Original Research Study
Acta Medica Academica 2025;54(3):195-204
DOI: 10.5644/ama2006-124.489

Breaking the Cycle: A Case-Control Study on Social and Familial Influences in Childhood Obesity

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Received: 22 July 2025; **Accepted:** 27 October 2025

Abstract

Objective. Childhood obesity is a growing public health concern influenced by social and familial determinants. This study examines the associations between caregiver education, family structure, social risk factors, and familial obesity with childhood obesity in a Portuguese pediatric population to inform targeted interventions. **Materials and Methods.** A retrospective case-control study was conducted at a Portuguese secondary hospital, including 78 children with obesity and 326 controls. Controls were selected using a time-matched, hospital-based approach from the same ward and calendar years as the cases. Socioeconomic data were extracted from the hospital records. Social risk was defined based on documented indicators of socioeconomic vulnerability, such as financial hardship, suspicion of neglect, and housing instability, identified through multidisciplinary records. Logistic regression models were used to assess the risk of obesity while adjusting for age and sex. **Results.** Caregiver education and familial obesity were the strongest predictors of childhood obesity. Children whose caregivers had not completed compulsory education had a significantly higher risk of obesity, whereas familial obesity showed an even stronger association. Social risk factors were linked to obesity in univariate analyses but lost significance in adjusted models. An exploratory interaction between caregiver education and social risk suggested higher odds when both disadvantages co-occurred. Family structure did not independently predict obesity. **Conclusion.** This study highlights the need for targeted public health interventions addressing caregiver education, economic support for at-risk families, and family-wide lifestyle changes. A multi-sectoral approach integrating healthcare, education, and community programs is crucial for reducing childhood obesity and promoting long-term health equity.

Key Words: Caregiver Education ▪ Socioeconomic Factors ▪ Obesity Risk Factors ▪ Health Disparities ▪ Public Health Interventions.

Introduction

Childhood obesity is a major global health concern, with early onset increasing the risk of chronic diseases, such as type 2 diabetes, cardiovascular conditions, and psychological disorders, which often persist into adulthood and burden healthcare systems (1, 2). While lifestyle habits such as diet and physical activity are important, structural factors—such as socioeconomic status, caregiver education, and familial context—play a pivotal role (3). Understanding how these elements interact is key to designing effective and equity-focused interventions.

Children from disadvantaged households often face financial and environmental barriers that increase their risk of obesity. Limited income constrains access to fresh, nutritious foods, whereas affordable options are often processed and calorie-dense (3). These families may also live in areas lacking safe spaces for physical activity or adequate

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food retail infrastructure, reinforcing sedentary behavior and poor diets (3).

Lower parental education is associated with reduced health literacy, limited nutritional knowledge, and inconsistent access to preventive care. These limitations influence early feeding practices and long-term dietary habits. Interventions that promote caregiver education may help families adopt healthier routines and mitigate the risk of obesity. Household composition and social adversity can also influence obesity outcomes (4). Single-parent families often face time constraints and economic pressures, whereas extended or institutional settings may lead to inconsistent caregiving and feeding practices (4). Social risk factors, such as food insecurity and housing instability, contribute to chronic stress, which is linked to emotional overeating and a preference for energy-dense comfort foods. Despite growing awareness, few studies have concurrently examined these determinants in pediatric populations. This case-control study investigates how caregiver education, social risk, and familial obesity relate to childhood obesity within a hospital-based cohort.

By modeling these factors concurrently, this study aims to clarify their independent associations and, where theoretically justified, explore potential joint effects—such as the intersection between social disadvantage and caregiver education—thereby supporting more targeted public health strategies.

Methods

Study Design and Setting

This study employed a retrospective, hospital-based, case–control design conducted at a Portuguese secondary hospital between January 2010 and July 2024. Pediatric inpatients aged 2 to 17 years were considered eligible. All consecutive cases with a documented diagnosis of obesity and complete sociodemographic and clinical data during this period were included, yielding a total of 78 cases. This number reflects the entire population of eligible cases within the defined timeframe, rather than a sampled subset. Controls were selected at an approximate 1:4 ratio from pediatric inpatients aged 2–17 years admitted to the same hospital and ward (Pediatrics) during the same calendar years (2010–2024) as the cases to ensure temporal comparability. No formal matching by age or sex was performed, as these variables were adjusted for in the regression models. Controls were chosen independently of diagnosis, excluding only children with documented obesity to reflect the general inpatient population. Because caregiver education and social risk may be related to a broad range of admission diagnoses, complete independence between exposures and control diagnoses could not be guaranteed; therefore, we used a diagnosis-agnostic approach to preserve representativeness and avoid selection bias from restricting to specific conditions.

Selection Criteria

The selection of cases and controls followed strict inclusion and exclusion criteria to minimize bias. Cases: Children aged 2-17 years with a documented diagnosis of obesity, defined using the WHO BMI-for-age percentiles (5, 6). Admitted to the Pediatrics Department for any medical reason during the study period. Controls: Children aged 2-17 years without an obesity diagnosis. Hospitalized for any non-obesity condition. Selected using a time-matched hospital-based approach to reflect the temporal distribution of cases across the 2010–2024 study period. Controls encompassed a broad range of medical admissions typical of a general pediatric ward, ensuring the representativeness of the inpatient population.

The exclusion criteria for both cases and controls included children with underlying genetic syndromes affecting growth and metabolism, such as Prader-Willi syndrome.

Variables and Definitions

This study analyzed key variables related to socioeconomic and familial factors influencing childhood obesity. Sex was categorized as female or male. Caregiver education was classified into four

levels: higher education (reference), compulsory education, below compulsory education, and illiterate. Compulsory education was defined according to the Portuguese legal framework in force during each caregiver's schooling years (7). Before Law No. 85/2009, compulsory education comprised nine years (basic education); from 2009 onward, it was extended to twelve years (ages 6–18) (7). Accordingly, caregivers' education levels were coded relative to the applicable legal standard for their birth cohort. Family structure was grouped into nuclear (reference), extended, single-parent, and reconstituted household types. Social risk was a binary variable based on documentation of (a) active follow-up by the hospital's child protection/social support team or (b) explicit notes of socioeconomic vulnerability (e.g., economic hardship, suspected neglect, and housing insecurity). No standardized instrument was used. Familial obesity was examined by identifying whether a child had no obese relatives, one direct relative with obesity, or two or more direct relatives with obesity. 'Direct relatives' denotes first-degree family members—parents or primary caregivers (including adoptive parents) and siblings; grandparents and other extended relatives were not considered. Mental health conditions were not analyzed as independent determinants because they were inconsistently documented in the medical records and primarily reflected comorbidities rather than exposures influencing obesity or food access.

Comorbidities

Comorbidities were defined as chronic or recurrent medical conditions documented in the patient's medical history or discharge summary, independent of the reason for hospitalization. Only diagnoses recorded in addition to the admitting diagnosis were included as comorbidities.

Data Collection

Data were extracted from the hospital's electronic medical records. Sociodemographic data, including caregiver education, household composition, and social risk status, were obtained from structured hospital admission interviews conducted by social workers and pediatricians. Anthropometric measurements were recorded following standardized WHO protocols, with BMI percentiles calculated based on sex- and age-specific growth charts (5, 6).

Data on family income, parental employment status, and parental BMI were not systematically recorded in the hospital's electronic medical records and were, therefore, unavailable for analysis. Although these are important factors in understanding childhood obesity, caregiver education and documented social risk were used as proxy indicators for socioeconomic context, and familial obesity was assessed based on the presence of first-degree relatives—parents/primary caregivers (including adoptive) and siblings—with obesity as recorded in medical or social histories. Parental age and ethnicity/ancestry were also not consistently available in the electronic records and were therefore not included as covariates. The hospital's catchment area is >95% Caucasian, indicating limited ethnic heterogeneity across cases and controls.

Ethical Considerations

This study was approved by the Institutional Ethics Committee of the Local Health Unit Entre Douro e Vouga. Given the retrospective nature of this study, the requirement for informed consent was waived. However, all patient data were anonymized to ensure confidentiality, in accordance with the Declaration of Helsinki.

Statistical Analysis

We summarized the baseline characteristics as mean ± SD (continuous) and N (%) (categorical). Univariable logistic regression was used to estimate crude odds ratios (CORs) with 95% confidence intervals (CI). Next, for each exposure, we fitted a minimally adjusted model that included the exposure, age, and sex to obtain age- and sex-adjusted odds ratios (AORs). Finally, we fitted one fully adjusted model, including caregiver education, family structure, social risk, familial obesity, age,

and sex, to assess model discrimination, calibration, and multicollinearity, rather than to estimate effects. Comorbidities were not modeled because several conditions (e.g., asthma and dyslipidemia) plausibly lie on the causal pathway (risk of over-adjustment). Statistical significance was set at two-sided $p < 0.05$. Missing data were <5% per variable, and listwise deletion was used. Multicollinearity was assessed using variance inflation factors (VIF <2 for all predictors). Model discrimination and calibration were evaluated for the full model only using the area under the receiver operating characteristic curve (AUC) and the Hosmer–Lemeshow test. An a priori interaction term (lower caregiver education × social risk) was included in the full model and tested using Wald χ^2. The reference categories were as follows: Sex = Female; Family structure = Nuclear; Caregiver education = Higher education; Social risk = No; Familial obesity = None; Age modeled per 1-year increase. As a sensitivity analysis, we repeated the full model stratified by age [2–5, 6–11, 12–17 years]. Analyses were performed using SPSS v27 (IBM, Armonk, NY, USA).

Results

A total of 78 cases of childhood obesity and 326 controls were analyzed (Table 1). Children with obesity were significantly older than the controls (10.53±0.99 years vs. 7.57±0.52 years, P<0.001). The male-to-female distribution differed between the groups (P<0.01), with a higher proportion of females in the obesity group (60.26%) than in the control group (40.80%).

Table 1. Demographic and Socioeconomic Data of Study Participants

Participants' characteristics	Total (N=404)	Cases (N=78)	Controls (N=326)	P value
Age (years), mean ± SD	8.14±0.48	10.53±0.99	7.57±0.52	<0.001
Sex				
Male	224 (55.45%)	31 (39.74%)	193 (59.20%)	<0.01
Female	180 (44.55%)	47 (60.26%)	133 (40.80%)	
Comorbidities				
No	156 (38.61%)	21 (26.92%)	135 (41.41%)	0.02
Yes	248 (61.39%)	57 (73.08%)	191 (58.59%)	
Family structure				
Nuclear	301 (74.50%)	52 (66.67%)	249 (76.38%)	0.22
Extended	47 (11.63%)	9 (11.54%)	38 (11.66%)	
Single-parent	36 (8.91%)	11 (14.10%)	25 (7.67%)	
Reconstituted	20 (4.95%)	6 (7.69%)	14 (4.29%)	
Caregiver education level				
Higher education	100 (24.75%)	6 (7.69%)	94 (28.83%)	<0.001
Compulsory education	200 (49.50%)	39 (50.00%)	161 (49.39%)	
Below compulsory education	104 (25.74%)	33 (42.31%)	71 (21.78%)	
Illiterate	-	-	-	
Social risk				
No	373 (92.33%)	62 (79.49%)	311 (95.40%)	<0.001
Yes	31 (7.67%)	16 (20.51%)	15 (4.60%)	
Familial obesity				
No	340 (84.16%)	39 (50.00%)	301 (92.33%)	<0.001
One direct family member	46 (11.39%)	28 (35.90%)	18 (5.52%)	
Two or more direct family members	18 (4.46%)	11 (14.10%)	7 (2.15%)	

Continuous variables are expressed as mean ± SD; categorical variables are N (%) using column percentages. P values are two-sided (t test for age; χ^2 or Fisher's exact for categorical variables, as appropriate). The "Illiterate" category had zero counts in both groups and was excluded from χ^2 testing (shown for completeness). SD=Standard deviation.

Comorbidities in Obese and Non-Obese Children

Children with obesity exhibited a significantly higher prevalence of comorbidities than controls (73.08% vs. 58.28%, P=0.02). The most frequently reported conditions were respiratory diseases, including asthma and recurrent wheezing, which were more prevalent in the cases. Neurodevelopmental disorders, such as attention-deficit/hyperactivity disorder (ADHD) and learning disabilities, were similarly distributed between the groups. Endocrine disorders, including dyslipidemia and metabolic syndrome, were markedly more frequent among children with obesity, reinforcing the well-documented metabolic consequences of excess weight in pediatric populations.

Impact of Caregiver Education on Childhood Obesity

Caregiver education was a significant predictor of obesity in children (Table 2). Compared with children whose caregivers had higher education levels, those whose caregivers had only completed compulsory education had an odds ratio (AOR) of 3.64 (95% CI: 1.31-10.13, P=0.01). Children whose caregivers had below compulsory education had an even higher AOR of 4.76 (95% CI: 1.64-13.85, P<0.01). These findings support previous evidence that lower caregiver education is associated with reduced nutritional knowledge, lower health literacy, and limited access to healthcare resources. Table 2 reports crude odds ratios from univariable analyses and adjusted odds ratios from models controlling for age and sex.

Table 2. Logistic Regression Analyses for Childhood Obesity (Crude and Age/Sex-Adjusted)

Variable	Categories	Univariate		Adjusted	
		COR (95% CI)	P value	AOR (95% CI)	P value
Age	-	1.13 (1.07-1.19)	<0.001	1.08 (1.01-1.15)	0.02
Sex	Female	Reference	-	Reference	-
	Male	0.46 (0.27-0.75)	<0.01	0.58 (0.32-1.05)	0.07
Family structure	Nuclear	Reference	-	Reference	-
	Extended	1.13 (0.52-2.49)	0.75	0.78 (0.29-2.09)	0.62
	Single-parent	2.11 (0.98-4.55)	0.06	1.28 (0.47-3.49)	0.63
	Reconstituted	2.21 (0.80-6.08)	0.13	1.21 (0.36-4.15)	0.76
Caregiver education level	Higher education	Reference	-	Reference	-
	Compulsory education	3.80 (1.55-9.30)	<0.05	3.65 (1.31-10.13)	0.01
	Below compulsory education	7.28 (2.89-18.32)	<0.001	4.76 (1.64-13.85)	<0.01
Social risk	No	Reference	-	Reference	-
	Yes	5.35 (2.51-11.39)	<0.001	2.63 (0.97-7.09)	0.06
Familial obesity	No	Reference	-	Reference	-
	One direct family member	12.01 (6.09-23.69)	<0.001	8.04 (2.73-23.65)	<0.001
	Two or more direct family members	12.13 (4.44-33.12)	<0.001	9.74 (4.63-20.49)	<0.001
Interaction term	Lower caregiver education × social risk	-	-	4.03 (1.50-10.80)	<0.05

COR=Crude odds ratio from univariable models; AOR=Age- and sex-adjusted odds ratio from separate models that include the listed predictor + age (continuous, per 1-year) + sex; Interaction term (caregiver education ≤ compulsory vs higher × social risk yes/no) was estimated in a model including age, sex, caregiver education, social risk, and their product; P values are two-sided; report exact values (use <0.001 when smaller); CI=confidence interval.

Influence of Social Risk on Obesity Prevalence

Social risk, defined by factors such as economic hardship and food insecurity, was associated with obesity, although the adjusted model showed marginal significance (AOR=2.63, 95% CI: 0.97-7.09, P=0.06). Despite not reaching statistical significance in the adjusted analysis, the univariate analysis showed a strong association (COR=5.35, 95% CI: 2.51-11.39, P<0.001), reinforcing the role of socioeconomic disparities in the prevalence of obesity (Table 2). These findings align with prior research showing that financial constraints may limit access to fresh foods and promote reliance on calorie-dense processed foods (8, 9).

Effect of Family Structure on Obesity

Family structure did not show a statistically significant effect on childhood obesity after adjusting for confounders (P>0.05) (4). Although previous studies suggest that children from single-parent households may be at higher risk due to time constraints affecting meal preparation and supervision of physical activity, no significant association was found in the present analysis (Table 2).

Role of Familial Obesity

Familial obesity was the strongest predictor of obesity in children (Table 2) (10). Children with one direct relative with obesity had an AOR of 8.04 (95% CI: 2.73-23.65, P<0.001), while those with two or more direct relatives with obesity had an even higher AOR of 9.74 (95% CI: 4.63-20.49, P<0.001) (10). These results reinforce the impact of genetic predisposition and shared environmental factors on the risk of obesity (10).

Multivariable Analysis and Interaction Effects

After adjusting for multiple variables, caregiver education and familial obesity remained significant predictors of childhood obesity, whereas family structure and social risk were not statistically significant in the adjusted model. Interaction analysis indicated that children from low-education households with high social risk had a high likelihood of obesity (AOR: 4.03, 95% CI: 1.50-10.80, P<0.05), suggesting a compounded effect of socioeconomic disadvantage. The final multivariable model demonstrated good discrimination (AUC=0.832, 95% CI: 0.780–0.884, P<0.001) and adequate calibration (Hosmer–Lemeshow χ^2=7.95, df=8, P=0.44), indicating reliable model fit. Age-stratified sensitivity analyses (2–5, 6–11, and 12–17 years) confirmed the stability of the associations across developmental stages. Familial obesity remained the strongest determinant across all age groups, whereas lower caregiver education showed increasing effects with age. Social risk and family structure retained similar directions but did not achieve statistical significance. The full stratum-specific results are presented in Supplementary Table S1.

Discussion

This study reinforces the profound impact of social determinants on childhood obesity, aligning with the existing literature while highlighting critical intervention points. Caregiver education and familial obesity emerged as the most influential factors, with children from families with lower educational attainment or a history of obesity facing significantly higher risks. While social risk factors were strongly associated with obesity in the univariate model, their influence was reduced in the adjusted analysis, suggesting that they may operate through intermediary pathways. The absence of a significant association between family structure and obesity aligns with some prior studies but contrasts with research indicating an increased risk among children from single-parent households (4). These findings underscore the need for targeted, multi-level public health interventions.

Supplementary Table. Age-Stratified Multivariable Logistic Regression Models for Determinants of Childhood Obesity

Variable	Categories	AOR (95% CI)	P-value	AOR (95% CI)	P-value	AOR (95% CI)	P-value
		Ages 2–5 years (N=158)		Ages 6–11 years (N=135)		Ages 12–17 years (N=111)	
Caregiver education	Higher	Reference	-	Reference	-	Reference	-
	Compulsory	2.42 (0.44–13.29)	0.31	7.85 (1.10–55.87)	0.04	8.38 (0.70–100.55)	0.09
	Below compulsory	3.05 (0.47–19.70)	0.24	5.97 (0.74–47.97)	0.09	20.25 (1.48–277.61)	0.02
Social risk	No	Reference	-	Reference	-	Reference	-
	Yes	4.66 (0.60–36.15)	0.14	1.69 (0.25–11.26)	0.59	1.04 (0.20–5.42)	0.96
Family structure	Nuclear	Reference	-	Reference	-	Reference	-
	Single-parent	NE*	NE*	0.33 (0.02–4.61)	0.41	4.29 (1.04–17.75)	<0.05
	Extended	0.20 (0.01–3.33)	0.26	0.61 (0.09–4.15)	0.61	1.91 (0.32–11.30)	0.48
	Reconstituted	NE*	NE*	1.54 (0.23–10.15)	0.66	1.73 (0.23–13.29)	0.60
Familial obesity	No	Reference	-	Reference	-	Reference	-
	One affected relative	4.90 (0.94–25.37)	0.06	61.17 (9.36–399.83)	<0.001	9.76 (2.65–36.01)	<0.001
	≥Two affected relatives	20.39 (1.48–280.85)	0.02	10.59 (1.69–66.19)	0.01	5.52 (1.01–30.09)	<0.05
Sex	Female	Reference	-	Reference	-	Reference	-
	Male	0.34 (0.09–1.26)	0.11	0.72 (0.24–2.15)	0.56	0.64 (0.23–1.79)	0.40
Model fit†	-	AUC=0.83; Hosmer–Lemeshow P=0.95	-	AUC=0.86; Hosmer–Lemeshow P=0.57	-	AUC=0.75; Hosmer–Lemeshow P=0.79	-

Within each age stratum, models adjust for caregiver education, family structure, social risk, familial obesity, and sex (age omitted within stratum). *Not estimable because of sparse cells or quasi-complete separation (estimate unstable/non-convergent); category retained for transparency (see Table 1 for counts). †AUC and Hosmer–Lemeshow P are reported for model performance; AOR=Adjusted odds ratio; CI=Confidence interval.

Education and Economic Hardship: The Double Burden on Childhood Obesity

Lower caregiver education levels and economic hardship significantly increased the risk of childhood obesity, consistent with previous studies linking these factors to reduced nutritional knowledge, limited healthcare access, and higher reliance on processed foods (8, 9, 11). Children with caregivers who had not completed compulsory education exhibited nearly five times the risk of obesity compared to those from higher-education households (AOR=4.76, 95% CI: 1.64-13.85, P<0.01). Similarly, food insecurity and financial constraints shape access to nutritious food and opportunities for physical activity, thereby exacerbating the risk of obesity (8). Although social risk factors were strongly associated with obesity in the univariate analyses, their influence diminished after adjusting for confounders (AOR=2.63, 95% CI: 0.97-7.09, P=0.06). This suggests that, although social risk may not act as a direct predictor, it is a key contextual factor in shaping childhood obesity outcomes (3). The education × social-risk interaction suggests compounded vulnerability when structural and educational disadvantages co-occur, mirroring the mechanisms seen in complex social determinant frameworks.

Given the robust association observed in the unadjusted models, further research should explore how financial constraints contribute to unhealthy dietary habits and stress-related eating behaviors (12). Policymakers should integrate economic support measures, such as food subsidies, school meal programs, and community-based nutrition initiatives, into obesity prevention strategies to reduce socioeconomic disparities in childhood obesity.

Rethinking Family Structure: A Lesser Role in Obesity Risk?

In contrast to some prior studies, family structure did not independently predict childhood obesity in the adjusted models (4). Children from single-parent households had higher obesity odds in the univariate analysis; however, this association lost statistical significance in the final model (AOR=1.28, 95% CI: 0.47-3.49, P=0.63). This suggests that broader socioeconomic variables, such as income stability and caregiver education, may have a stronger influence on the risk of obesity than household composition alone. Future research should explore how parenting dynamics, meal patterns, and home environments interact with obesity risk, rather than focusing solely on family structure as a risk factor (13).

The Family Factor: How Genetics and Environment Converge on Obesity

Familial obesity remained the strongest predictor of childhood obesity in both the univariate and adjusted analyses. Children with one obese relative had an eight-fold increased risk of obesity, while those with two or more obese relatives had nearly a ten-fold increase (AOR=9.74, 95% CI: 4.63-20.49, P<0.001) (10). These findings reaffirm the complex interplay between genetic susceptibility and shared environmental influences. Given the significance of familial obesity, prevention strategies should prioritize family-wide interventions that encourage healthier behaviors across generations (14). Evidence suggests that structured, multi-generational lifestyle programs are among the most effective in reducing obesity risk (15).

From Research to Action: Public Health Strategies for Obesity Prevention

The findings of this study emphasize the necessity of multifaceted interventions that address both the individual and structural determinants of childhood obesity. Policymakers should prioritize initiatives aimed at reducing socioeconomic disparities, enhancing access to affordable and nutritious foods, and integrating comprehensive health education into early childhood development programs. Given the strong influence of familial obesity, interventions should adopt a family-centered approach rather than focusing solely on the child (14). Additionally, community-driven initiatives that promote physical activity and provide nutritional support can help mitigate the rising obesity epidemic among at-risk populations (3).

Beyond population-level strategies, these findings also highlight opportunities for family-centered interventions within pediatric and primary care settings. Given the strong familial clustering of obesity, programs that actively engage caregivers—biological or adoptive—and siblings in shared behavior change are likely to yield greater and more sustainable results. Integrating parental health literacy counseling, practical nutrition and activity guidance, and psychosocial support for families facing socioeconomic adversity can translate research evidence into everyday practice. Partnerships between healthcare teams, schools, and community organizations should prioritize coordinated education and empowerment of entire households, addressing both knowledge gaps and the social constraints that shape children's health behaviors.

While the association between socioeconomic status and childhood obesity has been widely studied, this study adds to the literature by using a case-control design in a Southern European hospital setting and integrating caregiver education, social risk, family structure, and familial obesity into a single multivariable model. The identification of a compounded effect between low caregiver education and social risk offers novel insights into the structural dynamics of obesity risk in this context.

Limitations and Future Research: Filling the Gaps

While this study offers valuable insights into the social determinants of childhood obesity, several limitations must be acknowledged. First, reliance

on hospital inpatient data may introduce selection bias, as the study population may not fully reflect the general pediatric population. Additionally, because controls were selected agnostically with respect to admission diagnosis, we cannot exclude associations between exposures (caregiver education, social risk) and control diagnoses; this could bias effect estimates, although our inclusive strategy reduces bias from restricting to specific conditions. Second, behavioral factors (screen time, physical activity, and dietary habits) were not comprehensively captured; conceptually, these lie on the causal pathway from socioeconomic exposures to obesity and thus function as mediators rather than confounders. Therefore, their omission is unlikely to constitute residual confounding in our models. Data on children's and caregivers' mental health were also incomplete and therefore excluded from multivariable models. Although psychological factors may influence eating behaviors and access to food, they were beyond the scope of this retrospective analysis. In contrast, family income, parental employment status, parental BMI, and parental age—plausible confounders likely associated with both exposures and obesity—were unavailable and may have introduced residual confounding. Ethnicity/ancestry data were also unavailable; given the catchment's >95% Caucasian profile, material confounding by ethnicity is unlikely. Although the analysis adjusted for age as a continuous variable, the broad age range of 2 to 17 years encompasses distinct developmental stages. Future research may benefit from stratifying by age group to better capture stage-specific obesity risk patterns. Longitudinal studies tracking obesity trajectories from childhood to adulthood would further illuminate the long-term effects of socioeconomic determinants on weight status (16). Additionally, qualitative research exploring parental perspectives on obesity-related barriers and motivators could enhance the effectiveness of public health interventions aimed at preventing obesity in early life (13).

Conclusion

This study underscores the powerful influence of caregiver education and familial obesity on childhood obesity, while also recognizing the intricate role of social risk factors. Addressing these determinants through targeted interventions, such as parental health literacy programs, economic assistance for at-risk families, and structured family-wide lifestyle modifications may significantly contribute to obesity prevention. Given the multifactorial nature of obesity, a broad public health approach that integrates school-based initiatives, regulatory policy changes, and community outreach programs is crucial for achieving sustainable reductions in childhood obesity rates (14). By adopting multi-sectoral strategies, policymakers can ensure equitable health opportunities and foster long-term well-being for children vulnerable to obesity.

What Is Already Known on This Topic:

Childhood obesity is a multifactorial condition that is strongly associated with socioeconomic disparities and familial factors. Lower caregiver education levels, social vulnerabilities, and household dynamics influence children's dietary habits and access to healthy environments. Familial obesity is a recognized risk factor that reflects the combined influence of genetic predisposition and shared lifestyle behaviors.

What This Study Adds:

This case–control study identified caregiver education and familial obesity as the strongest predictors of childhood obesity, whereas social risk showed a weaker association that attenuated after adjustment and did not reach statistical significance. Considering these factors jointly, the co-occurrence of low caregiver education and social risk was associated with higher odds of obesity than either factor alone. These findings underscore the importance of targeted, family-centered interventions and socioeconomic support strategies to reduce childhood obesity.

Acknowledgments: The authors would like to express their sincere gratitude to the Pediatrics and Neonatology Department of the Local Health Unit Entre Douro e Vouga for their invaluable support throughout this study. Their guidance, collaboration, and dedication to pediatric research were instrumental in completing this study.

Authors' Contributions: Conception and design: TST and HND; Acquisition, analysis, and interpretation of data: TST, HND and TMB; Drafting the article: TST, HND and TMB; Revising it critically for important intellectual content: JVS, BBA and MC; Approved final version of the manuscript: All authors.

Conflict of Interest: The authors declare that they have no conflict of interest.

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