



RESEARCH ARTICLE

The Prevalence of Overweight and Obesity Among Children and Adolescents in Mosul City

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ABSTRACT

Background and Objective: Childhood obesity represents a growing threat to children's well-being globally. Growth is faster in middle-income countries and most rapid in low-income countries and has increased by two to five times during the decades of 1980s, 1990s and 2000 in developed countries. This study aimed to determine the prevalence of overweight and obesity at the level of Mosul city among children and adolescents.

Methods: A cross-sectional study was conducted on 6,880 children and adolescents (aged 2–18 years) residing in the city of Mosul between June 2023 and February 2024 to determine the prevalence of overweight and obesity there. Overweight and obesity in children were defined according to the 2007 WHO reference. It is the proportion of children who have a BMI standard deviation score of more than +1 and +2, respectively. It was established how common overweight and obesity were, and statistical comparisons were made between the two growth references, the Center for Disease Control (CDC) and International Obesity Task Force (IOTF), with the World Health Organization (WHO) reference.

Results: There were 4581 normal weight children and adolescents from 2 to 18 years of age out of 6880, 58% of whom were boys. Across all age groups, the overall prevalence of obesity and overweight was 11.14 and 11.74%, respectively. The highest percentage of overweight and obesity was in teenage children aged 11 to 15 years, with an almost equal prevalence of overweight and obesity among children in that age group 14.04 and 14.59%, respectively. The overall prevalence of overweight and obesity together (BMI > 85%) according to the WHO was higher, approximately 22.88% (11.14% overweight and 11.74% obesity), than that according to the IOTF and CDC, which was 19.04% (13.99% overweight and 5.05% obesity) for IOTF and was 18.80% (11.45% overweight and 7.35% obesity) for CDC. The prevalence of overweight and obesity is higher among children and adolescents who live on the left side of Mosul city compared to those who live on the right side of the city (25.01 vs. 20.98%).

Conclusions: This study showed low to equal levels of overweight and obesity prevalence compared to population groups of other Iraqi cities and low to moderate levels compared to developing and developed countries. Significant associations were found between overweight and obesity with age of adolescence, as well as residence (the right and the left side of town).

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INTRODUCTION

Overweight and obesity represent a growing threat to children's well-being globally, largely due to the trap of unhealthy and processed foods, as well as a lack of physical activity and a sedentary lifestyle.^{1,2} About 6% of the world's children under the age of five are overweight, meaning nearly 40 million children in this age group are on their way to becoming obese. Among children aged 5 to 19 years, rates of overweight are much higher. It is estimated that 18%, meaning more than 340 million people in this age group, are overweight. Growth is faster in middle-income countries and most rapid in low-income countries.³ In developed countries, the prevalence of overweight and obesity in children and adolescents has increased by two to five times during the decades of 1980s, 1990s and 2000.^{2,4} We can lower our risk of developing diseases later in life by emphasizing the value of growth during infancy and early life. It is critical to carefully track children's development and assess whether it is typical.⁵ There are many different guidelines to define overweight and obesity.⁶ As an important indicator of overweight and obesity in childhood, adolescence, and adulthood, the BMI can be relied upon, especially when the measurements (height and weight) are taken accurately and carefully and compared to appropriate growth charts and recommended limits. The BMI provides an excellent indicator of overweight and obesity that is sufficient for most clinical, screening, and surveillance purposes.⁷ Among adults, cutoff values related to health risk factors are based on fixed BMI values of 25 kg/m² for overweight and 30 kg/m² for obesity. In children and adolescents, there is a wide range of national and international references. The most used criteria are from the Disease Control and Prevention (CDC), the World Health Organization (WHO) and the International Obesity Task Force (IOTF).⁸ For children over the age of 2 years, definitions for overweight and obesity are based on the body mass index (BMI).⁹ Using the BMI, overweight and obesity for children and adolescents are defined as follows: Underweight: BMI <5th percentile. Normal weight: BMI > 5th percentile and <85th percentile. Overweight: BMI >85th percentile and <95th percentile. Obesity: BMI >95th percentile. Severe (morbid) obesity: BMI >99th percentile. Screening of children for overweight and obesity is mostly based on BMI, derived from measured height and weight. Pediatricians must calculate and graph a child's BMI on a gender-specific chart at every well-child visit. The CDC provides these graphs free of charge.¹⁰ However, the most frequently used criteria for childhood were those recommended by the IOTF which provide international age- and sex-specific cutoff points from 2 to 18 years old to evaluate prevalences of overweight and obesity.¹¹

The aim of this study

There is a close relationship between the development of overweight or obesity in childhood and adolescence, with subsequent overweight or obesity in adulthood and an increased risk of morbidity and mortality.¹² To maintain the health and well-being of children and adolescents in the city

of Mosul and reduce the burden of obesity-related diseases in adulthood. There is an urgent need for early diagnosis. This study aimed to determine the prevalence of overweight and obesity at the level of Mosul city among children and adolescents. The objective of this study was in two stages: First, to determine the prevalence rates of obesity and overweight among a representative sample of 2-18 years old children and adolescents in the city of Mosul, using the WHO criteria and then in the same manner by using other international systems, such as the CDC and IOTF criteria. Second: Comparing estimates of the prevalence of overweight and obesity by sex and age for the CDC and IOTF growth references with the WHO reference to evaluate the agreement between each of them separately.

MATERIALS AND METHODS

Design and study population

A cross-sectional study was used in the analysis of 6880 children and adolescents (aged 2–18 years) residing in the city of Mosul. Data for this study were collected from the reference data set in the primary health centers in the city of Mosul, affiliated with both the left primary health care sector and the right sector of the city represented by 2023 school health and nutrition programs. Therefore, the sample was representative of all the socioeconomic strata. According to the Ministry of Planning, the Central Bureau of Statistics, the updated population census for Nineveh Governorate for the year 2018 for the category of children and adolescents, the number of students present for the academic year 2017/2018 (kindergarten, primary, and secondary students) (governmental, family, and religious) was 688682.¹³ With the sample size allotted, it is possible to estimate the rate of obesity and overweight while ensuring that the maximum margin of error is not exceeded more than 1.18 with 95% confidence level and the sample size represented 1% of the total number of targeted children and adolescents in Nineveh Governorate. Data was collected between June 2023 and February 2024. A data collection form was designed to gather data on age, sex, and the mainland region (The right or left side of the city (as well as measures of body weight and height. Data of 4040 boys and 2840 girls aged 2 to 18 years were randomly sampled in the study. BMI was calculated by dividing weight in kilograms by the square of height in meters squared (kg/m²). WHO growth index for the year 2007, which is recommended for international use, was used. Using WHO cutoff values, the proportion of children whose BMI for age was above +1 and +2 standard deviation scores (SDS, z scores), respectively, was used to identify the prevalence of overweight and obesity.¹⁴ It was chosen to calculate the prevalence rate because of its advantages and being the international reference for monitoring overweight and obesity. It was possible to compare the prevalence data in this study with data from other population groups because they used similar references. All calculations were performed using the software published by the WHO. Similar calculations

were performed for the entire sample using the CDC software and the IOTF software separately. The 2000 CDC reference and IOTF reference were chosen to illustrate the effects of using these references on prevalence values and to allow us to compare results with other population groups who use them as a reference because these references are still being utilized in a large number of global healthcare facilities. Over 95 percentile BMI was regarded as obese, while BMIs between the 85th and 95th WHO percentiles were classified as overweight.¹⁵ First, each subject was classified as normal, overweight, obese and underweight by comparing his/her BMI with WHO percentiles for age and sex. The sample was also classified into four age groups: 2 to 5 years (preschool age), 6 to 10 years (elementary school age), 11 to 15 years (middle school age), and 16 to 18 years (high school age). Then, similarly, each subject's BMI was classified as overweight or obese using the IOTF and CDC cutoff values of BMI for age and sex separately. Overweight and obesity categories between the IOTF and CDC criteria for each child were matched to the WHO standard to measure the rate of agreement between the IOTF and WHO once and between the CDC and WHO again.

Statistical analysis

Data was entered and analyzed using SPSS software (version 26.0). Arithmetic mean, percentage and T-test statistics were applied. The prevalence of overweight and obesity was determined using the CDC and IOTF references in each age group, as determined by the WHO reference before. Values and the rate of agreement of the two criteria for measuring obesity and overweight were compared with the WHO standard using the Kappa coefficient test to ascertain the degree to which the identical child's score on each criterion was the same. When the observed agreement matches the expected agreement, the kappa statistic becomes 0, and when the agreement is perfect, it becomes 1. The *p-values* less than 0.05 were regarded as significant at this level.

RESULTS

During the nine months of compiling the sample for this study, 6,880 samples were collected; 4040 (58.72%) were male and 2840 (41.27%) were female. The anthropometric measures and characteristics of the children (The mean of age, height, weight and BMI of the study sample) are presented by sex in Table 1. For boys and girls, the corresponding mean (SD) age was 11 (4.17) years and 10 (4.23) years, respectively. In comparison to girls in the same age range, the boys had considerably greater BMI, higher height, and higher body weight. as shown in Table 1.

The study sample size was 6,880 children and adolescents aged 2 to 18 years, 4,581 (66.58%) of whom were normal weight and 58% of whom were boys Table 2. In all age categories, the general prevalence of being overweight and obese was 11.14% and 11.74%, respectively. The prevalence of obesity was greater in boys (12.74 vs 10.31%; *p* < 0.001) than in girls and girls had a higher prevalence of overweight (12.25 vs 10.37%; *p* < 0.000).

Table 1: Characteristics of study sample (n = 6880)

	Boys		Girls		P-value
	Mean	SD	Mean	SD	
Age in years	11.02	4.17	9.95	4.23	0.000
Height, cm	140.65	23.95	134.83	24.41	0.000
Weight, kg	39.83	18.26	36.53	17.39	0.000
BMI, kg/cm2	18.85	4.42	18.63	4.38	0.040
Sample size (%)	4040 (58.72%)		2840 (41.27%)		6880

BMI: Body mass index, SD: standard deviation

Table 2: Distribution of BMI categories by sex, age and main land region according to WHO criteria

Categories	Normal weight	Overweight	Obesity	Underweight	Total NO.(% according to categories)	P-value
	BMI > 5 th % and <85 th % NO.(%)	BMI >85 th % and <95 th NO.(%)	BMI >95 th % NO.(%)	BMI <5 th % NO.(%)		
<i>Sex</i>						
Male	2658 (65.69 %)	419 (10.37 %)	515 (12.74%)	448 (11.08 %)	4040 (58.72)	0.001
Female	1923 (67.71 %)	348 (12.25 %)	293 (10.31 %)	276 (9.71 %)	2840 (41.27)	0.000
Total	4581 (66.58 %)	767 (11.14 %)	808 (11.74 %)	724 (10.52 %)	6880 (100%)	
<i>Age (year)</i>						
2-5 preschool	974 (72.84%)	98 (7.32%)	91 (6.80%)	174 (13.01%)	1337 (19.43%)	0.000
6 -10	680 (72.57%)	30 (3.20%)	53 (5.65%)	174 (18.56%)	937 (13.61%)	0.014
11 15	2732 (63.10%)	608 (14.04%)	632 (14.59%)	357 (8.24%)	4329 (62.92%)	0.000
16-18	195 (70.39%)	31 (11.19%)	32 (11.55 %)	19 (6.85 %)	227 (4.02)	0.013
Total	4581 (66.58%)	767 (11.14%)	808 (11.74%)	724 (10.52%)	6880 (100%)	
<i>Main land region</i>						
Right side of the city	2465 (68.05%)	363 (10.02%)	397 (10.96%)	397 (10.96%)	3622 (52.64%)	0.000
Left side of the city	2116 (64.94%)	404 (12.40%)	411 (12.61%)	327 (10.03%)	3258 (47.35%)	0.000
Total	4581 (66.58 %)	767 (11.14 %)	808 (11.74%)	724 (10.52%)	6880 (100%)	

Overweight and Obesity in Children and Adolescents

The overall prevalence of overweight and obesity together (BMI > 85%), according to the WHO was high 22.88% (11.14% overweight and 11.74% obesity) Table 2.

According to age groups, the highest percentage of overweight and obesity was in teenage children aged 11 to 15 years, but there was no significant difference between the prevalence of overweight and obesity among children in that age group (11–15 years) ($p < 0.000$), as it was approximately equal, 14.04 and 14.59%, respectively. Likewise, the prevalence of overweight and obesity among preschool children (2–5 years) was almost equal, 7.32 and 6.80%, respectively, but it is much lower than the prevalence of overweight and obesity in the older age group 11 to 15 years. Table 2.

In Table 3, according to age groups, It was noted that a quarter of the number of school-age students between 6 to 18 years suffer from overweight and obesity (BMI > 85%), as the overall prevalence rate reached 24.99%, which is considered very high Table 3. According to gender, boys had a significantly higher prevalence of overweight (6.63 vs. 3.81%) and obesity (8.28 vs. 4.18%) in school-age children than in preschool-age children, $p < 0.006$. Likewise, for girls, there was a significantly higher prevalence of overweight (5.43 vs. 3.51%) and obesity (4.65 vs. 2.61%) in school-aged girls compared to young preschool girls $p < 0.013$ Table 3. According to the mainland region, the research sample was classified as follows:3622 (52.64%) residents of the right side of the city and 3258 (47.35%)

Table 3: Distribution of BMI categories by sex, age (preschool-school age), and the mainland region according to WHO criteria

Categories	Normal weight		Overweight		Obesity		Underweight		Total	P-value
	BMI > 5 th % and <85 th %		BMI >85 th % and <95 th %		BMI >95 th %		BMI <5 th %			
	Male	Female	Male	Female	Male	Female	Male	Female		
	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.		
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	NO.(% according to categories)	
<i>Age (years) preschool</i>										
2	108 (31.57%)	150 (43.85%)	27 (7.89%)	13 (3.80%)	21 (6.14%)	11 (3.21%)	8 (2.33%)	4 (1.16%)	342 (25.57%)	
3	40 (34.48%)	46 (39.65%)	3 (2.58%)	9 (7.75%)	4 (3.44%)	5 (4.31%)	6(5.17%)	3(2.58%)	116 (8.67%)	
4	119 (35.37%)	132(39.63%)	6 (1.80%)	9(2.70%)	13 (3.90%)	5(1.50%)	26(7.80%)	23(6.90%)	333 (24.90%)	
5	200(36.63%)	179 (32.78%)	15 (2.74%)	16 (2.93%)	18 (3.29%)	14(2.56%)	59 (10.80%)	45 (8.24%)	546 (40.83%)	
Total	467 (34.92%)	507 (37.92%)	51 (3.81%)	47 (3.51%)	56 (4.18%)	35 (2.61%)	99 (7.40%)	75 (5.60%)	1337 (100%)	
Male										0.006
Female										0.001
<i>Age (years) school age</i>										
6	254(39.81%)	210 (32.91%)	15 (2.35%)	4 (0.62%)	17 (2.66%)	13 (2.03%)	83(13.00%)	42(6.58%)	638 (11.51%)	
7	80(47.61%)	44(26.19%)	4(2.38%)	2(1.19%)	3(1.78%)	3 (1.78%)	15(8.92%)	17(10.11%)	168 (3.03%)	
8	23(41.81%)	16(29.09%)	0 (0%)	2(3.63%)	4(7.72%)	2(3.63%)	3(5.45%)	5(9.09%)	55 (0.99%)	
9	22(48.88%)	8(17.7%)	1(2.22%)	0 (0%)	4 (8.88%)	3(6.66%)	4(8.88%)	3 (6.66%)	45 (0.81%)	
10	13(41.93%)	10(32.25%)	1(3.22%)	1(3.22%)	0(0%)	4(12.90%)	2(6.45%)	00(0%)	31 (0.55%)	
11	37(22.02%)	53(31.54%)	12(7.14%)	16(9.52%)	25(14.88%)	15(8.92%)	2(1.19%)	8(4.76%)	168 (3.03%)	
12	261(23.38%)	378(33.87%)	82(7.34%)	114(10.21%)	106(9.49%)	113(10.12%)	27(2.41%)	35(3.13%)	1116 (20.13%)	
13	519(36.29 %)	358 (25.03%)	113(7.90%)	78(5.45%)	151(10.55%)	69(4.82%)	92(6.43%)	50(3.49%)	1430 (25.79%)	
14	563(52.42%)	203(18.90%)	78(7.26%)	49(4.56%)	72(6.70%)	23(2.14%)	70(6.51%)	16(1.48%)	1074 (19.37%)	
15	279(51.57%)	81(14.97%)	45(8.31%)	21(3.88%)	48(8.87%)	10(1.84%)	40(7.39%)	17(3.14%)	541 (9.76%)	
16	82(50.61%)	33(20.37%)	9(5.55%)	10(6.17%)	14(8.64%)	1(0.61%)	7(4.32%)	6(3.70%)	162 (2.92%)	
17	35(49.29%)	18(25.35%)	5(7.04%)	2(2.81%)	8(11.26%)	1(1.40%)	1(1.40%)	1(1.40%)	71 (1.28%)	
18	23(52.27%)	4(9.09%)	3(6.81%)	2(4.54%)	7(15.90%)	1(2.27%)	3(6.81%)	1(2.27%)	44 (0.79%)	
Total	2191(39.52%)	1416(25.54%)	368(6.63%)	301(5.43%)	459(8.28%)	258(4.65%)	349(6.29%)	201(3.62%)	5543 (100%)	
Male										0.006
Female										0.013
<i>Main land region</i>										
R-S	1598(44.11%)	867(23.93%)	234(6.46%)	129(3.56%)	288(7.95%)	109(3.00%)	253(6.98%)	144(3.97%)	3622 (52.64%)	
Male										0.002
Female										0.000
L-S	1060(29.26%)	1056(29.15%)	185(5.10%)	219(6.04%)	227(6.26%)	184(5.08%)	195(5.38%)	132(3.64%)	3258 (47.35%)	
Male										0.000
Female										0.005
Total	2658(73.38%)	1923(53.09%)	419(11.56%)	348(9.60%)	515(14.21%)	293(8.08%)	448(12.36%)	276(7.62%)	6880(100%)	

Table 4: The comparative prevalence of overweight using IOTF and CDC references with WHO reference

Age group	Sex	Overweight WHO	Overweight CDC	Overweight IOTF	Kappa coefficient CDC-WHO	p-value	Kappa coefficient IOTF- WHO	p-value
Preschool	Boys (n = 673)	51 (7.5%)	30 (4.4%)	40 (5.9%)	0.49	0.030	0.46	0.100
	Girls (n = 664)	47 (7%)	48 (7.2%)	38 (5.7%)	0.75	0.001	0.25	0.160
6-10	Boys (n = 548)	21 (3.8%)	33 (6%)	22 (4%)	0.16	0.033	0.34	0.430
	Girls (n = 389)	9 (2.3%)	15 (3.8%)	19 (4.8%)	0.42	0.039	0.48	0.130
11-15	Boys (n = 2622)	330 (12.5%)	331 (12.6%)	438 (16.7%)	0.68	0.012	0.72	0.000
	Girls (n = 1707)	278 (16.2%)	301 (17.6%)	353 (20.6%)	0.81	0.001	0.73	0.000
16-18	Boys (n = 197)	17 (8.6%)	20 (10%)	37 (18.7%)	0.90	0.001	0.50	0.250
	Girls (n = 80)	14 (17.5%)	10 (12.5%)	16 (20%)	0.42	0.162	0.51	0.500
Total	Boys (n = 4040)	419 (10.3%)	414 (10.2%)	537 (13.3%)	0.82	0.000	0.64	0.000
	Girls (n = 2840)	348 (12.3%)	374 (13.2%)	426 (15%)	0.76	0.000	0.64	0.000

Table 5: The comparative prevalence of obesity using IOTF and CDC references with WHO reference

Age group	Sex	Obesity WHO	Obesity CDC	Obesity IOTF	Kappa coefficient CDC-WHO	p-value	Kappa coefficient IOTF- WHO	p-value
Preschool	Boys (n = 673)	56 (8.3%)	42 (6.2%)	17 (2.5%)	0.68	0.130	0.35	0.100
	Girls (n = 664)	34 (5.1%)	30 (4.5%)	17 (2.5%)	0.76	0.250	0.24	0.250
6-10	Boys (n = 548)	28 (5.1%)	14 (2.5%)	9 (1.6%)	0.75	0.250	0.42	0.100
	Girls (n = 389)	25 (6.4%)	18 (4.6%)	15 (3.8%)	0.76	0.400	0.62	0.050
11-15	Boys (n = 2622)	402 (15.3%)	258 (9.8%)	184 (7%)	0.65	0.000	0.58	0.050
	Girls (n = 1707)	230 (13.4%)	124 (7.2%)	92 (5.4%)	0.45	0.010	0.21	0.150
16-18	Boys (n = 197)	29 (14.7%)	19 (9.6%)	13 (6.6%)	0.50	0.100	0.22	0.340
	Girls (n = 80)	3 (3.7%)	1 (1.3%)	1 (1.3%)	0.41	0.020	0.41	0.040
Total	Boys (n = 4040)	515 (12.7%)	333 (8.2%)	223 (5.5%)	0.72	0.000	0.36	0.010
	Girls (n = 2840)	293 (10.3%)	173 (6.1%)	125 (4.4%)	0.82	0.000	0.22	0.050

residents of the left side. The prevalence rates given by each classification (the right or the left side of the city) for nutritional status were significantly different ($p < 0.000$). It was found that children and adolescents who lived on the left side of the city of Mosul were more likely to suffer from overweight and obesity compared to those who lived on the right side of the city (25.01 vs. 20.98% $p < 0.000$). However, there was no clear difference between residents of the same area in terms of being overweight or obese. The percentages were very close, as the percentage of overweight and obesity on the right side was (10.02 and 10.96%) respectively and the percentage of overweight and obesity on the left side was (12.40 and 12.61%), respectively Table 2.

According to the statistical comparisons that were made between the two growth references, CDC and IOTF with WHO reference Table 4 illustrates that for the overweight group, there was a significantly higher prevalence of overweight at IOTF and CDC classifications (13.3% for boys and 15% for girls) and (10.2% for boys and 13.2% for girls), respectively than that of WHO classification (10.3% for boys and 12.3% for girls), ($p < 0.000$). The agreement between the IOTF- WHO criteria for overweight was substantial (Kappa = 0.64, $p < 0.000$) and was almost near perfect to substantial for CDC-WHO criteria (Kappa=0.82 for boys and 0.76 for girls, $p < 0.000$). The greatest

agreement between the CDC-WHO criteria appeared in the category of boys aged 16 to 18 years it was almost perfect (Kappa = 0.90, $p < 0.001$) and the lowest agreement between the CDC-WHO criteria was in the category of boys aged 6 to 10 years and was slight (Kappa = 0.16, $p < 0.033$) Table 4.

Conversely, in comparison to the WHO classification, which had 12.7% of boys and 10.3% of girls, the IOTF and CDC classifications had significantly lower rates of obesity (5.5% for boys and 4.4% for girls) and 8.2% for boys and 6.1% for girls, respectively. Agreement between the IOTF- WHO criteria for obesity was fair (Kappa = 0.36 for boys and 0.22 for girls, $p < 0.010 - 0.000$) and was substantial for the CDC-WHO criteria (Kappa = 0.72 for boys and 0.82 for girls, $p < 0.000$) Table 5.

DISCUSSION

In this study, the overall prevalence of overweight and obesity together (BMI > 85%) according to the WHO was higher, at approximately 22.88% (11.14% overweight and 11.74% obesity) than that according to the IOTF and CDC, which was 19.04% (13.99% overweight and 5.05% obesity) for the IOTF and was 18.80% (11.45% overweight and 7.35% obesity) for CDC. It was clear here that the CDC reference is the lowest in terms of estimating the prevalence of overweight and obesity, and

then the IOTF reference compared to the WHO reference shows how the type of reference used affects the prevalence data. What is noteworthy here is that the result of this study is consistent with other studies on childhood, which also indicated that the WHO standards estimate prevalence rates of obesity higher than the IOTF criteria and the CDC criteria. This supports the findings of other research that shows the incidence of overweight and obesity changes depending on the cutoff used to analyze BMI and assess the nutritional health of children and adolescents under the age of 18. In a study of a representative sample of United States children and adolescents collected between 2003 and 2006 using cutoff values established by the WHO, it was shown that among children and adolescents between the ages of 2 and 19, the prevalence of overweight and obesity was 31.9 and 11.3%, respectively.¹⁶ This was almost equivalent to the obesity prevalence rate of 11.74% found in the current study and much higher than the overweight prevalence rate of 11.14%. According to a more recent study, the incidence of obesity in children and adolescents in the United States between the ages of 2 and 19 grew to 19.7% between 2017 and 2020. Making them once again much higher than the rate in this study. In the same survey, the prevalence of obesity in children and adolescents in the United States was 22.2% in those aged 12 to 19 and 12.7% in those aged 2 to 5. This is somewhat consistent with the results of this research in terms of an increase in the prevalence of obesity with increasing age, taking into account the slight difference in the classification of age groups between the two studies, where percentages in the current study were as follows: The prevalence of obesity reached 6.80% among children aged 2-5 years and 14.59% among children aged 11-15 years. One of the most important observations about the results of this study is the high prevalence of overweight and obesity (BMI > 85%) among school students aged 6 to 18 years; the overall prevalence was 24.99% (12.06% for overweight) and (12.93% for obesity), meaning that nearly one in four school age children are overweight or obese, which is considered a significant percentage. These significant findings for school-age children had to be compared with other studies conducted on similar age groups. From studies conducted at the level of Arab countries and using the World Health Organization 2007 reference, a study in Saudi Arabia where the prevalence of overweight and obesity among children and adolescents between the ages of 5 to 18 years was 34.4%,¹⁷ which is considered higher than the result of this study, 24.99%. In a sample representing Kuwaiti students between the ages of 10 and 14 years, the overall obesity prevalence rate was 14.6%.¹⁸ This is very close to 14.35%, which is the overall obesity prevalence rate in the 11-15 year age group for this study. Using IOTF cutoffs, the prevalence of overweight was found to be (28.6% among boys and 18.9% among girls) in a sample of Qatari students aged 12 to 17 years, 19 vs (16.7% among boys and 20.6% among girls) in the current study. In terms of obesity prevalence, it was 4.7% for girls and 7.9%

for boys.¹⁹ It was close to (7% among boys and 5.4% among girls) in this study. In Jordan, 17.5% of intermediate school students were overweight and 9.6% were obese using the IOTF cutoffs, compared to 37.3% of male and female students (11–15 years old) who were overweight and 12.4% were obese in this study using IOTF cutoffs also.²⁰ To further clarify the findings of this study, the results were compared with similar local studies conducted in other Iraqi cities other than Mosul city. In Basra city, the prevalence of overweight and obesity among pupils in intermediate schools was investigated by a cross-sectional survey. It was found that 20.6% of the pupils were overweight and 22.6% were obese. These numbers are higher than the current Mosul City study's results of 14.04% for overweight and 14.59% for obesity.²¹ In Babil city, a study was conducted on primary school students from 7 to 13 years old using IOTF cutoffs, and the corresponding rates of obesity and overweight were 1.3 and 6%, respectively,²² compared to 4.4% for overweight and 2.7% for obesity in this study using the same cutoff values. On the other hand, the overall prevalence of overweight and obesity was 23.7% among primary school children aged 6 to 12 years in the city of Baqubah (using the WHO 2007 reference), which is considered higher than 17.6% overall prevalence of overweight and obesity in children aged 6-10 years in Mosul city, (Considering the minor variations in age groups between the two studies). As for the studies conducted in Iraqi Kurdistan, there are two cross-sectional studies in the cities of Erbil and Duhok. Both studies used the 2007 WHO reference to produce their findings. The results of the Erbil city study showed that 22.7% of children between the ages of 5 to 19 are overweight, while 7.7% are obese, and 5.9% are underweight,²³ compared to 9.72% of children aged 6 to 18 years who are overweight, while 10.42% are obese, and 7.99% are underweight in this study (also taking into account the slight differences in age groups between the two studies). In Duhok, The prevalence of overweight and obesity among children aged 13 to 18 was 13.27 and 14.91%, respectively. In Dohuk, it is worth noting that females are more likely to be overweight (16.77%), while males are more likely to be obese (13.68%),²⁴ and the findings of the current study, which showed that women had a greater prevalence of overweight (12.25% vs. 10.37%; $P < 0.000$) and men a higher prevalence of obesity (12.74 vs. 10.31%; $p < 0.001$), are entirely compatible with this. Similar content is being viewed by a new study entitled (Obesity: A Gender-View). This study shows that gender differences exist in obesity prevalence, phenotype and body fat distribution. Gender is an important variable in obesity analysis. The prevalence of obesity among males is higher than in females, but females have a higher percentage of body fat content compared to males, and gender appears to be an important factor in the manifestation of central (android) or peripheral (gynoid) obesity.²⁵ Another note to discuss is the higher prevalence of overweight and obesity among children and adolescents who live on the left side of the city of Mosul compared to those who live on the right side of the city (25.01

vs. 20.98%). The reason for this could be due to the abundance of restaurants serving fast food and sweets, the abundance of private transportation, and the lack of physical activity, in addition to the better standard of living enjoyed by residents on the left side of the city compared to the right side of the city.

CONCLUSION

There is a high prevalence of overweight and obesity in the city of Mosul among children, regardless of the growth index used. The study showed equal to low levels compared to population groups of other Iraqi cities and low to moderate levels compared to developing and developed countries. The relatively high incidence of obesity and overweight in school-age children emphasizes the need for additional research that takes into account the key risk factors and this high-risk age group. Age, gender, and the mainland region were identified as factors that influenced obesity status in schoolchildren. Thus, action must be taken to stop the number of overweight school-age children and adolescents from rising further and the health problems that go along with it. Health education programs through the media can be used to address this problem. The need for more research is highlighted by the disparities between national and international norms as well as the high prevalence rates of overweight and obesity.

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