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Weight status and body composition analysis among Polish boys with autism spectrum disorders

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ABSTRACT: Currently, autism spectrum disorders (ASD) are one of the main health care problems in both Poland and in other countries. There are limited studies on the physical growth and body composition among children and adolescents with ASD. Several studies have indicated that the prevalence of unhealthy weight is high among autistic patients. Therefore, the main aim of this study was to assess the prevalence of underweight, overweight and obesity of Polish boys with ASD and to analyse body composition.
A cross-sectional study was performed on 29 Polish boys aged 3–11 with autism. Anthropometric measurements were taken. Bioelectrical impedance analysis (BIA) was used to evaluate body composition. The percentile values and z-scores for body height, body weight and BMI were calculated. The CDC cut–points were used to determine weight status. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.
16.1% autistic boys had z-scores for body weight above two standard deviations, 12.9% had z-scores for body height above two standard deviations and z-scores for BMI above two standard deviations were found in 19.4% of the boys. 13.8% of autistic boys were underweight, 48.3% had healthy weight, 20.7% were overweight, and 17.2% were obese. The mean value of body fat percentage was 18.46%, and 16.1% of the boys with ASD had higher than normal fat tissue.
There is a high prevalence of overweight and obesity among Polish boys with autism.

KEY WORDS: obesity, autism, BMI, overweight, underweight

Introduction

Autism is currently one of the major health care problems in the world (Newschaffer and Kresch Curran 2003). Autism spectrum disorders (ASD; the ICD-10 codes: F.84, the ICD-11 codes: 6A02) are complex sets of neurodevelopmental disorders that occur in early childhood. People with ASD tend to

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have communication deficits such as responding inappropriately in conversations or misreading nonverbal interactions, and social deficits such as difficulty with building and understanding friendly relations appropriate for their age or presenting restricted, repetitive patterns of behaviors, interests, and activities (American Psychiatric Association 2013; Grzadzinski, Huerta and Lord 2013; WHO 2018). Current ASD prevalence estimates are significantly higher in comparison with previous years (Matson and Kozlowski 2011). In Canada, among children and adolescents aged 5–17, an estimated 1 in 66 have been diagnosed with ASD (Report of the National Autism Spectrum Disorder Surveillance System 2018). In Poland, based on epidemiological studies conducted in 2012 by Piskorz–Ogórek and colleagues (2015), it can be concluded that 1 in 2941 children have been diagnosed with ASD. Generally, males diagnosed with ASD is four times more prevalent than females.

ASD are very heterogeneous disorders, symptoms can range from relatively subtle and mild to very severe. Many children and adolescents with ASD also suffer from other medically relevant disorders that may have a negative impact on their growth. Most of them show significant cognitive and motor deficits. Also sleep problems are very common in this group (Bauman 2010). Other health problems include gastrointestinal disorders such as vomiting, diarrhea, constipation, abdominal pain, bloating, gaseousness, belching and reflux (Horvath and Perman 2002), as well as metabolic disorders including creatine deficiency, syndromes urea cycle disorders, Wilson's disease, Lesch–Nyhan syndrome, Smith–Lemli–Opitz syndrome, higher level of triglycerides and LDL/HDL, lower level of HDL, higher level of IGF-1, IGF-2, IGFBP-3, GHBP, TT, FT and leptin and lower level of AG, DG, GH are often observed (Mills et al. 2007; Kim et al. 2009; Al-Zaid et al. 2014). Among the atypical behaviors characterizing children with ASD, eating disorders are also mentioned and can affect up to 80% of children. Eating disorders mainly include food selectivity which consists refusal to eat, limited repertoire of consumed dishes or eating the same food several times a day (Williams, Gibbons and Schreck 2005; Bandini et al. 2010).

There are limited studies on physical growth and body composition among Polish individuals with ASD. Several studies have indicated that the prevalence of overweight and obesity is high in autistic children and adolescents (Curtin et al. 2005; Xiong et al. 2009; Curtin et al. 2010; Broder-Fingert et al. 2014; Salehi et al. 2015; Corvey et al. 2016; Granich et al. 2016; Castro et al. 2017; Healy, Aigner and Haegele 2019; Levy et al. 2019). Alternatively, alarming prevalence of underweight among this group has also been observed in the results of several studies (Hebebrand et al. 1997; Mouridsen et al. 20002; Bauset et al. 2013).

Taking into account the lack of studies in the Polish population and inconclusive worldwide studies, the main aim of this preliminary study was to assess the prevalence of unhealthy weight status (underweight, overweight and obesity) and to analyse body composition in a group of Polish boys with ASD.

Material and methods

Children were recruited from the institutions (diagnostic clinics, kindergartens) for children with special needs located

in Poznan (Wielkopolska voivodeship). The survey was carried out in compliance with the principles outlined in the Helsinki Declaration and subsequent amendments (World Medical Association Declaration of Helsinki, 2001). The present study was possible due to obtaining a permission by the Ethics Committee of Adam Mickiewicz University for research involving people (no 17/2017/2018 dated April 23, 2018). Headmasters of all institutions received invitation letters and information brochures about the research project. After their permission, parents were informed on the goals and methods of the study. The study included only these children whose parents had given a written consent to their children's participation.

The inclusive criteria were (1) diagnosis of ASD and current decision from a psychological and pedagogical counseling center about the need for special education, and (2) age between 3 and 11. Children recruited to this study had a diagnosis from a pedagogical and psychological counseling center. The diagnosis was based on ICD-10 criteria. The adjudication panel included a doctor (psychiatrist), psychologist, pedagogue and special pedagogue. The exclusive criteria were: (1) age below 3 or above 12, (2) the occurrence of additional diseases and health problems, in particular neurological and hormonal disorders, digestive system diseases or genetic disorders, (3) no written permission to participate in the study, and (4) difficulty in maintaining an independent standing posture.

Measurements were taken in the summer of 2018 by an individual researcher.

Chronological age was calculated in decimal values by subtracting the date of birth from the date of examination (Ries and Pöthing 1984). In order to assess the childrens' physical growth, anthropometric measurements, such as body height and body weight were taken according to standard procedures in institution rooms during morning hours (Knussmann 1988). Then BMI was calculated by taking a subject's weight (kg) and dividing it by subject's height squared (m^2). Based on the Center for Disease Control (CDC) growth charts (Kuczmarski et al. 2000) for 2–20 years of age, the percentile values and z-scores for body height, body weight and BMI were calculated. Then CDC Growth Charts were used to determine the following weight status: underweight (≤5th percentile), normal weight (5th < BMI < 85th), overweight (85th ≤ BMI <95th percentile) and obese (≥95th percentile for BMI). Bioelectrical impedance analysis was used to evaluate body composition. Fat mass, fat free mass, muscle mass, total body water, basal metabolic rate were assessed using the Body Composition Analyzer, TANITA MC-780 MA (TANITA, Japan). MC-780 MA had certificates allowing its use for medical purposes, meeting the standards NAWI CLASS III for scales used for medical measurements. The analyzer had an EU certificate CE0122 and met with the requirements of the Medical Device Directive MDD 93/42/EEC. The procedure required the patients to stand on the analyzer and hold a pair of handgrips, one in each hand. The measures were taken in conditions allowing for a stable measurement i.e. 3 hours after getting up, at least 3 hours after eating, 12 hours after vigorous exercise, and just before urination. All measurements were taken at the same time of a day – in late morning hours (Khalil, Mohktar and Ibrahim 2014).

Body fat percentage data were used for obesity classification, defining obese

above the 95th percentile on percentage of body fat reference curves (McCarthy et al. 2006).

All analysis were conducted with the Statistical Package for the Social Sciences (SPSS) version 25.

Results

29 boys diagnosed with autism aged 3.5 – 11.5 years participated in the study. The mean age of the sample was 6.81 years (SD = 2.59). Based on parents' declarations, all children who had qualified for the study did not have any congenital anomalies such as genetic disorders (e.g. Fragile X syndrome), neurological disorders such as epilepsy or metabolic diseases. Parents declared that the most common diseases among their autistic children were upper respiratory tract infections (31.0%) and allergies (20.7%). Parents did not report the prevalence of candidiasis in their children. Intellectual disability, mood disorder, attention deficit hyperactivity disorder (ADHD), delay of motor development, autoaggression and obsessive-compulsive disorders were the most common disabilities associated with ASD among the investigated boys. These disabilities are presented in Table 1. According to parents' reports, over half of the children suffered from sensory disorders including auditory, tactile and taste/olfactory hypersensitivity. Sleep disorders, as well as gastrointestinal disorders were also common in patients with ASD.

Table 1. Comorbidities with ASD among examined boys aged 3–11 years

Disorder	n	%
Intellectual disability	9	31.0
Attention deficit hyperactivity disorder (ADHD)	10	34.5
Delay of motor development	14	48.3
Mood disorders	9	31.0
Autoaggression	7	24.1
Obsessive-compulsive disorders	11	37.9
Sensory disorders	18	62.1
Auditory hypersensitivity	14	48.3
Tactile hypersensitivity	8	27.6
Taste/olfactory hypersensitivity	2	6.9
Sleep disorders	7	24.1
Gastrointestinal disorders	8	27.6
Abdominal pain	2	6.9
Flatulence	3	10.3
Constipation	5	17.2
Reflux	1	3.4
Loose stools	4	13.8

Parents were asked to declare if their child was being treated within the last year or before that period. Behavioral therapy was the most common form of therapy in the studied group – 58.6% of children received this form of therapy. Dietotherapy was used by 24.1% children. The undergoing therapies are shown in Table 2.

Seven boys with ASD were taking psychotropic drugs, including antipsychotic drugs (Rispolept, Haloperidol – 4 children), normotropic drugs (Vetira, Naltrexon – 2 children), anxiolytics drugs (Atarax, Hydroksyzyna – 2 children) and nootropic drugs (Gammalon, Celebroli-

Table 2. Applied therapies in boys with ASD aged 3–11 years

Therapy*	n	%
Dietotherapy	7	24.1
Gluten – free diet	5	17.2
Casein – free diet	3	10.3
Low sugar diet	5	17.2
Behavioral therapy	17	58.6
Pharmacotherapy	8	27.6
Dogotherapy	12	41.4
SI	16	55.2

*during the last year.

zyna – 1 child). Two autistic boys were taking asthma medications.

Table 3 presents the ASD patients anthropometric data.

The BMI showed that almost half of the ASD patients had normal, healthy weight – 48.3% (n = 14), 20.7% (n = 6) presented overweight and 17.2% (n = 5) were obese. 13.8% (n = 4) children were classified as underweight. The weight status of the individuals with autism spectrum disorder are presented in the Figure 1.

Body composition data according to the bioelectrical impedance analysis are shown in the Table 4. Based on fat tissue analysis it was found that 16.1% boys with ASD had fat tissue above normal (fat tissue reference values for McCarthy et al. 2006).

Table 4. Body composition analysis among boys with ASD aged 3–11 years

Element	Me ± SD (Min–Max)
%F	18.46 ± 5.38 (3.0–28.9)
%FFM	81.54 ± 5.38 (71.1–97.0)
%MM	76.76 ± 5.15 (66.7–90.9)
%TBW	60.9 ± 6.15 (52.9–77.6)
BMR kJ	435.55 ± 845.2 (2406–5812)
BMR kcal	1040.03 ± 201.97 (575–1388)

%F – percentage of body fat; %FFM – percentage of fat free mass; %MM – percentage of muscle mass, %TBW – percentage of total body water; BMR – basal metabolic rate.

Table 3. Z-scores for body weight, body height and BMI of ASD boys aged 3–11 years

	Z-scores (MIN–MAX)	Me	Z-scores > 2 SD N (%)
Z Body weight	0.34 (−2.84–5.2)	0.48	5 (17.2)
Z Body height	0.01 (−2.63–2.5)	−0.2	4 (13.8)
Z BMI	0.2 (−2.87–6.2)	0.4	6 (20.7)

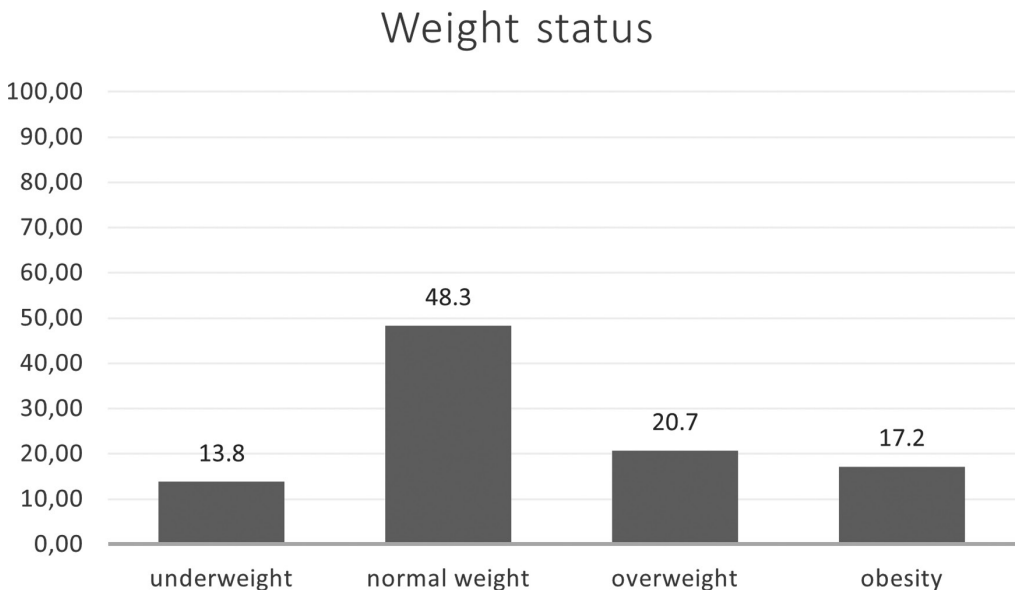

Fig. 1. Weight status of boys with ASD aged 3–11 years

Discussion

Overweight and obesity are generally recognized as the presence of excess body mass. One of the most common and simple methods to diagnose an individual's weight status is to calculate body mass index (BMI). Based on WHO definition, children and adolescents whose BMI-for-age is greater than or equal to the 85th percentile are classified as being overweight and children and adolescents with BMI equal or greater than the 95th percentile are obese. Poland has a medium to high prevalence level of childhood and adolescence overweight and obesity. According to the Global Nutrition Report (2020) 31.3% boys aged 5–19 years, examined in 2016, were overweight and 12.7% were obese. Based on the Polish Anthropological Survey, 24.75% children aged 7–12 years, examined by Gomula and colleagues (2012), were overweight or obese. In the study of Kułaga and colleagues (2016) the prevalence of overweight and obesity among children in the mentioned age was 30.4% in boys and 23.2% in girls. The prevalence of overweight and obesity differed by sex and age. Boys seem to have a higher prevalence of overweight and obesity compared to girls, and younger children tend to have a lower prevalence of excess body weight then adolescents (Mazidi et al. 2018).

There have been several studies that provide current estimates of the prevalence of overweight and obesity among children and adolescents with ASD. Twenty-one out of 31 studies reviewed by Matheson and Douglas (2017) had reported prevalence rates of overweight and obesity for adolescents with ASD in the USA. Analysis of the review of studies on the weight status in patients with ASD conducted in different countries in recent years are presented in Table 5.

Table 5 also shows the results of the research presented in this paper. The prevalence of overweight and obesity among Polish children with ASD is 37.9%. Based on the results of other studies (Table 5), it can be concluded that the prevalence of overweight and obesity among children and youth (aged 2–18) with ASD is in the range of 27.5–75.4%, mean 47.8%.

In a study by the Corvey et al. (2016) there was no association found between the severity of autistic symptoms and the prevalence of overweight and obesity.

Table 5. Review of the prevalence studies of overweight and obesity among children and adolescents with ASD

Study	Country	N	Age (years)	Overweight (%)	Obesity (%)
Curtin et al. 2005	USA	42	2–19	35.7	19.0
Xiong et al. 2009	China	429	2–11	33.6	18.4
Broder-Fingert 2014	USA	2 976	2–20	Autism: 14.8 Asperger: 11.1	Autism: 23.2 Asperger: 25.3
Corvey et al. 2015	USA	1 385	6–17	11.7	16.4
Salehi et al. 2015	Iran	85	7–14	24.7	22.4
Granich et al. 2016	Australia	208	2–16	16.3	18.8
Castro et al. 2017	Brazil	63	10.5±4.1	38.9	36.5
Healy et al. 2017	USA	875 963	10–17	19.4	23.1
Levy et al. 2018	USA	668	2–5	15.1	12.4
Trambacz-Oleszak 2021	Poland	29	3–11	24.1	13.8

Individuals with ASD had significantly higher odds of being overweight or obese in comparison to typically developing children and adolescents, controlling for age, gender, race/ethnicity and income. Zheng and co–workers (2017) conducted a meta-analysis in which they compiled the results of 15 scientific studies on overweight and obesity among patients with ASD (n = 1045538). The prevalence of obesity was significantly higher in individuals with ASD than in typically developing (OR = 1.84, 95% CI: 1.37–2.48, $p < 0.001$). However, they found that the prevalence of overweight in individuals with ASD was not significantly different from that in controls (OR = 1.07, 95% CI: 0.83–1.38, $p = 0.62$). Healy and colleagues (2018) in their study of 875,963 patients with ASD aged 10–17, revealed that adolescents with autism spectrum disorder had significantly higher odds of overweight (OR = 1.48, $p = 0.04$) and obesity (OR = 1.49, $p = 0.02$) in comparison to typically developing individuals. Similar findings among young children were reported by Levy and colleagues (2019). These authors estimated, based on the sample of 668 children with ASD aged 2–5, that odds ratio of overweight/obesity was 1.57 (95% CI: 1.24–2.00; $p < 0.001$).

Underweight and malnutrition of children and adolescents are also a common health care problem. Some studies showed a greater prevalence of underweight among patients with ASD in comparison to typically developing children. For example, in Castro et al. (2017) 15.8% of children with ASD were underweight. Furthermore, Bauset et al. (2013) indicated that the sex-and age-adjusted odds ratios for being underweight was 2.41 in children with ASD compared to healthy children. In this study, 13.8% boys with ASD were underweight, whichis a slightly higher percentage than the general population. In Poland, according to the Global Nutrition Report of children aged 5–19 years (2020) and the study on children aged 3–18 years from Krakow (Kowal et al. 2019), were 12.0% and 7.5%, respectively, underweight.

There has been almost no studies that analyze body composition in patients with ASD. Castro et al. (2017) analyzed body composition in 63 Brazilian children and adolescents with autism spectrum disorder through bioelectrical impedance. The prevalence of underweight was 15.8%, overweight – 38.9% and obesity – 36.5%. According to the body fat percentage, obesity prevalence was 49.2%, and 49.2% showed WC > 80th percentile for age. The study revealed a significant percentage of children and adolescents with ASD with overweight and truncal adiposity. In another study on the analysis of body composition in patients with ASD, Salehi with co-workers (2015) investigated 85 Iranian boys aged 7–14. The prevalence of underweight was 9.4%, overweight and obesity – 47.3%. Additionally, their study identified that the mean body fat percentage among patients with ASD was 23.5% ± 8.16% (5.9–39.6%), In Castro et al's. study the mean fat mass among autistic children was 23.2% (13.8–35.6%), whereas in the study presented in this paper it was – 18.46% ± 5.38% (3.0% – 28.9%), whereas the mean fat mass in overweight and obese children was 20.6%.

There are many factors associated with the prevalence of overweight and obesity in autistic individuals (Curtin et al. 2014; Zheng et al. 2017; Trambacz-Oleszak 2016; 2019). One of the causes may be associated disorders and health problems that negatively affect

metabolism and contribute to the accumulation of adipose tissue (Mills et al. 2007; Kim et al. 2009). Among examined Polish children with ASD, gastrointestinal disorders and sleep disorders were observed in 27.6% and 24.1%, respectively. Two boys with gastrointestinal disorders were underweight, four had normal weight, one was overweight and one had obesity.

Loose stools are a common gastrointestinal problem that affects body weight in children with ASD. Four out of 29 investigated autistic boys had loose stools, three of them had normal weight, one of them had overweight.

Among boys with sleep disorders, four had healthy weight, two were overweight and one was obese. Certain sensory disorders (indicated in 62.1% of examined boys with ASD), in particular tactile hypersensitivity, may be associated with unhealthy weight (Trambacz-Oleszak 2016). Among these boys only seven presented normal weight, five were overweight, three were underweight and obese. Low physical activity and motor problems commonly observed in children and youth with ASD are also among risk factors for weight gain (Macdonald, Esposito and Ulrich 2011). Forty-eight point three percent of the investigated boys with ASD showed delayed motor development. Normal weight had been indicated in six of them, underweight and overweight in three of them and one boy was obese.

The type of therapy provided to children with ASD is also important. . The most common therapy being received by patients with ASD in Poland is behavioral therapy. In behavioral therapy food is often used as a reward for desirable behavior. In the present study, 58.6% children with ASD were receiving this form of therapy. The prevalence of unhealthy weight in this group was high – three boys were underweight, five were overweight and three were obese. Other important factors associated with overweight and obesity among patients with ASD are genetic predispositions (Uchino and Waga 2013; Curtin et al. 2014; Lisik 2014; Wang et al.2018). and eating disorders mainly including food selectivity (Schreck et al. 2004; Evans et al. 2012). Taking medicines is also one of the most important factors that can negatively affect body weight. Second-generation antipsychotics (SGA) can cause clinically-significant weight gain but impact on body mass is related to type of medicines: weight gain appears to be the highest with clozapine and olanzapine, then by risperidone and quetiapine, and the least with ziprasidone and aripiprazole (McCloughen and Foster 2011). Approximately 30–60% children and youth with ASD take at least one psychotropic drug. The most common are sodium valproate and risperidon (Siegel 2012). In the present study 25.8% children were taking at least one psychotropic drug. Among them, only three were normal weight, three were overweight and two were obese. Moreover, two boys were taking asthma medicines – one of them had healthy weight and the other was overweight.

In this preliminary study group of Polish boys with ASD, the prevalence rates of overweight and obesity among Polish children with ASD were lower in comparison to most worldwide studies on weight status in children with ASD. Further studies are needed to define this trend in a larger Polish population.

A significant limitation of the presented results was the small size of the sample. This was due to difficulties in

reaching patients with ASD's diagnosis, obtaining consent for research and difficulties in conducting them e.g. reluctance in taking anthropometric measurements. However, this present study is a pilot study, being the first performed in Poland which combined anthropometric measurements with body composition analysis. Another limitation of this research was the lack of data on family history of overweight and obesity. There are many factors potentially associated with unhealthy body weight in children with ASD, including low physical activity, selective eating, sleep disorders, sensory disorders, gastrointestinal disorders, pharmacotherapy, dietotherapy, maternal stress and family functioning. It is almost impossible to control all of these factors.

Conclusions

On the grounds of reviewed scientific literature it may be concluded that the prevalence of unhealthy body weight (overweight and obesity) is at least as high, if not higher, in children and adolescents with ASD in comparison to other children and youth. Similar results were obtained by the pilot study conducted in Poland and presented in this paper. Children with ASD are at high risk of unhealthy weight status due to complex biological, personal and social factors. There is a need to monitor the physical growth of autistic children. Due to the strong association between obesity and other serious medical conditions, it is mandatory to create special obesity prevention programs in children with ASD.

Conflict of interest

The author declares that there is no conflict of interest.

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