Original Article

# Prevalence of Obesity among Primary School Children in Baghdad/AL-Rusafa 2022

**Safa Khalid Subhi, Lujain Alkhazrajy[1]**

Family Doctor/Ministry of Iraqi Health/ Al-Rusafa Health Directorate, [1]Department of Family and Community Medicine, Al-Kindy College of Medicine, University of Baghdad, Baghdad, Iraq



## Abstract

**Background:** Obesity is a complex, chronic condition that is characterized by multiple causes and adverse health consequences. The early detection of obesity in children can help us control it and thus improve growth and development. **Objectives:** To find out the prevalence of obesity among primary school children. To find out if there is any association between childhood obesity and certain variables (age, socioeconomic state [SES], type of school, and education of the father). **Subjects and Methods:** A cross-sectional study was conducted in the Iraq/Baghdad/Al-Russafa sector from March 1, 2022, to January 1, 2023. The study was conducted in the First Educational Directorate of Alrussafa. A convenient sample of six primary schools in Baghdad/Alrussafa including three private schools and three public schools. From these schools, a convenient sample of 650 students was enrolled in the current study. **Results:** A total of 650 participants were enrolled; 249 (38.3%) had normal weight, 241 (37.1%) of the participants were obese, 113 (17.4%) of them had overweight, and 47 (7.2%) had underweight. In addition, a significant association was obtained between the body mass index and gender ($P = 0.001$), and a higher proportion of participants was among males. There was a significant association between body mass index (BMI) and the type of school. The higher proportion of obese participants was among those who were in private schools ($P = 0.001$). **Conclusion:** A significant association was obtained between the BMI and gender and type of school. There was no significant association between the BMI and age, family size, or SES. The students who were male and were teaching in private schools were more prone to be obese.

**Keywords:** Children, Iraq, obesity, overweight

## Introduction

### Definition and epidemiology

Obesity is a complex, chronic condition that is characterized by multiple causes and adverse health consequences.[1,2] Although the definition of obesity and overweight has changed over time, it can be defined as an excess of body fat. There is no consensus on a cutoff point for excess fatness of overweight or obesity in children. The Centers for Disease Control and Prevention defined overweight as at or above the 95$^{th}$ percentile of body mass index (BMI) for age and "at risk for overweight" as between the 85$^{th}$ and 95$^{th}$ percentiles of BMI for age. European researchers classified overweight as at or above the 85$^{th}$ percentile and obesity as at or above the 95$^{th}$ percentile of BMI.[3]

Obesity was first included in the international classification of diseases in 1948. Since then, an epidemic has developed internationally, affecting all age groups.[4] During the last few decades, the number of obese and overweight children and adolescents has significantly increased in both developed and developing countries. This change poses a major public health threat globally.[5]

Childhood obesity has reached startling proportions in the United States (US), doubling in children and quadrupling in adolescents over the past 30 years. Even though levels have stabilized recently, 16.9% of US children are obese and an additional 14.9% are overweight.[6]

**Address for correspondence:** Dr. Safa Khalid Subhi, Family Doctor/Ministry of Iraqi Health/ Al-Rusafa Health Directorate, Baghdad, Iraq.
E-mail: sura42023@gmail.com

**Submitted:** 04-May-2024 **Revised:** 06-May-2024
**Accepted:** 07-May-2024 **Published:** 21-Aug-2024

Access this article online

Quick Response Code:

Website: www.journalijcm.org

DOI: 10.4103/IRJCM.IRJCM_16_24



**How to cite this article:** Subhi SK, Alkhazrajy L. Prevalence of obesity among primary school children in Baghdad/AL-Rusafa 2022. IRAQI J COMMUNITY MED 2024;37:110-6.

In Europe, the highest rates of childhood overweight and obesity are found in southern countries (20%–40%). In Spain, around 30% of children between 6 and 12 years old were overweight or obese in 2015.[7]

In Turkey, the prevalence of obesity increased from 0.6% to 7.3%, with an 11.6-fold increase between the periods 1990–1995 and 2011–2015.[5]

According to a cross-sectional descriptive study done in Iraq from 2017 to 2019, 26% of primary school students were obese. All age groups and grades had an almost equal prevalence of obesity.[8]

## Risk factors and pathophysiology

Childhood obesity is a multifactorial condition resulting from the interaction between multiple genetic and nongenetic risk factors, including behavioral, biological, and environmental factors, with the imbalance between energy intake and energy expenditure as the primary cause.[7,9] However, the causes and mechanisms are not fully understood yet.[10,11] There are likely critical periods of biological and behavioral plasticity beg.

### *Genetic risk factors*

Genetics is one of the biggest factors examined as a cause of obesity. The genetic factor accounts for <5% of cases of childhood obesity. However, genetic susceptibility often needs to be coupled with contributing environmental and behavioral factors to affect weight; therefore, while genetics can play a role in the development of obesity, it is not the cause of the dramatic increase in childhood obesity.[3] Genetic causes of obesity can be broadly classified into:[12,13]

- Monogenic causes: those caused by a single-gene mutation, primarily located in the leptin-melanocortin pathway
- Syndromic obesity: Marked obesity accompanied by additional phenotypes, such as neurodevelopmental disorders and other organ/system malformations
- Polygenic obesity: Caused by the combined effect of many genes, which are amplified in an environment that "promotes weight gain."

### *Nongenetic risk factors*

It is well documented that family members exert an integral role in the development and maintenance of their child's health and dietary behavior. Parental misperceptions regarding their children's body weight status, diet quality, and physical activity patterns have been related to an increased risk of childhood obesity and recognized as barriers to early prevention and intervention.[14]

Sociocultural factors have also been found to influence the development of obesity. Society tends to use food as a reward, as a means to control others, and as part of socializing. These uses of food can encourage the development of unhealthy relationships with food, thereby increasing the risk of developing obesity.[3]

Urbanization is one of the most important actors of an obesogenic environment. A strong correlation between obesity and urbanization and also between obesity and physical activity and chronic diseases is well documented. An inadequate social environment and buildings that are not suitable for walking around push children into an inactive lifestyle.[15]

## Complications

Being very obese (or even overweight) can cause health, psychological, and social problems for children. Children who are obese are more likely to have weight and health problems as adults.[16]

Obese children are more likely to remain obese in adulthood, and the adverse effects of childhood obesity may endure throughout their lifetime. In addition, childhood obesity is associated with an increased risk of a wide range of diseases. Therefore, early prevention of obesity is critical.[9]

Inning as early as fetal life with risk factors accumulating, and interacting with each other, across the life course.[11] Obesity predisposes humans to changes in both cardiac structure and hemodynamics.[17,18] Combined with excessive adiposity, obesity causes increased blood volume and cardiac output and can lead to cardiomyopathy. Two of the most common cardiac comorbidities of childhood obesity are dyslipidemia and hypertension. As a result of the increase in childhood obesity leading to adult obesity, the prevalence of coronary heart disease is estimated to increase from 5% to 16% by 2035, with more than 100,000 cases of coronary heart disease attributed to the predicted increase in obesity.[19]

Obesity increases insulin resistance in the skeletal muscles, liver, and adipose tissues, leading to prediabetes and type 2 diabetes.[20] Excessive ectopic fat accumulation in the skeletal muscles and liver exacerbates peripheral insulin resistance. Insulin resistance causes decreased glucose disposal in the skeletal muscles, increased glucose production in the liver, and the increased production of free fatty acids and inflammatory cytokines in the adipose tissues. Beta cell function and mass are also gradually decreased due to glucotoxicity, lipotoxicity, mitochondrial dysfunction, and endoplasmic reticular stress.[21]

In obese children, insulin resistance with compensatory hyperinsulinemia and hyperandrogenism are the putative factors that initiate early hypothalamic-pituitary-gonadal axis activation. Adipokines, including leptin and adiponectin, which affect kisspeptin release, can also stimulate the initiation of puberty, which is caused by premature activation of the hypothalamic–pituitary–gonadal axis, resulting in the early manifestation of secondary sexual characteristics.[22] Central precocious puberty is defined as breast development before 8 years of age in girls and testicular enlargement before 9 years of age in boys.[21]

Overweight and obese children are at greater risk of orthopedic complications than normal-weight children. Moreover, overweight children show a greater prevalence of fractures (hips), musculoskeletal discomfort, impaired mobility, and lower-extremity malalignment. Obesity that

continues into adulthood can lead to osteoarthritis and articular cartilage breakdown.[19]

Obese children are at risk for developing obstructive sleep apnea syndrome, obesity hypoventilation syndrome, and asthma. Aspiration pneumonia, pulmonary thromboembolism, chronic obstructive pulmonary disease, and respiratory failure may occur later in life. Several mechanisms have been suggested to explain the association between obesity and respiratory symptoms, including reduced compliance of the respiratory system, higher airway resistance, decreased lung volumes, expiratory flow rates, and altered ventilation and gas exchange.[23,24]

Childhood obesity appears with a powerful array of cardiovascular risk factors, including combined dyslipidemia, insulin resistance, and hypertension. The dyslipidemia pattern associated with childhood obesity consists of a combination of elevated triglycerides, decreased high-density lipoprotein cholesterol, and top normal to mildly elevated low-density lipoprotein cholesterol.[25] Combined dyslipidemia is very responsive to even small changes in weight status, diet composition, and activity. Most importantly, in obese children, adolescents and adults, even small amounts of weight loss are associated with significant decreases in triglyceride levels and increases in high-density lipoprotein cholesterol.[26]

Obesity, metabolic syndrome, and hyperinsulinemia are all risk factors for the development of cholelithiasis. Therefore, gallbladder disease should be part of the differential diagnosis for an obese adolescent with persistent right upper quadrant pain.[19]

In addition to being implicated in numerous medical concerns, childhood obesity affects children's social and emotional health. Obesity has been described as being "one of the most stigmatizing and least socially acceptable conditions in childhood".[3] Overweight children tend to protect themselves from negative comments and attitudes by retreating to safe places, such as their homes, where they may seek food as comfort. In addition, children who are overweight tend to have fewer friends than normal-weight children, which results in less social interaction and play, and more time spent in sedentary activities.[27]

### Prevention and control

Recognizing the complexity of childhood obesity, there is a consensus that the development and evaluation of a systems-oriented approach to childhood obesity prevention and treatment are needed. A systems approach would simultaneously address the drivers of obesity at the individual, family, health care, community, organizational, and societal levels multiple levels of prevention.[28] There are three levels of prevention in dealing with childhood obesity:[29,30]

- Primordial prevention deals with keeping a healthy weight and a normal BMI throughout childhood and into the teens
- Primary prevention aims to prevent overweight children from becoming obese
- Secondary prevention is directed toward the treatment of obesity to reduce the comorbidities and reverse overweight and obesity if possible.

### Rational of the study

In Asian countries, the emerging problem of being overweight and obese was highlighted more than a decade ago. Determinants such as changing eating habits, food availability, Western dietary influences, and lack of physical activity may be the cause of rapid increases in the prevalence of overweight and obesity.[31]

The early detection of obesity in children can help us control it and thus improve the growth and development of children.

### Objectives

1. To find out the prevalence of obesity among primary school children
2. To find out if there is any association between children's obesity and certain variables (age, socioeconomic state [SES], type of school, and education of the father).

## Subjects and Methods

### Study design and duration

A cross-sectional study was conducted in the Iraq/Baghdad/Al-Russafa sector from March 1, 2022, to January 1, 2023.

### Setting

The study was conducted in the First Educational Directorate of Alrussafa. It includes public primary and private schools. These schools formed the sample frame of the current study.

### Study population

#### *Sampling method*

A convenient sample of six primary schools in Baghdad/Alrussafa including three private schools and three public schools [Table 1]. From these schools, a convenient sample of 650 students was enrolled in the current study:

### Exclusion criteria

1. Children with a physical or mental impairment that could affect their normal growth
2. Children who were agitated or unwilling for anthropometric measurements
3. Children with chronic diseases on treatment, like children with asthma on steroid therapy.

### Data collection

A structured questionnaire was prepared by the researcher and revised by the supervisor was adopted to gather data; the questionnaire included two parts:

**Table 1: List of schools in the current study**

| Public school | Private school |
|---|---|
| Safana primary school | Alfateh private school |
| Alekua primary school | Alnoor private school |
| Alestekrar primary school | Albenouk private school |

### *Sociodemographic data*

These data were collected from the information contained in the school cards of the pupils and children (regarding the house and car ownership); the gathering of information and examination was done in a private room like and took about 10 to 20 min. The sociodemographic data included:

- The head of the family included:
  - Age
  - Education
  - Employment of the parents
  - Residency of the family
  - SES: It was calculated according to the following equation:

SES = Education + Occupation + House ownership × 0.5 + Car ownership × 0.1+ (age-20)/100 - Retired/unemployed/deceased.[32]

- Education levels are divided into eight levels. For occupation, we assigned scores to the most common job titles available in Iraq and neighboring countries based on the international standard classification of occupations. Jobs were classified into six categories and a score was assigned to each. House ownership was scored as 1 and given a weight of 0.5 and car ownership as 1 and given a weight of 0.1. Children's data included:
  - Age
  - Gender
  - Order of the child in the family
  - Type of the school (public or private).

### *Anthropometric measures*

These measures were obtained by measuring weight (kg) and height (m) by using devices conforming to the specifications of the Health World Organization (WHO) were used participants were weighed with light clothes and barefooted, and the weight and length measuring the WHO Standard Age- and Sex-Specific Growth Reference charts were used for defining overweight and obesity. The WHO uses child growth standards that analyze specific percentiles and standard deviations according to sex and age to define overweight and what constitutes obesity in childhood and adolescence. Growth patterns represent the distribution of an anthropometric measure in a population, reflecting its nutritional status.[33] Interpretation of cutoffs include:[34]

### Ethical issues

1. Approval to conduct the study was obtained from the scientific committee of the Department of Community and Family Medicine, the Iraqi Board of Medical Specializations
2. Approval from the First Educational Directorate of Alrussafa that was directed to the chosen schools
3. Willing of the parents to participate in the current study was taken before taking information and examination of the children.

### Statistical analysis

Microsoft Excel software, version 2016, was used to collect data. After that, the data were exported to the Statistical Package for the Social Science (version 26) (SPSS Inc., Chicago, IL, USA.), which was used for factor construction and data analysis. Descriptive data were presented in the form of tables and figures. Chi-square tests were used to determine if there is any association between studied variables and obesity of the children, where a $P < 0.05$ was considered statistically significant.

## Results

A total of 650 participants were enrolled in the current study. One hundred and ninety-one (29.4%) participants were aged 11 years and constituted the largest proportion of the sample; 102 (15.7%) were aged 10 years, and 99 (15.2%) were aged 12 years. Regarding age, 393 (60.5%) were male. Regarding the family size, 604 (92.9%) had a family size of ≤6. Nearly half of the participants, 286 (44%), were the second child in their families, as shown in Table 2. Most of the participants were in public schools (81.4%).

Regarding the BMI, 249 (38.3%) had normal weight, 249 (37.1%) of the participants were obese, 113 (17.4%) of them had overweight, and 47 (7.2%) had underweight. The highest proportion of the participants was living in families with a middle SES, 402 (61.8%), followed by those who were living in families with high SES, 190 (29.2%), while 58 (8.9%) were living in families with low SES.

A significant association was obtained between the prevalence of obesity and gender ($P = 0.001$), and a higher proportion of participants was among males There was no significant difference between the different ages and the prevalence of obesity ($P = 0.068$), as shown in Table 3. There was a significant association between BMI and the type of school. The higher proportion of obese participants in those who were in the private school ($P = 0.001$), as shown in Table 4.

## Discussion

Obesity is one of the 10 most preventable health risk; childhood obesity is one of the most serious public health challenges of the 21st century. The problem is global and is steadily affecting many low- and middle-income countries.[35] This study was one among other studies that tried to estimate the prevalence of obesity and related factors among primary school children.

### Prevalence of overweight and obesity

The main finding of the current study was that the prevalences of obesity and overweight among primary school children were 37.1% and 17.4%, respectively. In Baghdad/al-Karkh city in Iraq, a cross-sectional study was conducted among school children, revealing that the prevalence of obesity was 16.2%, overweight 16.7%, normal 62.6%, and underweight 4.5%.[35] The result of another study that was done in Basrah, southern Iraq, showed 11.2% of the students were underweight, 53.6% were normal, and 35.2% were overweight and obese.[36]

In comparison to other countries, another study that was done by Mushtaq *et al*. in Pakistan revealed that 70% of children were overweight and 7.5% were obese.[37] Another study in Finland revealed that the prevalence of overweight was 21.7%, obesity was 9.3%, and 69.0% were always normal weight according to national classification.[38] The difference in the prevalence of obesity between different studies in different populations might be related to the difference in environmental factors such as eating habits and duration of physical exercise in addition to genetic issues.

## Association between body mass index and gender

In the current study, the prevalence of obesity was significantly higher in males than females. In agreement, the same results were obtained in another study that was done by Sulaiman and AlAni in the Kurdistan region of Iraq.[8] The same results were obtained in another study that was done in Pakistan, as a higher prevalence of obesity was observed among boys than girls ($P = 0.028$).[37] In Finland, no significant association was obtained between the prevalence of obesity among primary school children and gender.[38] In Korea, Lee *et al*. concluded that the adjusted odds for childhood obesity were significantly higher for males than females.[39] This might be explained by the type and amount of foot that eating outside the home.

**Table 2: Sociodemographic distribution of the participants**

| Character | *n* (%) |
|---|---|
| Age group (years) | |
| 6 | 26 (4.0) |
| 7 | 88 (13.5) |
| 8 | 63 (9.7) |
| 9 | 81 (12.5) |
| 10 | 102 (15.7) |
| 11 | 191 (29.4) |
| 12 | 99 (15.2) |
| Gender | |
| Male | 393 (60.5) |
| Female | 257 (39.5) |
| Family size | |
| ≤3 | 95 (14.6) |
| 4–6 | 905 (78.3) |
| >6 | 64 (7.1) |

**Table 3: Association between age and gender and body mass index**

| Variables | Normal weight, *n* (%) | Obese, *n* (%) | *P* |
|---|---|---|---|
| Age | | | |
| 6 | 8 (44.4) | 10 (55.6) | 0.068 |
| 7 | 31 (41.3) | 44 (58.7) | |
| 8 | 29 (61.7) | 18 (38.3) | |
| 9 | 31 (47.0) | 35 (53.0) | |
| 10 | 36 (50.0) | 35 (49.3) | |
| 11 | 80 (59.7) | 54 (40.3) | |
| 12 | 34 (43.0) | 45 (57.0) | |
| Gender | | | |
| Male | 129 (43.4) | 168 (56.6) | 0.001 |
| Female | 120 (62.2) | 73 (37.8) | |

## Association between body mass index and age

There was no significant association between the prevalence of obesity and the age of the children. In comparison, in another study that was done in Basra City, Southern Iraq, the overweight and obese represent 15.32% of the first class, 34.81% of the third class, and 49.86% of the sixth class.[36] Lee *et al*. concluded that the adjusted odds for child overweight and obesity were significantly higher among 7–12 years old compared to 13–18 years old and 2–6 years old.[39] In another study, the highest prevalence of obesity was among children in the sixth grade in another study that was done in Finland.[38] The variation between different studies might be related to the difference between foot habits in different areas and other significant factors that could affect the prevalence of obesity in different ages.

## Association between body mass index and family size

Although no significant association between BMI and family size, the proportion of participants with obesity was higher among those who were living in a family size of ≤3. In comparison, the same results were obtained in another study that was done in the US and suggested that having more siblings is associated with a significantly lower likelihood of childhood obesity, indicating that children with siblings have healthier diets and watch less television. Furthermore, family mealtimes, eating out less frequently, reduced maternal work, and increased adult supervision of children may be potential mechanisms through which more siblings can have a protective effect on childhood obesity.[40] This variation might be related to the other factors that could affect the prevalence of obesity among children. In addition, eating habit is not related to the number of children in the family.

## Association between body mass index and school type

A significantly higher prevalence of obesity and overweight was obtained in private schools compared to public schools. In Pakistan, Mushtaq *et al*. revealed that the prevalence of obesity was higher in private schools compared to public schools.[37]

## Association between body mass index and socioeconomic state

There were no significant associations between the prevalence of obesity and family size and SES, even though the prevalence was higher in the middle, followed by low, and higher SES. In agreement, a same results in another study was done in Korea by Lee *et al*. and concluded that socioeconomic status did not affect the BMI of the participants.[39] In another study that was done in the Kurdistan region of Iraq, the prevalence was higher in the low SES compared to the high SES. In contrast, another study that was done in Pakistan revealed that the prevalence of obesity was higher in those with high SES compared to low SES.[37]

**Table 4: Association between the body mass index and family size, type of school, and socioeconomic state of the participants**

| Variables | Normal weight, *n* (%) | Obese, *n* (%) | *P* |
|---|---|---|---|
| Family size | | | |
| ≤3 | 28 (40.0) | 42 (60.0) | 0.069 |
| 4–6 | 208 (53.5) | 181 (46.5) | |
| >6 | 13 (41.9) | 18 (58.1) | |
| School | | | |
| Public | 319 (54.3) | 184 (45.7) | 0.001 |
| Private | 30 (34.5) | 57 (65.5) | |
| SES | | | |
| High | 26 (57.8) | 19 (42.2) | 0.345 |
| Middle | 145 (48.3) | 155 (51.7) | |
| Low | 78 (53.8) | 67 (46.2) | |

SES: Socioeconomic state

## Limitations

1. The teaching was online in the 1st month of the study, so there was difficulty in communication with the students
2. The gathering of students in 1 day was difficult, and the researcher had to make several visits to the same school to complete the required number.

## Conclusion

1. A significant association was obtained between the BMI and gender, and type of school. On the other, there was no significant association between BMI and age, family size, or SES
2. The students who were male, those with 7 years of age, and those who were teaching in private schools were more prone to be obese.

## Recommendations

1. Monitoring of the Student's BMI during primary school is mandatory for the diagnosis of obesity and overweight
2. Engagement of the health education system for the teaching staff regarding overweight and obesity
3. Enhancement of the cooperation between school health programs in the primary health-care centers and the teaching staff of the primary schools
4. Increasing sports classes in schools and not replacing them with other subjects.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## References

1. Damanhoury S, Newton AS, Rashid M, Hartling L, Byrne JL, Ball GD. Defining metabolically healthy obesity in children: A scoping review. Obes Rev 2018;19:1476-91.
2. Jastreboff AM, Kotz CM, Kahan S, Kelly AS, Heymsfield SB. Obesity as a disease: The obesity society 2018 position statement. Obesity (Silver Spring) 2019;27:7-9.
3. Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. Childhood obesity: Causes and consequences. J Family Med Prim Care 2015;4:187-92.
4. Kipping RR, Jago R, Lawlor DA. Obesity in children. Part 1: Epidemiology, measurement, risk factors, and screening. BMJ 2008;337:a1824.
5. Çelmeli G, Çürek Y, Arslan Gülten Z, Yardımsever M, Koyun M, Akçurin S, *et al*. Remarkable increase in the prevalence of overweight and obesity among school age children in Antalya, Turkey, between 2003 and 2015. J Clin Res Pediatr Endocrinol 2019;11:76-81.
6. Kapral N, Miller SE, Scharf RJ, Gurka MJ, DeBoer MD. Associations between birthweight and overweight and obesity in school-age children. Pediatr Obes 2018;13:333-41.
7. de Bont J, Casas M, Barrera Gómez J, Cirach M, Rivas I, Valvi D, *et al*. Ambient air pollution and overweight and obesity in school-aged children in Barcelona, Spain. Environ Int 2019;125:58-64.
8. Sulaiman SJ, AlAni MH. Prevalence of obesity and physical activity among primary school children in Erbil city/Iraq. Mosul J Nurs 2020;8:1-13.
9. Zhang Z, Dong B, Chen G, Song Y, Li S, Yang Z, *et al*. Ambient air pollution and obesity in school-aged children and adolescents: A multicenter study in China. Sci Total Environ 2021;771:144583.
10. Kim KY, Lee E, Kim Y. The association between Bisphenol A exposure and obesity in children-a systematic review with meta-analysis. Int J Environ Res Public Health 2019;16:2521.
11. Campbell MK. Biological, environmental, and social influences on childhood obesity. Pediatr Res 2016;79:205-11.
12. Wisham SL, Kraak VI, Liverman CT, Koplan JP, Editor. Progress in Preventing Childhood Obesity: How Do We Measure Up? Washington, DC: The National Academies Press. 2007.
13. Thaker VV. Genetic and epigenetic causes of obesity. Adolesc Med State Art Rev 2017;28:379-405.
14. Farajian P, Panagiotakos DB, Risvas G, Malisova O, Zampelas A. Hierarchical analysis of dietary, lifestyle and family environment risk factors for childhood obesity: The GRECO study. Eur J Clin Nutr 2014;68:1107-12.
15. Pirgon Ö, Aslan N. The role of urbanization in childhood obesity. J Clin Res Pediatr Endocrinol 2015;7:163-7.
16. Waters E, de Silva Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, *et al*. Interventions for preventing obesity in children. Cochrane Database Syst Rev 2011;12:CD001871.
17. Wyse C, Case L, Walsh Ó, Shortall C, Jordan N, McCrea L, *et al*. Evaluating 12 years of implementing a multidisciplinary specialist child and adolescent obesity treatment service: Patient-level outcomes. Front Nutr 2022;9:895091.
18. Alpert MA, Omran J, Bostick BP. Effects of obesity on cardiovascular hemodynamics, cardiac morphology, and ventricular function. Curr Obes Rep 2016;5:424-34.
19. Robinson GA, Geier M, Rizzolo D, Sedrak M. Childhood obesity: Complications, prevention strategies, treatment. JAAPA 2011;24:58-63.
20. Bays HE, Bindlish S, Clayton TL. Obesity, diabetes mellitus, and cardiometabolic risk: An obesity medicine association (OMA) clinical practice statement (CPS) 2023. Obes Pillars 2023;5:100056.
21. Lee J, Kim JH. Endocrine comorbidities of pediatric obesity. Clin Exp Pediatr 2021;64:619-27.
22. Nieuwenhuis D, Pujol Gualdo N, Arnoldussen IA, Kiliaan AJ. Adipokines: A gear shift in puberty. Obes Rev 2020;21:e13005.
23. Di Palmo E, Filice E, Cavallo A, Caffarelli C, Maltoni G, Miniaci A, *et al*. Childhood obesity and respiratory diseases: Which link? Children (Basel) 2021;8:177.
24. Sposato B, Scalese M, Migliorini MG, Riccardi MP, Balducci MT, Petruzzelli L, *et al*. Obesity can influence children's and adolescents' airway hyperresponsiveness differently. Multidiscip Respir Med 2013;8:60.
25. Cook S, Kavey RE. Dyslipidemia and pediatric obesity. Pediatr Clin North Am 2011;58:1363-73, ix.
26. Siri Tarino PW, Williams PT, Fernstrom HS, Rawlings RS, Krauss RM.

Reversal of small, dense LDL subclass phenotype by normalization of adiposity. Obesity (Silver Spring) 2009;17:1768-75.
27. Niehoff V. Childhood obesity: A call to action. Bariatr Nurs Surg Patient Care 2009;4:17-23.
28. Hoelscher DM, Butte NF, Barlow S, Vandewater EA, Sharma SV, Huang T, *et al*. Incorporating primary and secondary prevention approaches to address childhood obesity prevention and treatment in a low-income, ethnically diverse population: Study design and demographic data from the Texas childhood obesity research demonstration (TX CORD) study. Child Obes 2015;11:71-91.
29. Pandita A, Sharma D, Pandita D, Pawar S, Tariq M, Kaul A. Childhood obesity: Prevention is better than cure. Diabetes Metab Syndr Obes 2016;9:83-9.
30. Kumanyika S, Dietz WH. Solving population-wide obesity – Progress and future prospects. N Engl J Med 2020;383:2197-200.
31. Ngan HT, Tuyen LD, Phu PV, Nambiar S. Childhood overweight and obesity amongst primary school children in Hai Phong city, Vietnam. Asia Pac J Clin Nutr 2018;27:399-405.
32. Omer W, Al-Hadithi T. Developing a Socioeconomic Index for Health Research in Iraq; 2022. Available from: https://www.emro.who.int/emhj-volume-23-2017/volume-23-issue-10/developing-a-socioeconomic-index-for-health-research-in-iraq.html. [Last accessed on 2024 Apr 03].
33. Pérez Bermejo M, Alcalá Dávalos L, Pérez Murillo J, Legidos García ME, Murillo Llorente MT. Are the growth standards of the World Health Organization valid for Spanish children? The SONEV Study. Front Pediatr 2021;9:700748.
34. Lobstein T. Commentary: Which child obesity definitions predict health risk? BioMed Cent 2017;43:1-2.
35. AL-Daboony S J. Prevalence of overweight and obesity among primary school children in Baghdad/Al-Karkh. Iraqi Med J 2018;60:1-6.
36. Jassim FA, Maki ZT, Issa SS. Prevalence of overweight and obesity among primary school children in Basrah city center. HIV Nurs 2023;23:152-7.
37. Mushtaq MU, Gull S, Abdullah HM, Shahid U, Shad MA, Akram J. Prevalence and socioeconomic correlates of overweight and obesity among Pakistani primary school children. BMC Public Health 2011;11:724.
38. Häkkänen P, Ketola E, Laatikainen T. Development of overweight and obesity among primary school children-a longitudinal cohort study. Fam Pract 2016;33:368-73.
39. Lee HS, Duffey KJ, Kim CI, Popkin BM. The relationship between family and child weight status by household structure in South Korea: 2007-2010. Nutr Diabetes 2013;3:e73.
40. Datar A. The more the heavier? Family size and childhood obesity in the U.S. Soc Sci Med 2017;180:143-51.