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Multivariate analysis of associated factors for overweight and obesity in children and adolescents – a cross-sectional study

Analiza wielokierunkowa czynników towarzyszących nadwadze i otyłości u dzieci i młodzieży – badanie przekrojowe

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Abstract

Introduction and Objective. Overweight and obesity in children and adolescents has been one of the major health and social challenges worldwide for several decades. Obesity is a multifactorial disease in which the risk factors may appear with various severity and combinations. The aim of the study was to identify associated factors for childhood obesity and conduct a multivariate analysis.

Materials and method. The study included a group of 268 schoolchildren and adolescents. The children were assigned to one of two groups: study group – children with overweight and obese, and control group – children with normal weight. Data were collected using questionnaires related to prenatal, biological, environmental, behavioural, and nutritional risk factors for obesity.

Results. Of the examined factors, six proved to be significantly associated with the risk of developing childhood overweight or obesity: gender (<0.05), maternal pre-pregnancy BMI (p < 0.001), maternal BMI (<0.001), lower socio-economic status (SES) (p <0.05), waking time at weekends (p <0.05), and snacking between meals (p <0.05). The results of the multivariate analysis indicate that the chance of a child being overweight or obese was over 6.5 twice as likely if the mother was overweight or obese (OR = 6.564; p <0.001). Male children were approximately twice more likely to become obese or overweight than female children (OR = 2.199; < 0.05). The risk of excess weight was 2.5 times higher in children who ate between meals than in the rest of the group (OR = 2.514; p < 0.05).

Conclusions. Factors related to the mother, and not both parents, have a stronger impact on the development of overweight and obesity in children. Women`s excess body weight at pre-pregnancy is the most significant factor influencing the child`s future high body weight.

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Key words

risk factors, associated factors, multivariate analysis, childhood obesity, childhood overweight

Streszczenie

Wprowadzenie i cel pracy. Nadwaga i otyłość u dzieci i młodzieży od kilkudziesięciu lat stanowi jedno z głównych wyzwań zdrowotnych i społecznych na całym świecie. Otyłość jest chorobą o podłożu wieloczynnikowym, w której czynniki ryzyka mogą występować w różnym nasileniu i w różnych kombinacjach. Celem naszego badania było zidentyfikowanie czynników powiązanych z otyłością wieku dziecięcego i przeprowadzenie analizy wieloczynnikowej.

Materiał i metody. Badaniem objęto grupę 268 dzieci i młodzieży. Dzieci przydzielono do jednej z dwóch grup: badanej – dzieci z nadwagą i otyłością – oraz kontrolnej – dzieci z prawidłową masą ciała. Dane zebrano za pomocą autorskich kwestionariuszy uwzględniających prenatalne, biologiczne, środowiskowe, behawioralne i żywieniowe czynniki ryzyka rozwoju otyłości.

Wyniki. Sześć spośród badanych czynników okazało się istotnie powiązanych z ryzykiem rozwoju nadwagi lub otyłości u dzieci: płeć męska ($p < 0,05$), wysokie BMI matki przed ciążą ($p < 0,001$), wysokie BMI matki ($p < 0,001$), niski status społeczno-ekonomiczny rodziny (SES) ($p < 0,05$), pora pobudki dziecka w weekendy ($p < 0,05$), podjadanie między posiłkami. Wyniki analizy wieloczynnikowej wskazują, że prawdopodobieństwo wystąpienia nadwagi lub otyłości u dziecka było ponad 6,5 raza większe, jeśli matka miała nadwagę lub otyłość (OR = 6,564; $p < 0,001$). Chłopcy byli około dwa razy bardziej narażeni na rozwój otyłości niż dziewczynki (OR = 2,199, $p < 0,05$). Ryzyko nadwagi było 2,5 raza większe u dzieci, które podjadały między posiłkami niż w pozostałej grupie (OR = 2,514, $p < 0,05$).

Wnioski. Większy wpływ na rozwój nadwagi i otyłości u dzieci mają czynniki związane z matką, a nie z obojgiem rodziców. Nadmierna masa ciała kobiet przed ciążą jest najważniejszym

czynnikiem wpływającym na nadmierną masę ciała dziecka w przyszłości.

Słowa kluczowe
czynniki ryzyka, czynniki towarzyszące, analiza wieloczynnikowa, otyłość u dzieci, nadwaga u dzieci

INTRODUCTION

Overweight and obesity in children and adolescents has been one of the major health and social challenges worldwide for several decades. Over the past three decades, the number of children with excess body weight has systematically increased in most countries, reaching the size of a global epidemic, and affecting an increasingly younger part of society [1]. Recent estimates indicate that above 38 million (5.6%) children under the age of 5 years, and more than 330 million children and adolescents aged 5–19 years were overweight or obese [2]. Poland is characterized by one of the highest percentages of children with excessive body weight in Europe. The World Health Organization European Childhood Obesity Surveillance Initiative (COSI) report indicates that Poland ranks 8th out of 33 countries participating in the study [3].

Obese children and adolescents are 5 times more likely to become obese in adulthood. It is estimated that about 55% of children who develop obesity will remain obese until adolescence, and about 80% of obese adolescents will still be obese into adulthood[4].

Obese children have a higher risk of health consequences such as hypertension, dyslipidaemia, glucose intolerance, non-alcoholic fatty liver disease, asthma or depression [5]. Childhood obesity increases the risk of morbidity and mortality in adulthood from such diseases as diabetes type 2, cardiovascular disease and certain cancers [6].

There are many risk factors for the development obesity, among which the following have been studied: prenatal risk factor – maternal pre-pregnancy Body Mass Index (BMI), gestational weight gain (GWG) [7], biological factors – birth weight, premature delivery, rapid growth, adiposity rebound [8], environmental factors – origin, family income, parents' education and employment, school and home environment [9, 10], nutritional factors – breastfeeding duration, way of introduction of complementary feeding, parental eating habits, energy and nutritional density of the diet, snacking [11, 12], behavioural factors – physical activity, sedentary lifestyle, short sleep time and low sleep quality, screen time [13] and genetic factors [14].

The aim of the study was to identify associated factors for childhood and adolescent obesity.

MATERIALS AND METHOD

Research design and ethics. The study included a group of 268 children and adolescents (143 girls and 125 boys) aged 7–18 (12 ± 3.31) and carried out in 2016–2018. The study was_conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Medical University in Lodz (No. RNN/366/17/KE, dated 16 November 2015), and by the Ethics Committee of Polish Mother's Memorial Hospital Research Institute (No. 110/2015, dated 8 December 2015).

The children were enrolled for the study from among patients hospitalized at the Paediatrics, Immunology and Nephrology Department. Children and adolescents were hospitalized for reasons other than obesity, underweight, malnutrition or stunting. The study excluded children with:

- chronic diseases that may affect growth (such as: Growth hormone deficiency, Celiac disease, Intestinal malabsorption syndrome);
- diseases that may be the cause of secondary obesity such as:
  - endocrine causes (e.g., Hypothyroidism, Cushing disease, Polycystic ovaries, Hypogonadism, Pseudohypoparathyroidism);
  - genetic causes: (e.g., POMC deficiency, Prader-Willi syndrome, Beckwith-Wiedemann syndrome).

Anthropometric measurements (body weight, height and body tissue composition) were performed. Height was measured using a SECA 213L stadiometer. The TANITA DC 430 MA S composition analyser was used to measure body weight and to analyse body tissue composition. The obtained results were related to the norms of body fat content in children [15]. All children included in the study group had body fat content above the norm for age and gender [15]. Based on the body weight and height, BMI was calculated and plotted on a gender-specific percentile grid. The current developmental standards for the Polish population were used in the study, prepared on the OLA and OLAF [16].

The children were assigned to one of two groups:

1) study group 1 (N=189) – children with overweight and obese;
2) control group (N=79) – children with normal weight (Tab. 1).

Table 1. Basic characteristics of the studied groups

Variable	Parameter	Total (N=268)	Study group (N=189)	Control group (N=79)	p-value
Gender	Girls	53.4% (N=143)	47.1% (N=89)	68.4% (N=54)	**0.0023**
	Boys	46.6% (N=125)	52.9% (N=100)	31.6% (N=25)	
Age [years]	SD	12.2 ± 3.31	12.25 ± 3.25	12.08±3.47	0.6
Body fat [kg]	SD	18.78 ± 11.41	23.32 ± 10.44	8.02 ± 4.03	**<0.001**

Data collection and quality control. The data about patients and family was obtained using proprietary questionnaires. The questionnaires were collected personally by members of the research team who verified the understanding of the questions by the parents or guardians of the children on an ongoing basis. The studied risk factors were divided into prenatal and biological, environmental, behavioural, and nutritional factors.

Gestational weight gain (GWG) were defined as the amount of weight gained between conception and just before the birth of the infant. GWG was interpreted according to the guidelines of the Institute of Medicine (2009). GWG should be between 12.5–18.0 kg in underweight mothers, 11.5–16.0 in mothers with normal weight, 7.0–11.5 kg in

overweight mothers and 5.0–9.0 kg in obese mothers [17]. Information relating to the family economic situation was collected according to the subjective assessment of the child's parents or guardians. For a more precise analysis of sleep quality based on the given wakeup time and sleep onset time the sleep duration was calculated. Weekday sleep time was calculated thus:

(weekday sleep times × 5 + weekend sleep times × 2)/7.

Sleep time was analysed to the standards of the American Academy of Sleep Medicine, according to which, for optimal health, children aged 6–12 should sleep regularly for 9–12 hours a day, while adolescents aged 13–18 should regularly sleep 8–10 hours a day [18].

Statistical analysis. Percentage distribution was used to create descriptive characteristics of categorical variables. The chi-squared test or the Fisher test was used to compare groups and test the statistical significance of the relationships between two categorical variables. P values<0.05 were considered statistically significant. The Mann-Whitney U test was used to compare distributions of numerical variables between 2 groups.

The logistic model was obtained by applying the backward stepwise elimination based on the Akaiki criterion, taking into account, as predictors of overweight or obesity, all the variables for which significant results were obtained in terms of their relationship with the dependent variable in the univariate analysis.

All calculations were made with the R version 3.5 package.

RESULTS

Identification of significant risk factors. From the 34 examined factors, 6 of them: children's gender (p<0.05), maternal pre-pregnancy BMI (p< 0.001), maternal BMI (p<0.001), lower socio-economic status (SES) (p<0.05), waking time at weekends (p< 0.05) and snacking between meals (p<0.05), proved to be significantly associated with the risk of developing childhood overweight or obesity.

The study group was dominated by boys (52.9%) and the difference between the groups was statistically significant (52.9% vs. 31.6%; p < 0.05). All children included in the study group had body fat content above the norm for age and gender. The average content of adipose tissue in the study group significantly differed from the average in children without overweight or obesity (23.2 kg vs. 8.02 kg; p < 0.001).

Prenatal and biological factors. In the group of prenatal and biological factors, maternal pre-pregnancy overweight (p <0.001) was found to be an associated factor for the development of excess body weight in the child (Tab. 2). There were no differences in maternal weight gain during pregnancy.

Environmental factors. In the group of analysed environmental factors, significant differences between the groups were shown with regard to the current maternal BMI (p <0.0001) (Tab. 3). Mothers of children with excess body weight were more obese than mothers of children with normal body weight. No such relationship was found for paternal BMI.

Table 2. Identification of potential prenatal and biological associated factors for overweight or obesity in children and adolescents

Variable	Parameter	Total (N = 268)	Study group (N=189)	Control group (N =79)	p-value
Maternal pre-pregnancy BMI	Underweight	3.4% (N=9)	2.2% (N=4)	6.5% (N=5)	**0.0002**
	Normal weight	67.2% (N=176)	61.1% (N=113)	81.8% (N=63)	
	Overweight	21.8% (N=57)	27.6% (N=51)	7.8% (N=6)	
	Obesity	7.6% (N=20)	9.2% (N=17)	3.9% (N=3)	
Gestational weight gain	Correct	39.6% (N=103)	37.7% (N=69)	44.2% (N=34)	0.4
	Incorrect	60.4% (N=157)	62.3% (N=114)	55.8% (N=43)	
Birth weight	<3rd percentile	11% (N=29)	10.3% (N=19)	12.7% (N=10)	0.4
	3rd – 15th percentile	6.8% (N=18)	6.5% (N=12)	7.6% (N=6)	
	15th – 50th percentile	31.8% (N=84)	29.2% (N=54)	38% (N=30)	
	50th-85th percentile	31.1% (N=82)	31.4% (N=58)	30.4% (N=24)	
	> 97th percentile	5.7% (N=15)	7% (N=13)	2.5% (N=2)	

Children with normal weight were more likely than children with overweight or obesity to come from families with a very good economic situation (p <0.05).

Behavioural factors. In terms of the analysed behavioural factors, statistically significant differences between the studied groups occurred in the distribution of waking time at weekends (p <0.05) (Tab. 4). Children with excess body weight got up earlier on weekends (p <0.05) but also went to sleep earlier (p = 0.05). However, it was not possible to precisely define the nature of this relationship.

Nutritional factors. Snacking between meals was more common in overweight and obese children (p <0.05), (Tab. 5). In both studied groups, the majority of children reported eating 4–5 meals a day and eating meals 'quite regularly'. However, analysis of responses to the regular consumption of individual meals showed that most (62.7%) children with normal weight consumed afternoon snacks regularly (p <0.05).

Multivariate analysis. The results of the multivariate analysis indicate that the chance of a child being overweight or obese was over 6.5 times higher if the mother was overweight or obese (OR = 6.564; p <0.001). Male children were approximately twice as likely to become obese or overweight than female children (OR = 2.199; <0.05). The risk of excess weight was 2.5 times higher in children who ate between meals than in the rest of the group (OR = 2.514; p <0.05) (table 6).

The model did not include the variable corresponding to the SES as it could not be accurately interpreted. The values within the norm were adopted as the reference category of the mother's BMI before pregnancy. The current mother's BMI and the mother's pre-pregnancy BMI were not included in a single model due to the strong correlation between the 2 variables (chi-squared test; p <0.001).

Table 3. Identification of potential environmental associated factors for overweight or obesity in children and adolescents

Variable	Parameter	Total (N = 268)	Study group (N=189)	Control group (N=79)	p-value
Maternal BMI	Underweight	0.8% (N=2)	0.5% (N=1)	1.4% (N=1)	**0.0001**
	Normal weight	45.1% (N=116)	37% (N=68)	65.8% (N=48)	
	Overweight	31.1% (N=80)	33.7% (N=62)	24.7% (N=18)[a]	
	Class I obesity	15.6% (N=40)	20.1% (N=37)	4.1% (N=3)[b]	
	Class II obesity	5.8% (N=15)	6.5% (N=12)	4.1% (N=3)	
	Class III obesity	1.6% (N=4)	2.2% (N=4)	0.0% (N=0)	
Paternal BMI	Underweight	0.9% (N=2)	1.3% (N=2)	0.0% (N=0)	0.1
	Normal weight	14.5% (N=32)	11.5% (N=18)	22.2% (N=14)	
	Overweight	51.8% (N=114)	51% (N=80)	54% (N=34)	
	Class I obesity	22.7% (N=50)	24.8% (N=39)	17.5% (N=11)	
	Class II obesity	7.7% (N=17)	9.6% (N=15)	3.2% (N=2)	
	Class III obesity	2.3% (N=5)	1.9% (N=3)	3.2% (N=2)	
Family structure	Two-parent family	22.8% (N=61)	24.5% (N=46)	19% (N=15)	0.4
	One-parent household	77.2% (N=206)	75.5% (N=142)	81% (N=64)	
Maternal education	Primary	5.7% (N=15)	5.9% (N=11)	5.3%(N=4)	0.3
	Middle vocational	3.8% (N=10)	2.7% (N=5)	6.6% (N=5)	
	Secondary vocational	12.6% (N=33)	10.8% (N=20)	17.1% (N=13)	
	Secondary	36.3% (N=95)	38.2% (N=71)	31.6% (N=24)	
	Higher	41.6% (N=109)	42.5% (N=79)	39.5% (N=30)	
Paternal education	Primary	9% (N=21)	10.8% (N=18)	4.4%(N=3)	0.1
	Middle vocational	3.8% (N=9)	2.4% (N=4)	7.4%(N=5)	
	Secondary vocational	29.5% (N=69)	31.9% (N=53)	23.5% (N=16)	
	Secondary	31.6% (N=74)	31.9% (N=53)	30.9% (N=21)	
	Higher	26.1% (N=61)	22.9% (N=38)	33.8% (N=23)	
Maternal employment	Employed	74.5% (N=193)	74.9% (N=137)	73.7% (N=56)	0.8
	Not employed	24.7% (N=64)	24.6% (N=45)	25% (N=19)	
	No information	0.8% (N=2)	0.5% (N=1)	1.3% (N=1)	
Paternal employment	Employed	78.2% (N=201)	79.6% (N=144)	75% (N=57)	0.1
	Not employed	10.5% (N=27)	7.7% (N=14)	17.1% (N=13)	
	No information	11.3% (N=29)	12.7% (N=23)	7.9% (N=6)	
Family economic situation	very good	17.4% (N=46)	12.4% (N=23)	29.5% (N=23)	0.004
	good	80.3% (N=212)	84.9% (N=158)	69.2% (N=54)	
	bad	2.3% (N=6)	2.7% (N=5)	1.3%(N=1)	
	very bad	0.0% (N=0)	0.0% (N=0)	0.0% (N=0)	
Passive smoking: time spent in a closed space	never	84.1% (N=222)	82.4% (N=154)	88.3% (N=68)	0.8
	1–2 hours daily	10.6% (N=28)	11.8% (N=22)	7.8% (N=6)	
	3–5 hours daily	2.3% (N=6)	2.7% (N=5)	1.3% (N=1)	
	above 5 hours daily	3% (N=8)	3.2% (N=6)	2.6% (N=2)	

[a] maternal BMI overweight vs. normal weight p<0.01; [b] maternal BMI class I obesity vs. normal weight p<0.01; [c] father's economic situation very good vs. good p<0.01

DISCUSSION

A multivariate analysis was carried out in the current study which included a wide range of prenatal, biological, environmental, behavioural and nutritional factors associated the development of obesity. Male gender, maternal pre-pregnancy BMI, maternal BMI, lower socio-economic status, waking time at weekends and snacking between meals, proved to be significantly associated with the risk of developing childhood overweight or obesity. These findings indicate that among the analyzed factors, those related to the mother programmed the child's future body weight to the greatest extent. This emphasizes the role of prenatal factors and nutritional education of women planning pregnancy. Other factors that have been found to be important are sleep-related factors that are modifiable and are a significant part of lifestyle modification treatment. The results also indicate that factors related to economic status and gender are associated with the development of obesity.

The underlying causes of obesity development have been of interest for many years, but no clear answer currently exists. This is mainly due to the complexity of its multifactorial etiology, comprising, *inter alia*, factors influencing the prenatal period, individual biological features

Table 4. Identification of potential behavioural risk factors for overweight or obesity in children and adolescents

Variable	Parameter	Total (N = 268)	Study group (N=189)	Control group (N=79)	p-value
Waking time on school days	Median (IQR)	7:00 (6:30–7:30)	7:00 (6:30–7:30)	7:00 (6:30–7:15)	0.5
	Range	5:00–10:00	5:00–10:00	5:30–9:30	
Waking time on weekends	Median (IQR)	9:00 (8:00–10:00)	9:00 (8:00–10:00)	9:00 (8:30–9:45)	0.0379
	Range	6:30–11:00	6:30–10:30	7:00–11:00	
Sleep onset time on school days	Median (IQR)	22:00 (21:30–23:00)	22:00 (21:30–22:30)	22:00 (21:00–23:00)	0.7
	Range	19:00–01:30	19:00–01:30	20:30–00:30	
Sleep onset time on weekends	Median (IQR)	23:00 (22:00–23:15)	22:30 (22:00–23:00)	23:00 (22:00–23:30)	0.1
	Range	19:00–01:30	19:00–01:30	20:30–00:30	
Sleep duration according to standards	normal for age	82.5% (N=221)	83.1% (N=157)	81% (N=64)	0.8
	<age norms	17.5% (N=47)	16.9% (N=32)	19% (N=15)	
Time spent sitting per day	<4 hours	41.9% (N=109)	42.6% (N=78)	40.3% (N=31)	0.8
	> 4 hours	58.1% (N=151)	57.4% (N=105)	59.7%(N=46)	
Physical education classes	Yes	92.6% (N=239)	94.6% (N=174)	87.8% (N=65)	0.1
	No	7.4% (N=19)	5.4% (N=10)	12.2% (N=9)	
Extra-sports activities	Yes	60.2% (N=157)	58.9% (N=109)	63.2% (N=48)	0.6
	No	39.8% (N=104)	41.1% (N=76)	36.8% (N=28)	
Weekly physical activity hours	<6 hours	55.1% (N=147)	55.9% (N=105)	53.2% (N=42)	0.8
	> 6 hours	44.9% (N=120)	44.1% (N=83)	46.8% (N=37)	

Table 5. Identification of potential nutritional risk factors for overweight or obesity in children and adolescents

Variable	Parameter	Total (N = 268)	Study group (N=189)	Control group (N =79)	p-value
Eating 4–5 meals per day	Yes	54.7%(N=145)	51.1% (N=95)	63.3% (N=50)	0.1
	No	45.3% (N=120)	48.9% (N=91)	36.7% (N=29)	
Regular consumption of					
meals	Very regular	2.7% (N=7)	2.2% (N=4)	3.8% (N=3)	0.5
	Quite regular	72.5%(N=187)	70.9%(N=127)	75.9% (N=60)	
	Irregular	21.7% (N=56)	22.9% (N=41)	19% (N=15)	
	Very irregular	3.1% (N=8)	3.9% (N=7)	1.3% (N=1)	
breakfast	Yes	80.3%(N=208)	79.9% (N=147)	81.3% (N=61)	0.9
second breakfast	Yes	61.1% (N=151)	59.9% (N=106)	64.3% (N=45)	0.6
dinner	Yes	83.9% (N=213)	84.2% (N=154)	83.1% (N=59)	1.0
afternoon snacks	Yes	51.5% (N=123)	47.1% (N=81)	62.7% (N=42)	0.0431
supper	Yes	84.3% (N=204)	86.5% (N=148)	78.9% (N=56)	0.2
Number of meals per day while watching TV	0 meals	28.5% (N=75)	23.9% (N=44)	39.2% (N=31)	0.07
	1 meal	25.1% (N=66)	24.5% (N=45)	26.6% (N=21)	
	2–3 meals	41% (N=108)	45.1% (N=83)	31.7% (N=25)	
	All meals	5.3% (N=14)	6.5% (N=12)	2.5% (N=2)	
Snacking	Yes	85.3% (N=215)	89.4% (N=160)	75.3% (N=55)	0.0078
Eating vegetables	At least 2 times	62.9% (N=151)	65.5% (N=108)	57.3% (N=43)	1.0
	Once a day	27.9% (N=67)	25.5% (N=42)	33.3% (N=25)	
	No vegetables	9.2% (N=22)	9.1% (N=15)	9.3% (N=7)	
Eating sweets	Yes	93.8% (N=241)	95% (N=171)	90.9% (N=70)	0.3
Amount of fluid consumed during the day	0,5–1l	18% (N=46)	17.3% (N=31)	19.7% (N=15)	0.8
	1–1,5l	36.1% (N=92)	37.4% (N=67)	32.9% (N=25)	
	> 1,5l	45.9% (N=117)	45.3% (N=81)	47.4% (N=36)	

Table 6. Logistic model explaining the chances of a child becoming overweight or obese

Parameter	Odd Ratio (OR)	2,5%	97,5%	p-value
Male sex	2.199	1.203	4.106	0.012
Maternal pre-pregnancy BMI: underweight	0.585	0.136	2.373	0.4
Maternal pre-pregnancy BMI: overweight or obese	6.564	2.836	18.003	<0.001
Snacking	2.514	1.127	5.639	0.024

and environmental factors [19]. Moreover, the impact of any associated factor in an individual assessment may not have a significant effect in multivariate analysis.

The results of the current study emphasize the significant role of prenatal factors, especially the impact of maternal pre-pregnancy overweight in the development of obesity in children, and the metabolic programming of future offspring. These observations coincide with other studies carried out thus far [20]. Voerman et al. came to similar conclusions in a meta-analysis conducted on the influence of maternal pre-pregnancy BMI. GWG above the standards of the Institute of Medicine only slightly increased the risk of overweight and obesity in childhood [21]. The results of these studies correspond with the current findings in which GWG did not significantly affect the risk of developing obesity in a child.

Only the current BMI of the mother and not of the father was associated with obesity in the child, which was also strongly correlated with the mother's obesity before pregnancy, which emphasizes the presence of abnormal body weight in the long-term and the lack of measures aimed at weight loss. Other studies provide similar conclusions [22, 23].

Among the environmental factors analyzed in this study, lower SES was also associated with a higher risk of obesity, which is confirmed by studies conducted by Rogers et al. [24].

In the development of obesity, factors related to the child's behaviour, including physical activity, diet and sleep, are also very important. In the presented study, the differences between the study groups ($p<0.001$) occurred in the distribution of waking time at weekends, but no differences were found between the groups regarding sleep duration. In recent years, researchers have emphasized the role of sleep in the pathogenesis of obesity. It has been suggested that insufficient sleep can lead to obesity by activating a hormonal response leading to an increase in appetite and overall caloric intake [25]. Studies by Li, Zhang et al. conducted on a group of children and adolescents show that a short sleep time may increase the risk of obesity, but the protective effect of long sleep on the development of excessive body weight has not been confirmed [26]. Skjåkødegård et al. reported that there were no significant differences in sleep duration in a group of children and adolescents with normal and excess body weight, but a later time of falling asleep was associated with obesity-promoting behaviours, such as a longer 'screen time' [27]. Both the impact of sleep duration and detailed parameters concerning its quality on the risk of childhood obesity require further extensive research.

Within the analysed nutritional factors, it was observed that obese children were significantly more likely to skip an afternoon snack, despite the fact that the groups did not differ in the declared regularity of meals. This observation may be due to the fact that dietary data was collected from questionnaires rather than from daily food diaries that track the distribution of meals more closely. This relationship may suggest that obese children actually eat less regularly than children with normal body weight. The relationship between skipping meals and an increased risk of obesity has been observed in other studies [28, 29]. The current analysis of nutritional factors showed a significant impact of snacking on the risk of developing obesity. These results are consistent with observations from other studies in which snacking involved particularly high-energy foods, such as sweets, fried foods, salty and spicy snacks [30].

The current study, despite the multifactorial dimension and the wide range of factors studied, has several limitations. The cross-sectional nature of the study prevented a more complete analysis of the long-term impact of the studied factors on the development of obesity. In addition, the collection of data on sleep and diet was reported by parents using a questionnaire, which may have resulted in inaccurate data.

The results of this study may improve the effective identification of children at risk. This, in turn, enables the early introduction of preventive measures and prevents the development of short- and long-term obesity complications, which generate significant costs associated with their treatment. In addition, the identification of associated factors for obesity allows for the development of more effective treatment regimens. The conducted research may constitute a starting point for further longitudinal research assessing obesity risk factors in children and adolescents.

CONCLUSIONS

The influence on the future child`s weight occurs already during the pre-pregnancy and the intrauterine development of the child. The excess body weight of women during pre-pregnancy is a verysignificant risk factor influencing the child`s future body weight. Factors related to the mother, and not both parents, have a stronger impact on the development of overweight and obesity in children.

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