The prevalence of obesity of children (aged 13-15) and the significance of selected obesity risk factors

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Abstract

Introduction: Childhood obesity has become a global epidemic. The aim of the study was to assess obesity prevalence in a group of children aged 13-15 in the urban and rural environment of the Lodz region and to establish the influence of selected obesity risk factors.
Material and methods: The study involved 1012 children, aged 13-15, and was performed in two secondary schools located in the city and two in the country. In each case, body height and weight were measured and BMI was calculated; also the perinatal data, the duration of breastfeeding, and the prevalence of obesity and type 2 diabetes within children's families were recorded.
Results: The prevalence of obesity in the studied population was 18.1%, being higher in the urban population than in the rural one. The prevalence of obesity of the relatives of obese children was higher (43.7%) than that of children with normal body weight (26.7%). No correlation was found between current BMI and birth weight; however, hypotrophy was more frequently observed among obese children from the rural environment. No significant differences were found between the duration of breastfeeding of obese and slim children.
Conclusions: The prevalence of obesity in the age group 13-15 is 18.1% and it is higher in the urban population than in the rural one. Obesity history in the child's family is an important risk factor of childhood obesity. No correlations between current BMI and birth weight or the duration of breastfeeding in this age group were observed.

Key words: obesity, children, risk factors.

Introduction

Overweight and obesity have become a global epidemic and are increasing rapidly in both age groups of childhood and adolescence [1-3]. The risk factors for obesity include: birth weight, physical activity, dietary factors, parental fatness as well as social and environmental factors. Prevention of obesity is an important issue in health promotion as obesity is a potential risk factor for atherosclerotic cardiovascular diseases, type 2 diabetes mellitus (DM2), hypertension and dyslipidaemia among adults. Adolescent fatness was a major cause of mortality, cardiovascular disease, colorectal cancer, gout and arthritis irrespective of body fatness at the time that the morbidity was diagnosed [4, 5]. The metabolic groundwork for these diseases is laid down in childhood. The risk of persistence of obesity in adulthood is very high and it rises with age among obese children [6-8].

Thus, improvement of the knowledge of risk factors for obesity of children as well as early prevention is necessary.

The aim of the study was to assess obesity prevalence within the 13 to 15 age group of children in the urban and rural environment of the Lodz region and to establish the influence of selected risk factors on childhood obesity.

Material and methods

The study was performed in four (4) selected secondary schools in the Lodz region (two located in the city of Lodz and the other two in the rural environment). The study involved 1012 children altogether (542 girls and 470 boys) aged 13-15. In each case, the current body height and weight were measured. Based on the obtained values, the body mass index standard deviation score (BMI SDS) was calculated, expressing the BMI of the examined child by the number of standard deviations from the mean value for age and sex in the Polish population [9]. Obesity was diagnosed if BMI SDS value was higher than +2.0.

Additionally, data concerning the perinatal period (gestational age, birth weight and birth length), duration of breastfeeding as well as frequency of obesity and diabetes mellitus type 2 within the children's families were collected.

Hypotrophy was diagnosed whenever birth weight was below -2.0 SD when compared to the reference values for gestational age and sex, while hypertrophy occurred whenever birth weight was above +2.0 SD in comparison to the same reference values. Prematurity was identified whenever gestational age was shorter than 38 weeks.

Depending on the time of breastfeeding declared, the children were assigned to one of four groups: 1) no breastfeeding (formula feeding only), 2) duration of breastfeeding lasting less than 6 months, 3) duration of breastfeeding lasting 6-12 months, 4) duration of breastfeeding lasting over 12 months.

Each child was asked to fill in a lifestyle questionnaire, focusing on the mode of spending their daily 8-hour after-school spare time period and how it was divided between passive activities (learning, watching television, using the Internet, playing computer games) and physical activity (regular activity, sport training, exercise).

The following statistical analyses of the data were performed: one-way analysis of variance with Tukey's multiple comparison test to compare the mean values in the examined groups. In the case of abnormal distribution of the variables, U Mann Whitney or Kruskal-Wallis non-parametric test was applied.

The analysis of the correlation of parametric data was conducted based on a typical regression and correlation analysis. The data in nominal scales were analyzed with a χ^2 test and a Fisher's exact test. A p value of less than 0.05 was considered as statistically significant.

Results

The examined group of 1012 children consisted of 529 children from an urban environment (225 boys and 304 girls) and 483 children (245 boys and 238 girls) from a rural environment. The statistical analysis (Fisher's test) shows that there is no relationship between the sex of a child and its qualification to either urban or rural group (χ^2=2.09; p=0.18). Thus, in the first phase of the analysis of the population of the examined children there was no division into girls and boys from an urban environment and girls and boys from a rural one as both groups were equal in this respect.

Comparison of the results of auxological parameter analysis of children with respect to their place of residence

We did not find any statistical differences between the height of children from the urban environment and those from the rural one, but the children from the urban environment weighed more – their mean value of BMI SDS was statistically higher than the mean value of BMI SDS of the children from a rural environment (Table I). On the other hand, the children from an urban environment were born with significantly lower weight and length than the children from a rural environment (Table I).

Comparison of the results of auxological parameter analysis of children with obesity and those with normal body weight within the whole examined group

The prevalence of obesity in the whole analyzed population was 18.1%. The obese children were significantly shorter than their slim peers. We did not find any statistical differences between birth weight and length within the group of children with obesity and those with normal body weight (Table II).

Table I. Comparison of the results of auxological parameter analysis of the children in respect to their place of residence

	Urban (n=529)	Rural (n=483)
Current height [m]	1.65±0.08	1.65±0.09
Current weight [kg]	57.13±12.05	55.73±11.0
BMI [kg/m^2]	20.91±3.40*	20.43±2.91*
BMI SDS	0.69±1.82*	0.43±1.57*
Birth weight [g]	3251.3±536.25*	3346.05±591.35*
Birth length [cm]	54.06±3.68*	55.42±3.32*

*$p<0.05$

Table II. Comparison of the results of auxological parameter analysis of children with obesity and those with normal body weight within the whole examined group

	Normal body weight	Obesity
N°	829 (81.9%)	183 (18.1%)
Current height [m]	1.65±0.09*	1.63±0.08*
Current weight [kg]	53.84±9.70*	68.36±11.91*
BMI [kg/m^2]	19.61±2.12*	25.52±2.67*
BMI SDS	-0.04±1.08*	3.32±1.26*
Birth weight [g]	3298.3±572.9	3313.4±542.9
Birth length [cm]	54.86±3.59	54.38±3.40

**p<0.05*

Comparison of the results of auxological parameter analysis of children from urban and rural environments with respect to sex of the children

When taking into consideration the children from the urban environment only, we did not find any statistical differences between BMI, BMI SDS and birth weight of boys and girls, but the birth length of boys was statistically higher than that of girls. However, within the group of children from the rural environment, the BMI SDS of girls was statistically higher than the BMI SDS of boys. Moreover, the birth weight and length of girls were statistically smaller than those of boys (Table III).

Comparison of the results of auxological parameter analysis of children from both urban and rural environments with respect to sex of the children and the occurrence of obesity

The prevalence of obesity within the whole analyzed population was 18.1% (see above), but it was higher among children from the urban environment than among children from the rural environment (21.7 vs. 14.1%); a significant coincidence was found between the prevalence of obesity and place of residence (χ^2=6.97, p<0.01) (Table IV).

In the urban environment, obesity was diagnosed with similar frequency among girls as among boys (21.2 vs. 22.7%), while in the rural environment it was observed with similar frequency among girls (22.3%) but among boys the frequency was lower (6.1% only) (Table V). Thus, we observed the relationship between obesity and sex of children in rural population.

The obese children (both boys and girls) from the urban environment were significantly taller than the obese children from the rural environment. We did not observe any statistical differences between either obese boys or obese girls from the urban and rural environment as far as birth weight and length were concerned. Yet the children with normal body weight (boys as well as girls) from the urban environment were diagnosed to have significantly lower birth weight and length when compared to

Table III. Comparison of the results of auxological parameter analysis of children from the urban and rural environment with respect to the sex of the children

	Urban (n=529)		Rural (n=483)	
	Boys	Girls	Boys	Girls
N°	225	304	245	238
Current height [m]	1.68±0.10*	1.62±0.06*	1.68±0.1*	1.61±0.06*
Current weight [kg]	59.39±13.51*	55.45±10.55*	56.67±11.45*	53.74±10.15*
BMI [kg/m^2]	20.77±3.42	21.02±3.38	20.23±2.49	20.63±3.28
BMI SDS	0.59±1.74	0.77±1.87	0.23±1.25*	0.64±1.82*
Birth weight [g]	3300.39±549.0	3217.0±525.51	3465.85±616.17*	3224.75±539.86*
Birth length [cm]	54.96±3.83*	53.42±3.44*	56.0±3.40*	54.84±3.13*

**p<0.05*

Table IV. Comparison of the results of auxological parameter analysis of children from both the urban and rural environment with respect to the sex of the children and the occurrence of obesity

	Urban (n=529)		Rural (n=483)	
	Normal body weight	Obesity	Normal body weight	Obesity
N°	414 (78.3%)	115 (21.7%)*	415 (85.9%)	68 (14.1%)*
Current height [m]	1.65±0.09	1.65±0.08	1.65±0.09	1.60±0.67
Current weight [kg]	53.37±9.21	69.88±11.34	55.57±10.86	64.6±11.28
BMI [kg/m^2]	19.54±2.11	25.6±2.45	20.38±2.87	25.1±2.6
BMI SDS	-0.07±1.1	3.29±1.19	0.41±1.55	3.3±1.14
Birth weight [g]	3229.4±562.8	3326.5±377.26	3359.61±565.07	3274.1±715.28
Birth length [cm]	54.03±3.83	54.0±2.97	55.52±3.2	54.8±3.91

**p<0.05*

Table V. Comparison of the results of auxological parameter analysis of the children from both the urban and rural environment with respect to the sex of the children and the occurrence of obesity

	Urban (n=529)		Rural (n=483)	
	Normal body weight (n=414)		Normal body weight (n=415)	
	Boys	Girls	Boys	Girls
N°	174 (78.8%)	240 (77.3%)	230 (93.9%)	185 (77.7%)
Current height [m]	1.68±0.1	1.62±0.06	1.68±0.1	1.62±0.06
Current weight [kg]	59.39±13.51	52.12±10.55*	56.93±10.98	50.66±7.44*
BMI [kg/m^2]	20.77±3.42	19.73±2.06*	19.89±2.06	19.32±2.08*
BMI SDS	-0.19±1.05	0.02±1.12	0.01±0.94	-0.13±1.13
Birth weight [g]	3272.7±577.4*	3191.7±561.2	3468.1±629.7*	3222.8±453.07
Birth length [cm]	54.95±4.06*	53.41±2.92*	56.03±3.42*	54.88±2.80*
	Obesity (n=115)		Obesity (n=68)	
	Boys	Girls	Boys	Girls
N°	51 (21.2%)	64 (22.7%)	15 (6.1%)	53 (22.3%)
Current height [m]	1.69±0.08*	1.62±0.06*	1.63±0.08*	1.59±0.06*
Current weight [kg]	73.1±12.05	67.27±10.0	66.86±13.26	64.45±10.61
BMI [kg/m^2]	25.54±1.52	25.66±2.6	25.11±3.23	25.1±2.41
BMI SDS	3.17±0.93	3.38±1.4	3.32±1.42	3.2±1.05
Birth weight [g]	3406.8±412.0	3303.3±370.4	3426.9±300.1	3231.5±775.8
Birth length [cm]	55.0±2.80	53.47±2.92	55.31±3.20	54.72±4.10

$p<0.05$

their peers with normal body weight from the rural environment (Table V).

We did not find any statistical correlation between birth weight or birth length and actual BMI SDS value among the population examined. It appears that neither birth weight nor birth length has any influence on the development of obesity among children aged 13-15.

Analysis of data collected by means of a questionnaire concerning children's lifestyle

All the children declared spending most of their after-school spare time in a passive way (learning, watching television, using the computer) with the exception of the slim children from the rural environment, whose proportion between passive and active ways of spending their spare time was 50:50. But slim children, both from the urban and rural environment, declared their everyday after-school physical activity or participation in sports activities to last longer than those of the obese children (Table VI). The results of the questionnaire indicate the dependence between the lifestyle and the prevalence of obesity in the studied group.

The analysis of the data concerning the incidence of obesity and type 2 diabetes mellitus

Analysis of data concerning the prevalence of obesity and type 2 diabetes mellitus within the families of the examined children with regard to the division into slim and obese children as well as those from a rural or urban environment.

a) For the whole examined population, the frequency of obesity among relatives (parents and grandparents) of obese children was higher than that among the relatives of children with normal body weight (43.7 vs. 26.7%). Additionally, the influence of the obesity of the parents on the obesity of the child was proven to be stronger than the influence of the obesity of the grandparents. While obesity diagnosed within parents (one of them or both) occurred more often in cases of obese children than of slim ones (18.1 vs. 4.9%) and, similarly, obesity diagnosed within both the parents and the grandparents occurred significantly more often in cases of obese children than of slim ones (18.6 vs. 4.1%), the frequency of obesity only among grandparents was similar in both groups (15.2 vs. 13.1%). Thus, a significant coincidence was found between prevalence of obesity in children and prevalence of obesity in their relatives, especially in parents (χ^2=10.45, $p<0.005$; χ^2=30.42, $p<0.00005$; χ^2=17.18, $p<0.00005$, relatively), but not in grandparents only (χ^2=0.35, $p=0.55$). The frequency of obesity among the child's family members did not depend on the place of residence of that child (rural vs. urban environment) (Table VII).
b) The frequency of DM2 within the families of children who suffer from obesity was similar to the frequency of DM2 within the families of children

Table VI. Data collected by means of a questionnaire concerning the way of spending 8 hours of after-school spare time (% of time) in particular analyzed groups of children

	Urban		Rural	
	Normal body weight	Obesity	Normal body weight	Obesity
N°	414	115	415	68
Actively (regular activity, sport training, exercise)	2.5 h (31.5%)	1.5 h (18.75%)	4.0 h (50%)	2.0 h (25%)
Passively (learning, watching television, internet using, computer games)	5.5 h (68.5%)	6.5 h (81.25%)	4.0 h (50%)	6.0 h (75%)

Table VII. Prevalence of obesity within the families (parents and grandparents) of children in particular analyzed groups

	The whole population (n=1012)		Urban (n=529)		Rural (n=483)	
	Normal body weight (n=829)	Obesity (n=183)	Normal body weight (n=414)	Obesity (n=115)	Normal body weight (n=415)	Obesity (n=68)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Obesity within family not occurring	608 (73.3%)	103 (56.3%)	305 (73.7 %)	57 (49.6%)	303 (73.0%)	46 (67.7%)
Obesity within family occurring	221 (26.7%)*	80 (43.7%)*	109 (26.3%)	58 (50.4%)	112 (27.0%)	22 (32.3%)
parents only	41 (4.9%)*	33 (18.1%)*	16 (3.8%)	23 (20.0%)	25 (6.0%)	10 (14.7%)
parents and grandparents	55 (6.6%)*	23 (12.5%)*	28 (6.8%)	21 (18.3%)	27 (6.6%)	2 (2.9%)
grandparents only	125 (15.2%)	24 (13.1%)	65 (15.7%)	14 (12.2%)	60 (14.4%)	10 (14.7%)

*$p<0.05$

Table VIII. Prevalence of DM2 within families (parents and grandparents) of children in particular analyzed groups

	The whole population (n=1012)		Urban (n=529)		Rural (n=483)	
	Normal body weight (n=829)	Obesity (n=183)	Normal body weight (n=414)	Obesity (n=115)	Normal body weight (n=415)	Obesity (n=68)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
DM2 within family not occurring	625 (75.4%)	137 (74.9%)	303 (73.2%)	92 (80.0%)	322 (77.6%)	45 (66.2%)
DM2 within family occurring	204 (24.6%)	46 (25.1%)	111 (26.8%)	23 (20.0%)	93 (22.4%)	23 (33.8%)
parents only	8 (1.0%)	6 (3.3%)	0 (0.0%)	2 (1.7%)	8 (1.9%)	4 (5.9%)
parents and grandparents	14 (1.6%)	3 (1.6%)	10 (2.4%)	3 (2.6%)	4 (1.0%)	2 (2.9%)
grandparents only	182 (22.0%)	37 (20.2%)	101 (24.4%)	18 (15.7%)	81 (19.5%)	17 (25.0%)

with normal body weight (25.1 vs. 24.6%). Also, no statistical difference in the prevalence of DM2 among the families of obese children from both the rural and the urban environment was established. No stronger influence of DM2 with which the parent or grandparent was diagnosed on the obesity of the child was found. No differences in the prevalence of DM2 among the obese children's family members depending on the place of residence of the obese children were discovered (Table VIII).

Analysis of the frequency of prematurity, prenatal hypotrophy and hypertrophy among the examined population

Similar frequencies of prenatal hypotrophy between the group of obese children and the group of children with normal body weight in the whole examined population were found. However, a separate analysis of the children from the rural and urban environment showed that the frequency of prenatal hypotrophy among obese children from the rural environment is higher than among children with normal body weight (11.8 vs. 3.9%) with the significant coincidence between prenatal hypotrophy and obesity in children from rural environment (χ^2=6.65, $p<0.01$). Such a correlation could not be observed among the group of children from the urban environment. Prematurity as well as prenatal hypertrophy were observed to occur significantly more often among children with normal body weight than among children with obesity. Therefore, it appears that neither of the two has any influence on the prevalence of obesity in the examined group of children (Table IX).

Table IX. Frequency of prematurity, hypo- and hypertrophy in particular analyzed groups of children

	The whole population (n=1012)		Urban (n=529)		Rural (n=483)	
	Normal body weight (n=829)	Obesity (n=183)	Normal body weight (n=414)	Obesity (n=115)	Normal body weight (n=415)	Obesity (n=68)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Prematurity	56 (6.8%)*	4 (2.2%)*	36 (8.7%)	2 (1.7%)	20 (4.8%)	2 (2.9%)
Hypotrophy	44 (5.3%)	16 (8.7%)	28 (6.8%)	8 (7.0%)	16 (3.9%)*	8 (11.8%)*
Hypertrophy	88 (10.6%)*	10 (5.5%)*	28 (6.8%)	4 (3.5%)	60 (14.5%)	6 (8.8%)

**p<0.05*

Table X. Duration of breastfeeding in particular analyzed groups of children

	The whole population (n=1012)		Urban (n=529)		Rural (n=483)	
	Normal body weight (n=829)	Obesity (n=183)	Normal body weight (n=414)	Obesity (n=115)	Normal body weight (n=415)	Obesity (n=68)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Formula feeding only	282 (34.0%)	69 (37.7%)	135 (32.6%)	53 (46.1%)	147 (35.4%)	16 (23.5%)
Breastfeeding <6 months	274 (33.1%)	63 (34.4%)	121 (29.2%)	32 (27.8%)	153 (36.9%)	31 (45.6%)
Breastfeeding 6-12 months	162 (19.5%)	40 (21.9%)	89 (21.5%)	26 (22.6%)	73 (17.6%)	14 (20.6%)
Breastfeeding >12 months	40 (4.8%)	8 (4.4%)	24 (5.8%)	4 (3.5%)	16 (3.9%)	4 (5.9%)

Analysis of the influence of the duration of breastfeeding on prevalence of obesity

Analysis of data of the children from the rural environment indicated that breastfeeding during the first six months of life is more frequent than formula feeding in this population, while in the children from the urban environment formula feeding prevailed. But no significant relationship was found between the duration of breastfeeding and body weight (Table X).

Discussion

The prevalence of obesity has been considerably increasing in recent years, yet a clear racial discrepancy can be observed – the prevalence of obesity and overweight was proven to be higher among children and adolescents of the Hispanic-American and Afro-American races than the Caucasian race [10, 11]. In the European countries the prevalence of obesity is accordingly assessed to be approximately 20% [12-14]. Studies regarding the assessment of the prevalence of obesity among children and adolescents in Poland are conducted in a narrow range and, so far, the precise prevalence of obesity among particular age groups in Poland has not been established.

Our studies show that approximately 20% of children aged 13-15 are obese and urban environment children suffer from it more frequently than children from a rural environment. Worth noting is the fact that in the rural environment it is mainly girls who are obese (22%), while only 6% of boys suffer from it. These observations are entirely consistent with the data from the literature pointing to the higher prevalence of obesity in the urban environment compared to the rural one [15]. On the other hand, our data also correlate with those studies indicating that the prevalence of obesity among people of a low social and economic status is higher among women than men [6]. Thus, it appears that the conclusions from other medical studies are additionally confirmed by our research concerning teenagers.

It seems that one of the reasons for higher prevalence of obesity among children from the urban environment is, according to the results of questionnaire-based research, less everyday physical activity and more time spent passively relaxing and learning. As it is known, there is a negative correlation between the BMI value and the numbers of hours spent on passive relaxation as well as a positive correlation between the BMI value and a number of hours devoted to physical activity by children and adolescents [16-18].

The significantly lower birth weight among children from the urban environment compared to children from the rural environment that we could observe in the examined group may be another risk factor. Even though no correlation between birth weight and current body weight in the whole group was found and the statistical analysis showed that there was no relationship between prenatal hypotrophy and obesity in children, such a correlation was found with regard to the children from the rural environment. This fact may imply that prenatal hypotrophy, more frequently occurring in the urban environment,

is caused by diverse factors, including social and economic conditions, not always resulting in the development of so-called "thrifty phenotype" and successive development of obesity [19, 20]. Nevertheless, the more frequent occurrence of hypotrophy among obese children from a rural environment in comparison to children with a normal body weight proves this element to be important as a risk factor for the development of obesity already among adolescents [21]. When it comes to breastfeeding, the opinions are diverse. Some authors claim that a minimum of 6 months of breastfeeding protects the child against obesity during the developmental age [22, 23]. Our analysis fails to provide evidence for a correlation between the duration of breastfeeding and the BMI SDS value of the examined children. It appears that breastfeeding has less influence than it is commonly believed to have, since other factors, namely the child's lifestyle and genetic predispositions, are likely to have greater significance [24].

On the other hand, cases of obesity among members of the child's closest family are undeniably an obesity development factor. We have affirmed a higher frequency of obesity among children in cases where at least one of their parents was obese. Nevertheless, we have found no evidence for such a relationship in cases where only the grandparents were affected with obesity, while the parents were not. This higher prevalence of obesity among the obese children's relatives that we have observed may be caused by hereditary factors as well as incorrect dietary habits incorporated in the family lifestyle. These observations are consistent with the majority of available studies devoted to this subject [15, 25].

All activities attempting to select risk groups for the development of obesity and to apply preventive steps and health education are a significant function of the primary care physicians as well as obesity prevention and treatment clinics.

In conclusions the prevalence of obesity in the age group 13-15 is 18.1% and it is higher in the urban population than in the rural one. Obesity history in the child's family (especially when it concerns parents) is an important risk factor of childhood obesity. No correlations between obesity and birth weight or the duration of breastfeeding in this age group were observed. There is a clear relationship between the way of spending spare time and the occurrence of obesity among children.

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