Childhood Obesity and Quality of Meals:
The Saudi School Meal and Home Meal Study
SSMHMS – A Cross Sectional Study

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Abstract Epidemiological studies have shown a strong association between childhood obesity and quality of food consumed in schools and at home as well. The objectives of this study are to assess quality of school meals and home meals of children between the age 3 to 5 years old, and their obesity level. A cross sectional study conducted on one hundred and thirty children (3-6 years of age; 73 boys and 57 girls) of a private preschool in Jeddah city .Firstly we assessed children weights using anthropometric measurements (height, weight, BMI, IBW/Age, IHT/Age). Secondly Schools meals were analyzed using the USD super tracker (food analysis program) and dietary intakes using both FFQs and 2-day food records to be filled by mothers. We also assessed mother's knowledge, using a questionnaire. Statistical analysis was conducted using SPSS program by applying one way ANOVA using the LSD test and univariate ANOVA test. Data have shown that the prevalence of normal weight, underweight and overweight of the subjects were 66.1%, 6.7% 26.3% respectively. Results showed a significant difference between normal weight student and overweight ($p \geq 0.001$) and a significant difference between underweight student ($p \geq 0.001$) and overweight student. Also, there was a significant difference between underweight student and normal weight student ($p \geq 0.001$). School meal analysis results indicated that the total calories on breakfast are slightly low (23% of total requirement) but the total calories in lunch are slightly high (40% of total requirement) comparing to RDA. Protein content was at the normal range, whereas carbohydrates and saturated fat were at the higher level at lunch (>7%). Finally, responses from mothers on child's home meals were zero. In conclusion, the current study showed that 27% of children were overweight, and meals did not meet the RDA with carbohydrate and fat and lack of interest with mothers to be involved in child nutrition. Such data suggests an increase in the awareness of nutrition and health to staff responsible of preparing meals at schools, teachers and mothers to prevent childhood obesity.

Keywords: *obesity, childhood, school meals, home meals, mothers*

1. Introduction

Childhood obesity is a chronic disease that develops from cultural, genetic, and environmental factors related to poor habits and lifestyles adapted from home or from the school [1]. It is a major public health problem and nutritional disorder in all developed countries and also increasing in developing countries, such as Saudi Arabia [2]. Obesity is a medical term that refer to a status where excess body fat is gathered in the adipose tissue that results from excessive food intake and physical inactivity [3]. During the growing years of childhood and early puberty the number of the fat cells elevates. In order to assess body fat or adiposity and identify risk factors associated with it there are several methods and equipment that can be used, which include body mass index (BMI), waist circumference, and waist to hip ratio [4]. Body patterns are partially affected by gender. In women, fat cells exist in the breasts, hips and thighs, while in men, it exists in the abdomen. This explains why men tend to develop central obesity around the abdomen area which is known as (apple – shaped) where women develop lower body fat around the hip and thigh and is known as (pear – shaped) [5]. There are several health consequences related to obesity, such as diabetes, hypertension, cardiovascular diseases, sleep apnea, osteoarthritis, cancer, kidney stones and respiratory diseases [6]. Among a vast amount of studies, significant relationship between chilhood obesity and risk of devolping cardiovascular diseases has been commonly seen [7]. Furthermore, obesity might lead to social consequences as well, such as discrimination at school and in social events [8]

The quality of diet and poor lifestyles is considered the number one reason related to obesity in Saudi Arabia. A descriptive cross sectional study carried in Hail have shown that among 5000 Saudi civilians living in Hail region selected from 30 primary health care centers, a high overall prevalence of obesity was seen (63.6%),

with a significant higher prevalence rate among females, compared to males and in higher rates at middle ages 41-55 years. The growing economy of KSA has increase the burden of obesity in recent years due to the marked changes in lifestyle include the increased consumption of fast foods and sugar-dense beverages and reduced consumption of fruits and vegetables, people are adopting sedentary lifestyle (use of cars, elevators, and remotes) and less healthful eating habits. Also, could be related to genetic factors, medications (e.g. steroids) or body composition (i.e. females have more fractional fat% than males) [9]. Another cross-sectional study was conducted in the year 2017 among 233 male and female staff at Qassim University campus, where a self-administered questionnaires showed that 30% of participants have one or more risk factors for CHD, and 20.6% are at risk of obesity. Increased consumption of fast foods and sugar-dense beverages has been revealed to be a common concern among the Saudi population, where a percentage of 10.3% of population examined were diabetic, 12.4% have hypertension, 10.7% have dyslipidemia and 54% of the participants have a family history of at least one chronic disease as a risk factor for CHD [10].

Another concern are the family, their knowledge and involvements in quality of eating and lifestyles. According to studies overweight parents have a big influence on whether a child become obese (11). 40% of the mothers who were overweight showed a significant relation with having overweight children at the age 6 years old [12]. There are many factors that affect child intake, which is mainly associated with parental behavior, where they have a great impact on children choices of food. A cross sectional study included 1489 mothers and children, and proved that poor maternal knowledge and lifestyles such as smoking plays a role in children being obese and less active [13]. Furthermore, recent research has been directed towards fathers and their influence on childhood obesity. It is a forgotten member when it comes to child's nutrition and health but according to a review carried in 2018, fathers represents only 17% of participation among 600 studies that covers family influence on child nutrition and health. Between the year 2008 and 2015 only 1% of the intervention studies have included only fathers, where a higher percentage of involvements when mothers are added [14]. Both parents involvements is essential, where studies have also stated that divorced parents have a signigifican influence in the children diets, seen mainly with preadoloscents, such as skimming meals, eating out and high consumption of sugary beverages [15]. Another cross sectional study was carried to compare between married and divroced parents with childhood obesity and a significant association was seen with eating behaviour and BMI scores to be related to obesity when parents are separated [16].

Furthermore, the influence of the school is considered a major influence on children diet and health, children consume between 19 to 50 % of the daily calories in schools [17]. Many studies proved that there is a strong association between school meals and the obesity [18]. It was stated that most of these meals are high in calories, sugar, saturated fat and poor nutritionally [19]. A poor nutritionally type of food is defined as "A food that provide less than 5 % of RDA of each of 8 specified nutrients per serving". These nutrients are protein, vitamin C, vitamin A, riboflavin, thiamine, niacin, calcium and iron [20]. However, in the US, several food programs has been implemented, such as the National School Lunch program which has shown a clear accomplishment in class room [21]. More than 28 million students participate in National School Lunch Program, where school meal at lunch time provided at least one-third of children requirement for energy, protein, vitamin C, vitamin A, iron and calcium. Children who receive lunch at school regularly have greater intake of fiber and several nutrients than children who have their lunch at home [22]. One study reported the difference between breakfast served at school and breakfast served at home, where the one served at school contain more calories and protein, whereas the one served at home contain more total fat, dietary cholesterol and sucrose [23]. New rules have been implemented for the National School Lunch and School Breakfast programs to make most schools elevate the availability of vegetables, fruits, skimmed and reduced fat fluid milk and whole grains. These rules require also a decreased level of sodium, trans fat and saturated fat in meals and meet the calorie requirements of children, which shows significant improvements in class room observed by teachers [24,25]. Health promoting programs in schools must also provide enough education and time for nutrition education and physical activity. It was seen in Singapore that cost effective promoting programs in schools, reduce BMI levels significantly when nutrition education and physical activity classes are implemented [26]. In Saudi Arabia, physical activity is considered a challenge due to costume traditions and also weather. Due to recent awareness, The Ministry of Health have developed DPAS The National Diet and Physical Activity Strategy, which is designed to be implemented through awareness events, training, workshops, and creating national guides for professionals and educators. Such initiative is believed to play major roles in reducing childhood obesity in Saudi Arabia [27]. However, Saudi Arabia still lacks school feeding programs to support meal time, duration, and meals content with regards to quality and quantity

The influence of the house and the schools on the quality of diet and habits introduced to children by parents and teachers are both essential areas to tackle in childhood obesity. Great knowledge on food, nutrition and health, and healthy cooking practices are the solutions. Thus we carry this study to assess the quality of food given to Saudi children and relate it with obesity level. In the current study the main two objectives are to assess quality of school meals and home meals of children between the age 3 to 5 years old, and their obesity level to establish preliminary results and start a national cross sectional study covering private and public schools.

2. Materials and Methods

2.1. School Sampling

SSMHMS Saudi School Meal & Home Meal Study is a cross-sectional survey carried out in one kindergarten private school (3-6 years of age; 73 boys and 57 girls) from January 2017 till May 2017. A private school was

chosen as a pilot and we included three levels of preschool levels (KG1, KG2, and KG3). Inclusion criteria included children with age 3-6 years old children that signed the consent form from both genders Exclusion criteria, included children with age below 3 years and above 6 years old, and those who their parents didn't sign the consent form of the study. This study is registered in (HA-02-J-008); The Research Ethics Committee of the Faculty of Medicine, King Abdul-Aziz University, Ministry of Education approved this study.

2.2. Study Design and Measurements

The school have received a questionnaire to assess the composition of school meals offered in schools. We also involved mothers in the present study by providing their children nutrition assessment based on food consumed at home, in a FFQ food frequency questionnaire form and a 2-day food rescored form. Parents have been given a consent form that included the study information and an option to join the study or not.

2.2.1. Healthy Weight Measurement

Anthropometry include: height, weight and body mass index(kg/m^2) measurements, performed by two registered dietitians. The weight measured once by using electronic balance from Detecto company and the height was measured three times by using freestanding Stadiometer and then plotted on growth charts, according to the Center for Disease Control (CDC).The US Center for Disease Control (CDC) classify each child as "normal", "at risk of overweight" and "overweight". The children with BMI >85th or <95th percentile for age and gender were defined as at risk for overweight and if BMI >95th percentile were defined as obese. In addition we also measured BW/Age, IBW/Age, IHT/Age, WT/HT, IHT/WT.

2.2.2. School Meal Analysis

The school has provided school meals to all children, which was a schedule of a 5-day menu specifically for lunchtime, covering 30% of daily energy. Lunch menu, is required to meet mini- mum standards recommended in the Child and Adult Care Food Program (CACFP). In this school, the class teacher served food, and portion sizes were detected accordingly. Therefore, less variation was seen in this trial. Recipe was explained in details by the chef, including portion sizes and then assessed using the USDA super tracker.

2.2.3. Dietary Intake

Dietary food intake and eating pattern data were obtained by using food frequency questionnaire and 2-day food records, which was explained in written instructions to be filled by their mothers at home. Data analysis were carried using the USDA super tracker, following USDA standards.

2.3. Statistical Analysis

One-way analysis of variance (ANOVA) was used to show significant differences in BMI between ages, classes and BMI categories (underweight, normal, overweight) group plus the differences within each group. Significant

differences between and within age, classes BMI categories was detected using the LSD tests and represented by "*" p <0.05, "**" p<0.01 and "***" p < 0.001. Data were analyzed by using SPSS program software, version 16.0.

3. Results

3.1. Anthropometric Measurement Analysis

Weight and height were measured among all children and the BMI was calculated accordingly. The prevalence of normal weight, underweight and overweight of the subjects were 66.1%, 6.7% 26.3% respectively (Table 1). Results indicated that there is no significant difference in BMI according to classes (Table 2) and age groups (Table 3). With regards to BMI categories, there was a significant difference between normal weight student and overweight ($p \geq 0.001$); there was a significant difference between underweight student ($p \geq 0.001$) and overweight student; there was a significant difference between underweight student and normal weight student ($p \geq 0.001$).

Table 1. The prevalence of BMI categories between student

N	%	BMI categories
9	6.7[a]	Underweight
88	66[c]	Normal
35	26.3[c]	Overweight

a: significant different between b & c, $p \geq 0.001$, b: significant different between a & c, $p \geq 0.001$, c: significant different between a & b, $p \geq 0.001$

Table 2. Anthropometric measurements (BMI), according to classes (CDC)

Class	Number of responses	Mean ± SD	BMI categories
KG1	16	15.06 ±0.929	Normal
KG2	46	15.89 ±2.461	Normal
KG3	70	15.64 ±2.265	Normal

Mean values were significantly different from mean value at baseline, a *P*>0·05 *P*<0.05, **P*<0·01, ***P*<0·001; using One-way ANOVA and LSD test.

Table 3. Anthropometric Measurement (BMI) according to age (CDC)

Age	Number of responses	Mean ± SD	BMI categories
3	6	15.33 ±1.033	Normal
4	30	15.90 ±2.454	Normal
5	67	15.63 ±2.275	Normal
6	29	15.55 ±2.097	Normal

Mean values were significantly different from mean value at baseline, a *P*>0·05 *P*<0.05, **P*<0·01, ***P*<0·001; using One-way ANOVA and LSD test.

3.2. School Meal Analysis

School meal nutrient contents were assessed using the USDA super tracker recipe analysis (Table 4). The total calories on breakfast are slightly low (23% of total requirement) but the total calories in lunch are slightly high (40% of total requirement) comparing to RDA. Protein content was at the normal range, whereas

carbohydrates and saturated fat were at the higher level at lunch (>7%). The result of school meal analysis in our study were the total calories on breakfast are slightly low (23% of total requirement) but the total calories in lunch are slightly high (40% of total requirement) comparing to RDA. Protein content was at the normal range, whereas carbohydrates and saturated fat were at the higher level at lunch (>7%).

Table 4. School meal analysis including breakfast and lunch

Meals	kcal	Protein	CHO	fat	Saturated fat
Breakfast	326	14 g	48g	5 g	5 g
RDA(30% of total nutritional requirements)	420	10%-30%	45%-65%	25%-35%	<7%
% of kcal and nutrients intake	23%	13 %	45%	10%	10%
	A	B	B	A	C
Lunch	560	21 g	116 g	12 g	0
RDA(30% of total nutritional requirements)	420	10%-30%	45%-65%	25%-35%	<7%
% of kcal and nutrients intake	40%	20%	110 %	26%	0
	C	B	C	B	-
Total kcal and nutrient in breakfast and lunch	886	35 g	164 g	17 g	5 g
RDA60% of total nutritional requirements)	60% of total kcal	10%-30%	45%-65%	25%-35%	<7%
% of total kcal and nutrients intake in breakfast and lunch)	63%	29%	136%	31%	9%
	C	B	C	B	C

A: mean lower than the RDA requirements., **B**: mean meet the RDA requirements., **C**: mean higher than the RDA requirements.

3.3. Home Meals Analysis and Mother Involvement

Home meal analysis and mother involvement was assessed by number of responses who carried both FFQ and diet diaries, where results showed that there was no response from the mothers.

Table 5. Mothers involvements

Measurement tool	Number of response
FFQ	0
Diet diary	0

4. Discussion

Epidemiological studies have proved an increase in adult obesity in Saudi Arabia, due to environmental factors influencing the population at childhood age [28] According to Aljaaly in the year 2010, 24% of adolescents in Saudi schools were overweight in association with several factors, which included skipping breakfast, physical inactivity and low knowledge with regards to food and nutrition [29]. According to the literature, one of the significant factors affecting obesity levels in adolescents, are factors present at childhood age [30], where it starts within the house due parents involvements and also from the schools due to low quality of meals and food options [31]. The SSMHMS is the first Saudi study to assess both school meals and home meals and relate it to obesity level, which also indirectly gives a conclusion on how far the school and home are influencing the child nutrition and health. In our study, results have shown that nearly 30% of the children are overweight using CDC growth charts and professionally carried by clinical dietitians at the school. On the hand other studies have collected data from children using self-reported weight and heights which have shown that 13.4% of the children were overweight and 13.5% were obese by [32].

Self-reporting has several limitation and bias which could be affected by children knowledge. In agreement with our study, a comprehensive review from 215 papers, have revealed that childhood obesity has risen in the year 2000 and a steep rise has been seen between the age 5 and 10 years old [33]. On the other hand, El, mouzan, has stated that when using CDC as a reference a lower prevalence of obesity and overweight was seen in his study were he screened 19317 healthy children and adolescents from the age 5 to 18 years old (34). This suggests that most of the studies carried from the year 2000, showing an increase in overweight and obesity at the age of 5 which supports our findings.

Children dietary status play major roles in developing obesity at later ages due to over eating and food nutrients exceeds the RDA. There is an increase demand for preschool children were they usually gain up to 4 to 5 pounds each year. Our study have shown that the breakfast and lunch provide calories lower than the RDA but carbohydrates and fats higher than the RDA, where meals are not balanced. However such results do not really reflect what children are actually eating. A systematic review was carried to assess if the accuracy of school meals evaluation carried by researchers where most of the studies uses diet recalls, food records and food frequency questionnaires in schools to report which foods are consumed [35]. Another study have examined students food choices in relation to food standards and free foods provided by the school, which is another important measurement that indicates how the behavior is related to school meal options. In that study, sandwiches, pizza and desserts, were the most chosen items [36], which are rich in carbohydrates and fats. In agreement with our study, a cross sectional study was carried in the year 2013 to assess school meals of preschools, and results showed that mean intake of calories is 339 kcal, which is similar to the current study meals energy level (420kcal). Also it showed higher percentage of carbohydrates and fats but does not show its relation to the RDA. In that study they have also looked at the food waste, which was mostly

fruits and vegetables another indication of poor nutrition and lifestyles [37]. Another limitation related to our study is that in most schools, children choose their own food from the canteen unlike few private schools where meals are prepared in school. It is more controllable and educational if schools prepare their meals and all children have similar choices than having a canteen. A study carried on 12 primary schools in Australia have evaluated mothers and teachers point of views on children eating from the canteen via self-reporting questionnaires. Results have shown that more than 50% of children buy unhealthy options from the canteen at least once per week. In that study teachers were more concerned than mothers, where mothers have shown less interest [38]. In addition, dietary intakes at school includes more than the foods and beverages prepared in school, where more intakes are taken from other sources such as vending machine and canteen. Thus the opportunities for eating during the school day extend well beyond the school lunchroom and breakfast and lunch. This bring us to mothers involvements and their influence on childhood obesity. A cross sectional study was carried on 523 mothers have shown a strong association between mothers knowledge and their diet, which was mainly seen with soft drinks consumption increasing with less awareness [39]. Thus mothers involvements, their knowledge exhibit a strong influence on children health and nutrition at a younger age through elementary and less influence was seen when reaching high school [31]. In our study, we have requested mothers to provide us with information related to their children diet to assess the quality of meals prepared at home but we received zero responses among 132 mothers. In agreement with our study, less interest was seen by mothers in the literature [38]. However, main limitation in our study may be due to our selection of methods, where food records was a better option to be used, where it is considered the gold standard method of all dietary assessment methods, but it is time consuming [40]. The best way in research is to use methods applied in the current study but combined with interviews to make it easier for mothers to provide information needed accurately, which was successfully seen in studies related to food habits [41]. In addition, we were using super tracker due to its convenience and easy use and also it is considered a method that is applicable to the community to enhance healthy eating by measuring nutrients intake in the diet, but unlikely for the Saudi populations [42]. However for the future we aim to use other meal analysis softwares, combined with food composition tables to define Saudi meals, and also not only focusing on carbohydrates, fats and proteins but also on essential nutrients including vitamins and minerals [43]. These results has been added to this paper in order to find a solution and discuss possible ways to reach mothers in our next studies. Enhancing the knowledge of the child's family is essential and may reduce percentages of obesity in children. A study was carried in Turkey on a total of 302 mothers have shown that most mothers with high level of education, have children with a normal weight [44]. Another study was conducted on maternal knowledge showed significant influence not only on diet and weight of children but also on their health and growth [45]. In our study 6.7% only was seen underweight, which may also play major roles in

health and growth of the child. Students who attended the school involved in this pilot study is from a high socioeconomic background, where overweight and obesity is more relevant than underweight status [46]. With regards to the whole family, the role of the fathers and siblings are usually neglected, where more pressure is carried on mothers. A recent study carried by Mosli showed that paternal involvements results in higher BMI of the child, unlike when mothers were college graduates and more knowledge, a lower BMI of children were seen [47]. In addition, Mosli et al, 2015 have proved that siblings have an impact on the last born child's health and nutrition, where a positive association with overweight and obesity was seen. Similar to that result, a strong positive association was also seen with the only child [48]. Future work must be directed towards involving the whole family, in relation to childhood obesity and nutrition.

5. Conclusion

Our study found preliminary data that there is a high percentage of obesity among children aged 3 to 5 years old in Saudi Arabia, which may be related to the poor quality of school meals that are high in carbohydrates and fats and may be due to lack of mothers interest in child nutrition and quality of home meals. Such data suggests that both school and mothers influence children health and obesity level at a younger age. We need to increase awareness of child health and nutrition to parents via schools, in a form of workshops and training sessions from a younger age. Also, schools must be evaluated and monitored with regards to their school meals prepared or food choices found in canteen. Future work will carry the SSMMS on a higher scale with a higher sample size to represent Jeddah following same objectives. We plan to modify our methods and measurements by calculating what children are actually eating in schools rather than what schools are providing. Regarding quality of meals consumed at home, we will contact the family based on an interview to be able calculate their intakes, their eating habits and lifestyles too. We plan to attract family participation with free consultations and vouchers.

Acknowledgments

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