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Pediatric obesity – time to act as early as possible

Otyłość dziecięca – czas, by działać jak najszybciej

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Abstract

There has been a global increase in the average body mass index (BMI) in children and an alarming trend of increasing weight among the youngest children in recent decades. Childhood excess weight and obesity result in premature adult mortality and morbidity. Obesity is not only a risk factor for other diseases but is also a complex, multifactorial disease in its own right, linked to a genetic predisposition influenced by an increasingly permissive environment from intrauterine life throughout childhood and adolescence into adulthood. Knowledge of the prevalence of obesity from the earliest life stages and its trajectory is essential to raise awareness of the risks at each stage and to indicate the potential age of prevention and intervention. Taking effective anti-obesity measures in children, both preventive and therapeutic, is now a necessity, with successful interventions used to decrease body weight and thus reduce health consequences. Identified risk factors in the first 1,000 days of life and even earlier, before conception, suggest that this is a key period for the development of overweight and obesity, and it appears to be the best time for preventive action. The growing phenomenon of obesity among children requires not only prevention but also integral treatment. Lifestyle change intervention programs are considered key to the treatment of childhood obesity. Obesity trajectories, the higher effectiveness of applied interventions observed in younger age groups, and the dependence of the risk of developing complications on the duration of obesity confirm the need for early diagnosis and treatment of obesity in children from an early age. The main aim should be to prevent the onset of obesity, thus reducing the future health, social, and financial consequences.

Key words: pediatric obesity, child, obesity management, BMI trajectory.

Streszczenie

W ostatnich dekadach nastąpił globalny wzrost średniego wskaźnika masy ciała (*body mass index* – BMI) u dzieci i pojawił się niepokojący trend zwiększania masy ciała w grupie najmłodszych dzieci. Nadmiar masy ciała i otyłość w wieku dziecięcym skutkują przedwczesną śmiertelnością i zachorowalnością dorosłych. Otyłość nie jest jedynie czynnikiem ryzyka innych chorób, ale złożoną, wieloczynnikową chorobą samą w sobie, związaną z predyspozycjami genetycznymi, na które wpływa coraz bardziej permisywne środowisko, począwszy od życia wewnątrzmacicznego poprzez dzieciństwo i okres dojrzewania do dorosłości. Wiedza o częstości występowania otyłości od najwcześniejszych okresów życia człowieka i jej trajektorii jest niezbędna dla uświadomienia ryzyka na poszczególnych jego etapach i wskazania potencjalnego wieku prewencji i interwencji. Podejmowanie u dzieci skutecznych działań zarówno prewencyjnych, jak i terapeutycznych jest obecnie koniecznością, a skuteczne interwencje stosowane w celu redukcji masy ciała zmniejszają skutki zdrowotne. Zidentyfikowane czynniki ryzyka w okresie 1000 pierwszych dni życia, a nawet wcześniej, jeszcze przed poczęciem, sugerują, że jest to ważny okres dla rozwoju nadwagi i otyłości i wydaje się najbardziej właściwym okresem dla działań profilaktycznych. Narastające zjawisko otyłości wśród dzieci wymaga nie tylko profilaktyki, lecz także integralnego leczenia. Programy interwencyjne związane ze zmianą stylu życia uważa się za kluczowe w leczeniu otyłości u dzieci. Trajektorie otyłości, większa skuteczność stosowanych interwencji obserwowana w młodszych grupach wiekowych oraz zależność ryzyka rozwoju powikłań od czasu trwania otyłości potwierdzają konieczność wczesnego rozpoznawania i leczenia otyłości u dzieci od najmłodszych lat. Głównym celem opieki powinno być zapobieganie powstawania otyłości, gdyż zmniejsza to skutki zdrowotne, społeczne i finansowe.

Słowa kluczowe: otyłość dziecięca, dziecko, leczenie otyłości, trajektoria BMI.

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Introduction

According to the latest data from the World Health Organization (WHO), nearly one-fifth of the world's children are now overweight or obese, representing about 39 million children under the age of 5 years and 340 million between the ages of 5 and 19 years [1]. There has been a global increase in the average body mass index (BMI) of children and an alarming trend of increasing weight among the youngest children in recent decades [2]. Between 1990 and 2014, the prevalence of overweight among children under 5 years old increased from 4.8 to 6.1% [2]. Curbing the obesity epidemic among children under 5 years old by 2025 is one of the 2025 Global Nutrition Targets [3]. In 2021, obesity was responsible for about 2.8 million deaths from non-communicable diseases, including cardiovascular diseases, diabetes, cancer, neurological disorders, chronic respiratory diseases, and digestive disorders. The pandemic revealed that people with obesity have a significantly higher risk of severe COVID-19 [4, 5]. One of the WHO's core goals is to reduce premature mortality from non-communicable diseases by 30% by 2030, which will not be possible without reducing the current extent of obesity [6]. Obesity is not just a risk factor for other diseases but is a disease in its own right. In 1997, the WHO recognized obesity as a chronic disease. In 2021 the European Commission defined obesity as "a chronic relapsing disease, which in turn acts as a gateway to a range of other non-communicable diseases" [7]. Obesity is a complex, multifactorial disease associated with a genetic predisposition influenced by an increasingly permissive environment from intrauterine life throughout childhood and adolescence into adulthood [8–11]. The risk of obesity can be passed from one generation to the next, not only through the influence of biological factors, but mainly through behavioural factors [2]. Dietary patterns and other health habits are formed early in life and persist throughout adulthood [4, 12].

Children's eating behaviour is determined by the environment in which they are raised. If exposed to an obesogenic environment [13] that accepts children's weight gain, offers affordable and promoted ultra-processed foods, decreases opportunities for physical activity and being outdoors, and increases the time spent in front of a screen, it can be expected that with inappropriate behavioural and biological responses, obesity can develop rapidly. With globalization and urbanization, children's exposure to obesity-inducing environments is increasing [2].

The trend of increasing obesity among children and adolescents is resulting in an increase in the incidence of obesity-related complications, such as hypertension, dyslipidaemia, hepatic steatosis, and psychosocial complications, as well as a shift in the timing of their onset to increasingly younger age groups. In addition to an increase in the prevalence of obesity among children, its severity is also increasing [14–17]. Childhood overweight and obesity results in premature adult mortality and morbidity [18]. Taking effective measures in children, both preventive and therapeutic, is now a necessity, while effective interventions used to reduce body weight minimize the health and economic consequences. It is essential to know the prevalence of obesity from the earliest stage of a person's life and its trajectory for awareness of risk at its various stages and to indicate the potential age for prevention and intervention. For these purposes, it is crucial to determine the age at which obesity develops and to identify critical periods in childhood that are characterized by accelerated and sustained weight gain.

Because childhood obesity is currently one of the most significant public health problems, numerous international scientific societies, including Polish ones, have formulated their own recommendations for the treatment and prevention of obesity adapted to the local situation [19, 20].

Prevalence and trajectories of obesity

Results from the English National Child Measurement Program conducted in 2019/2020 showed that 9.9% of children in the 4–5-year-old age group were obese. After 6 years of follow-up of the same group (assessment at age 10–11 years), the rate obesity in this group had risen to 21% [14]. The program also proved that boys were more likely to be obese, as well as children living in poorer areas. A retrospective analysis of the body weight of obese Polish children aged 5–18 years revealed that more than 36% of them showed obesity as early as age 2 years, and the percentage increased with age (at ages 4 and 6 years) [21]. A study of 7738 American preschool children (mean age 5.6 years) found that 12.4% of them were obese and another 14.9% were overweight. Reassessment of this group at age 14 years showed obesity in 20.8% and overweight in 17.0% [22]. It was proven that overweight 5-year-olds were 4 times more likely to be obese when they reached 14 years old than normal-weight children. It was estimated that 5-year-old children with a normal BMI had only a 6% probability of becoming obese at age 14 years, while the risk of children with a BMI at the 99th percentile rose to 72%. Nearly half of the obese 14-year-olds were already overweight by age 5 years, and 75% of them had a BMI above the 70th percentile [22].

Another study, evaluating only obese preschool children, found that lasting remission of obesity by age 14 years (a drop in BMI below the 95th percentile) was achieved by only 21.6% of them. Girls were more likely to achieve remission [23]. A study published in 2022 indicated an increase in the prevalence of obesity in preschool children at an increasingly young age and in a more severe form [15]. The prevalence of obesity was studied in 2 groups of American children aged 6 to 11 but born 12 years apart (born in 1993 and 2005). Both groups were anthropometrically assessed at the same checkpoints and developmental stages. The group born earlier showed an overweight prevalence of 15.1% and an obesity prevalence of 12%, while the group of children born 12 years later showed an overweight prevalence at a similar level (15.7%), but the obesity prevalence increased to 15.3%. Over the 12-year span, the percentage of preschool children with severe obesity also increased from 2.9% to 3.9%, which then increased with their age [15]. A Norwegian study of 8-year-old children found

20.4% of them to be overweight or obese. It was found that these children were characterized by a significant increase in BMI as early as in the first 9 months of life and a high BMI at age 2 years [24]. Ward *et al.* estimated, based on a simulation model for predicting obesity trajectories, that the probability of obesity at age 35 years was 74.9% for an obese 2-year-old, and 88.2% for an obese 19-year-old [25]. This means that children aged 2 years with severe obesity have only a 1 in 5 chance of not being obese at age 35 years, while by age 5 years this chance is halved. Observation of changes in BMI SDS (standard deviation score) in a group of 762 Dutch children from birth to 18 years of age allowed identification of the critical period when a child's weight gain has a significant impact on the onset of overweight in adulthood. The age range of 2 to 6 years was shown to be the earliest period in which changes in BMI SDS have an impact on adult overweight, and is therefore extremely important for developing strategies for primary prevention of overweight [26]. A long-term prospective and retrospective study of a German group also tracked BMI dynamics in a large group of 51,505 children (from infancy to the age of 18 years) to determine the age at which obesity may become entrenched [27]. It was found that more than half of obese adolescents were overweight (22%) or obese (31%) as early as age 5 years, and the percentage of obese children increased with age. In half of the children who had excess body weight at age 2 years, it normalized during adolescence. In contrast, up to 90% of children who were obese at age 3 years remained obese into adolescence. It was shown that among adolescents who were overweight or obese, the largest weight gains were observed between the ages of 2 and 6 years. Acceleration of annual increases in BMI during preschool (but not school) age were associated with a 1.4-fold greater risk of overweight or obesity in adolescence when compared to the children whose BMI remained stable [27]. Similarly, a systematic review and meta-analysis of 14 studies [28] found that children who showed rapid weight gain in the first 2 years of life were 3.66 times more likely to be overweight or obese later in life. This implies that early childhood is a critical period for the development of obesity. Its appearance at this time is usually associated with its survival into adolescence. Therefore, it is extremely important for paediatricians to pay attention to the dynamics of children's weight gain and growth from as early as infancy. Under physiological conditions, in the first year of a person's life there is a significant weight gain associated with an increase in the number of adipocytes, which then remains stable for several years. Around age 6 years, there is another period of rapid adipose tissue growth, which is referred to as the "adiposity rebound" [29]. It is associated with an increase in both the size and number of adipocytes. It has been shown that among children who develop the "adiposity rebound" prematurely or in whom the phenomenon is more intense, the risk of developing obesity is higher [29, 30]. According to Geserick *et al.*, tracking the dynamics of BMI during early childhood, rather than just assessing its absolute value, is vital for identifying children at risk of obesity in later life. The occurrence of accelerated growth of BMI dynamics before the age of 6 years requires early intervention even before the onset of obesity. This is especially true for children with factors that predispose them to the development of obesity, and it can help to identify high-risk children who require prompt intervention even before overweight is apparent [27].

Risk factors for the development of obesity

A growing amount of evidence suggests that the first 1000 days of life, encompassing the time from conception to the age of 24 months, is a key period for the development of later overweight and obesity. Several important risk factors have been identified during this period: excessive maternal weight before pregnancy, excessive maternal weight gain during pregnancy, maternal smoking during pregnancy, gestational diabetes, absence or short duration of breastfeeding, high protein intake, caesarean section, vitamin D_3 deficiency, high birth weight or excessive weight gain in the first year of life, low socioeconomic status, shortened daily sleep of the infant, and early (< 4 months of age) introduction of solid foods. All these factors can co-occur and, through a cumulative effect, further increase the risk of obesity [31].

It has been proven that children born with high body weight had a higher BMI throughout childhood and adolescence. As many as 43.7% of them were overweight or obese during adolescence, while this phenomenon occurred in less than 30% of children born with adequate or insufficient weight for gestational age [27]. A US study indicated that children with birth weights above 4,000 g who displayed excess weight at age 5 years were at outstanding risk of obesity during the following 9 years. Although children with high birth weight accounted for 12% of the study population, they accounted for more than 36% of those who were obese by age 14 years. Thus, more than a third of the high-birth-weight children became obese adolescents [15, 22]. In addition, a Norwegian study highlights that children diagnosed with obesity at age 8 years had a higher BMI SDS at birth than 8-year-olds of normal weight [24]. In each age group, children with at least one obese parent are more likely to become obese as adults. Normal-weight children between the ages of 1 and 2 years, with at least one obese parent, are more likely to be obese as adults than are children of slim parents (28% vs. 10%). Obese children between the ages of 3 and 5 years have a 24% probability of obesity in adulthood if neither parent is obese and a staggering 62% if at least one parent is obese [32]. Maternal BMI is a stronger predictor of obesity in children than paternal obesity. Maternal obesity more than doubles the risk of obesity in offspring in adulthood. A systematic review and meta-analysis of 72 studies found a 264% increase in the risk of obesity in children born to mothers who were obese before conception, and an 89% increase in children of overweight mothers [33]. Not only maternal BMI before pregnancy but also excessive maternal weight gain during pregnancy is associated with childhood obesity [34]. Many of these risk factors are potentially modifiable factors, and the period of the first 1,000 days or earlier, even before conception, seems to be the most appropriate period for preventive measures [31, 35]. The rise in the preva-

lence of obesity in children at an increasingly young age shows that the preventive interventions that have been used for many years, targeting only the school environment, are inadequate and overdue [33, 36].

Obesity treatment intervention programs

The growing phenomenon of obesity among children requires not only prevention but also integral treatment. Lifestyle change intervention programs are considered key to the treatment of childhood obesity [37–39]. Scientific evidence suggests that multi-component interventions addressing physical activity, nutrition, and behaviour change are the most effective [40]. Cochrane meta-analyses [39, 40, 41] evaluating the effectiveness of lifestyle interventions in children with excess body weight observed the greatest reduction in BMI SDS in interventions targeting the youngest children (ages 2–5 years). BMI trajectories [27] show the importance of using early effective intervention to prevent obesity persisting into later childhood. The need to treat obesity as early as possible is underscored by the fact that the smallest overall reduction in BMI SDS was observed in interventions given to children aged 6–11 years. It is likely that this age group of early school children is influenced by a broader environment than younger children, but they are less autonomous than their older adolescent peers and rely more on parental support. Many researchers indicate that it is the family that plays a key role in the effectiveness of treatment programs for overweight and obesity in children and adolescents [43, 44]. Parental involvement is aimed at supporting the child in making proper dietary choices and developing healthy behaviours. Parents are role models for children, especially in younger age groups, where inappropriate parental attitudes and behaviours can lead to the development of excess body weight [45–47]. Studies confirm that children under the age of 12 years achieve better results from interventions if their parents are also involved [48]. An intervention to treat obesity in children aged 5 to 11 years, which was targeted only at their parents, has also been shown to be effective [49]. A systematic review of 18 studies on 23 intervention programs observed that parental involvement in the intervention had a greater effect on their children's BMI drop than that of a psychologist, but it was less effective than when the intervention involved a dietician or nutrition specialist and a physician. The authors of the review explain this by the large age diversity of participants in the studies analysed, and they believe that adolescents may have more trust in specialists whereas younger children trust their parents more [50]. In another systematic review, Kelishadi *et al.* [51] showed that parents with low confidence were more likely to drop out of the program. These observations suggest the need to assess parents' willingness to change their lifestyle before starting the program [45, 47], or to find methods to increase parental motivation and involvement in the intervention. An additional factor influencing the effectiveness of family interventions, especially when parents also present excess weight, is to encourage them to try to reduce their weight together, along with their child [48].

What is important in the treatment of obesity is not only the effectiveness of the interventions used to reduce the BMI/BMI z-score during and after the intervention but also the sustainability of the changes achieved. The reason why the effects of applied interventions may not persist in the long term is usually not because of the failure of the initial intervention but because of the lack of maintenance interventions. Because obesity is a chronic relapsing disease [52] manifesting itself in an environment conducive to obesity, it is not surprising that short-term effects do not persist over the long term, especially in children who are highly susceptible to the influences of their surrounding environment [42]. Maintenance therapies are therefore a very important component of effective interventions. An analysis including 11 studies on the effectiveness of maintenance therapies after the completion of obesity treatment in children confirmed their stabilizing effect on BMI SDS, in contrast to the control group, in which an increase in BMI SDS was observed [53].

Results of long-term observational studies on the effectiveness of interventions in children with excess body weight indicate and highlight a greater effectiveness of applied interventions in younger children. Wiegand *et al.*, in a 2-year follow-up of 3135 patients aged 5–25 years, showed that younger children aged 5–11 years were more likely to reduce weight than 12–15-year-olds, and suggested that the use of interventions before the onset of puberty may be effective in long-term weight maintenance [54]. Reinehr *et al.*, in a 5-year follow-up of 662 motivated obese children participating in a year-long lifestyle change intervention, indicated greater effectiveness of the intervention in children younger than 8 years [55]. Another study that summarized a 5-year follow-up of 220 children aged 5 to 13 years participating in an outpatient behavioural intervention showed the largest effect in the 4–6-year-old age group. The age of the child at the start of treatment proved to be the only factor influencing treatment efficacy in this study [56]. Likewise, a 3-year follow-up of 654 children aged 2 to 18 years who participated in a multidisciplinary family intervention showed that children in the 2–6-year-old age group had the greatest reduction in BMI SDS at 12, 24, and 36 months of follow-up [57].

Risk of complications

The need to apply interventions to children with excess body weight in early childhood is also stressed by the results of studies evaluating the link between childhood BMI and the risk of developing complications. The chance of developing complications increases with the duration of obesity [58].

A large population-based cohort study involving 276,835 children proved that higher BMI values in childhood increase the risk of ischaemic heart disease in adulthood. This risk increases with age, remains moderate for 7-year-olds, but soars at the age of 13 years [59].

A retrospective study of 37,672 men confirmed that those who were overweight in adolescence had a higher risk of acute coronary events and death from acute coronary events than those who were never overweight. In contrast, men with over-

weight in childhood and its remission in adolescence showed no increased risk of acute coronary events. Excessive BMI during adolescence most likely initiates the coronary atherosclerotic process and thus increases the risk and severity of acute coronary events in adults [60].

Another retrospective study of 62,565 men found that those who were overweight in early childhood but achieved remission of their excess weight between the ages of 7 and 13 years and maintained a normal weight in early adulthood, had a risk of type 2 diabetes like normal-weight men whose weight had always been normal. Similarly, men who achieved remission of overweight later (between age 13 years and early adulthood) had a risk of type 2 diabetes higher than those who had never been overweight, but lower than men who had been overweight since childhood and never showed remission. The unfavourable effects of being overweight in children at age 7 years on the risk of type 2 diabetes may be reduced by remission of overweight before adolescence and maintaining a normal body weight into early adulthood, while the adverse effects of being obese at age 7 years or overweight at age 13 years are only partially reversible [61].

Summary

Early diagnosis of obesity in children is crucial, so that it can be effectively managed even before complications develop. It is particularly important to identify children at high risk of obesity and its complications. Reducing the number of children with obesity will result in a reduction in the prevalence of obesity and its complications among adults.

Because obesity is a chronic disease with escalating effects over time, its treatment should begin as early as possible and continue throughout childhood, adolescence, and early adulthood, with a transition to adult care. Intervention programs related to lifestyle changes and dietary modification are considered central to the treatment of childhood obesity. Such programs should be integrated with school- or community-based programs to reach the widest audience possible.

The primary goal should be to prevent obesity in children, especially the youngest, by fostering physical activity, a healthy diet, and a health-promoting environment, because achieving effective, long-term results through lifestyle modification after obesity has occurred is difficult.

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