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Childhood Obesity - Risk Factors and Consequences of the Disease

Karol Dolepski

Medical University of Lublin

Racławickie avenue 1, 20-059 Lublin, Poland

k.dolepski@gmail.com

https://orcid.org/0009-0003-2199-7268

Kamila Duszyńska

Medical University of Lublin

Racławickie avenue 1, 20-059 Lublin, Poland

kamilad994@gmail.com

https://orcid.org/0009-0006-6764-9033

Alicja Góral
Medical University of Lublin
Racławickie avenue 1, 20-059 Lublin, Poland
https://orcid.org/0009-0009-7203-1379
agoral515@wp.pl

Krystian Żuk
Stefan Kardynał Wyszyński
Province Specialist Hospital in Lublin
Kraśnicka avenue 100, 20-718 Lublin, Poland
krystianzuk@gmail.com
https://orcid.org/0009-0003-9752-6112

Michał Czachajda
Medical University of Lublin
Racławickie avenue 1, 20-059 Lublin, Poland
mczachajda@gmail.com
https://orcid.org/0009-0009-7129-6180

ABSTRACT

Introduction: In recent years, there has been a global increase in the prevalence of obesity among children and adolescents. Researchers around the world are making efforts to better understand the mechanisms behind childhood obesity, to predict and prevent its consequences.

The purpose of this paper: to present the latest reports on the risk factors and consequences of obesity in the minor population.

Materials and methods: To search for relevant articles, the PubMed and Google Scholar databases were searched using terms such as: ‘childhood obesity‘, ‘adolescent adiposity’, childhood obesity risk factors’, ‘childhood obesity implications’.

Summary of current knowledge: A number of risk factors for childhood obesity have been demonstrated, which can be categorized in various ways. Among the most influential are behavioral factors, related to young people's choices regarding diet or physical activity undertaken. It has been proven that excessive fat accumulation is promoted by a diet based on highly processed foods and the consumption of high-calorie meals. Studies have shown that

factors independent of children’s behavior are important, such as disorders of prenatal development, the way the mother cares for her newborn, or the socioeconomic status of the child's family. Childhood obesity adversely affects the musculoskeletal and respiratory systems, causes mental illness and increases the risk of cancer in adulthood.

Conclusions: Childhood obesity is an important public health problem today due to its prevalence and numerous negative effects on the human body both in youth and adulthood. It is extremely important to thoroughly understand the risk factors of the childhood obesity and to be able to predict its consequences, which will allow to effectively combat the problem in question.

Keywords: childhood obesity, adolescent obesity, child obesity, childhood overweight, childhood onset obesity

Childhood obesity

Obesity has become a significant public health problem worldwide to the extent that it is now said to be an epidemic [1]. In recent years, we can observe an increase in the incidence of childhood obesity both in the most developed countries and in those whose economic development is not at a high level [2]. Current figures from the United States show that by the age of 14, 17% of the country's adolescent population is overweight and 20.8% are obese [3]. According to the World Health Organization’s definition, overweight and obesity are defined as abnormal and excessive fat accumulation, respectively, which can affect health in an adverse way [4]. The most common measure of the degree of obesity is the body mass index (BMI), but using it has its limitations, for example, people of smaller stature may have inflated values for this index, which additionally does not reflect the distribution of body fat. Other tools can help, such as neck circumference, waist circumference, waist-to-height ratio or neck skinfold thickness [5]. It is very important to know the risk factors for childhood obesity, which often overlap and interact with each other, which can help to create effective prevention programs, which are extremely important given the multitude of negative effects of obesity among the youngest [6].

Behavioral risk factors for childhood obesity

An unhealthy diet can be a key risk factor for the development of childhood obesity, so it is important to identify those foods that contribute to its occurrence. An association between frequent consumption of fast food and high sugar drinks and the incidence of overweight and obesity among adolescents has been shown. Similarly, meals with high amounts of meat and refined cereals also had an adverse effect [7]. Recent studies show that dietary patterns acquired in childhood can also be reproduced in adulthood, and the topic of eating patterns was addressed by Dalrymple et al. in a randomized clinical trial involving 3-year-old children of obese mothers. Offspring of obese women are at risk of developing the disease. The diet that increased the risk of childhood obesity was based on the consumption of more processed foods, numerous snacks, significant consumption of sweets, crisps or biscuits [8]. A meta-analysis by Poorolajal et al. investigated behavioral factors affecting the development of obesity among 5-19 year olds struggling with obesity or overweight, such as physical activity, sleep, watching TV and playing computer games. Insufficient sleep and not eating breakfast have been proven to increase the risk of childhood obesity, as has watching TV for more than 2 hours a day, which raises the odds by 42% [2]. Certain character traits may also be related to the risk of obesity, as according to current knowledge, low levels of conscientiousness in children correlated with the occurrence of the above disease among such individuals [9]. There is research indicating that high social competence of children and adolescents, their popularity or the way they are perceived by their peer group, may influence adequate nutritional status, while those with low social competence, not being the focus of their peer network, have an increased risk of being overweight. This is due, among other things, to undertaking less activity or compensating for feelings of loneliness by watching TV and eating unhealthy foods [10]. A meta-analysis by Sammels et al. investigated the association of autism spectrum disorders with the prevalence of childhood obesity and estimated the prevalence in the above group at 17%. In addition, the risk of obesity-related disease among them was 58% higher than in typically developed children relative to their age. The researchers suspected that factors such as low physical activity, taking psychotropic medication and consuming high-calorie foods may have been behind this [11]. In their meta-analysis, An et al. demonstrated an association between grandparent caregiving and excess body weight. They indicate that the risk of being overweight or obese in this group increases by 30%, which is largely due to the elderly perceiving more weight as a result of good nutrition, so that they often give their children more food. Other reasons may include giving sweets and unhealthy food to grandchildren to show them love or exempting them from chores

that require physical activity [12]. Research also suggests a link between parental and child obesity not only for genetic reasons, but also for behavioral reasons, as adults' obesity-promoting lifestyles and behaviors can easily be passed on by them to their children, who are more likely to have unhealthy diets or sedentary lifestyles if their parents are obese [13]. Tellez-Rojo et al. in a randomized clinical trial reported that the prevalence of obesity at 60 months in children whose mothers were overweight during the first year after birth was almost twice as high as among children born to women with a recommended BMI. The reason for this was attributed to a tendency towards a more calorie-dense diet, which resulted in excessive child weight gain [14].

Socio-economic factors

Recent studies indicate that environmental factors such as family social status influence the risk of childhood obesity [15,16]. Social groups with lower education, income, ethnic or racial minority groups have a higher prevalence of obesity-related disease, which, if sustained from childhood to adulthood, can reduce an individual's socio-economic achievements [16]. In a randomized clinical trial conducted in Nashville, TN by Heerman et al. the researchers sought to determine whether children from low-income minority backgrounds were more likely to develop the condition. During a three-year follow-up, it was noted that of the children who were of normal weight at the start of the study, 24% were obese after 36 months. Furthermore, of the children who were overweight at the start of follow-up, 55% were obese after 36 months [15]. Recent scientific reports suggest that living in an unsafe neighborhood is associated with a reduction in physical activity of eight minutes per week and may increase BMI, but has no effect on adolescent obesity risk [17]. Another aspect worth looking at is the proven link between air pollution in young people's living places, particularly those living in countries with a high rate of industrialization, and weight gain and the chance of obesity-related disease. BMI increased with 10 μg/m3 increased exposure to particulate matter (PM) 10, PM 2.5 and nitrogen oxide (NO_2). Examples of mechanisms that may be behind this include increased oxidative stress in body tissues, impaired breathing during sleep due to exposure to air pollution resulting in reduced air quality, or not undertaking physical activity outdoors due to poor air quality [1].

Pregnancy and the first months of life

According to current research, a pregnant woman's obesity and excessive weight gain during pregnancy can result in a higher percentage of body fat and even obesity in her offspring [18,19]. In addition, excessive weight in pregnancy is a risk factor for gestational hypertension and gestational diabetes, both of which affect the nutrient supply and development of the fetus,

which may consequently induce developmental adaptations of adipose tissue, disturbances of its metabolic and neuroendocrine functions, and may result in obesity of the child in later years [18]. Another risk factor for childhood obesity is maternal smoking during pregnancy, which, according to recent data, increases the chance of overweight offspring by 37% and 55% for obesity compared to if the pregnant woman did not smoke. The above harmful behavior can lead to reduced birth weight in the newborn, probably as a result of the vasoconstrictive effect of nicotine in the fetus and its hypoxia, which is able to affect the growth pattern at birth and lead to excessive body fat [20]. In their meta-analysis, Wan et al. showed that another factor that may be important in the pathogenesis of childhood obesity is the intake of antibiotics during pregnancy, particularly in the second trimester. For the first and third trimesters, the findings were inconclusive [21]. There are studies done in recent years that suggest that the use of antibiotics also after birth can lead to the development of childhood obesity [22,23]. The study group of the meta-analysis by Miller et al. were children under 24 months of age taking antibiotics, and the above relationship was small and stronger among boys, as well as children exposed to multiple treatments or broad-spectrum antibiotic therapy [23]. Lack of breastfeeding or too short a period of breastfeeding may also contribute to an increased risk of childhood obesity. According to the researchers, naturally fed babies have better control over food intake, and the use of milk replacers can make the baby pay less attention to satiety signals. In addition, modified milk contains higher amounts of protein than natural milk, which can lead to increased weight gain [24]. Recent research suggests that there is a link between the rate of growth in the first months of life and the later risk of childhood obesity. The researchers deduced that the earlier a child's intensive weight gain takes place, the greater the chances of this happening, as the above risk was greater if the rapid weight gain took place in the first three months of life than in the first 12 months [25].

The effects of childhood obesity

Childhood obesity affects both the life of the individual and society as a whole, and obese children and adolescents are highly likely to maintain abnormal body weight into adulthood as well, with a number of negative consequences, including economic ones [26]. Adolescents suffering from obesity-related illness have a higher risk of developing mental disorders, particularly depression [27,28]. Sutaria et al. in their meta-analysis estimated the risk of the disease among overweight and obese children, including more than 140,000 children in their study. The researchers found that, compared to their normal-weight peers, those who were obese had a 32% higher risk of developing depression at the time of the study and in the future,

and the odds were higher among female subjects. The prevalence of depression among children with obesity was estimated at 10.4%, but no association was observed between overweight alone and increased risk of depression in boys and girls [29]. Moreover, greater severity of depressive symptoms was noted among obese patients relative to the general adolescent population [27]. A meta-analysis conducted by Wang et al. aimed to study the association between childhood obesity and depression and anxiety symptoms in the Chinese population. According to data from this study, the prevalence of depression among overweight/obese children was 21.73%, and among normal-weight individuals was 17.96%. The prevalence of anxiety symptoms was estimated at 39.80% among the overweight/obese group versus 13.99% in the normal-weight group [28]. Childhood obesity may have a significant association with cancer in adulthood, as demonstrated in their meta-analysis by Khonsari et al. According to the researchers, childhood obesity increased the risk of malignant cancer in adulthood by 33% and mortality from it by 28%, and the risk discussed above was higher in women. Adolescent obesity, in particular, may raise the odds of developing colorectal or ovarian cancer. The exact mechanism behind this is not yet understood, but researchers suspect a role for chronic inflammation, endocrine disruption and oxidative DNA damage [30]. Current research shows that childhood obesity can also result in cardiovascular dysfunction, as evidenced by reports of its association with atrial fibrillation (AF) in adulthood [30,31]. With the increase in the prevalence of obesity in society, it has been observed that more and more patients are presenting to the doctor with the arrhythmia in question, which may be the result of excessive weight at different stages of life, but there is evidence to suggest that the higher the BMI in the earlier years of life, the greater its effect on the occurrence of AF. One reason for this relationship is the accumulation of epicardial fat, which can cause myocardial conduction disturbances or even processes of myocardial fibrosis [31]. In addition, childhood obesity may influence the onset of spontaneous hypertension in later years, as evidenced by a study suggesting that a one standard deviation increase in BMI was significantly associated with an increased risk of abnormal blood pressure values [32]. Another system that can be affected by childhood obesity is the respiratory system, and current reports indicate a link between overweight and obesity in adolescents and their risk of developing bronchial asthma [33-35]. This was proven in their meta-analysis by Deng et al. according to whom overweight and obese children were 1.23 and 1.40 times more likely to have asthma, respectively, and the risk was higher for girls [33]. Azizpour et al. in their study, on the other hand, suggest that overweight and obesity in children/adolescents increase the risk of asthma by 1.64 and 1.92 times, respectively, and that

a BMI above the 85th percentile shows a significant association with the disease [35]. Excess body fat in the trunk area can lead to impaired lung ventilation, which, along with hormonal disturbances created by obesity, promotes the development of asthma [33]. Childhood obesity can underlie disorders of musculoskeletal development in children [36-38]. This is evidenced by the association between overweight/obesity in minors and the alignment of their joints, as studied by Molina-Garcia et al. in their meta-analysis involving 1,757,107 subjects. The aforementioned analysis showed that children who are overweight or obese have a significantly higher risk of excessive lumbar lordosis (RR = 1.41), flat feet (RR = 1.49), knee valgus (RR = 5.92), and total joint defects (RR = 1.68) [36]. In addition, childhood obesity may be related to biomechanical changes during gait, which is one of the risk factors for musculoskeletal abnormalities. According to the researchers, there are differences in the walking pattern of overweight and obese children relative to their normal-weight peers. The gait pattern of obese children is characterized, among other things, by a greater range of motion of the pelvis in the transverse plane, increased internal rotation of the hip joint, the width of the step or a longer stride phase [37]. In addition, the various phases of gait take longer in these people, which, in addition to slower walking, can cause joint and muscle strain [38]. Recent data also indicate that increased child weight is related to changes in running mechanics, which translates into an increased risk of injury and joint degeneration in overweight/obese minors [39]. According to current reports, childhood obesity can affect the weight loss process as a result of dietary interventions taking place as early as adulthood, as confirmed by a clinical trial conducted by Morales et al. in which a dietary intervention based on the Mediterranean diet was applied to more than 4,000 participants. They proved that participants who were obese as infants and children showed slower weight loss as a result of the diet from the first week of the program, and from week 3 the difference with other subjects began to widen. In particular, individuals who were obese as infants had worse results, and according to some researchers, weight in the first months of life is an important risk factor for obesity in adulthood. Changes in fat metabolism created early in life may be behind this, as evidenced by estimates suggesting that the odds of returning to normal weight in adolescence in individuals who were obese in childhood are as low as 20% [40]. Recent reports indicate that overweight and obesity in children may have a negative impact on their school attendance, as confirmed by a study by An et al. which found that overweight and obese children may be behind more school absences of 27% and 54%, respectively, compared to their normal-weight peers. This is thought to be due to the poorer health of obese individuals resulting from excess body fat and psychosocial factors

related to lower self-esteem. A higher number of absences from school often results in poorer educational performance and impaired social development of adolescents, also translating into their lower well-being [41]. Excessive body weight in children and adolescents has many negative consequences, as is well illustrated by a study by Ling et al. of worldwide expenditures (2022, totals expressed in US $) resulting from childhood overweight and obesity, who estimate that the increased annual health care costs for these individuals amount to $237.55 per capita ($190.51 as a result of overweight, and $307.72 generated by obesity) and are highest in the 12-18 age group. It is also estimated that the additional spending on prescribed medications for obese children amounts to $64.69 per capita per year, and according to the study, these individuals are more likely to use prescription drugs than their peers with a normal BMI, particularly using them to combat respiratory diseases. By 2050, overweight adolescents in the U.S. could generate $13.62 billion in direct and $49.02 billion in indirect increased medical costs annually, according to the researchers' projections [26].

Conclusions

In conclusion, childhood obesity is an extremely topical issue, widely discussed in the public debate, as it has affected an increasing number of children and adolescents worldwide in recent years. A better understanding of risk factors and the public education that goes with it are crucial in the fight against the obesity epidemic, which carries a number of unfavorable consequences from the point of view of both the individual and the population as a whole. It is worth remembering that the causes of obesity in the underage population are complex, and can be related not only to the behavior and choices of the individual, but also be independent of him, for example, having its origin in the prenatal period. Among the consequences of childhood obesity we can include: mental illness, cancer, respiratory problems or musculoskeletal disorders. The earlier the treatment of the disease in question begins, the greater the chance of avoiding the repercussions associated with it, and these can manifest themselves only in adulthood and affect a person's physical as well as mental health.

Author's contribution:

Conceptualization: Karol Dolepski; methodology: Karol Dolepski, Alicja Góral, Michał Czachajda, Kamila Duszyńska, Krystian Żuk; software: Karol Dolepski, Krystian Żuk; check: Kamila Duszyńska, Krystian Żuk, Alicja Góral; formal analysis: Karol Dolepski, Krystian Żuk; investigation: Karol Dolepski, Kamila Duszyńska, Alicja Góral, Michał Czachajda, Krystian Żuk; resources: Karol Dolepski, Krystian Żuk, Kamila Duszyńska, Michał Czachajda; data

curation: Karol Dolepski, Kamila Duszyńska; writing – rough preparation: Karol Dolepski; writing – review and editing: Alicja Góral, Krystian Żuk, Kamila Duszyńska, Michał Czachajda; visualisation: Karol Dolepski, Alicja Góral; supervision: Alicja Góral, Kamila Duszyńska; project administration: Karol Dolepski, Michał Czachajda.

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