

ORIGINAL ARTICLE

PARENTAL OBESITY AND BARIATRIC SURGERY – IMPLICATIONS IN CHILDHOOD OBESITY

Mariana Andrade¹, Susana Corujeira^{1,2}.

¹Serviço de Pediatria, Unidade Autónoma de Gestão da Mulher e Criança, Unidade Local de Saúde de São João,

²Departamento de Ginecologia-Obstetrícia e Pediatria, Faculdade de Medicina da Universidade do Porto Porto, Portugal.

ABSTRACT

Obesity is a major public health challenge in the 21st century. Due to genetic and environmental factors, children of parents with obesity have a greater risk of developing obesity.

This study aimed to explore the relationship between parental obesity and the severity of obesity and comorbidities in children, also comparing between children whose parents had undergone bariatric surgery or not.

We conducted a single-center, retrospective observational study including all patients followed up at Pediatric Obesity Clinic between September and December 2022.

219 children were included, of whom 48.4% had at least one parent with obesity and 11.9% had at least one parent who underwent bariatric surgery. Children of parents with obesity showed a trend toward more severe obesity (BMI +3.46 vs. +3.15 SDS). This difference was less marked among children of parents who had bariatric surgery. Comorbidities were more frequent both in children of parents with obesity and in children of parents who had bariatric surgery. Notably, children of parents who underwent bariatric surgery had significantly higher rates of dyslipidemia (50.0% vs. 29.5%) and obstructive sleep apnea (19.2% vs. 7.1%).

The results of this study indicate a greater severity of obesity in children of parents with obesity and a greater prevalence of obesity comorbidities in children of parents who underwent bariatric surgery. Therefore, it is essential to implement obesity prevention strategies throughout the community, with a particular focus on families with adults with obesity.

Introduction

The prevalence of childhood obesity has risen dramatically over the past four decades, making it one of the most significant public health challenges of the 21st century and a leading preventable cause of non-communicable diseases.¹ According to the latest World Obesity Atlas, 22% of children and adolescents aged 5–19 years were overweight or obese globally in 2020. Projections indicate that this trend will continue,

Address for Correspondance: Mariana Andrade, Unidade Local de Saúde de São João, E.P.E.Alameda Professor Hernâni Monteiro 4200-319 Porto, Portugal.

Email: marianamandrade@outlook.pt

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ABBREVIATIONS

ALT – Alanine transaminase
 AST – Aspartate transaminase
 BMI – Body mass index
 BP – Blood pressure
 FPG – Fasting plasma glucose
 HbA1c – Glycated haemoglobin
 HDL-C – High-density lipoprotein cholesterol
 IQR – Interquartile range
 LDL-C – Low-density lipoprotein cholesterol
 MASLD - Metabolic dysfunction-associated steatotic liver disease
 MBS – Metabolic and bariatric surgery
 PCOS – Polycystic ovary syndrome
 OSA – Obstructive sleep apnea
 SCFE – Slipped capital femoral epiphysis
 SD – Standard deviation
 SDS – Standard deviation score
 TC – Total cholesterol
 TG – Triglycerides

with Portugal expected to see an annual increase of 0.9% in childhood obesity between 2020 and 2035.²

Childhood obesity is associated with serious short- and long-term health risks, including metabolic disorders, insulin resistance, type 2 diabetes, steatotic liver disease, orthopedic disease and psychological problems. It is also a recognized risk factor for cardiovascular disease, certain cancers, and increased overall mortality.³ Additionally, children and adolescents with obesity are approximately five times more likely to remain obese into adulthood,^{4,7} contributing to significant personal, public health, and economic burdens.⁷



Parental obesity has been associated with a higher prevalence of childhood obesity,⁸ which can be explained not only by genetic and epigenetic factors, but also by a common environment – sharing the same eating habits and behaviors, engaging in similar physical activities, having access to the same infrastructures and healthcare services. It also seems to be associated with a greater severity of childhood obesity and an increased prevalence of its metabolic comorbidities.⁹

A growing subset within this context is that of “bariatric families”—households where one or more parents have undergone metabolic and bariatric surgery (MBS). Evidence shows an increased risk of obesity among these children, even when comparing with children with obese parents who have not had MBS. However, the effect of parental bariatric surgery on the health outcomes of these children is uncertain.¹⁰

The aim of this study is to evaluate the relationship between parental obesity and the severity of childhood obesity and its comorbidities. Specifically, we compare children with obesity based on whether their parents are obese or not, and whether they have undergone MBS or not.

Methods

We conducted a retrospective observational study including all patients managed in the obesity clinic of the Department of Pediatrics in a tertiary university hospital in Porto, Portugal, between September and December 2022. The STROBE guidelines were followed throughout the study.¹¹

All patients were evaluated in the outpatient clinic; a thorough clinical history, physical exam and measurements were performed in each consultation. In every patient, the following variables were recorded: weight, height, body mass index (BMI), systolic and diastolic blood pressures (mean of 3 measurements taken with a Mindray VS-900 vital signs monitor). Obesity was defined as a BMI z-score ≥ 2 SDS according to the World Health Organization growth charts.¹² Caregivers were asked about parental history of obesity and bariatric surgery. 219 children were included in this study, 106 of which with at least one parent with obesity.

Standard laboratory evaluation included measurement of the serum levels of glucose, glycated haemoglobin (HbA1c), total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, triglycerides, alanine transaminase (ALT) and aspartate transaminase (AST) over a 12-hour fast, as well as abdominal ultrasound, performed by experienced radiologists at our center, for detection of hepatic steatosis.

Metabolic dysfunction-associated steatotic liver disease (MASLD) was defined by the evidence of intrahepatic fat accumulation (steatosis) based on liver imaging with ultrasound and/or persistent elevated ALT concentrations to more than twice the upper limit of normal (<26 UI/L for boys and <22 U/L for girls)¹³.

Diagnosis of dyslipidemia was based on the American Academy of Pediatrics diagnostic criteria: Total cholesterol (TC): ≥ 200 mg/dL; Low-density lipoprotein cholesterol (LDL-C): ≥ 130 mg/dL; Non-high-density lipoprotein cholesterol (non-HDL-C): ≥ 145 mg/dL;

High-density lipoprotein cholesterol (HDL-C): <40 mg/dL; Triglycerides (TG): ≥ 100 mg/dL (ages 0–9 years); ≥ 130 mg/dL (ages 10–19 years).¹⁴

Hypertension was defined as blood pressure (BP) $\geq 95^{\text{th}}$ percentile in children 1–13 years of age, and BP $> 130/80$ mmHg in children above 13 years of age, in three distinct visits, or confirmed by 24 h-ambulatory blood pressure monitoring.¹⁵

Pre-diabetes was defined as fasting plasma glucose (FPG) 100–125 mg/dL and/or HbA1c 5.7% to 6.4%; Diabetes mellitus type 2 was defined as FBG ≥ 126 mg/dL and/or HbA1c $>6.5\%$.¹⁶

Diagnosis of obstructive sleep apnea (OSA) was made by polysomnogram when there was clinical suspicion. Polycystic ovary syndrome (PCOS) was diagnosed based on clinical or biochemical evidence of hyperandrogenism and abnormal menstrual pattern for age reflecting ovulatory dysfunction.¹⁷ Among orthopedic comorbidities, we included slipped capital femoral epiphysis (SCFE) and Blount’s disease.

Statistical analysis was performed with IBM® SPSS® Statistics, version 28, between March–September 2023. Descriptive statistics were examined for all variables. Continuous variables were expressed as median with interquartile range (IQR) when they were not normally distributed and as mean \pm standard deviation (SD) for normally distributed variables. Categorical variables were presented as number and percentage. All statistical tests were two-sided. Categorical variables were compared by the chi-square test and continuous and ordinal variables by the independent samples T-test. A p level < 0.05 was considered statistically significant.

Results

The clinical and demographic characteristics of the children who were included in this study (n=219) are summarized in Table 1. Mean age at first appointment was 10,7 years. Mean BMI z-score was +3,3 SDS.

The overall prevalence of parental obesity (at least one parent) was 48,4%. Parental MBS prevalence was 11,9%, this increasing to 24,5% among those whose parents had obesity.

Comorbidities were present in 61,2% of patients with the most common being MASLD (37,5%) and dyslipidemia (32,9%). Regarding treatment, at the time of data collection 187 children (85,4%) were solely under lifestyle measures; 5 (2,3%) were under treatment with metformin and 8 (3,7%) with liraglutide; and 16 (7,3%) had already undergone MBS. 7 children (3,1%) were awaiting bariatric surgery at the time this study was conducted.

(Table 1. Clinical and demographic data of children included in the study)

In the parental obesity group, the mean BMI Z-score at first appointment was higher (+3,5 versus + 3,2; $p=0,005$) when compared to the group of children without parents with obesity. Although there were no statistically significant differences regarding the presence of comorbidities, MASLD, dyslipidemia, OSA and PCOS were more frequent in this group (Table 2).

(Table 2. Comparison between children with, or without, at least one obese parent)

In the group whose parents had undergone MBS, the mean BMI Z-scores at first appointment was slightly higher and all the comorbidities were more frequent (69,2 versus 59,0%) except for type 2 diabetes and orthopedic complications. There were significant differences in the prevalence of dyslipidemia (50% vs 29,5%) and obstructive sleep apnea (19,2% vs 7,1%) in this group (Table 3).

(Table 3. Comparison between children with, or without, at least one parent who had undergone bariatric surgery)

Table 1. Clinical and demographic data of children included in the study. SD= Standard deviation; SDS = Standard deviation score; BMI = Body mass index; MASLD = Metabolic-associated steatotic liver disease

Gender (Male:Female, n, %)	113:106 (51,6/48,4)
Mean age at 1st appointment (years, SD)	10,7±3,9
Mean age at current appointment (years, SD)	12,7±3,8
Parental obesity, n (%)	106 (48,4)
Parental bariatric surgery, n (%)	26 (11,9) Among those with obese parents: 24,5%
Mean BMI Z-score (SDS)	+3,3
Presence of comorbidities, n (%)	134 (61,2)
<ul style="list-style-type: none"> • MASLD 82 (37,5) • Dyslipidemia 72 (32,9) • Arterial hypertension 18 (8,2) • Obstructive sleep apnea 18 (8,2) • Pre-diabetes 6 (2,7) • Orthopedic comorbidities 5 (2,3) • Polycystic ovary syndrome 4 (1,8) • Type 2 diabetes mellitus 1 (0,5) 	
Treatment at current appointment, n (%)	
<ul style="list-style-type: none"> • Lifestyle measures only 190 (86,7) • Liraglutide 8 (3,7) • Metformin 5 (2,3) • Post-bariatric surgery 16 (7,3) 	

Table 2. Comparison between children with, or without, at least one obese parent. BMI = Body mass index; MASLD = Metabolic-associated steatotic liver disease; DM2 = Diabetes mellitus type 2; OSA = Obstructive sleep apnea; PCOS = Polycystic ovary syndrome

	Parental obesity (N= 106)	No parental obesity (N= 113)	Independent sample t-test value	Chi-square test value	p
Sex (Male: Female, %)	52/54 (49/51)	59/44 (57/43)	-	1,42	0,23
Mean age at first appointment (years)	11,1	10,3	-1,49	-	0,14
Mean BMI Z-score at first appointment	3,5	3,2	-1,95	-	0,05
Presence of comorbidities (%)	61 (61,3)	42 (59,2)	-	0,10	0,76
Arterial hypertension (%)	8 (7,5)	9 (8,7)	-	0,10	0,75
MASLD (%)	41 (38,7)	37 (35,9)	-	0,17	0,68
Dyslipidemia (%)	37 (34,9)	30 (29,1)	-	0,80	0,37
Pre-diabetes (%)	3 (2,8)	3 (2,9)	-	0,00	0,97
DM2 (%)	0 (0)	1 (1)	-	1,03	0,30
OSA (%)	11 (10,4)	7 (6,8)	-	0,85	0,35
PCOS (%)	3 (2,8)	1 (1,0)	-	0,96	0,32
Orthopedic comorbidities (%)	2 (1,9)	3 (2,9)	-	0,23	0,63

Table 3. Comparison between children with, or without, at least one parent who had undergone bariatric surgery. BMI = Body mass index; MASLD = Metabolic-associated steatotic liver disease; DM2 = Diabetes mellitus type 2; OSA = Obstructive sleep apnea; PCOS = Polycystic ovary syndrome

	Parental obesity (N= 106)	No parental obesity (N= 113)	Independent sample t-test value	Chi-square test value	p
Sex (Male: Female, %)	52/54 (49/51)	59/44 (57/43)	-	1,42	0,23
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Mean BMI Z-score at first appointment	3,5	3,2	-1,95	-	0,05
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Arterial hypertension (%)	8 (7,5)	9 (8,7)	-	0,10	0,75
MASLD (%)	41 (38,7)	37 (35,9)	-	0,17	0,68
Dyslipidemia (%)	37 (34,9)	30 (29,1)	-	0,80	0,37
Pre-diabetes (%)	3 (2,8)	3 (2,9)	-	0,00	0,97
DM2 (%)	0 (0)	1 (1)	-	1,03	0,30
OSA (%)	11 (10,4)	7 (6,8)	-	0,85	0,35
PCOS (%)	3 (2,8)	1 (1,0)	-	0,96	0,32
Orthopedic comorbidities (%)	2 (1,9)	3 (2,9)	-	0,23	0,63

Discussion/conclusion

Results of this study point towards a higher severity of obesity in children who have parents with obesity, coinciding with the findings of Martinez-Villanueva et al.⁹ However, while our findings suggest a trend toward higher BMI z-scores in children of parents who underwent MBS, the difference was not statistically significant. The causal direction remains unclear: Bao et al,¹⁸ Lent et al,¹⁹ and Pufal et al,²⁰ described a higher severity of obesity in these children, whereas Hirsch et al,²¹ and Sellberg et al²² described a positive effect of parental bariatric surgery on their children's weight status, with a decrease on children's weight at 9-12 months post-operatively. It is described that some families may experience lifestyle improvements after parental weight loss surgery, such as modeling the parent's prescribed diet and increasing physical activity; however, this improvement seems to be time-limited.¹⁰ It is also possible that underlying socioeconomic challenges or psychosocial stressors - which may drive both parental decisions to undergo surgery and contribute to obesogenic environments - play a mediating role in these associations.

Obesity-related comorbidities were more common both in children with parental obesity (61% vs. 42%) and in those whose parents had undergone MBS (69.2% vs. 59.0%). However, in this study, these differences were not statistically significant when considering the overall presence of comorbidities.

Dyslipidemia and obstructive sleep apnea were significantly more frequent in children whose parents had undergone MBS. These relationships may either represent a previously under-recognized familial or genetic clustering of metabolic and respiratory risk factors, or, particularly in the case of dyslipidemia, the influence of shared environment. Further studies are needed to determine whether this reflects genetic inheritance, shared environmental exposures, or

possibly the psychological and nutritional adaptations following parental surgery that inadvertently impact the child.

Most complications were more prevalent in the group with parental bariatric surgery, with the exceptions of diabetes and orthopedic issues. Although type 2 diabetes mellitus (T2DM) is increasingly diagnosed among adolescents, only one case of T2DM was observed in this study—and it occurred in a child without a family history of obesity. Pre-diabetes, a precursor to T2DM, was more common in children whose parents had undergone bariatric surgery.

This study has several limitations. First, we did not differentiate whether the parent affected by obesity or who had undergone bariatric surgery was the mother, the father, or both. Although previous research suggests maternal obesity may have a greater impact on child outcomes,⁹ our sample size did not allow for this level of subgroup analysis. Given the influence of maternal health behaviors, intrauterine environment, and early feeding practices, future studies should consider disaggregating parental roles to better inform targeted interventions.

Additionally, we did not assess the timing of parental bariatric surgery in relation to the child's BMI and comorbidity evaluation. As a result, we cannot draw definitive conclusions about the direct impact of parental surgery on the child's health outcomes. Lastly, the study was conducted in a tertiary care setting, which primarily receives referrals for the most severe cases of pediatric obesity, particularly those being considered for bariatric surgery. This may introduce a selection bias and limit the generalizability of our findings.

Families play a central role in the prevention and management of childhood obesity, as parents largely shape their children's eating habits, physical activity, and screen time behaviors.¹⁷ To reduce the global burden of childhood obesity - epidemiologically, economically, and socially - prevention strategies must more effectively target families, particularly those with adults affected by obesity or who have undergone bariatric surgery. This includes not only primary prevention but also tertiary prevention by actively involving the family in the treatment of children with obesity.

The recommended first-line approach across all age groups is intensive health behavior and lifestyle treatment (IHLBT), which relies on the active engagement of families working alongside a multidisciplinary care team. When parents themselves have obesity, these lifestyle changes may be more extensive but also hold greater potential for improving the health of the entire household.²¹ Parental bariatric surgery can serve as a unique opportunity to promote healthier routines within the family, potentially benefiting both the adult patient and their children. However, since post-surgical lifestyle improvements often diminish over time, long-term, family-centered support is essential to sustain positive changes and prevent obesity-related complications in at-risk children. Longitudinal or interventional studies are warranted to disentangle whether parental MBS leads to sustained improvements in children's obesity outcomes, or if the observed effects are confounded by familial, behavioral, or socioeconomic factors.

Compliance with Ethical Standards**Funding:** None**Conflict of Interest:** None**References:**

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