 hours	15 6.4%	21 9.1%	27 9.3%	31 11.7%		1.75(0.40–7.62)	42 8.0%	52 10.5%		0.47(0.16–1.41)
7–8 hours	43 18.2%	55 23.7%	61 21.0%	59 22.3%		1.59(0.40–6.31)	104 19.8%	114 22.9%		0.41(0.14–1.15)
8–9 hours	66 28.0%	56 24.1%	81 27.9%	65 24.5%		1.06(0.27–4.14)	147 27.9%	121 24.3%		0.34(0.12–0.94)
9–10 hours	87 36.9%	75 32.3%	78 26.9%	67 25.3%		1.07(0.27–4.15)	165 31.4%	142 28.6%		0.36(0.13–1.01)
≥11 hours	15 6.4%	14 6.0%	20 6.9%	17 6.4%		1.16(0.26–5.24)	35 6.7%	31 6.2%		0.36(0.11–1.15)

Table 4: Children's active characteristics of Saudi Arabian children categorised as normal weight (≥ 25 th & ≤ 75 th P) and obese (≥ 95 th P) of BMI for age percentile.

Active characteristics	Boys		p value	Girls		p value	Normal Weight Group		Obese Group		p value	OR 95%CI						
	Normal Weight	Obese		Normal Weight	Obese		Normal Weight	Obese	OR 95%CI	OR 95%CI								
Often the child to be very active during (PE) classes																		
He/she don't do PE	6	2.5%	17	7.3%	0.000	Ref	93	32.1%*	90	34.0%*	0.039	Ref	99	18.8%	107	21.5%	0.000	Ref
Hardly ever	7	3.0%	64	27.6%	3.37(1.00–11.36)	Ref	20	6.9%	37	14.0%	1.89(1.02–3.50)	Ref	27	5.1%	101	20.3%	3.53(2.13–5.84)	Ref
Sometimes	41	17.4%	50	21.6%	0.43(0.15–1.19)	Ref	81	27.9%	69	26.0%	0.87(0.56–1.34)	Ref	122	23.2%	119	23.9%	0.89(0.61–1.29)	Ref
Quite often	82	34.7%	49	21.1%	0.21(0.07–0.57)	Ref	55	19.0%	43	16.2%	0.78(0.48–1.28)	Ref	137	26.0%	92	18.5%	0.61(0.41–0.89)	Ref
Always	100	42.4%	49	21.1%	0.17(0.06–0.46)	Ref	40	13.8%	25	9.4%	0.63(0.35–1.13)	Ref	138	26.2%	74	14.9%	0.48(0.32–0.71)	Ref
Child do most at recess time																		
Sat down (talking watching)	46	19.5%	55	23.7%	0.000	Ref	104	35.9%	111	41.9%	0.215	Ref	150	28.5%	166	33.4%	0.000	Ref
Stood or walked around	25	10.6%	78	33.6%	2.60(1.43–4.74)	Ref	36	12.4%	43	16.2%	1.11(0.66–1.87)	Ref	61	11.6%	121	24.3%	1.79(1.22–2.61)	Ref
Ran or played a little bit	45	19.1%	39	16.8%	0.72(0.40–1.29)	Ref	57	19.7%	39	14.7%	0.64(0.39–1.04)	Ref	102	19.4%	78	15.7%	0.69(0.47–0.99)	Ref
Ran around (played quite)	93	39.4%	51	22.0%	0.45(0.27–0.77)	Ref	82	28.3%	63	23.8%	0.72(0.47–1.09)	Ref	175	33.3%	114	22.9%	0.58(0.42–0.81)	Ref
Ran and played hard	27	11.4%	9	3.9%	0.27(0.11–0.65)	Ref	11	3.8%	9	3.4%	0.76(0.30–1.92)	Ref	38	7.2%	18	3.6%	0.42(0.23–0.78)	Ref

* Throughout time of conducting data collection, by law, no (PE) classes at girl's school in Saudi, however, some private school have.

4. Discussion

Limited contemporary studies exist on the PA behaviors in children of Saudi Arabia. Our study has provided extensive data around PA and its associated effects on both genders, aged 9–12 years. We have highlighted that PA behaviours are associated with Saudi Arabian children's categorisations of being of normal weight or obese. Interestingly, these behaviours are different between boys and girls. Jogging or running, bicycling, MVPA and VPA, were significantly different between normal weight and obese children, especially for boys but not among girls. Moreover, lack of participation in PA contributed to a higher risk of being obese in both groups. Normal weight children were "active" during PE and in most recess times. Home, school, and public parks were the preferred places of all children to engage in PA. However, importantly and interestingly, daily sleeping hours did not confirm a marked difference in the weight status results for either group. To the best of our knowledge, this study is the first of its kind to obtain information and make an in-depth comparison of habits of PA between normal weight and obese children in Saudi Arabia.

Other than the inconsistency of data linking obesity and physical activities (Venn et al. 2007), the majority of research on the habits of PA among children suggests that obese children are less active (Hills, King & Armstrong, 2007; Planinsec & Matejek, 2004) and they possess poorer movement skills in comparison to normal weight children (Okely, Booth & Chey, 2004). Furthermore, they prefer to participate in sedentary behaviours especially screen-based inactivity, lying, and reclining (Marshall et al. 2004). Our study found that normal weight children, especially boys, participated in significantly more PA categorised as MVPA and VPA than obese children. These findings of increased frequency of MVPA agree with longitudinal research conducted on 9-year old Spanish children (Laguna et al. 2013). Another study confirms that the participation of MVPA in overweight boys is less in comparison to their non-overweight counterparts, however, such a difference was absent in girls (Colley et al. 2011). A representative multi-national sample of children derived from 12 countries (developed and developing) concluded that associations of MVPA and VPA to obesity were significant in all these countries (Katzmarzyk et al. 2015). Moreover, MVPA, in children between the ages of 9 and 12, is more strongly related to obesity than sedentary behaviour (Katzmarzyk et al. 2015, De Bourdeaudhuij et al. 2013). Regarding gender specifically, more MVPA frequency and less sedentary in girls was linked to lower BMI and waist circumference; however, in boys, MVPA emerges as being most significant for weight and weight status, yet being sedentary seems not to be as relevant (De Bourdeaudhuij et al. 2013).

Regarding this gender difference, the underlying mechanism not yet well understood; however, it is evident that girls for a given BMI percentile, have generally higher levels of percent body fat (Heo et al. 2014), which could influence the connections with physical activity (Katzmarzyk et al. 2015). Interestingly, girls in our study achieved the same frequency PA, independent of weight status (normal weight/obesity). This may explain why Saudi Arabian girls, due to the country's social traditions and culture, in most cases have fewer chances than boys to engage in leisure-time PA. Socio-culturally, most parents in Saudi Arabia do not encourage girls to participate in PA in their own leisure time or pursuits (Al-Hazzaa et al. 2013). Also, parents may feel it is unsafe for girls to venture into outdoor play areas. Consequently, they spend more time at home and more time sitting. The explanation for this is that compared to boys, Saudi Arabian girls generally have limited opportunities to take up various forms of PA, both in and outside the school. In five European countries, girls compared to boys, spent significantly less time in all PA (Verloigne et al. 2012). These sorts of findings concur with those reported in our analysis. It appears that among Saudi Arabian girls, the statement "high BMI is followed by less activity, but that less activity is not followed by higher BMI" (Metcalf et al. 2011) may apply, and provides another reason for why gender differences exist. Thus, our findings suggest that a merit special attention to Saudi girls when made intervention programmes to promote PA. There is a need to extra investigate why a PA difference between girls and boys exists.

Our study found that the preferred places for all children to do PA were home, school and public parks. Home is seen to be safe because the children are playing under the watchful eyes of their parents. Home is where there is enough space, such as a backyard, to assist children to take part in daily PA (Dunton et al. 2010). One Australian study targeted children's parents, and reported that a familiar place where children participate in active free-play was the yard at home or at a park and playground; 74% and 33%, respectively (Veitch et al. 2006). A previous study among children (Page et al. 2005) indicated that children (normal weight, overweight and obese) are usually highly active while at school compared to being at home during the evening hours. The authors suggest that the place is where the children will most likely be more physically active is when they interact with friends who are of their own age. However, in our study, we found that schools and public parks were preferred by among normal weight children to participate in PA, and may suggest a tendency of obese children to avoid PA, publicly, in front of other non-obese peers.

Children's PA behaviors are influenced by outside building environments (Ding et al. 2011). In Saudi Arabia, unfortunately, there is limited availability of facilities and places that are suitable for outdoor/indoor activities where children of both sexes can play, for example parks and sports grounds (Al-Nakeeb et al. 2012). The country has a desert climate that is extremely hot in summer and very cold and windy in winter, which is generally discourages engaging in PA for a substantial part of the year (Al-Nuaim et al. 2012). This style of living has increased sedentary behaviour, which may equally affect PA behaviors among the current cohort, especially girls. The provision of facilities to increase engagement in PA in the Saudi Arabian community may constitute a very effective intervention.

There are other factors which lead to sedentary behaviour among the youths in Saudi Arabia. These include widespread dependence on vehicles to transport people for short distance trips instead of walking, including to and from school (Al-Hazzaa, 2006). Walking and cycling to and from school is not common in Saudi Arabia. Most of the cities in Saudi Arabia are highly developed and modern, consisting of residential and commercial networks that only encourage movement by automobile, not walking. Also, the majority of schools in Saudi Arabia lack physical education programs for girls (Al-Hazzaa et al. 2011). Throughout our data collection period government girls' schools were banned from offering physical exercise classes. This is changing but more time is needed for this to have some effect on girl's schools in country.

In children, it is not clear if fatness leads to inactiveness or inactiveness leads to obesity (Metcalf et al. 2011). When establishing the relationship between BMI and various PA behaviour, it is essential to consider the different volume of sedentary behavior. There exists a perception that high levels of inactivity do not equate to the absence of PA (Wong & Leatherdale, 2009). A German study among 8 to 11-year-old children addresses the issue that inactive children are more likely to be overweight when compared to active children who are likely to be non-overweight. It concluded that the amount of time spent being "passive" was significantly higher in overweight children, while non-overweight children were more "active" (Kreuser et al. 2013). Our study findings were consistent with these.

Although evidence on sleeping hours suggest that obese children (both boys and girls) sleep less than normal weight (Hart, Cairns & Jelalian, 2011; Pileggi et al. 2013), our study findings did not support this conclusion. Our results found no significant associations between sleeping hours and weight status, even between sexes or groups. It seems that sleeping hours in our cohort is not one of the factors that could increase children's obesity risk. There may be other factors involved such as sedentary time, physical activity, parents' obesity, diet, etc. Although few studies found no association, one longitudinal study among US children between the ages of 9–11 reported short sleep in girls has a relationship with BMI. Yet this was not the case for boys (El-Sheikh et al. 2014).

4.1. Study strengths and limitations

Despite the data in this study being mostly self-reported, which can lead to the problem of recall and social desirability bias, most of the questions used to collect the activity data originate from previously validated measures. Furthermore, data on children's physical behaviours were collected from parents, which is suggested for children less than 12 years of age (Sithole & Veugelers, 2008). Prompt cards were employed to help their understanding of the questions and improve response accuracy.

Our study did not investigate the duration of PA performed. As we used self-report questionnaires, missing and clearly inaccurate estimates of PA duration were reported. However, among youth, questionnaires can accurately determine the mode of activity, in addition to frequency, behaviours, and, therefore, capturing qualitative data (Corder et al. 2009; Sylvia et al. 2014).

The study does not include an investigation of the role of sedentary behaviors. Previous research studies reveal that sedentary and PA behaviours should be deemed distinct constructs; evaluations in one field should not necessarily be applicable as markers of the other (Pearson et al. 2014). This emphasises the necessity to examine these links separately in pre-adolescent children (Must & Tybor, 2005). Therefore, the current study's data and analysis make an essential contribution to the relevant evidence base.

Ethics and Consent

Our study received ethical approval from the two key institutions: firstly, the Institutional Review Board (IRB) at the Ministry of Health in Saudi Arabia (Approval no. 15-336E); and secondly, The University of Queensland Behavioural and Social Sciences Ethical Review Committee (BSSERC) (Approval no. 2015001629). Furthermore permission was granted by the Ministry of Education in Saudi Arabia to conduct the study in designated schools.

Acknowledgements

We take this opportunity to appreciate the parents, households, and children who participated in the research willingly. Equally, we give thanks to the dieticians who assisted in the gathering of anthropometric information and the dissemination of the questionnaires.

Funding Information

This research was partly supported by King Abdulaziz City for Science and Technology (Riyadh City, Saudi Arabia). The funders had no role in the design, analysis or writing of this article.

Competing Interests

The authors have no competing interests to declare.

References

- Al-Hazzaa, H. M.** (2006). School backpack: How much load do Saudi boys carry on their shoulders? *Saudi Med J*, 27(10), 1567–1571.
- Al-Hazzaa, H. M.** (2007). Rising trends in BMI of Saudi adolescents: Evidence from three national cross-sectional studies. *Asia Pacific Journal*, 16(3), 462–468.
- Al-Hazzaa, H. M., Abahussain, N., Al-Sobayel, H., Qahwaji, D., & Musaiger, A.** (2011). Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. *International Journal of Behavioral Nutrition and Physical Activity*, 21(8), 140. DOI: <https://doi.org/10.1186/1479-5868-8-140>
- Al-Hazzaa, H. M., Al-Nakeeb, Y., Duncan, M. J., Al-Sobayel, H. I., Abahussain, N. A., Musaiger, A. O., Lyons, M., Collins, P., & Nevill, A.** (2013). A Cross-Cultural Comparison of Health Behaviors between Saudi and British Adolescents Living in Urban Areas: Gender by Country Analyses. *Int. J. Environ. Res. Public Health*, 10(12), 6701–6720. DOI: <https://doi.org/10.3390/ijerph10126701>
- Al-Hazzaa, H. M., & Musaiger, A. O.** (2011). Arab teens lifestyle study (ATLS): Objectives, design, methodology and implications. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 4, 417–426. DOI: <https://doi.org/10.2147/DMSO.S26676>
- Al-Nakeeb, Y., Lyons, M., Collins, P., Al-Nuaim, A., Al-Hazzaa, H. M., & Duncan, M. J.** (2012). Obesity, Physical Activity and Sedentary Behavior Amongst British and Saudi Youth: A Cross-Cultural Study. *Int. J. Environ. Res. Public Health*, 9(4), 1490–1506. DOI: <https://doi.org/10.3390/ijerph9041490>
- Al-Nuaim, A., Al-Nakeeb, Y., Lyons, M., Al-Hazzaa, H. M., Nevill, A., Collins, P., & Duncan, M. J.** (2012). The prevalence of physical activity and sedentary behaviours relative to obesity among adolescents from Al-Ahsa, Saudi Arabia: Rural versus urban variations. *Journal of Nutrition and Metabolism*, 2012(3), 156–164. DOI: <https://doi.org/10.1155/2012/417589>
- Alturki, H. A., Brookes, D. S., & Davies, P. S.** (2018). Comparative evidence of the consumption from fast-food restaurants between normal-weight and obese Saudi schoolchildren. *Public Health Nutrition*, 21(12), 2280–2290. DOI: <https://doi.org/10.1017/S1368980018000757>
- Cancela, J., Ayán, C., & Castro, A.** (2013). An evaluation of questionnaires assessing physical activity levels in youth populations. *Journal of Child Health Care*, 17(3), 274–293. DOI: <https://doi.org/10.1177/1367493512461571>
- Centers for Disease Control and Prevention (CDC).** (2000). Children BMI. Available at: http://www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/about_childrens_BMI.htm [last accessed 10 March 2018].
- Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S.** (2011). Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, 22(1), 15–23.
- Corder, K., Van Sluijs, E., Wright, A., Whincup, P., Wareham, N., & Ekelund, U.** (2009). Is it possible to assess free-living physical activity and energy expenditure in young people by self-report? *The American Journal of Clinical Nutrition*, 89(3), 862–870. DOI: <https://doi.org/10.3945/ajcn.2008.26739>
- De Bourdeaudhuij, I., Verloigne, M., Maes, L., Van Lippevelde, W., Chinapaw, M. J., Te Velde, S. J., Manios, Y., Androustos, O., Kovacs, E., Dössegger, A., & Brug, J.** (2013). Associations of Physical Activity and Sedentary Time with Weight and Weight Status among 10-to-12-year-old Boys and Girls in Europe: A Cluster Analysis within the ENERGY Project. *Pediatric Obesity*, 8(5), 367–75. DOI: <https://doi.org/10.1111/j.20476310.2012.00117.x>

- Denicola, E., Aburizaiza, O., Siddique, A., Khwaja, H., & Carpenter, D.** (2015). Obesity and public health in the Kingdom of Saudi Arabia. *Reviews On Environmental Health, 30*(3), 191–205. DOI: <https://doi.org/10.1515/reveh-2015-0008>
- Ding, D., Sallis, J., Kerr, J., Lee, S. M., & Rosenberg, D.** (2011). Neighborhood environment and physical activity among youth: A review. *Am J Prev Med, 41*(4), 442–55. DOI: <https://doi.org/10.1016/j.amepre.2011.06.036>
- Dunton, G., Jerrett, M., Wolch, J., Spruijt-Metz, D., & Pentz, M. A.** (2010). The Availability of Active Space and Equipment at Home: Associations With Physical Activity and Body Mass Index in Children and Parents. *Obesity, 18*(2), S131–S131.
- El-Sheikh, M., Bagley, E. J., Keiley, M. K., & Erath, S. A.** (2014). Growth in body mass index from childhood into adolescence: The role of sleep duration and quality. *J Early Adolesc, 34*(8), 1145–1166. DOI: <https://doi.org/10.1177/0272431613519499>
- Fryar, C. D., Gu, Q., & Ogden, C. L.** (2012). Anthropometric reference data for children and adults: United States, 2007–2010. National Center for Health Statistics. *Vital Health Stat, 11*(252), 1–48.
- Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U.** (2012). Global physical activity levels: Surveillance progress, pitfalls, and prospects. *The Lancet, 380*(9838), 247–257. DOI: [https://doi.org/10.1016/S0140-6736\(12\)60646-1](https://doi.org/10.1016/S0140-6736(12)60646-1)
- Hardy, L. L., Mahrshahi, S., Drayton, B. A., & Bauman, A.** (2016). *NSW Schools Physical Activity and Nutrition Survey (SPANS) 2015: Full Report*. Sydney: NSW Department of Health.
- Hart, C. N., Cairns, A., & Jelalian, E.** (2011). Sleep and Obesity in Children and Adolescents. *The Pediatric Clinics of North America, 58*(3), 715–733. DOI: <https://doi.org/10.1016/j.pcl.2011.03.007>
- Heo, M., Wylie-Rosett, J., Pietrobelli, A., Kabat, G. C., Rohan, T. E., & Faith, M. S.** (2014). US pediatric population-level associations of DXA-measured percentage of body fat with four BMI metrics with cutoffs. *Int J Obes, 38*(1), 60–8. DOI: <https://doi.org/10.1038/ijo.2013.134>
- Hills, A. P., Andersen, L. B., & Byrne, N. M.** (2011). Physical activity and obesity in children. *Br J Sports Med, 45*(11), 866–870. DOI: <https://doi.org/10.1136/bjsports-2011-090199>
- Hills, A. P., King, N. A., & Armstrong, T. P.** (2007). The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: Implications for overweight and obesity. *Sports Med, 37*(6), 533–45. DOI: <https://doi.org/10.2165/00007256-200737060-00006>
- Katzmarzyk, P. T., Barreira, T. V., Broyles, S. T., Champagne, C. M., Chaput, J. P., Fogelholm, M., Hu, G., Johnson, W. D., Kuriyan, R., Kurpad, A., Lambert, E. V., Maher, C., Maia, J., Matsudo, V., Olds, T., Onywera, V., Sarmiento, O. L., Standage, M., Tremblay, M. S., Tudor-Locke, C., Zhao, P., & Church, T. S.** (2015). Physical Activity, Sedentary Time, and Obesity in an International Sample of Children. *Medicine & Science in Sports & Exercise, 47*(10), 2062–9. DOI: <https://doi.org/10.1249/MSS.0000000000000649>
- Kowalski, K., Crocker, P., & Donen, R.** (2004). *The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual*. Saskatoon: College of Kinesiology, University of Saskatchewan.
- Kreuser, F., Kromeyer-Hauschild, K., Gollhofer, A., Korsten-Reck, U., & Rottger, K.** (2013). Obese equals lazy? Analysis of the association between weight status and physical activity in children. *Journal of Obesity, 8*. DOI: <https://doi.org/10.1155/2013/437017>
- Laguna, M., Ruiz, J. R., Gallardo, C., García-Pastor, T., Lara, M. T., & Aznar, S.** (2013). Obesity and physical activity patterns in children and adolescents. *Journal of Paediatrics and Child Health, 49*(11), 942–949. DOI: <https://doi.org/10.1111/jpc.12442>
- Marshall, S. J., Biddle, S. J., Gorely, T., Cameron, N., & Murdey, I. R.** (2004). Relationships between media use, body fatness and physical activity in children and youth: A meta-analysis. *Int J Obes Relat Metab Disord, 28*(10), 1238–46. DOI: <https://doi.org/10.1038/sj.ijo.0802706>
- McCarthy, H. D., Cole, T. J., Fry, T., Jebb, S. A., & Prentice, A. M.** (2006). Body fat reference curves for children. *International Journal of Obesity, 30*(4), 598–602. DOI: <https://doi.org/10.1038/sj.ijo.0803232>
- Metcalfe, B. S., Hosking, J., Jeffery, A. N., Voss, L. D., Henley, W., & Wilkin, T. J.** (2011). Fatness leads to inactivity, but inactivity does not lead to fatness: A longitudinal study in children (EarlyBird 45). *Arch Dis Child, 96*(10), 942–7. DOI: <https://doi.org/10.1136/adc.2009.175927>
- Must, A., & Tybor, D. J.** (2005). Physical activity and sedentary behavior: A review of longitudinal studies of weight and adiposity in youth. *Int J Obes, 29*(2), S84–96. DOI: <https://doi.org/10.1038/sj.ijo.0803064>
- Nader, P. R., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O'Brien, M.** (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *JAMA, 300*(3), 295–305. DOI: <https://doi.org/10.1001/jama.300.3.295>

- Nooijen, C. F. J., Galanti, M. R., Engström, K., Möller, J., & Forsell, Y.** (2017). Effectiveness of interventions on physical activity in overweight or obese children: A systematic review and meta-analysis including studies with objectively measured outcomes. *Obesity Reviews*, *18*(2), 195–213. DOI: <https://doi.org/10.1111/obr.12487>
- Okely, A. D., Booth, M. L., & Chey, T.** (2004). Relationships between body composition and fundamental movement skills among children and adolescents. *Res Q Exerc Sport*, *75*(3), 238–47. DOI: <https://doi.org/10.1080/02701367.2004.10609157>
- Özgür, P., & Aslan, N.** (2015). The Role of Urbanization in Childhood Obesity. *Journal of Clinical Research in Pediatric Endocrinology*, *7*(3), 163–167. DOI: <https://doi.org/10.4274/jcrpe.1984>
- Page, A., Cooper, A. R., Stamatakis, E., Foster, L. J., Crowne, E. C., Sabin, M., & Shield, J. P.** (2005). Physical activity patterns in nonobese and obese children assessed using minute-by-minute accelerometry. *Int. J. Obes. (Lond)*, *29*(9), 1070–6. DOI: <https://doi.org/10.1038/sj.ijo.0802993>
- Pearson, N., Braithwaite, R. E., Biddle, S. J., van Sluijs, E. M., & Atkin, A. J.** (2014). Associations between sedentary behaviour and physical activity in children and adolescents: A meta-analysis. *Obesity Reviews*, *15*(8), 666–675. DOI: <https://doi.org/10.1111/obr.12188>
- Pileggi, C., Lotito, F., Bianco, A., Nobile, C. G. A., & Pavia, M.** (2013). Relationship between chronic short sleep duration and childhood body mass index: A school-based cross-sectional study. *PLoS One*, *8*(6), e66680. DOI: <https://doi.org/10.1371/journal.pone.0066680>
- Planinsec, J., & Matejek, C.** (2004). Differences in physical activity between non-overweight, overweight and obese children. *Coll Antropol*, *28*(2), 747–54.
- Sithole, F., & Veugelers, P. J.** (2008). Parent and child reports of children's activity. *Health Rep*, *19*(3), 19–24.
- Sylvia, L. G., Bernstein, E. E., Hubbard, J. L., Keating, L., & Anderson, E. J.** (2014). Practical Guide to Measuring Physical Activity. *J Acad Nutr Diet*, *114*(2), 199–208. DOI: <https://doi.org/10.1016/j.jand.2013.09.018>
- Telford, A., Salmon, J., Jolley, D., & Crawford, D.** (2004). Reliability and validity of physical activity questionnaires for children. The Children's Leisure Activities Study Survey (CLASS). *Pediatric Exercise Science*, *16*(1), 64–78. DOI: <https://doi.org/10.1123/pes.16.1.64>
- Veitch, J., Bagley, S., Ball, K., & Salmon, J.** (2006). Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health and Place*, *12*(4), 383–393. DOI: <https://doi.org/10.1016/j.healthplace.2005.02.009>
- Venn, A. J., Thomson, R. J., Schmidt, M. D., Cleland, V. J., Curry, B. A., Gennat, H. C., & Dwyer, T.** (2007). Overweight and obesity from childhood to adulthood: A follow-up of participants in the 1985 Australian Schools Health and Fitness Survey. *Med J Aust*, *186*(9), 458–60.
- Verloigne, M., van Lippevelde, W., Maes, L., Yildirim, M., Chinapaw, M., Manios, Y., Androustos, O., Kovács, E., Bringolf-Isler, B., Brug, J., & De Bourdeaudhuij, I.** (2012). Levels of physical activity and sedentary time among 10-to 12-year-old boys and girls across 5 European countries using accelerometers: An observational study within the ENERGY-project. *Int. J. Behav. Nutr. Phys. Act.*, *31*(9), 34. DOI: <https://doi.org/10.1186/1479-5868-9-34>
- Wong, S. L., & Leatherdale, S. T.** (2009). Association between sedentary behavior, physical activity, and obesity: Inactivity among active kids. *Prev Chronic Dis*, *6*(1), A26.

How to cite this article: Alturki, H., Brookes, D., and Davies, P. (2018). Differences in Physical Behaviour between Obese and Normal Weight Saudi Arabian Boys and Girls: What is Worth Noting? *Physical Activity and Health*, *2*(1), pp. 51–65. DOI: <https://doi.org/10.5334/paah.25>

Submitted: 17 October 2018 **Accepted:** 20 November 2018 **Published:** 10 December 2018

Copyright: © 2018 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.

 *Physical Activity and Health* is a peer-reviewed open access journal published by Ubiquity Press.

OPEN ACCESS 