ORIGINAL ARTICLE

The Association Between Physical Activity and Obesity among School Children and Adolescents in Jeddah, Saudi Arabia

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Abstract

Obesity affects children's physical and psychological well-being. In this study we investigated the associations of obesity with physical activity, socioeconomic factors, and lifestyle among Saudi children and adolescents. A stratified sample of 729 school children and 794 adolescent students was recruited. Waist circumference and body mass index were used to categorize the participants as obese and non-obese, and a structured mixed questionnaire was used to collect socioeconomic, physical activity, and lifestyle data. The results revealed that obese adolescent males (33.5%) were significantly more common than obese adolescent females (13.6%, $P < 0.001$). Body mass index-based and waist circumference-based obesity was significantly more common in private schools compared to public schools among school children and adolescents ($P = 0.013$ and $P = 0.002$, respectively). Student obesity was associated with higher parental education, especially among the school children ($P = 0.006$). Among adolescents, obesity was strongly associated with family income ($P = 0.002$) and time spent watching television ($P = 0.004$). Non-obese children and adolescents were considered subjectively more active than their obese counterparts ($P < 0.001$ and $P = 0.011$, respectively). In conclusion, obesity was common among school children and adolescents, and was associated with private schooling, adolescent male sex, parental education, and family income. Physical inactivity and time spent watching television were important risk factors for obesity among Saudi school children and adolescents.

Keywords

Obesity; Prevalence; Physical inactivity; School children; Adolescents

INTRODUCTION

Obesity among children and adolescents affects their physical and psychological well-being[1]. Several studies have evaluated the prevalence of obesity and overweight status among Saudi children, based on local sociocultural variations and rapid urbanization patterns[2-4]. The results indicate that Saudi children become overweight at the approximate age of 5–9 years, and increasing prevalence are observed among adolescents[5]. Several cross-sectional studies have also highlighted alarming increases in the Saudi prevalence of obesity based on body fat percentage and body mass index (BMI)[6-8].

Environmental and lifestyle factors contribute to the worldwide obesity epidemic[9], and Saudi Arabia has undergone rapid recent changes in living standards. This modernization has led to lifestyle changes that include decreased physical activity and an increasingly sedentary lifestyle[3,10-12]. These changes are likely related to increased reliance on computer technology, telecommunication, and urbanization, which are associated with noticeable health effects[13].

The World Health Organization (WHO) has reported that 60% of the world's population is inactive and that physical inactivity is a threat to global health, based on physical activity assessments among different populations [14]. Saudi studies have also suggested that the prevalence of physical inactivity is 43.3–99.5%[13], and Al-Hazzaa[10] has reported that Saudi children and adolescents perform minimal physical activity. Mahfouz *et al.*[15] investigated the sex-based differences in adolescent obesity, and reported that the lack of mandatory physical activity during school activities was a significant risk factor for obesity. Al-Ghamdi[16] also explored the association between obesity and time spent watching television among Saudi school children, and reported that replacement of physical activity with television watching was a risk factor for obesity.

There are minimal data regarding the Saudi epidemiology of physical activity, despite the fact that Saudi Arabia has undergone massive changes in the national standard of living and has an increasing prevalence of childhood obesity[6-8]. The available data regarding the Saudi prevalence of physical activity have typically been obtained in urban areas using large and randomized samples[10-12,17], with physical activity not being a major outcome of interest[12,17]. Thus, additional data is needed to understand, prevent, and control obesity among Saudi children. The present study aimed to investigate the associations of obesity with physical activity, socioeconomic factors, and lifestyle among Saudi school children and adolescents. The null hypothesis to be tested was: physical activity and socioeconomic factors are not associated with obesity among Saudi children and adolescents.

PARTICIPANTS AND METHODS

This cross-sectional study was performed in Jeddah, Saudi Arabia, and collected data during January–May 2017. Based on previous studies, the prevalence of obesity were assumed to be 30% among school children and 23% among adolescent students [18]. The required sample size was calculated using free web-based software (OpenEpi version 2), and individuals were randomly sampled from the elementary and secondary schools in Jeddah. The 620 public and private elementary schools teach approximately 120,000 boys and 118,500 girls. Based on a required sample of 895 school children, and a male: female ratio of 1:0.97, we recruited 450 boys and 445 girls. The 320 public and private secondary schools teach approximately 50,250 male students and 48,100 female students. Based on a required sample of 751 adolescents, and a male: female ratio of 1:0.95, we recruited 380 male adolescents and 371 female adolescents.

Schools were randomly selected for the recruitment using a previously prepared numbered list and a random number generator[19]. One public elementary school and one private elementary school were selected for each sex and each of the four main regions in Jeddah (East, South, West, and North), in order to obtain the required number of school children. For each school, two Grade 3 classes (7–10 years old) were randomly selected, and a substitute school was randomly selected if a previously selected school only had one Grade 3 class. The same procedure was performed to recruit the secondary school students (Grade 11, 15–19 years old).

The study's protocol (#028-16) was approved by the Ethical Committee of King Abdulaziz University, Faculty of Dentistry (KAUFD), the Ministry of Education in Jeddah, and each school's principal. Students were instructed to bring a consent form home to their parents, and only students who returned signed

consent forms were included in the evaluations. All school staff and included students received an explanation of the study before we performed the examination and measurements procedures.

Sociodemographic and Physical Activity Data

A structured questionnaire was used to gather the participants' data. The structured questionnaire was reviewed by three experts to review the questionnaire items, evaluate the correspondence between its parts and to comment on how the questions were relevant to the study. The experts rated each question and these rates were analyzed statistically to calculate the validity of questionnaire. The analysis revealed a 97.6% agreement about the questionnaire parts. The questionnaires were distributed during the first school visit, were completed at home by the parents, and were collected during the second visit.

The first part of the questionnaire collected demographic and socioeconomic data. Parents were asked to provide their name, age, sex, nationality, profession, and education level, as well as their child's school name and grade. Parental education was categorized as less than secondary school, secondary school, university, and post-graduate studies. The second part of the questionnaire included closed-ended questions regarding frequencies of physical activity (*e.g.,* playing sports or walking instead of motorized transportation) and time spent watching television or playing video games. In addition, the parents were asked to provide their subjective assessment of whether or not their children were physically active.

Anthropometric Measurements

The research team was adequately trained to evaluate each participant's height, weight, and waist circumference (WC). A calibration exercise was performed for the height and WC measurements, which evaluated the intra-examiner reliability where 10 patients who attended KAUFD clinics were tested before and after a one-week interval (Kappa score 0.87) and inter-examiner reliability where 20 patients who attended KAUFD clinics (Kappa score 0.79). Disagreements in any measurements were resolved by re-taking the measurements until consensus was reached.

The anthropometric measurements were taken twice for each participant, and the average value was used for the analysis. Waist circumference was obtained using a regular measuring tape at the superior iliac crest while standing and during minimal breathing. Height was recorded using a commercial non-elastic measuring tape while the participant stood without shoes and with straight shoulders, freely hanging arms, and looking straight forward. The tape was used to measure the distance between the floor and a point that was marked on the wall at the highest point of the participant's head. Weight was measured using an electronic weight scale while the participants were wearing minimal clothing and no shoes[20,21].

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, Version 23 (IBM Corp., Armonk, NY USA). Data were reported as numbers and percentages. The associations of WC-based and BMI-based obesity with the participants' characteristics were evaluated in each age group using the chi-square test with Bonferroni multiple comparison correction. All P-values were two-sided, and differences were considered statistically significant at P-values of < 0.05.

RESULTS

The participants' sociodemographic characteristics are shown in Table 1. The students included 729 children (7–10 years old, 46.2% female and 53.8% male) and 794 adolescents (15–19 years old, 51.9% female and 48.1% male). Similar proportions of the participants were enrolled in private and public schools (children: 50.3% *vs.* 49.7%, adolescents: 50.6% *vs*. 49.4%, respectively), and similar distributions were observed among the four districts of Jeddah. The students' fathers generally had a college degree (children: 52.7%, adolescents: 42.8%), with mothers of school children most commonly having graduated from high school (35.0%) and mothers of adolescents most commonly having a college degree (38.7%). The fathers were most commonly self-employed or employed in private companies (children: 32.8%, adolescents: 36.1%), while mothers were generally unemployed (children: 72.7%, adolescents: 72.5%). Based on BMI, 18.0% of the children and 16.0% of the adolescents were overweight, while 18.2% of children and 23.2% of adolescents were obese. Based on WC, 17.7% of the children and 18.8% of the adolescents were obese, while 82.3% of children and 81.2% of adolescents were non-obese.

Table 1. Participant characteristics.

	Age groups			
	7–10 years		15–19 years	
	n	%	n	%
Gender				
Female	337	46.22%	412	51.88%
Male	392	53.77%	382	48.11%
School Type				
Private	367	50.34%	402	50.62%
Public	362	49.65%	392	49.37%
District				
East	115	15.77%	187	23.55%
North	229	31.41%	213	26.82%
South	170	23.31%	192	24.18%
West	215	29.49%	202	25.44%
Mother Occupation				
Self-Employed	20	2.74%	43	5.41%
Government Employee	116	15.91%	145	18.26%
Privately Employed	51	6.99%	18	2.26%
Unemployed	530	72.70%	576	72.54%
Other	12	1.64%	12	1.51%
Father Occupation				
Self-Employed	164	22.49%	287	36.14%
Government Employee	155	21.26%	128	16.12%
Privately Employed	239	32.78%	170	21.41%
Soldier/Police	75	10.28%	49	6.17%
Laborer	32	4.38%	19	2.39%
Unemployed	14	1.92%	100	12.59%
Mother Educational Level				
<High School	101	13.85%	125	15.74%
High School	255	34.97%	268	33.75%
College	335	45.95%	307	38.66%
Postgraduate Degree	38	5.21%	94	11.83%
Father Educational Level				
< High School	75	10.28%	80	10.07%
High School	189	25.92%	180	22.67%
College	384	52.67%	340	42.82%
Postgraduate Degree	81	11.11%	194	24.43%
BMI Classification				
Underweight	7	9.60%	55	6.92%
Normal weight	458	62.82%	428	53.90%
Overweight	131	17.96%	127	15.99%
Obese	133	18.24%	184	23.17%
WC Classification				
Non-obese	600	82.30%	645	81.23%
Obese	129	17.69%	149	18.76%

The physical activity data are shown in Table 2. Approximately three-quarters of the school children (73.9%) and adolescents (76.5%) played sports, with frequencies classified as 1 time/week, 2–3 times/week, and ≥ 4 times/week. Approximately two-thirds of school children (69.3%) and only 38% of adolescents played 2–3 times/week. Time spent watching television was classified as 1 hr/day, 2–3 hr/day, and ≥ 4 hr/day. Approximately one-half (52.9%) of school children and 36.6% of adolescents watched an average of 2–3 hr/day. High percentages of school children and adolescents did not walk to school (94.7% and 91.9%, respectively) or elsewhere (89.4% and 84.9%, respectively). The parents' subjective opinions

Table 2. Physical activity.

		Age Group			
		7–10 Years		15–19 Years	
		n	%	n	%
Is your child engaged in sports?	No	190	26.06%	186	23.42%
	Yes	538	73.79%	607	76.44%
If yes, how many times per week?	No	0	0.00%	181	22.79%
	1	93	12.75%	165	20.78%
	2–3	505	69.27%	302	38.03%
	≥ 4	131	17.96%	146	18.38%
How many hours per day does the child spend watching TV?	1	207	28.39%	192	24.18%
	2–3	386	52.94%	290	36.52%
	≥ 4	136	18.65%	311	39.16%
To go to school, does your child walk or use transportation (car/bus)?	Transportation	690	94.65%	729	91.81%
	Walk	39	5.34%	64	8.06%
Other than school, does your child walk or take transportation to go out?	Transportation	652	89.43%	673	84.76%
	Walk	77	10.56%	120	15.11%
In your opinion, is your child physically active or sedentary?	Active	679	93.14%	654	82.36%
	Sedentary	50	6.85%	140	17.63%

indicated that (93.1%) of the children and (82.4%) of the adolescents were physically active, and only (6.9%) of children and (17.6%) of adolescents were considered physically inactive.

Table 3 shows the participants' demographic characteristics according to age and BMI category. The proportion of obese adolescent males (33.5%) was significantly higher than the proportion of obese adolescent females (13.6%, $P < 0.001$). Private schooling was also associated with BMI-based obesity among children ($P = 0.013$) and adolescents ($P = 0.002$). Student obesity increased with higher parental education levels, with the strongest association observed among the school children ($P = 0.006$). Student BMI-based obesity was not significantly associated with parental occupation, although BMI-based obesity was significantly associated with family income among adolescents ($P = 0.002$). The prevalence of normal-weight adolescents was highest in the "sufficient income" category (68.5%), and was followed by the "some saving" category (58.4%) and the "insufficient income" category (53.6%).

Table 4 shows the participants' demographic characteristics according to age and WC category. Significant sex-based differences in the WC categories were observed among the children ($P = 0.001$) and adolescents ($P = 0.04$). The prevalence of obese females was greater among school children ($P = 0.032$), while the prevalence of obese males was greater among adolescents ($P < 0.001$). Similar to the associations with BMI-based obesity, WC-based obesity was associated with school type, parental occupation, and family income.

Table 5 shows the physical activity data according to age and BMI category. In both age groups, BMI-based obesity was not significantly associated with playing sports, frequency of playing sports, or walking instead of using motorized transportation. However, time spent watching television was associated with adolescent obesity, with 45.1% of adolescent students watching ≥ 4 hr/day ($P = 0.004$). The parents' subjective assessment of physical activity was significantly associated with obesity, with greater physical activity reported for normal-weight children ($P = 0.011$) and normal-weight adolescents ($P < 0.001$), compared to their obese counterparts.

Table 6 shows the physical activity data according to age and WC category. Similar to the BMI-based association, time spent watching television was significantly associated with WC-based obesity among

Table 3. Demographic characteristics of the school children stratified by age and body mass index.

		Age Group											
		7–10 Years						15–19 Years					
		Underweight/ Normal Weight		Overweight		Obese		Underweight/ Normal Weight		Overweight		Obese	
		n	%	n	%	n	%	n	%	n	%	n	%
Gender	Female	206	61.12%	70	20.77%	61	18.10%	294	71.35%	62	15.04%	56	13.59%
	Male	259	66.07%	61	15.56%	72	18.36%	189	49.47%	65	17.01%	128	33.50%
P-value		0.179						<0.001					
School type	Private	216	58.85%	71	19.34%	80	21.79%	223	55.47%	66	16.41%	113	28.10%
	Public	249	68.78%	60	16.57%	53	14.64%	260	66.32%	61	15.56%	71	18.11%
P-value		0.013						0.002					
District	East	71	61.77%	20	17.39	24%	20.86%	109	58.28%	25	13.36%	53	28.34%
	North	145	63.31%	40	17.46	44%	19.21%	134	62.91%	39	18.30%	40	18.77%
	South	113	66.47%	31	18.23	26%	15.29%	109	56.77%	35	18.22%	48	25.00%
	West	136	63.25%	40	18.60	39%	18.13%	131	64.85%	28	13.86%	43	21.28%
P-value		0.941						0.196					
Mother Occupation	Self-Employed	12	60.00%	6	30.00%	2	10.00%	24	55.81%	5	11.62%	14	32.55%
	Government Employee	66	56.89%	25	21.55%	25	21.55%	83	57.24%	26	17.93%	36	24.12%
	Privately Employed	26	50.98%	8	15.68%	17	33.33%	9	50.00%	4	22.22%	5	27.77%
	Unemployed	354	66.79%	89	16.66%	87	16.41%	359	62.32%	90	15.79%	127	22.04%
	Other	7	58.33%	3	25.00%	2	16.66%	8	66.66%	2	16.66%	2	16.66%
P-value		0.762						0.058					
Father Occupation	Self-Employed	106	64.63%	23	14.02%	35	21.34%	178	62.02%	44	15.33%	65	22.64%
	Government Employed	97	62.58%	28	18.06%	30	19.35%	75	58.59%	17	13.28%	36	28.12%
	Privately Employed	144	60.25%	50	20.92%	45	18.82%	108	63.52%	31	18.23%	31	18.23%
	Soldier/police	53	70.66%	12	16.00%	10	13.33%	27	55.10%	8	16.32%	14	28.57%
	Laborer	24	75.00%	4	12.50%	4	12.50%	11	57.89%	2	10.52%	6	31.57%
	Unemployed	9	64.28%	4	28.57%	1	7.14%	57	57.00%	18	18.00%	25	25.00%
	Other	32	64.00%	10	20.00%	8	16.00%	27	65.85%	7	17.07%	7	17.07%
P-value		0.778						0.647					
Mother Educational level	< High School	68	67.32%	24	23.76%	9	8.91%	76	60.80%	23	18.40%	26	20.80%
	High School	176	69.01%	37	14.50%	42	16.47%	172	64.17%	35	13.05%	61	22.76%
	College/Postgraduate Degree	221	59.24%	70	18.76%	82	21.98%	235	58.60%	69	17.20%	97	24.18%
P-value		0.006						0.465					
Father Educational level	< High School	52	69.33%	16	21.33%	7	9.33%	54	67.50%	10	12.50%	16	20.00%
	High School	137	72.48%	25	13.22%	27	14.28%	106	58.88%	31	17.22%	43	23.88%
	College/Postgraduate Degree	276	59.35%	90	19.35%	99	21.29%	323	60.48%	86	16.10%	125	23.40%
P-value		0.006						0.756					
Family income	Insufficient	258	62.92%	73	17.80%	79	19.26%	258	55.5%	73	55.7%	79	59.4%
	Sufficient	143	66.82%	41	19.15%	30	14.01%	143	30.8%	41	31.3%	30	22.6%
	Some Savings	64	60.95%	17	16.19%	24	22.85%	64	13.8%	17	13.0%	24	18.0%
P-value		0.354						0.002					

Table 4. Demographic characteristics of the school children stratified by age and waist circumference.

Demographics		Age Group							
		7–10 Years				15–19 Years			
		Non-obese		Obese		Non-obese		Obese	
		n	%	n	%	n	%	n	%
Gender	**Female**	261	77.44%	76	22.55%	346	83.98%	66	16.01%
	Male	339	86.47%	53	13.52%	299	78.27%	83	21.72%
P-value		**0.001**				**0.040**			
School type	**Private**	291	79.29%	76	20.70%	304	75.62%	98	24.37%
	Public	309	85.35%	53	14.64%	341	86.98%	51	13.01%
P-value		**0.032**				**<0.001**			
District	**East**	96	83.47%	19	16.52%	141	75.40%	46	24.60%
	North	186	81.22%	43	18.77%	176	82.63%	37	17.37%
	South	137	80.58%	33	19.41%	154	80.21%	38	19.79%
	West	181	84.18%	34	15.81%	174	86.14%	28	13.86%
P-value		**0.763**				**0.051**			
Mother Occupation	**Self-Employed**	17	85.00%	3	15.00%	32	74.42%	11	25.58%
	Government Employee	92	79.31%	24	20.68%	112	77.24%	33	22.76%
	Privately Employed	37	72.54%	14	27.45%	14	77.78%	4	22.22%
	Unemployed	443	83.58%	87	16.41%	477	82.81%	99	17.19%
	Other	11	91.66%	1	8.33%	10	83.33%	2	16.67%
P-value		Numbers too small				Numbers too small			
Father Occupation	**Self-Employed**	126	76.83%	38	23.17%	232	80.84%	55	19.16%
	Government Employee	130	83.87%	25	16.13%	100	78.13%	28	21.88%
	Privately Employed	199	83.26%	40	16.74%	139	81.76%	31	18.24%
	Soldier/police	65	86.67%	10	13.33%	39	79.59%	10	20.41%
	Laborer	28	87.50%	4	12.50%	16	84.21%	3	15.79%
	Unemployed	12	85.71%	2	14.29%	84	84.00%	16	16.00%
P-value		Numbers too small				0.579			
Mother Educational level	**< High School**	89	88.11%	12	11.88%	110	88.00%	15	12.00%
	High School	215	84.31%	40	15.68%	215	80.22%	53	19.77%
	College/Postgraduate Degree	296	79.35%	77	20.64%	320	79.80%	81	20.19%
P-value		**0.071**				**0.107**			
Father Educational level	**< High School**	64	85.33%	11	14.66%	69	86.25%	11	13.75%
	High School	162	85.71%	27	14.28%	148	82.22%	32	17.77%
	College/Postgraduate Degree	374	80.43%	91	19.56%	428	80.14%	106	19.85%
P-value		**0.212**				**0.397**			
Family income	**Insufficient**	338	82.43%	72	17.56%	178	84.36%	33	15.63%
	Sufficient	181	84.57%	33	15.42%	239	83.56%	47	16.43%
	Some Savings	81	77.14%	24	22.85%	227	76.68%	69	23.31%
P-value		**0.261**				**0.041**			

Table 5. Physical activity of the school children stratified by age and body mass index.

		Age Group											
		7–10 Years						15–19 Years					
		Underweight/ Normal Weight		Overweight		Obese		Underweight / Normal Weight		Overweight		Obese	
		n	%	n	%	n	%	n	%	n	%	n	%
Q1	No	117	25.16%	34	26.15%	39	29.32%	113	23.44%	28	22.05%	45	24.46%
	Yes	348	74.84%	96	73.85%	94	70.68%	369	76.56%	99	77.95%	139	75.54%
P-value		0.718						0.808					
Q2	No	0	0.00%	0	0.00%	0	0.00%	113	23.40%	26	20.47%	42	22.83%
	1	51	10.97%	19	14.50%	23	17.29%	102	21.12%	22	17.32%	41	22.28%
	2–3	323	69.46%	97	74.05%	85	63.91%	176	36.44%	52	40.94%	74	40.22%
	≥ 4	91	19.57%	15	11.45%	25	18.80%	92	19.05%	27	21.26%	27	14.67%
P-value		0.735						0.151					
Q3	1	134	28.82%	37	28.24%	36	27.07%	123	25.47%	29	23.02%	40	21.74%
	2–3	258	55.48%	72	54.96%	56	42.11%	181	37.47%	48	38.10%	61	33.15%
	≥ 4	73	15.70%	22	16.79%	41	30.83%	179	37.06%	49	38.89%	83	45.11%
P-value		0.345						0.004					
Q4	Transportation	440	94.62%	124	94.66%	126	94.74%	440	91.29%	113	88.98%	176	95.65%
	Walk	25	5.38%	7	5.34%	7	5.26%	42	8.71%	14	11.02%	8	4.35%
P-value		0.061						0.939					
Q5	Transportation	412	88.60%	117	89.31%	123	92.48%	407	84.44%	107	84.25%	159	86.41%
	Walk	53	11.40%	14	10.69%	10	7.52%	75	15.56%	20	15.75%	25	13.59%
P-value		0.684						0.634					
Q6	Active	452	97.20%	121	92.37%	106	79.70%	414	85.71%	102	80.31%	138	75.0%
	Sedentary	13	2.80%	10	7.63%	27	20.30%	69	14.29%	25	19.69%	46	25.0%
P-value		0.011						<0.001					

Q1–6, questions of the physical activity questionnaire

Table 6. Physical activity of the school children stratified by age and waist circumference.

		Age Group							
		7–10 Years				15–19 Years			
		Non-obese		Obese		Non-obese		Obese	
		n	%	n	%	n	%	n	%
Q1	**No**	156	26.04%	34	26.36%	153	23.76%	33	22.15%
	Yes	443	73.96%	95	73.64%	491	76.24%	116	77.85%
P-value		**0.941**				**0.676**			
Q2	**No**	0	0.00%	0	0.00%	150	23.26%	31	20.81%
	1	69	11.50%	24	18.60%	130	20.16%	35	23.49%
	2–3	422	70.33%	83	64.34%	244	37.83%	58	38.93%
	≥ 4	109	18.17%	22	17.05%	121	18.76%	25	16.78%
P-value		**0.090**				**0.738**			
Q3	**1**	173	28.83%	34	26.36%	163	25.31%	29	19.46%
	2–3	326	54.33%	60	46.51%	237	36.80%	53	35.57%
	≥ 4	101	16.83%	35	27.13%	244	37.89%	67	44.97%
P-value		**0.024**				**0.192**			
Q4	**Transportation**	567	94.50%	123	95.35%	584	90.68%	145	97.32%
	Walk	33	5.50%	6	4.65%	60	9.32%	4	2.68%
P-value		**0.698**				**0.007**			
Q5	**Transportation**	536	89.33%	116	89.92%	541	84.01%	132	88.59%
	Walk	64	10.67%	13	10.08%	103	15.99%	17	11.41%
P-value		**0.843**				**0.159**			
Q6	**Active**	574	95.67%	105	81.40%	542	84.03%	112	75.17%
	Sedentary	26	4.33%	24	18.60%	103	15.97%	37	24.83%
P-value		**< 0.001**				**0.011**			

Q1–6, questions of the physical activity questionnaire

the children (P = 0.024). Furthermore, the parents' subjective assessment of physical activity was also significantly associated with WC-based obesity, with greater physical activity reported for normal-weight children (P < 0.001) and normal-weight adolescents (P = 0.011), compared to their obese counterparts.

DISCUSSION

Several governmental reports have confirmed high rates of overweight status and obesity among Saudi children and adolescents, and previous reports have linked sedentary lifestyle to obesity[10,18,22,23]. Therefore, the present study aimed to evaluate the associations of obesity with physical activity, socioeconomic factors, and education among children and adolescents in Jeddah. School children and adolescent students were selected for the present study because they can perform various types of physical activity in school and during their daily lives[24]. The null hypothesis that physical activity and socioeconomic factors are not associated with obesity among Saudi children and adolescents is rejected.

The study revealed non-significant differences in the BMI values for the male and female children, although female children were significantly more likely to have WC-based obesity, compared to male children. This discrepancy may be related to the different measurements for BMI and WC, as WC considers fat accumulation around the lower trunk, while BMI measures body mass regardless of the ratio of muscle to fat. Another explanation might be that boys are usually more active and more likely to participate in physical activity and sports, compared to girls. Similarly, Farsi *et al*.[25] found that female children were more obese, compared to male children, based on WC measurements but not BMI. However, 2005 data from the health survey for England revealed a lower incidence of obesity among girls who were ≤ 11 years old, compared to boys[26].

In the present study, adolescent males were significantly more obese based on BMI and WC, compared to adolescent females. Similarly, Abalkhail[6] studied overweight and obesity trends among schoolchildren and adolescents in Jeddah using data from 1994 and 2000, and found that 14–16-year-old girls were less obese, compared to their male counterparts. In addition, Farsi and Elkhodary[27] studied the prevalence of overweight status and obesity among adolescents, and reported that males were more likely to be obese (*vs.* females), because they more frequently went out with their friends and ate junk food. Moreover, similar findings have been reported among adolescents from Saudi Arabia[28,29], Britain[30], and the United States (US)[31]. It is possible that these differences are related to greater consumption of sugar and sugar-sweetened carbonated beverages among male adolescents, compared to female adolescents[29]. Nevertheless, other Saudi studies revealed that obesity was more prevalent among female adolescents, compared to male adolescents[4,32]. Al-Hazzaa *et al*.[33] have reported that physical activity was a weak risk factor for obesity among females, while Collison *et al*.[29] have reported that all Saudi children are increasingly gravitating towards sugar-rich foods and unhealthy dietary choices. Thus, less physical activity and greater sugar consumption among Saudi adolescents may explain their relatively high prevalence of obesity, compared to school children.

Interestingly, the prevalence of BMI-based and WC-based obesity among children and adolescents was significantly higher in private schools, compared to public schools. Similar results have been reported by Pattanaik *et al*.[34] who observed a higher prevalence of obesity/overweight status among school children in private Indian schools. Furthermore, Patnaik *et al*.[35] and Jagadesan *et al*.[36] have reported a higher proportion of overweight status/obesity in other private schools. The service of obesity-promoting foods in private schools might play a major role in this association[37]. Furthermore, children who attend public school more frequently come from lower income families, who might not be able to afford school food or to provide large meals at home. In contrast, children who attend private schools are more likely to have money to buy snacks and can afford larger meals. Other studies[38,39] have attributed the differences in obesity prevalence between public and private schools to the students walking to school and being driven to school, respectively.

Among the students in the present study, BMI-based obesity was associated with higher parental education, although this association was more significant among school children. In contrast, findings from an American health and nutrition examination survey (2005–2008) revealed that children and adolescents whose fathers had low education levels were more likely to be obese, compared to families in which the father had a college degree[40]. Nevertheless, Al Alwan *et al*.[41] also found a significant association

between obesity/overweight status among mothers with higher levels of education. Moreover, Gnavi *et al.*[42] and Anderson *et al.*[43] have reported associations between childhood obesity and the mother working, which may be related to the children skipping meals and selecting unhealthy snacks because they spend large amounts of time away from home[42,43]. Because educated Saudi women frequently spend most of their time at work or engaged in social activities, rather than spending time with their children, a caregiver or maid typically spends the most time with the children and has the greatest influence on their diet and time spent watching television. However, in contrast with our findings, reports from the United States (US)[44] and United Kingdom (UK)[45] have revealed that obesity was more prevalent among children from parents with low education levels. Moraeus *et al.*[46] also found a higher prevalence of overweight status and obesity among children whose parents had low educational levels, as these children were less likely to play organized sports and more likely to be physically inactive.

Among adolescents, BMI-based obesity was associated with family income in the present study, as normal-weight adolescents were most common in the "sufficient income" group, compared to the "some saving" and "insufficient income" group, while obesity was most common among high-income families. Similarly, Alam[2] observed a high obesity rate in the affluent districts of Riyadh, with anecdotal evidence of inactive children residing in fancy houses. Moreover, Amin *et al.*[47] studied overweight and obese male students (10–14 years old) in the eastern region of Saudi Arabia, and reported a significant relationship between high socio-economic standards and obesity. It is possible that families with low incomes try to save money by preparing their meals at home and only eating once or twice per day, while more affluent families can afford more meals/snacks per day, home delivery services, and eating in restaurants[48].

In the present study, playing sports, the frequency of playing sports, and walking to school/other destinations were not significantly associated with obesity among the children and adolescents. However, normal-weight students (based on BMI or WC) were more likely to be considered physically active by their parents, compared to overweight or obese students. Mahfouz *et al.*[15] and Al-Hazzaa *et al.*[49] have also evaluated the associations of physical activity and other lifestyle factors with obesity, and reported positive correlations between obesity and physical inactivity. Furthermore, Saudi studies have reported that a lack of exercise was a significant risk factor for obesity among adolescents from southwestern Saudi Arabia[34], and that low physical activity was associated with obesity among Saudi adolescents[3].

Time spent watching television is an important factor in the development of childhood obesity[50]. In the present study, watching television for ≥ 4 hr/day was significantly associated with BMI-based obesity, and similar findings have been reported by other researchers[16,51]. It is possible that watching television for prolonged periods reduces the amount of physical activity and/or causes children to consume more or different foods. Nevertheless, other studies have revealed weak[52] or negative associations between obesity and watching television among children and adolescents[49,53]. However, weak or negative associations might be related to relatively short follow-ups or different age groups being examined in the different studies.

The present study has several strengths. First, we recruited a large number of students from various geographical areas in Jeddah. Second, we considered both BMI and WC data to categorize the participants as obese or non-obese. Third, a reliable and valid closed-ended questionnaire was used to obtain data regarding obesity, socioeconomic characteristics, lifestyle, and physical activity. Nevertheless, the present study also has several limitations. First, the cross-sectional design precludes any commentary regarding the causality of the associations that we observed. Second, the questionnaire relied on subjective parental assessments for some variables, which could have been inaccurate, although this format is common in similar studies. Third, we only evaluated children from Jeddah, and it is possible that our findings are not representative of other regions of Saudi Arabia.

Conclusion

In conclusion, obesity was common among school children and adolescents, and was associated with private schooling, adolescent male sex, parental education level, and family income. Physical inactivity and time spent watching television are important risk factors for obesity among school children and adolescents. It is therefore recommended for authorities developing prevention programs to implement healthy lifestyle education programs with great focus on increasing physical education hours and on educating

children and parents to the hazards of overweight/obesity. In addition, more future programs should be directed to parents to encourage their positive role in reducing the time their children spend watching TV and their engagement in physical activities.

Future Research

Further analytical studies should be encouraged to study other possible risk factors in other provinces in Saudi Arabia to expand our research on a national scale and to encourage cross-national initiatives to establish monitoring and preventing programs.

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Conflict of Interest

The authors have no conflict of interest.

Disclosure

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Ethical Approval

Obtained.

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العلاقة بين النشاط البدني والبدانة بين أطفال المدارس والمراهقين في جدة، المملكة العربية السعودية

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المستخلص. تؤثر السمنة على سلامة الطفل البدنية والنفسية لذا بحثت هذه الدراسة العلاقة بين السمنة والنشاط البدني والعوامل الاجتماعية والاقتصادية وأسلوب الحياة بين الأطفال والمراهقين السعوديين. وقد قيمت هذه الدراسة المقطعية عينة من الطلبة مكونة من ٧٢٩ طفلا و٧٩٤ طالبا في جدة، المملكة العربية السعودية وقد تم قياس محيط الخصر ومؤشر كتلة الجسم لتصنيف اللذين يعانون من السمنة المفرطة والذين لا يعانون من السمنة، وتم استخدام استبيان لجمع البيانات الاجتماعية والاقتصادية والنشاط البدني، ونمط الحياة. أظهرت انتائج ان الذكور المراهقين البدناء (٣٣,٥٪) أكثر شيوعا بكثير من المراهقات البدينات وكانت نسبة السمنة القائمة على مؤشر كتلة الجسم والخصر أكثر شيوعا في المدارس الخاصة مقارنة بالمدارس الحكومي بين أطفال المدارس والمراهقين (٠,٠١٣و٠,٠٠٢=P). كما اظهرت النتائج ارتبطات السمنة بارتفاع مستوى تعليم الوالدين، وخاصة بين الأطفال. هذا واظهرت النتائج ايضا ارتباط السمنة بقوة مع دخل الأسرة (P٠,٠٠٢ =) والوقت الذي يقضيه المراهقين فى مشاهدة التلفزيون (P٠,٠٠٤ =). واعتبر الأطفال والمراهقين غير البدنيين أكثر نشاطا من نظرائهم البدناء (P < ٠,٠٠١ و P٠,٠١١ = على التوالي). السمنة شائعة بين أطفال المدارس والمراهقين، وخاصة بالمدارس الخاصة، والمراهقين من الذكور،وأظهرت النتايج علاقة بين السمنة وتعليم الوالدين ودخل الأسرة. كما اظهرت النتائج ان الخمول البدني والوقت الذي يقضى فى مشاهدة التلفاز من عوامل الخطر الهامة المسببة للبدانة بين المراقين وأطفال المدارس السعودية.