Obesity prevention interventions in Saudi Arabian children-building the evidence base: An in-depth analysis of socio-demographic characteristics and dietary habits of obese and normal weight schoolchildren

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Abstract

Background: A better understanding of the relationships between obesity, socio-demographic variables and eating practices is necessary for effective obesity prevention. Our study aimed to provide an in-depth investigation into the food habits and consumption trends, in urban socio-demographic obese and normal weight Saudi Arabian children.

Methods: A multicentre cross-sectional study was conducted from December 2015 to March 2016, in the capital of Saudi Arabia, Riyadh. Participants were divided into groups (obese, normal weight), and further stratified by sex. The total cohort comprised of 1023 children, aged 9.00 to 11.99 years, and 2046 parents/guardian. Participants in each group were randomly selected using a multistage stratified cluster-sampling technique. A self-paced questionnaire collected data of: weight; height; waist-circumference; BMI; and body fat composition in children. In parents, only weight, height, and BMI were recorded.

Results: Lack of space in the home environment to do physical activity was identified as a significant risk factor for obesity, between obese and normal weight groups ($p=0.000$), and stratified by sex (boys, $p=0.006$; girls, $p=0.014$). Calories consumed/day were significantly different between groups ($p=0.000$), and stratified by sex (boys, $p=0.000$; girls, $p=0.034$). These significant differences continued if soft drinks were freely available in the home fridge (boys, $p=0.000$; girls, $p=0.024$; groups, $p=0.000$), and for children with good close friends ($p=0.000$). Furthermore, family income ($p=0.027$); eating snacks before sleep ($p=0.000$); eating away from home ($p=0.000$); eating from school canteen ($p=0.042$); eating while going back home ($p=0.000$); parent reading food labels ($p=0.002$), and keeping non-core food freely available at home ($p=0.009$), were all significantly different between groups, and specifically, among boys. Obese parents clearly showed to be a high-risk factor for their children to be obese in both groups, especially mothers' weight ($p=0.034$), mothers BMI ($p=0.038$), and fathers BMI ($p=0.037$).

Conclusion: Our results highlight and provide specific opportunities for valid targeted intervention strategies to prevent and manage obesity amongst Saudi Arabian children.

Keywords: Childhood obesity prevention; Socio demographic, Food intake, Dietary pattern, Schoolchildren, Saudi Arabia

Introduction

Childhood obesity is reaching disturbing levels in many developed and developing countries, posing an urgent and complex public health challenge [1]. Prevention and control of

non-communicable diseases, such as obesity, is considered a core priority at a global level [2]. Obesity is predicted to have both epidemic and pandemic characteristics [3]. Obesity prevention and intervention in children is a topic of great interest

and importance in the health of many nations. One country identified as facing a high prevalence of childhood obesity is Saudi Arabia; therefore, prevention has become a major priority [4]. The elevated rates of overweight and obesity in Saudi Arabian children are now deemed an epidemic [5], with the prevalence of obesity still increasing [4-6]. Data from 2010 showed the prevalence of overweight and obesity in young individuals (5–18 years) was 34.4%: specifically, 37.0% in upper primary school children (9–12 years), and up to 38.2% in secondary school children (13–15 years) [6]. In comparison in 2002, the prevalence of overweight and obesity in 9 to 12 year old children was only 16.8% [7], meaning the prevalence has more than doubled in less than 10 years for this age group. This growth cannot be ignored, and urgent obesity prevention intervention programs for children must be developed.

In the context of the continuing increased levels of obesity in Saudi Arabian children, and the associated secondary comorbidities, there is a critical and urgent need to develop obesity prevention interventions that reverse increasing trends of obesity and limits resulting health consequences [8]. Limited studies reporting successful interventions that curb childhood obesity exist [9-11]. In Saudi Arabia, some research supports the claim of a high prevalence of overweight/obesity among Saudi Arabian children, but those that have been focused on primary schoolchildren to examine the effect of different factors associated with childhood obesity (such as eating habits, socio-demographic differentials, life style, etc.) are very scarce. Providing evidence-based data on obesity in Saudi Arabian primary school age children is critically needed. Therefore, the main aim of this study is to investigate and obtain information about factors that may affect Saudi Arabian boys and girl's weight status, using the social-ecological theory in both obese and normal weight children. The desired outcome will be to elucidate evidence based realistic and achievable treatment strategies for clinical implementation. This study is the first of its kind to be conducted in urban areas of Saudi Arabia, providing comparative data on many factors and variables of obese and normal weight primary school children.

Population and methods

Setting

The study was implemented in Riyadh, as it is the best representative city for the Saudi Arabian population in many ways [12]. Riyadh's population is typically made up of people from all different Saudi Arabian provinces. Therefore, it was a statistically good choice to provide a wider demographic representation. Convenience samples of participants were selected from each of the five geographical areas (north, south, east, west, and centre) to cover most of the Riyadh city. All data were gathered over a period of 4 months, December 2015 to March 2016.

Study design and Sampling

Our study was a cross sectional, convenience sample of volunteer children who participated after having secured

parental consent. Logistic regression was used to explore the association between the dependant variables, obese/normal weight (based on BMI), and other variables. A sample size of $n=200$ in each age group, for each gender, would allow for a maximum of 16 independent variables, within a logistic regression which is within accepted ratio of subjects to independent variables, i.e., between 12 to 15 subjects per independent variable. Other analysis included comparison of percentages found as answers to various questions, asked of the families, between those with an obese child and those with a normal weight child.

Data collection

The data were collected from primary schools of boys and girls in grades 4 (ages 9 to 10), 5 (ages 10 to 11), and 6 (ages 11 to 12). Riyadh is divided into 5 districts (north, south, east, west, and centre). Two primary government schools (one boys and one girls) were randomly selected from each district to take part in the study. Furthermore, two private schools were randomly selected (one boys and one girls). Overall, a total of 12 schools were selected to participate in the study. Nevertheless, to maximise data collection on obese children, additional recruitment occurred in both public and private obesity clinics. The public clinic recruitment occurred during the day, and a free private clinic was held in the evenings, catering parents and children unable to attend day sessions due to time constraints.

Selection Criteria

All participants meet the inclusion criteria of: (i) children between the ages of 9.00 and 11.99 years; (ii) Saudi Arabian nationality (iii) living in Riyadh city; (iv) two groups were recruited according to BMI percentile based on CDC Data [13]: (a) obese group (BMI >95th percentile), (b) normal weight group (BMI between the 25th to 75th percentile). The 75th percentile was used as the BMI cut-off point, as opposed to the 85th percentile, to ensure a clear distinction between normal weight and obese. Written informed consent was obtained from parents/guardian.

Ethical approval

Our study was approved by the Institutional Review Board (IRB) at the Ministry of Health in Saudi Arabia (Approval no. 15-336E). The Ethical Clearance for Research Involving Human Participants was reviewed and obtained from The University of Queensland Behavioral and Social Sciences Ethical Review Committee (BSSERC) (Approval no. 2015001629). In addition, permission to conduct the study at primary schools was obtained from the Ministry of Education in Riyadh.

Anthropometric measurements

Anthropometric variables for both groups (obese and normal weight) were as follows: height, weight, and waist circumference (WC) were measured, and BMI was calculated using

height and weight, in all consenting children. Measurements were performed by trained data collectors using standard protocols. Weight was recorded to the nearest 100 grams, without excess outer clothing and shoes, using a calibrated portable scale «Seca, Germany». Height was measured to the nearest centimeter (cm) using a calibrated portable measuring stadiometer, with participants standing upright without shoes. BMI was calculated as body weight, in kilograms (kg), divided by height, in meters, squared (kg/m^2). Waist circumference measurement was recorded to the nearest 0.5 cm at the navel area, and was classified according the CDC anthropometric reference percentile data for children [14].

For the parents of the recruited children, self-reported height, weight was recorded, via instructions to each parent to measure their weight to the nearest 0.5 kilogram and their height to the nearest cm. BMI was calculated as per child, but classified according to cut-off point for adults, i.e., (underweight, $<18.5 \text{ kg}/\text{m}^2$; normal weight $18.5\text{--}24.9 \text{ kg}/\text{m}^2$; Overweight $25.0\text{--}29.9 \text{ kg}/\text{m}^2$; Obese $\geq 30.0 \text{ kg}/\text{m}^2$) [15].

Body Composition Assessment

A bioelectrical impedance analysis (BIA) device, OMRON BF511 (Model HBF-511B-E), was used as a fast, easy to use, portable, accurate and reliable method of body composition assessment [16], that was required in our cohort. The classification levels of fat percentage used in our study was based on McCarthy *et al.*, [17]. For the 9 to 12 age group, child body fat percent was considered low, $<16.1\%$; normal between 16.1% to 32.4% , and high, between 32.5% to 35.3% . Over 35.4% fat was considered very high. Additionally, BIA is shown to be more reliable than traditional skin-fold thickness measurement [18,19].

Data processing and Statistical Analysis

Data in each questionnaire, at each collection centre were checked twice: initially by the assistant data collectors (Dietitians) and a final check was completed by the main researcher (HA). The data were electronically entered, using standardised entry codes written on an SPSS data file. All data were analysed using IBM SPSS Statistics, version 24 (SPSS, Inc, Chicago, IL, USA). Descriptive statistics were presented as means $\pm$ standard deviations (SD), or proportions. The main analysis was a comparative analysis between the two groups (obese and normal weight) and stratified by sex. The *t*-test determines the distribution of ages in the obese and normal weight groups. Chi square was used to determine any significant associations between obese and normal weight groups, and the dependant variables. Logistic regression was performed to assess the impact of demographic and other variables on the likelihood that children would be categorised as obese. The level of significance was set at $p<0.05$.

Dietary and demographic data

All questionnaires used in our study are widely accepted, valid and reliable [20,21]. Data on food consumption trends

was gathered using a variety of questionnaires. The questionnaires allowed for the collection of data relating to weekly consumption of main meals and snacks, in-house and meal outings, eating while watching television or using other devices, and a 24-hours food intake record [22]. In addition, food intake habits, including normal place for breakfast, packed home prepared lunch for school, eating during school breaks and from the school canteens, eating on return trip home, responsibility of food preparation for the participants, and, availability of soft drinks and/or unhealthy snacking at all times for the child at home, were all recorded. A family information questionnaire was designed to collect information about the socio-demographics data including: household status; education level; income; work status, and parent's consanguinity from the parents/caregivers. Children supplied demographic information consisting of grades earned in school, chronological age, friends, number of child sibling and their rank in the family. All questionnaire booklets were sent to parents/caregivers to complete at home.

Results

A total of 1200 eligible participants volunteered to take part in this study following informed consent. The total number of children accepted into the cohort, after checks, revision and meeting eligibility criteria, was 1023. The stratified sample represented different geographical areas of Riyadh including 497 obese and 526 normal weight children, and a total of 2046 of their parents/caregivers.

The number of children in each year of age and the mean and standard deviation of anthropometric data from both children and their parents/guardians are shown in Table 1. The data are shown for each gender classified according to obese or normal weight. The age distribution for boy and girl participants, in obese and normal weight groups, were the same. Waist circumference and body fat percentages for normal and obese groups reflected normal range perimeters for the respective groups. The study cohort was clearly specified and selected, therefore, as expected, statistically significant differences were seen in weight, height, WC, body fat percent, and BMI of all participants of both genders and groups ($p=0.000$). Obese children had parents with higher weight and BMI compared to parents with lower weight and BMI and normal weight children, with statistically significant differences between groups: mother weight ($p=0.034$), mother BMI ($p=0.038$), and father BMI ($p=0.038$).

A comparison of the socio-demographic characteristic data, i.e., education level, employment status, income, between obese and normal weight parent/guardian, are presented in Table 2, including the odds ratios of variables that may determine children to be classified as obese. The analysis showed no statistical differences between sex or groups for parent education level and their occupations. However, an increase education of the father was significantly associated to reduced obesity in boys ($\text{OR}=1.97$, $95\% \text{ CI}=1.20\text{--}3.22$, $p=0.004$),

Table 1. Anthropometric measurements of children and their parent/guardian, categorised as normal weight ($\geq 25^{\text{th}}$ & $\leq 75^{\text{th}}$ P) and obese ($\geq 95^{\text{th}}$ P) of BMI for age percentile.

Measurements	Boys		<i>p</i> value Odd ratio (95%CI)	Girls		<i>p</i> value Odd ratio (95%CI)	Normal weight Group (N=526)	Obese Group (N=497)	<i>p</i> value Odd ratio (95%CI)
	Normal weight (N=236)	Obese (N=232)		Normal weight (N=290)	Obese (N=265)				
Children			<i>P</i> =0.394			<i>P</i> =0.578			<i>P</i> =0.262
Age groups (years)									
09 - <10	81 34.3%	79 34.1%	Ref	92 31.8%	88 33.2%	Ref	173 32.9%	167 33.6%	Ref
10 - <11	89 37.9%	76 32.8%	1.14(0.73-1.76)	104 35.9%	84 31.7%	1.18(0.78-1.78)	193 36.7%	160 32.2%	1.16(0.86-1.56)
11 - <12	66 28.0%	77 33.2%	0.83(0.53-1.31)	94 32.0%	93 35.1%	0.96(0.64-1.45)	160 30.4%	170 34.2%	0.90(0.67-1.23)
Age in years (mean $\pm$ SD)	9.94 $\pm$ 0.79	9.99 $\pm$ 0.82	<i>P</i> =0.461†	10.01 $\pm$ 0.80	10.02 $\pm$ 0.82	<i>P</i> =0.863†	9.98 $\pm$ 0.79	10.01 $\pm$ 0.82	<i>P</i> =0.544†
Weight (kg)	33.7 $\pm$ 6.2	55.8 $\pm$ 10.4	0.000	34.8 $\pm$ 7.0	53.0 $\pm$ 11.5	0.000	34.3 $\pm$ 6.6	54.3 $\pm$ 11.1	0.000
Height (cm)	138.7 $\pm$ 7.1	141.4 $\pm$ 7.6	0.011	139.3 $\pm$ 8.4	139.9 $\pm$ 7.9	0.011	139.0 $\pm$ 7.8	140.9 $\pm$ 7.8	0.022
Waist circumference (cm)	67.9 $\pm$ 6.7	86.3 $\pm$ 9.4	0.000	65.8 $\pm$ 7.0	78.9 $\pm$ 8.4	0.000	66.8 $\pm$ 6.9	82.3 $\pm$ 9.6	0.000
Body fat (%)	20.1 $\pm$ 6.4	35.5 $\pm$ 3.4	0.000	22.8 $\pm$ 6.0	35.9 $\pm$ 3.6	0.000	21.6 $\pm$ 6.3	35.7 $\pm$ 3.5	0.000
BMI (kg/m ²)	17.4 $\pm$ 2.0	27.7 $\pm$ 3.3	0.000	17.8 $\pm$ 2.1	26.5 $\pm$ 2.8	0.000	17.6 $\pm$ 2.0	27.1 $\pm$ 3.1	0.000
Parent/Caregiver									
Mother									
Age (years)	37.9 $\pm$ 6.1	38.7 $\pm$ 5.4	0.153	37.7 $\pm$ 6.1	38.3 $\pm$ 6.8	0.452	37.8 $\pm$ 6.1	38.5 $\pm$ 6.2	0.730
Height (cm)	161.0 $\pm$ 5.9	160.5 $\pm$ 6.2	0.175	159.9 $\pm$ 5.8	158.9 $\pm$ 7.3	0.199	160.4 $\pm$ 5.9	159.7 $\pm$ 6.8	0.305
Weight (kg)	69.4 $\pm$ 12.4	73.1 $\pm$ 10.5	0.079	69.4 $\pm$ 11.6	73.4 $\pm$ 13	0.034	69.3 $\pm$ 11.9	73.3 $\pm$ 11.9	0.034
BMI (kg/m ²)	26.7 $\pm$ 4.8	28.4 $\pm$ 3.9	0.106	26.9 $\pm$ 4.4	28.9 $\pm$ 5.3	0.098	27.1 $\pm$ 3.8	28.7 $\pm$ 4.7	0.038
Father									
Age (years)	45.0 $\pm$ 7.6	46.0 $\pm$ 7.1	0.515	43.8 $\pm$ 7.2	44.4 $\pm$ 8.2	0.834	44.3 $\pm$ 7.4	45.2 $\pm$ 7.7	0.807
Height (cm)	172.2 $\pm$ 7.0	169.6 $\pm$ 6.5	0.054	170.9 $\pm$ 6.9	169.2 $\pm$ 6.9	0.132	171.5 $\pm$ 6.9	169.3 $\pm$ 6.7	0.032
Weight (kg)	81.9 $\pm$ 12.8	84.8 $\pm$ 13.1	0.129	78.8 $\pm$ 12.6	84.2 $\pm$ 15.4	0.163	80.2 $\pm$ 12.7	84.5 $\pm$ 14.3	0.079
BMI (kg/m ²)	27.7 $\pm$ 3.7	29.4 $\pm$ 4.4	0.108	26.7 $\pm$ 3.8	29.1 $\pm$ 4.8	0.117	27.1 $\pm$ 3.8	29.3 $\pm$ 4.6	0.037

as did parent's consanguinity (OR=0.66, 95% CI=0.45-0.95, *p*=0.027). These differences were not seen in the girls, or as a group. Home type and ownership showed no statistical differences for obese or normal weight groups. However, there was a 42% increase odds risk of being an obese child when the home had no space to perform outdoor physical activities (OR=1.70, 95% CI=1.27-2.28, *p*=0.000). Children of low to mid income families were more likely to be obese than children of high-income families (*p*=0.027).

The socio-demographic characteristics i.e., grades achieved, friendships, of normal weight and obese boys, girls and the combined group, are shown in [Table 3](#), along with the odds ratio that the children would be categorized as being obese. There was no association between school type and school grades with weight status. Normal weight children were found to have more friends, and the difference was significant (OR=1.89, 95% CI=1.14-3.15, *p*=0.012), especially amongst the boys (OR=2.45, 95% CI=1.24-4.84, *p*=0.008). In addition, the normal weight group also enjoyed a better relationship with their friends, showing a positive significant difference between all groups and sex (*p*=0.000). No relationships were found between weight status and the number of children in the family or ranking among siblings.

Frequencies of eating main meals and snacks per week

with family, as opposed to eating out, screen time while eating, and the relationship of these variables to weight status of all children, is shown in [Table 4](#), including the odds ratio of variables that may categorise children as being obese. Data showed no association between the frequency of eating any main meals or snacks, and being obese or normal weight. The exception being eating snacks before sleep, particularly in the boys group (*p*=0.000). Additionally, frequent eating away from home (*p*=0.000) and eating during screen time (*p*=0.004) were positively related to obesity in boys only. Eating meals with the family did not show a marked difference in the weight data in either group.

The weight status of the children was greatly influenced by several factors, such as place of food consumption; type of food consumed (home packed vs. school canteen); parental awareness of food labels; food preparer; availability of junk food/sugary drinks, and food consumption returning home from school. The relationship of these factors to weight status is shown in [Table 5](#), including odds ratios that the children would be categorised as being obese. The place where breakfast is normally eaten (OR=0.77, 95% CI=0.60-0.99, *p*=0.049), eating from: the school canteen (OR=0.74, 95% CI=0.55-0.99, *p*=0.042), while going home from school (OR=0.55, 95% CI=0.41-0.74, *p*=0.000); soft drinks being freely available in the fridge at

Table 2. Family socio-demographic characteristics of Saudi Arabian children categorised as normal weight ($\geq 25^{\text{th}}$ & $\leq 75^{\text{th}}$ P) and obese ($\geq 95^{\text{th}}$ P) of BMI for age percentile.

Socio-demographic factors	Boys		Girls		<i>p</i> value	OR 95%CI	Normal weight	Obese	<i>p</i> value	OR 95%CI	Normal weight Group	Obese Group	<i>p</i> value	OR 95%CI
Father's Education														
- <Elementary School	12	5.1%	13	5.6%	0.004	1.73(0.72-4.17)	27	9.3%	26	9.8%	39	7.4%	39	7.8%
- Secondary School	12	5.1%	3	1.3%		0.40(0.10-1.50)	32	11.0%	38	14.3%	44	8.4%	41	8.2%
- High School	42	17.8%	36	15.5%		1.37(0.75-2.48)	79	27.2%	84	31.7%	121	23.0%	120	24.1%
- Diploma	22	9.3%	37	15.9%		2.69(1.39-5.20)	29	10.0%	22	8.3%	51	9.7%	59	11.9%
- Bachelor Degree	82	34.7%	101	43.5%		1.97(1.20-3.22)	94	32.4%	60	22.6%	176	33.5%	161	32.4%
- Post Graduate	64	27.1%	40	17.2%		Ref	29	10.0%	34	12.8%	93	17.7%	74	14.9%
Father Work														
- Yes	210	89.0%	203	87.5%	0.803	Ref	248	85.5%	219	82.6%	458	87.1%	422	84.9%
- No	22	9.3%	23	10.0%		1.08(0.58-2.00)	29	10.0%	35	13.2%	51	9.7%	58	11.7%
Mother's Education														
- <Elementary School	25	10.6%	15	6.5%	0.645	0.78(0.27-2.21)	48	16.6%	49	18.5%	73	13.9%	64	12.9%
- Secondary School	17	7.2%	18	7.8%		1.37(0.47-3.96)	31	10.7%	40	15.1%	48	9.1%	58	11.7%
- High School	53	22.5%	59	25.4%		1.44(0.58-3.57)	66	22.8%	67	25.3%	119	22.6%	126	25.4%
- Diploma	29	12.3%	32	13.8%		1.43(0.54-3.76)	28	9.7%	25	9.4%	57	10.8%	57	11.5%
- Bachelor Degree	99	41.9%	98	42.2%		1.28(0.53-3.07)	107	36.9%	77	29.1%	206	39.2%	175	35.2%
- Post Graduate	13	5.5%	10	4.3%		Ref	9	3.1%	7	2.6%	22	4.2%	17	3.4%
Mother Work														
- Yes	90	38.1%	80	34.5%	0.411	Ref	98	33.8%	72	27.2%	188	35.7%	152	30.6%
- No	146	61.9%	152	65.5%		1.17(0.80-1.70)	192	66.2%	193	72.8%	338	64.3%	345	69.4%
Are the parents related?														
- Yes	98	41.5%	120	51.7%	0.027	Ref	161	55.5%	130	49.1%	259	49.2%	250	50.3%
- No	137	58.1%	111	47.8%		0.66(0.45-0.95)	129	44.5%	132	49.8%	266	50.8%	243	48.9%
Family Home														
- Villa	131	55.5%	134	57.8%	0.466	Ref	134	46.2%	130	49.1%	265	50.4%	264	53.1%
- Unit	16	6.8%	21	9.1%		1.28(0.64-2.56)	12	4.1%	9	3.4%	28	5.3%	30	6.0%
- Floor	37	15.7%	39	16.8%		1.03(0.61-1.71)	79	27.2%	57	21.5%	116	22.1%	96	19.3%
- Apartment	45	19.1%	35	15.1%		0.76(0.46-1.25)	63	21.7%	68	25.7%	108	20.5%	103	20.7%
- Others	7	3.0%	3	1.3%		0.41(0.10-1.65)	2	0.6%	1	0.4%	9	1.7%	4	0.8%
Home ownership														
- Rented	118	50%	101	43.6%	0.161	Ref	112	38.6%	89	33.6%	230	43.7%	190	38.2%
- Owned	118	50%	131	56.4%		1.29(0.90-1.86)	178	61.4%	176	65.3%	296	56.3%	307	61.8%
Home has a space to do physical activities														
- Yes	200	84.7%	173	74.6%	0.006	Ref	226	77.9%	182	68.6%	426	81%	355	71.4%
- No	36	15.3%	59	25.4%		1.89(1.19-3.00)	64	22.1%	83	31.3%	100	19%	142	28.6%
Income (Saudi Riyal)														
- ≤ 5000	18	7.6%	18	7.8%	0.043	1.34(0.66-2.73)	39	13.4%	40	15.1%	57	10.8%	58	11.7%
- > 5000 & ≤ 10000	39	16.5%	45	19.4%		1.55(0.93-2.58)	81	27.9%	93	35.1%	120	22.8%	138	27.8%
- > 10000 & ≤ 15000	59	25.0%	80	34.5%		1.82(1.18-2.82)	93	32.1%	78	29.4%	152	28.9%	158	31.8%
- > 15000	120	50.8%	89	38.4%		Ref	77	26.2%	54	20.4%	197	37.5%	143	28.8%

*Not all percentage adds up to 100% due to some small amounts of missing data.

Table 3: Socio-demographic characteristics of Saudi Arabian children categorised as normal weight ($\geq 25^{\text{th}}$ P) and obese ($\geq 95^{\text{th}}$ P) of BMI for age percentile.

Socio-demographic factors	Boys		Girls		p value		OR		95%CI		p value		Obese Group		OR		95%CI	
	Normal weight	Obese	Normal weight	Obese														
School type																		
- Government	141	59.7%	143	61.6%	0.675		Ref		0.92(0.63-1.33)		0.007		370	70.3%	Ref		0.53(0.33-0.84)	
- Private	95	40.3%	89	38.4%									156	29.7%				0.77(0.58-1.01)
Child Grades at School																		
- Excellent	174	73.7%	152	65.5%	0.077		1 (Ref)				0.134		391	74.3%	Ref			Ref
- Very Good	49	20.8%	67	28.9%			1.56(1.02-2.40)						114	21.7%	0.69(0.45-1.07)			1.05(0.78-1.41)
- Good	8	3.4%	12	5.2%			1.71(0.68-4.31)						15	2.9%	1.62(0.61-4.26)			1.65(0.85-3.22)
- $\leq$ Medium	4	1.7%	1	0.4%			0.28(0.03-2.58)						4	0.8%	---			0.27(0.03-2.42)
Child has (many) friends																		
- Yes	223	94.5%	203	87.5%	0.008		Ref		2.45(1.24-4.84)		0.524		501	95.2%	Ref		1.29(0.58-2.84)	Ref
- No	13	5.5%	29	12.5%									25	4.8%				1.89(1.14-3.15)
Child has a good relationship with them†																		
- Yes	223	94.5%	175	75.4%	0.000		.000				0.292		501	95.2%	.000			.000
- No	0	0%	28	12.1%									0	0%				
No. of child siblings																		
- 2 or less	52	22.0%	63	27.2%	0.152		Ref				0.277		101	19.2%	Ref			Ref
- 3 to 4	106	44.9%	84	36.2%			0.65(0.41-1.04)						235	44.7%	1.21(0.73-2.00)			0.86(0.61-1.20)
- 5 or more	78	33.1%	85	36.6%			0.88(0.55-1.43)						190	36.1%	1.47(0.89-2.44)			1.10(0.78-1.54)
Rank among siblings																		
- First	59	25.0%	63	27.2%	0.579		Ref				0.665		140	26.6%	Ref			Ref
- Second	48	20.3%	36	15.5%			0.70(0.40-1.22)						109	20.7%	0.87(0.53-1.42)			0.79(0.54-1.14)
- Third	31	13.1%	31	13.4%			0.93(0.50-1.72)						75	14.3%	0.90(0.52-1.56)			0.92(0.61-1.37)
- Fourth	25	10.6%	35	15.1%			1.31(0.70-2.44)						54	10.3%	0.91(0.49-1.71)			1.12(0.72-1.74)
- $\leq$ Fifth	44	18.6%	39	16.8%			0.83(0.47-1.45)						87	16.5%	1.11(0.65-1.88)			0.97(0.66-1.42)
- Last Child	29	12.3%	28	12.1%			0.90(0.48-1.69)						61	11.6%	1.42(0.81-2.48)			1.16(0.76-1.76)

*Not all percentage adds up to 100% due to some small amounts of missing data.

† If answer was "yes" to the previous question.

Table 4. Differentiations in food habits frequencies between Saudi Arabian children categorised as normal weight (≥ 25 th & ≤ 75 th P) and obese (≥ 95 th P) of BMI for age percentile.

Food Habits Frequencies/Week	Boys		p value	OR 95%CI	Girls		p value	OR 95%CI	Normal weight Group	Obese Group	p value	OR 95%CI
	Normal weight	Obese			Normal weight	Obese						
Eating breakfast												
- Rarely	19 8.1%	25 10.8%	0.056	Ref	33 11.4%	34 12.8%	0.101	Ref	52 9.9%	59 11.9%	0.404	Ref
- 1 to 2	25 10.6%	41 17.7%		1.24(0.57-2.71)	20 6.9%	12 4.5%		0.58(0.24-1.37)	45 8.6%	53 10.7%		1.03(0.60-1.79)
- 3 to 4	19 8.1%	25 10.8%		1.00(0.43-2.32)	41 14.1%	21 7.9%		0.49(0.24-1.01)	60 11.4%	46 9.3%		0.67(0.396-1.15)
- 5 to 6	16 6.8%	10 4.3%		0.47(0.17-1.27)	22 7.6%	19 7.2%		0.83(0.38-1.82)	38 7.2%	29 5.8%		0.67(0.36-1.23)
- Daily	157 66.5%	131 56.5%		0.63(0.33-1.20)	173 59.7%	179 67.5%		1.00(0.59-1.69)	330 62.7%	310 62.4%		0.82(0.55-1.24)
Eating snack between breakfast and lunch												
- Rarely	47 19.9%	34 14.7%	0.176	Ref	76 26.2%	87 32.8%	0.579	Ref	123 23.4%	121 24.3%	0.640	Ref
- 1 to 2	36 15.3%	26 11.2%		0.99(0.51-1.95)	48 16.6%	39 14.7%		0.71(0.42-1.19)	84 16.0%	65 13.1%		0.78(0.52-1.18)
- 3 to 4	42 17.8%	38 16.4%		1.25(0.67-2.33)	49 16.9%	42 15.8%		0.74(0.44-1.25)	91 17.3%	80 16.1%		0.89(0.60-1.32)
- 5 to 6	24 10.2%	33 14.2%		1.90(0.95-3.77)	30 10.3%	25 9.4%		0.72(0.39-1.34)	54 10.3%	58 11.7%		1.09(0.69-1.70)
- Daily	87 36.9%	101 42.7%		1.60(0.94-2.71)	86 29.7%	72 27.2%		0.73(0.47-1.13)	173 32.9%	173 34.8%		1.01(0.73-1.41)
Eating lunch												
- Rarely	6 2.5%	3 1.3%	0.431	Ref	13 4.5%	7 2.6%	0.531	Ref	19 3.6%	10 2.0%	0.540	Ref
- 1 to 2	10 4.2%	4 1.7%		0.80(0.13-4.87)	8 2.8%	12 4.5%		2.78(0.77-10.04)	18 3.4%	16 3.2%		1.68(0.60-4.68)
- 3 to 4	16 6.8%	15 6.5%		1.87(0.39-8.87)	20 6.9%	14 5.3%		1.30(0.41-4.08)	36 6.8%	29 5.8%		1.53(0.61-3.79)
- 5 to 6	18 7.6%	18 7.8%		2.00(0.43-9.25)	23 7.9%	22 8.3%		1.77(0.59-5.27)	41 7.8%	40 8.0%		1.85(0.76-4.47)
- Daily	183 77.5%	192 82.8%		2.09(0.51-8.51)	225 77.6%	210 79.2%		1.73(0.67-4.42)	408 77.6%	402 80.9%		1.87(0.86-4.07)
Eating snack between lunch and dinner												
- Rarely	49 20.8%	44 19.0%	0.505	Ref	68 23.4%	64 24.2%	0.840	Ref	117 22.2%	108 21.7%	0.933	Ref
- 1 to 2	42 17.8%	34 14.7%		0.90(0.49-1.65)	43 14.8%	43 16.2%		1.06(0.61-1.82)	85 16.2%	77 15.5%		0.98(0.65-1.47)
- 3 to 4	43 18.2%	41 17.7%		1.06(0.58-1.91)	51 17.6%	41 15.3%		0.85(0.50-1.45)	94 17.9%	82 16.5%		0.94(0.63-1.40)
- 5 to 6	22 9.3%	33 14.2%		1.67(0.85-3.28)	37 12.8%	28 10.6%		0.80(0.44-1.46)	59 11.2%	61 12.3%		1.12(0.71-1.74)
- Daily	80 33.9%	80 34.5%		1.11(0.66-1.85)	90 31.0%	89 33.6%		1.05(0.67-1.64)	170 32.3%	169 34.0%		1.07(0.76-1.50)
Eating dinner												
- Rarely	8 3.4%	5 2.2%	0.703	Ref	7 2.4%	11 4.2%	0.666	Ref	15 2.9%	16 3.2%	0.753	Ref
- 1 to 2	5 2.1%	9 3.9%		2.88(0.60-13.74)	11 3.8%	14 5.3%		0.81(0.23-2.78)	16 3.0%	23 4.6%		1.34(0.52-3.48)
- 3 to 4	19 8.1%	16 6.9%		1.34(0.36-4.94)	28 9.7%	27 10.2%		0.61(0.20-1.81)	47 8.9%	43 8.7%		0.85(0.37-1.94)
- 5 to 6	25 10.6%	27 11.6%		1.72(0.49-5.98)	40 13.8%	32 12.1%		0.50(0.17-1.46)	65 12.4%	59 11.9%		0.85(0.38-1.87)
- Daily	179 75.8%	175 75.4%		1.56(0.50-4.87)	203 70.0%	181 68.3%		0.56(0.21-1.49)	382 72.6%	356 71.6%		0.87(0.42-1.79)
Eating snack before sleep												
- Rarely	166 70.3%	112 48.3%	0.000	Ref	196 67.6%	177 66.8%	0.631	Ref	362 68.8%	289 58.1%	0.000	Ref
- 1 to 2	24 10.2%	24 10.3%		1.48(0.80-2.74)	26 9.0%	32 12.1%		1.36(0.78-2.37)	50 9.5%	56 11.3%		1.40(0.93-2.11)
- 3 to 4	19 8.1%	22 9.5%		1.71(0.88-3.31)	29 10.0%	23 8.7%		0.87(0.49-1.57)	48 9.1%	45 9.1%		1.17(0.76-1.81)
- 5 to 6	1 0.4%	19 8.2%		28.16(3.71-213.37)	14 4.8%	16 6.0%		1.26(0.60-2.66)	15 2.9%	35 7.0%		2.92(1.56-5.45)
- Daily	25 10.6%	55 23.4%		3.26(1.91-5.54)	24 8.3%	17 6.4%		0.78(0.40-1.50)	49 9.3%	72 14.5%		1.84(1.24-2.73)
Eating "together" with family												
- Rarely	8 3.4%	6 2.6%	0.053	Ref	6 2.1%	8 3.0%	0.292	Ref	14 2.7%	14 2.8%	0.066	Ref
- 1 to 2	6 2.5%	11 4.7%		2.44(0.57-10.44)	10 3.4%	5 1.9%		0.37(0.08-1.69)	16 3.0%	16 3.2%		1.00(0.36-2.75)
- 3 to 4	31 13.1%	43 18.5%		1.84(0.58-5.86)	14 4.8%	23 8.7%		1.23(0.35-4.29)	45 8.6%	66 13.3%		1.46(0.63-3.37)
- 5 to 6	35 14.8%	48 20.7%		1.82(0.58-5.74)	28 9.7%	25 9.4%		0.67(0.20-2.19)	63 12.0%	73 14.7%		1.15(0.51-2.61)
- Daily	156 66.1%	124 53.4%		1.06(0.35-3.13)	231 79.7%	204 77.0%		0.66(0.22-1.94)	387 73.6%	328 66.0%		0.84(0.39-1.80)
Eating away from home												
- Rarely	152 64.4%	96 41.4%	0.000	Ref	191 65.9%	156 58.9%	0.066	Ref	343 65.2%	252 50.7%	0.000	Ref
- 1 to 2	73 30.9%	119 51.3%		2.58(1.75-3.80)	77 26.6%	74 27.9%		1.17(0.80-1.72)	150 28.5%	193 38.8%		1.75(1.33-2.29)
- 3 to 4	8 3.4%	11 4.7%		2.17(0.84-5.60)	17 5.9%	27 10.2%		1.94(1.02-3.69)	25 4.8%	38 7.6%		2.06(1.21-3.51)
- 5+	3 1.3%	6 2.6%		3.16(0.77-12.96)	3 1.0%	8 3.0%		3.26(0.85-12.51)	6 1.2%	14 2.8%		3.17(1.20-8.37)
- Daily												
Eating during watching												
- Rarely	77 32.6%	45 19.4%	0.004	Ref	104 35.9%	103 38.9%	0.780	Ref	181 34.4%	148 29.8%	0.212	Ref
- 1 to 2	29 12.3%	28 12.1%		1.65(0.87-3.12)	37 12.8%	27 10.2%		0.73(0.41-1.29)	66 12.5%	55 11.1%		1.01(0.67-1.54)
- 3 to 4	47 19.9%	49 21.1%		1.78(1.03-3.07)	48 16.6%	39 14.7%		0.82(0.49-1.35)	95 18.1%	88 17.7%		1.13(0.78-1.62)
- 5 to 6	23 9.7%	44 19.0%		3.27(1.75-6.11)	35 12.1%	30 11.3%		0.86(0.49-1.51)	58 11.0%	74 14.9%		1.56(1.03-2.34)
- Daily	60 25.4%	66 28.4%		1.88(1.13-3.12)	65 22.4%	65 24.5%		1.01(0.65-1.56)	125 23.8%	131 26.4%		1.28(0.92-1.77)

*Not all percentage adds up to 100% due to some small amounts of missing data.

Table 5. Differentiations in food intake and some dietary pattern between Saudi Arabian children categorised as normal weight (≥ 25 th & ≤ 75 th P) and obese (≥ 95 th P) of BMI for age percentile.

Food intake	Boys		p value	OR 95%CI	Girls		p value	OR 95%CI	Normal weight Group	Obese Group	p value	OR 95%CI
	Normal weight	Obese			Normal weight	Obese						
Place where normally breakfast eating												
- At Home	145 61.5%	151 67.2%	0.190	Ref	161 55.5%	163 61.5%	0.153	Ref	306 58.2%	319 64.2%	0.049	Ref
- At School	91 38.5%	76 32.8%		0.77(0.53-1.13)	129 44.5%	102 38.5%		0.78(0.55-1.09)	220 41.8%	178 35.8%		0.77(0.60-0.99)
Bring food from home to school												
- Yes	150 63.6%	169 72.8%	0.036	Ref	215 74.1%	186 70.2%	0.369	Ref	365 69.4%	355 71.4%	0.442	Ref
- No	85 36.0%	63 27.2%		0.65(0.44-0.97)	75 25.9%	77 29.1%		1.18(0.81-1.72)	160 30.4%	140 28.2%		0.90(0.68-1.17)
Eating during school breaks												
- Yes	193 81.8%	196 84.5%	0.435	Ref	227 78.3%	214 80.8%	0.519	Ref	420 79.8%	410 82.5%	0.307	Ref
- No	43 18.2%	36 15.5%		0.82(0.50-1.33)	62 21.4%	51 19.2%		0.87(0.57-1.32)	105 20.0%	87 17.5%		0.84(0.61-1.16)
Eating from school canteen												
- Yes	175 74.2%	199 85.5%	0.002	Ref	206 71.0%	189 70.9%	0.992	Ref	381 72.4%	388 78.1%	0.042	Ref
- No	61 25.8%	33 14.2%		0.47(0.29-0.76)	83 28.6%	76 28.7%		0.99(0.69-1.44)	144 27.4%	109 21.9%		0.74(0.55-0.99)
Eating while going back home												
- Yes	54 22.9%	98 42.2%	0.000	Ref	50 17.2%	55 20.4%	0.300	Ref	104 19.8%	153 30.8%	0.000	Ref
- No	182 77.1%	134 57.8%		0.40(0.27-0.60)	239 82.4%	210 79.2%		0.79(0.52-1.22)	421 80.0%	344 69.2%		0.55(0.41-0.74)
Parent "normally" read "Food Labels" when buy foods to the child												
- Yes	128 54.2%	79 34.1%	0.000	Ref	152 52.4%	139 52.5%	0.973	Ref	280 53.2%	218 43.9%	0.002	Ref
- No	108 45.8%	153 65.9%		2.29(1.58-3.33)	137 47.2%	126 47.5%		1.00(0.72-1.40)	245 46.6%	279 56.1%		1.46(1.14-1.87)
Who normally prepare the food for child?												
- Mothers	185 78.4%	170 73.3%	0.008	Ref	230 79.3%	229 86.4%	0.181	Ref	415 78.9%	399 80.3%	0.083	Ref
- Housemaids	27 11.4%	48 20.7%		1.93(1.15-3.23)	31 10.7%	19 7.2%		0.61(0.338-1.12)	58 11.0%	67 13.5%		1.20(0.82-1.75)
- Fathers	0 0%	0 0%		---	0 0%	1 0.4%		---	0 0%	1 0.2%		---
- The Child him/her self	1 0.4%	3 1.3%		3.26(0.33-31.68)	9 3.1%	6 2.3%		0.67(0.23-1.91)	10 1.9%	9 1.8%		0.93(0.37-2.32)
- Others	23 9.7%	11 4.7%		0.52(0.24-1.10)	19 6.6%	10 3.8%	0.52(0.24-1.16)	42 8.0%	21 4.2%	0.52(0.30-0.89)		
Soft drinks available in the home fridge at all times for the child?												
- Yes	18 7.6%	66 28.4%	0.000	Ref	24 8.3%	38 14.3%	0.024	Ref	42 8.0%	104 20.9%	0.000	Ref
- No	217 92.0%	166 71.6%		0.21(0.12-0.36)	265 91.4%	227 85.7%		0.54(0.31-0.92)	482 91.6%	393 79.1%		0.32(0.22-0.48)
Keeping (chips, biscuit, sweets ... etc.) always available at home for the child?												
- Yes	77 32.6%	116 50%	0.000	Ref	93 32.1%	84 31.7%	0.903	Ref	170 32.3%	200 40.2%	0.009	Ref
- No	159 67.4%	116 50%		0.48(0.33-0.70)	196 67.6%	181 68.3%		1.02(0.71-1.46)	355 67.5%	297 59.8%		0.71(0.55-0.92)

Table 6. 24-hr Food record intake differences between Saudi Arabian children categorised as normal weight ($\geq 25^{\text{th}}$ & $\leq 75^{\text{th}}$ P) and obese ($\geq 95^{\text{th}}$ P) of BMI for age percentile.

Food intake	Boys		p value	Girls		p value	Normal weight Group	Obese Group	p value
	Normal weight	Obese		Normal weight	Obese				
24-hr Food Record									
Calories consumed/day	1,766 $\pm$ 276	2,070 $\pm$ 323	0.000	1,686 $\pm$ 290	1956 $\pm$ 322	0.034	1,723 $\pm$ 286	2013 $\pm$ 323	0.000

home (OR=0.32, CI=0.22-0.48, $p=0.000$), and freely available non-core foods at home (OR=0.71, CI=0.55-0.92, $p=0.009$) were all positively associated with an increased risk of being obese. Conversely, and interestingly, parents who normally read the food labels was a protective factor for obesity in children (OR=0.68, 95% CI=0.53-0.87, $p=0.002$). There was no significant association between eating during school breaks and obesity ($p=0.307$), or who normally prepared food for child ($p=0.083$).

The mean and standard deviation of total calories consumed per day in the children is summarised in **Table 6**. The 24-hour food record data shows that total caloric intakes were significantly different between obese and normal weight groups ($p=0.000$), and in boys ($p=0.000$) and girls ($p=0.034$).

Discussion

Our study highlights sociodemographic and dietary practices associated with the occurrence of normal weight or obesity among Saudi Arabian children. Interestingly, these factors effected boys and girls differently. A fathers' education level, parent's consanguinity, eating during screen time, and taking home packed meals to school, were significantly associated with obesity among boys, but not girls. Conversely, low to mid income, snacking before sleep, frequent eating away from home, place where normally breakfast is eaten, eating from school canteen, buying and eating food when returning home from school, keeping non-core foods (soft drinks, chips etc.) freely available at home for the child, were variable contributing to a higher risk of being obese in both groups. Importantly, irrespectively of sex and group, a home not having enough space to perform physical activities, or keeping soft drinks freely available in the home for the child, were factors that increased the risk of obesity.

An overweight and/or obese parent is a significant risk factor for overweightness in their children [23,24]. To our knowledge, this study is the first to be conducted and examine this evidence in Saudi Arabia. This study clearly found obese children had parents with higher weight and BMI compared to normal weight children. A high weight and BMI in mothers were significant risk factor for her child to become obese, especially if the child was a girl. However, for fathers only a high BMI was a risk factor for their child to be obese.

The socio-economic status of the participants was associated with the levels of obesity shown. Literacy amongst parents had a significant bearing on their child's weight status [25,26]. The evidence of the relationships between parental

education and obesity is presented with mixed results. While some research would suggest that higher education in parents mean a stronger likelihood of obese children [27], other studies have concluded that obesity was related to parents not having sufficient education [28]. Our study did not support either of these conclusions. Our results found no significant associations of parental education on the weight of all children. Interestingly, the fathers of normal weight boys frequently had a post-graduate education. Whereas, fathers of the obese boys reported their highest level of education as either, an undergraduate or diploma qualification.

Of note, previous research in developed countries shows, low socioeconomic status predicts a higher rate of obesity [29]. Whereas, in developing countries, a higher income group were more likely to have increased prevalence of obesity [30]. Our research suggests that high-income families have more normal weight children, and low to mid income families have more obese children. Our results are similar to high-income families in developed countries [31,32]. This result is not surprising as Riyadh, being the capital of Saudi Arabia, is greatly influenced by the trends in developed countries. Studies show the weight status in the low socioeconomic strata of developed countries is influenced by factors like health insurance, local grocers and the availability of healthy foods, food prices, immobile activities (i.e., technology use, watching television) and access to physical activity clubs, like gyms [33]. These factors are very comparable to the low socioeconomic demographics in Riyadh.

A lack of space to perform physical activity at home is negatively associated with obesity among children [34]. In our study, homes that had space to do physical activities was a protective factor against obesity. A space, such as a yard, helps children to engage in regular physical activities that reduce excessive weight gain [35]. An Australian study of 8 to 12 years old children found that most of their after-school play activity occurred within the home grounds [36]. Generally, from a safety perspective, a yard at home is viewed as a place where children often play under the watchful eyes of the family.

Evidence of relationships between parental consanguinity and childhood obesity is scarce in the literature, where the focus is on relationships between consanguinity and some genetic diseases [37,38]. However, our study showed a relationship between parental consanguinity and childhood obesity among boys, but not among girls and/or the combined groups (**Table 2**). Further investigation is required

to explore our results.

Few studies have examined the impact of childhood obesity on school performance. Studies have focused on the physical health of the child in conjunction with their academic success [39], while longitudinal data in over 6000 children showed the changes in weight status adversely effects academic success, and psychosocial health [40]. Our research found no significant differences in school scores achieved between obese and normal weight groups. Our results of no significant relationships between child obesity and subsequent academic performance are supported by longitudinal research in Taiwanese primary schoolchildren [41].

Obese children tend to have fewer friends than normal weight children [42], resulting in a loss of, or deficiency in, social interaction and group activities with more time, by force, spent on individual activities and/or inactivity in general [43]. Obese children face multiple social challenges within their environment. These may be in the form of bullying, taunts and isolation from mainstream peer groups [44]. In our study, having fewer friends was exclusively amongst obese boys but not amongst girls. This is supported by earlier research examining self-esteem and peer acceptance in among $n=313$ pre-pubertal girls in Northern England [45]. Our study also showed amongst the obese participants, even if they had «many» friends, these relationships were often strained. The differences were significant.

Research indicates children who miss breakfast increase their risk of being obese [46]. While our results show boys were more prone to skip breakfast compared to girls, the difference were not significant. Interestingly, eating breakfast at home significantly increased the risk of obesity. It may be possible that the type, quantity, and/or quality of breakfast eaten at home, by those who were obese in our study, are poor choices. Research evidence examining the association between skipping meals and children's weight is limited [47,48], and, therefore, restricts our comparative analysis. However, our data showed no significant differences or association between skipping lunch and dinner, and weight status, as per a previous smaller Finnish study of 9 to 11 year old children [48].

Conflicting results have been shown on the influence of frequent eating or snacking and childhood obesity. The WHO reports the evidence for the association between snacking and obesity is insufficient [49]. In fact, it may depend on the type, quantity, and time of snack consumption. Eating snacks between meals is told to reduce the risk of obesity as the child tends to eat fewer food items at the next meal. Healthy snacking between meals is, therefore, reported to have a protective effect from obesity among children [50]. However, our data did not show any significant associations between frequent snacking and weight status. This is consistent with a summarised review on snacking patterns in children, which did not find any significant associations between snacking and weight [51]. The exception to our data was the association

between the children's weight and eating prior to sleep. Poor causal evidence exists regarding children snacking before sleep and possible increase risk of obesity. A recent study in Greece of children aged 9–13 years [52] and in 7–11 years in northern Italy [53], all found that bed time snacking tended to be positively associated with overweightness, especially in children that engaged in low levels of physical activity. Our finding is congruent with these two studies.

While Saudi Arabian regulations ban the sale of soft drinks and junk food in school canteens, including preventing students from bringing junk food to school, this regulation is, unfortunately, ineffectual. Unhealthy meals in Saudi Arabian school canteens are associated with increasing obesity levels in school aged children [54]. Our findings clearly show the obese child group significantly consumed a greater amount of school canteen foods and drinks. In addition, obese children had a higher consumption of unhealthy snacks, compared to normal weight children, when returning home from school. In a large Mexican school-children study, a direct link was found between the consumption of high-energy dense foods while going to and from school and weight gain. Furthermore, by reducing availability of these foods, thus consumption, forced a change in eating behaviors and directly affected weight [55]. Our results show that eating away from home was common among obese group and the statistical difference between obese and normal weight was significant. Interestingly, eating “together” with family was more habitual among normal weight children compared to overweight/obese children, but the difference was not significant. Highlighting, by reducing the “availability” of high-energy dense foods may have a positive impact to reduce the prevalence of obesity in Saudi Arabian children.

The food intake and dietary assessments of our cohort showed the level of obesity was significantly associated with freely available soft drinks and/or unhealthy snacks to children at home. The associations between high sugar-sweetened drinks and/or unhealthy snacks, and weight gain in children is globally evidenced and recognised, providing the political will to initiate taxing sugar products and soft drinks [56,57]. Our study focused on ways that parents and/or caregivers could deal with availability of foods at home. Freely available soft drinks and unhealthy snacks for children leads to many unhealthy habits, such as high consumption of sugary drinks and snacks and high fat snacks instead of healthy substitutes, i.e., milk/water, fruits and vegetables [58]. In addition, this highlights the importance of parental control when it comes to having sugar laden soft drinks and junk snacks in the home [59], and may highlight how greater health-conscious parental involvement with their child(s) diet could be a key fact in intervention management and dietary control [60]. Parents who read “food labels” when buying food for their children is a protective factor against obesity. Our study found a direct link between weight management and parents who actively applied/adopted healthy food choices in the home, and those

who do not. While children are educated on the benefits of healthy eating, many are still greatly influenced, in and out of the home, by their family's food choices. This highlights an urgent need for parents to take the responsibility to reinforce better food choices for the health outcomes in their children. Strong evidence is shown in our study that increased parental awareness towards healthier eating directly affected the risk, or otherwise, of childhood obesity.

Conclusion

The findings and results from our study may provide substantive unique information on sociodemographic, and several foods and eating habits that influence the incidence of obesity in Saudi Arabian children. Our study provides strong base-line data on factors associated with obesity among school children in Saudi Arabia, which can be considered as part of any program to tackle the problem of obesity in this age group.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	HA	DB	PD
Research concept and design	✓	--	✓
Collection and/or assembly of data	✓	--	--
Data analysis and interpretation	✓	--	✓
Writing the article	✓	✓	✓
Critical revision of the article	✓	✓	✓
Final approval of article	✓	✓	✓
Statistical analysis	✓	--	✓

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