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Research Paper

The prevalence of abdominal obesity among pupils with visual impairment in Poland

Magdalena Wrzesińska, Ph.D. [a,*], Beata Urzędowicz, M.D., Ph.D. [b], Tadeusz Nawarycz, Ph.D. [c], Sławomir Motylewski, Ph.D. [d], Lucjan Pawlicki, M.D., Ph.D. [b]

[a] Department of Psychosocial Rehabilitation, Medical University of Lodz, Lodz, Poland
[b] Department of Internal Medicine and Cardiac Rehabilitation, Medical University of Lodz, Lodz, Poland
[c] Department of Biophysics, Experimental and Clinical Physiology, Medical University of Lodz, Poland
[d] Department of Methodology of Teaching Motor Skills, Medical University of Lodz, Lodz, Poland

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ABSTRACT

Background: Obesity particularly affects young people with disabilities, whose ability to participate in health promotion programs is reduced.
Objective: The aim of the study is to determine the prevalence of abdominal obesity among students with visual impairment in Poland according to waist-to-height ratio, including indicators such as gender, age or certain additional coexisting disabilities or disorders.
Methods: A total of 238 students who were blind or partially-sighted, aged 7.35–23.35 years (mean age 15.5; ±3.9 years), were included in the study. Abdominal obesity was estimated using waist-to-height ratio; a cutoff point of ≥0.50 was determined as central obesity.
Results: Abdominal obesity was identified among 26.9% [N = 64] of the participants: 33.1% [N = 41] of male students and 20.2% [N = 23] of female students (ch2 = 5.02; p = 0.025; Phi = 0.145). Of all the students, the multivariate logistic regression showed that abdominal obesity was one and a half times more likely to be detected in the 7–9 year age group (OR = 1.56; 95% CI 0.58–4.18; P = 0.376) than the 19–23 year age group. However, among the female subjects, abdominal obesity was over six times more common in the 7–9 year group (OR = 6.48; 95% CI 1.29–32.5; P = 0.022) than in the group of early adults. Central obesity was detected almost three times more frequently among students with visual impairment and additional intellectual disability (OR = 2.99; 95% CI 0.52–17.1; P = 0.215) than those with only visual impairment.
Conclusion: Prevention programs aimed at reducing abdominal obesity among pupils with visual impairment from special schools are needed.

The World Health Organization (WHO) reports that obesity is particularly common in people with disabilities.[1] Excessive body weight is recognized as a secondary consequence of disability, the one which intensifies already existing health problems and could be a cause of other disorders.[2,3] Moreover, economic analysis indicates that excess weight in those with disabilities could result in higher expenditures incurred by the health care system.[2]

Obesity particularly affects young people with disabilities whose ability to actively participate in health promotion programs is reduced due to several barriers.[4] Apart from a lack of preventive activities and limited access to leisure equipment, there is a shortage of professional personnel to implement health promotion programs.[5–7] In addition, the social and emotional aspect of disability, manifested by social isolation, contributes to higher inequalities in the disabled, resulting in lower rates of participation in physical activities.[7–10]

It is estimated that more than 4% of the general population is

Abbreviation: AO, abdominal obesity; BMI, body mass index; HD, hearing disability; ID, intellectual disability; Max, maximum; Me, median; Min, minimum; n, sample size; p, probability value; SD, standard deviation; WC, waist circumference; WHO, World Health Organization; WHtR, waist-to-height ratio; VI, visual impairment; z, result of Mann-Whitney *U* Test.

* Corresponding author. Medical University of Lodz, Department of Psychosocial Rehabilitation, Pl. Hallera 1, 90-647, Lodz, Poland.
E-mail address: wrzesinska.m@wp.pl (M. Wrzesińska).

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visually impaired, including 3.65% with low vision and 0.58% with blindness. The risk of visual impairment increases with age, and it has been confirmed that about 7% of children and adolescents in the 0–14 age group, over 28% of people in the 15–49 age group and over 65% of people aged 50 and older were blind or poor-sighted.[11] People with visual impairment are particularly susceptible to social and economic discrimination.[11–13] Additionally, children with visual impairment typically master life and community skills later than sighted children.[14,15]

Young people with visual impairment are less physically active, which predisposes them to an excessive body weight. They have limited access to various forms of physical activities.[16,17] Moreover, a small body of data indicates that between 18.4% and 63% of young blind people and those with low vision are overweight or obese.[18–20]

For many years, body mass index (BMI) has been used for evaluating the risk of cardiovascular disease. Currently, abdominal obesity (AO) is regarded as a better indicator of chronic disease, metabolic syndrome or cardiovascular diseases.[21–23] Recent cross sectional or prospective studies indicate that identifying a waist-to-height ratio $\geq$0.5 (WHtR$\geq$ 0.5) is a much more useful way of screening adults, children or adolescents for cardiometabolic risk than BMI or waist circumference.[24–27] Additionally, waist-to-height ratio has recently been acknowledged as a simpler and more predictive indicator of “early health risk” associated with AO, than the more complex “matrix” based on traditional boundary values for BMI and waist circumference.[28] Moreover, an analysis of cardiometabolic risk factors among the group defined as “healthy” according to BMI and WHtR $\geq$0.5 found them to have significantly higher cardiometabolic risk factors than those with “healthy” BMI but WHtR< 0.5. A number of studies confirm that waist-to-height ratio is also recommended in pediatric or General Practice, because of its lack of dependence on age, gender, race or ethnicity.[27]

Nonetheless, as in the case of waist circumference, the prevalence of AO defined by WHtR$\geq$ 0.5 is heterogeneous across countries. Central obesity defined by WHtR$\geq$0.5, has been observed in over 16% of boys and almost 8% of girls in China, and in the every third child or adolescent in America.[29,30] In a comparative study of Polish and German schoolchildren, the prevalence AO was found to be similar for boys (6.7% vs. 8.5%) but significantly lower for the Polish girls (5.3%) than the German girls (12.7%).[31] However, no uniform consensus on waist-to-height ratio cut-off points for children and adolescents from different populations has yet been reached.[32,33]The predictive ability of waist circumference and waist/height ratio to indicate central adiposity in children is also controversial. The cutoff points suggested for these parameters vary among studies because of the lack of standardization of the anatomical site used for measurements or some differences are related to ethnicity.[34]

The present study serves as an attempt to raise general awareness of the problem of central obesity in young people with visual impairment in Central Europe. Its aim is to determine the prevalence of AO among students with visual impairment according to waist-to-height ratio, including indicators such as gender, age or certain additional coexisting disabilities or disorders.

Materials and methods

Procedure for realization of the project

Students with special needs may enrol in all types of schools in Poland based on individual mental or physical development and special need. School attendance in Poland is obligatory until the age of 18, but pupils with various types of disabilities may extend their schooling obligation to the age of 16 for primary school, 21 for junior high school and 24 for secondary school.[35,36]

After receiving consent from the Bioethics Committee of the Medical University of Lodz (no. RNN/291/14/KB), information about the planned research project was sent to all ten Polish special schools for blind and low vision pupils. The study was approved by four special schools in Łódź, Kraków, Wrocław and Dąbrowa Górnicza. In the second stage, 700 people aged seven to 24 were invited to participate in the project. Three hundred and twenty-eight gave their written consent to participate in the study. Two hundred and seventy-four subjects were included in the examination. Due to the fact that some school medical records were incomplete, and that some pupils could not cooperate or were absent during the day of data collection, 238 persons were ultimately qualified for the statistical analysis.

Characteristics of the study subjects

A total of 238 students aged 7.35–23.35 years (mean age 15.5 $\pm$ 3.9 years) were included in the study. All students had been diagnosed with visual impairment of varied etiologies. Each subject was classified as a pupil with special needs on the basis of specialist diagnosis before commencing study in the school. The majority (N = 199; 83.6%) were diagnosed with low vision and the rest were blind (N = 39; 16.4%). The level of visual impairment and identification of other disabilities or disorders were based on ICD-10 criteria.[37] Standardized protocols were used by trained examiners: a physician, public health professionals and an Anthropology specialist. In the schools, the team members cooperated with school staff and nurses.

All the studied subjects were diagnosed with visual impairment before the age of five years, and in 172 cases (72.3%), this disability was the only one present. In 37 (15.5%) of the subjects, visual impairment was concomitant with mild intellectual disability (ID), and 18 (7.6%) subjects also demonstrated mild hearing disability (HD), while four (1.7%) subjects had mild motor disability. Seven pupils (2.9%) displayed more than two other disabilities.

According to the medical records of the special schools, 11.3% of the studied subjects had neurological disturbances (n = 27), 5.5% with bronchial asthma (n = 13), 4.6% with endocrine disturbances (n = 11), 3.8% with genetic disorders (n = 9), 3.8% with Attention Deficit Hyperactivity Disorder (n = 9), 2.9% with diabetes (n = 7) and 1.7% with cardiac disorders after surgical correction (n = 4). All the studied subjects with the above disorders were placed under the care of a medical specialist.

Anthropometric measurements

While taking the medical history, the physician asked the subject about current complaints, chronic diseases (diabetes, celiac disease, cardiac disorders), headaches, abdominal pains, frequency of bowel emptying and diarrhoea, which might be a cause of potential underweight. The medical examination included an evaluation of the skin, mucous membrane, auscultation of the heart and lungs and palpation of the abdominal cavity. After the medical examination, each subject was classified according to anthropometry measurements.

The anthropology measurements were taken by the same team, a public health professional and an anthropology professional, based on a study protocol prepared earlier. All measurements were conducted in the office of the school nurse between 8:00 a.m. and 1:00 p.m. Subjects wore light clothes during the examination, but without shoes. The school nurses were responsible for the coordination of the study and preparing documents with the unnecessary information. The ages of the subjects were calculated from the dates of birth and the examination. All medical equipment

Table 1
Anthropometric characteristics by age group in boys and girls.

Age (years)	n	Height					WC					WhtR				
		Mean	SD	Me	Min	Max	Mean	SD	Me	Min	Max	Mean	SD	Me	Min	Max
Males																
7–9	15	133.9	9.20	131.0	123.2	157.0	64.4	10.00	61.5	54.0	90.0	0.48	0.05	0.48	0.44	0.63
10–13	32	148.5	12.40	145.6	129.1	195.0	70.2	11.10	69.5	50.0	96.0	0.47	0.07	0.45	0.38	0.63
14–18	40	172.5	9.47	173.3	149.8	195.0	79.2	12.40	77.0	61.0	121.0	0.46	0.07	0.44	0.35	0.66
19–23	37	171.9	7.76	173.4	152.0	187.6	83.6	13.00	81.0	61.0	126.0	0.49	0.08	0.47	0.37	0.77
Females																
7–9	11	127.6	6.19	126.9	116.4	138.0	62.4	6.72	61.0	52.0	73.0	0.49	0.06	0.48	0.41	0.61
10–13	24	148.8	9.42	147.0	132.2	170.3	70.1	8.93	67.0	57.8	92.3	0.47	0.06	0.46	0.40	0.60
14–18	38	161.5	7.83	161.2	143.2	184.7	73.7	9.28	72.0	62.0	105.0	0.46	0.07	0.44	0.38	0.73
19–23	41	160.4	7.84	160.8	144.6	182.5	72.0	9.11	71.0	58.0	96.0	0.44	0.08	0.44	0.10	0.61

n- sample size; SD- standard deviation; Me- median; Min- minimum; Max- maximum; BMI- body mass index; WC- waist circumferences; WHtR- waist-to-height ratio.

(stadiometer and anthropometric tape) was calibrated, and the same devices were used during the examinations of participants.

Body height was measured with the use of a stadiometer, in a standing position, to an accuracy of 1 mm. The measurements were made twice. If the difference between the measurements was exceeded 4 mm, the height of the student was measured for a third time.

The waist was measured at the end of free exhalation using the anthropometric tape with an accuracy of 1 mm. All participants were measured in a standing position, with an even distribution of body weight on both feet, after emptying their bladder. The result of measurement was the smallest value of the circumference of the trunk between the lower edge of the costal arches and the alae of the ilium. The waist was measured twice and a third measurement was taken if the differences between the results of the first and the second results was 3 cm. The methodology was based on Polish study OLAF PROJECT (PL0080).[38,39] Abdominal obesity was estimated using the waist-to-height ratio, calculated by dividing the waist circumference in cm by height in cm; values equal to or above a cutoff point of 0.50 were regarded as indicators of abdominal obesity. Table 1 shows the anthropometric characteristics according to age group in males and females.

Statistical analysis

For the purpose of statistical analysis, the subjects were classified into age groups: children (7–9 years old), early adolescents (10–13 years old), late adolescents (14–18 years old) and young adults (19–23 years old).

The Statistica v 10 software package was used for statistical analysis. The obtained results were analyzed using the chi-square test. Yates's correction and Fisher's exact test was used for small numbers. The nonparametric Mann-Whitney *U* test was used to compare mean values between age groups including gender groups. Phi and Cohen's d were analyzed as effect size to report the strength of the statistical relationship.

The association between the presence of abdominal obesity and gender, age group, type of visual impairment, presence of additional disability or disorders was evaluated by multivariate logistic regression analysis. Visually-impaired subjects with other disabilities such as ID and HD were included in the statistical analysis. Subjects with visual impairment and other disabilities were excluded from multivariate logistic regression analysis because of insufficient quantity of subgroups. Confidence intervals (CIs) were presented as 95% CI. A p-value less than 0.05 was considered to be significant.

Table 2
Prevalence of abdominal obesity among males and females based on waist-to-height ratio.

	Total	7-9 years	10-13 years	14-18 years	19-23 years
	N (%)				
Males (N = 124)[a]					
WHtR<0.50	83 (66.9)	11 (73.3)	21 (65.6)	29 (72.5)	22 (59.5)
WHtR≥0.50	41 (33.1)	4 (26.7)	11 (34.4)	11 (27.5)	15 (40.5)[b]
Females (N = 114)					
WHtR<0.50	91 (79.8)	6 (54.5)	17 (70.8)	32 (84.2)	36 (87.8)
WHtR≥0.50	23 (20.2)	5 (45.5)	7 (29.2)	6 (15.8)	5 (12.2)
Blind (N = 39)					
WHtR<0.50	27 (69.2)	4 (80,0)	4 (57,1)	10 (66.7)	9 (75,0)
WHtR≥0.50	12 (30.8)	1 (20.0)	3 (42.9)	5 (33.3)	3 (25.0)
Low Vision (N = 199)					
WHtR<0.50	147 (73.9)	13 (61,9)	34 (69.3)	51 (81.0)	49 (74,2)
WHtR≥0.50	52 (26.1)	8 (38.1)	15 (30.6)	12 (19.0)	17 (25.8)
Total (N = 238)					
WHtR<0.50	174 (73.1)	17 (65,4)	38 (67.9)	61 (78.2)	58 (74,4)
WHtR≥0.50	64 (26.9)	9 (34.6)	18 (32.1)	17 (21.8)	20 (25.6)

n- sample size; WHtR- waist-to-height ratio.
[a] Males vs Females p = 0.025.
[b] Males vs Females p = 0.004.

Results

Central obesity was detected among 26.9% [N = 64] of the studied students: in 33.1% [N = 41] of male students and 20.2% [N = 23] of female students (ch2 = 5.02; p = 0.025; Phi = 0.145). AO was detected over three times more frequently in male than female students in the 19- to 23-year age group (M: 40.5% [N = 15]; F: 12.2% [N = 5]; ch2 = 8.20; p = 0.004; Phi = 0.324), and this difference was significant (Table 2).

With regard to gender, male students were generally found to have higher mean WHtR than female students, but the differences were not significant (M: 0.474 ± 0.071; F = 0.458 ± 0.070; z = 1.611; p = 0.107). Similarly, the differences in mean WHtR between the sexes were only significant in the 19–23 age group (M = 0.487 ± 0.078; F = 0.441 ± 0.078; z = 2.612; p = 0.009), with a

Table 3
Mean level of waist -to -height ratio according to gender and age group.

Age (years)	Male		Female		z	p
	Mean ± SD	Me	Mean ± SD	Me		
7–9	0.479 ± 0.049	0.477	0.490 ± 0.058	0.480	0.675	0.500
10–13	0.473 ± 0.070	0.454	0.472 ± 0.061	0.463	0.141	0.888
14–18	0.460 ± 0.071	0.444	0.457 ± 0.066	0.441	0.010	0.992
19–23	0.487 ± 0.078	0.472	0.441 ± 0.078	0.437	2.612	0.009
Total	0.474 ± 0.071	0.459	0.458 ± 0.070	0.448	1.611	0.107

SD- standard deviation; Me- median, p- probability value; z- result of Mann-Whitney *U* Test.

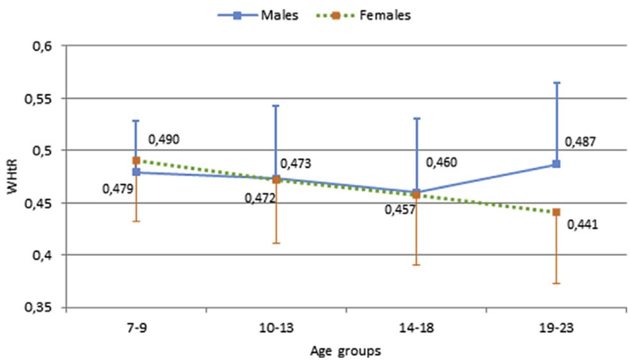

Fig. 1. Mean level of WHtR in gender group according age group.

medium effect size (Cohen's d = 0.5897) (Table 3) (Fig. 1).

In our group the multivariate logistic regression showed that abdominal obesity was detected one and a half times more frequently in the 7–9 years group (OR = 1.56; 95% CI 0.58–4.18; P = 0.376) than the early adults group. However, among the female subjects central obesity was also observed over six times more frequently in the 7–9 years group (OR = 6.48; 95% CI 1.29–32.5; P = 0.022), and almost three times more frequently among the 10–13 years group (OR = 2.75 95% CI 0.71–10.7; P = 0.139), than in the group of early adults. In total, central obesity was observed almost three times more frequently among students with additional intellectual disability (OR = 2.99; 95% CI 0.52–17.1; P = 0.215) than those with only visual impairment. Additionally, male students with additional intellectual disability were more than five times more likely to demonstrate WHtR ≥0.50 than pupils with visual impairment alone (OR = 5.25; 95% CI = 0.43–63.6; P = 0.188) (Table 4).

However, male students with an additional hearing impairment were half as likely to have AO than male students with only visual impairment (OR = 0.42; 95% CI 0.02–9.16; P = 0.577). Moreover, WHtR ≥0.50 was detected one and a half times more frequently in the female subjects with a coexisting hearing impairment (OR = 1.57; 95% CI 0.09–27.8; P = 0.754) and of with a mental disability (OR = 1.54; 95% CI 0.11–21.6; P = 0.746) than the female subjects with only a visual impairment.

Discussion

Some reports confirm that children and adolescents with visual impairment have greater prevalence of overweight and obesity than their peers without disabilities, according to BMI criteria. In a similar age group with visual impairment, Montero[20] identified overweight in every fourth person and obesity in 12%, Chen et al.[18] observed overweight in 18% of subjects from a group aged 7–17 years with a sensory disability, while Greguol, Gobbi & Carraro[19] reported the prevalence of overweight and obesity in more than 60% of Brazilians and 27% of Italians aged 8–14 with visual impairment. About 14% of female students and 18% of male students aged 7–18 years from the general population have been found to be overweight or obese in Poland.[38] However, body mass index does not provide any information about the distribution of body fat, and waist-to-height ratio is a simple screening tool in detecting central fat distribution. In the present study, abdominal obesity was identified in every third male subject and every fifth female subject, and was found to be more common in children and adolescents without disabilities. However, the proportion of students with WHtR ≥0.5 in the group of Polish children and adolescents aged 7–19 without disability is much lower, amounting to 6.7% for boys and 5.3% for girls.[31] It also should be noted that significant differences were noted in the early adults group: the male students had a higher mean value of WHtR, and they were three times more likely to demonstrate AO than female students. Additional statistical analysis showed that among the female subjects, central obesity was detected more frequently among children and adolescents than young adults. Reports on body fat distribution indicated a gender dimorphism regarding fat distribution around the body throughout life: girls have significantly higher amounts of body fat than boys, and accumulate less fat on the waist but more around the hips. These gender differences are amplified with maturation and it is observed especially from late puberty to early adulthood.[40,41] Unfortunately, as no other reports concerning the prevalence of abdominal obesity in pupils with visual impairment could be found, it was not possible to compare these results with those of other studies.

Our findings also indicate that subjects with visual impairment and coexisting intellectual disability, particularly male students, were at higher risk of AO than pupils with only visual impairment. These findings have been confirmed in previous studies concerning

Table 4
Abdominal obesity according to age group, type of visual impairment, presence of other disabilities or disorders.

	Total				Males				Females			
	N (%)	OR	95%CI	p	N (%)	OR	95%CI	p	N (%)	OR	95%CI	p
Age (years)												
7–9	9 (14.1)	1.56	(0.58–4.18)	0.376	4 (9.8)	0.55	(0.14–2.22)	0.398	5 (21.7)	6.48	(1.29–32.5)	0.022
10–13	18 (28.1)	1.23	(0.56–2.69)	0.603	11 (26.8)	0.79	(0.28–2.21)	0.651	7 (30.5)	2.75	(0.71–10.7)	0.139
14–18	17 (26.6)	0.69	(0.32–1.49)	0.347	11 (26.8)	0.46	(0.17–1.25)	0.124	6 (26.1)	1.32	(0.35–4.96)	0.678
19–23	20 (31.2)	1.00			15 (36.6)	1.00			5 (21.7)	1.0		
Type of visual impairment												
Blind	12 (18.8)	1.07	(0.49–2.35)	0.862	9 (22.0)	1.18	(0.44–3.13)	0.743	3 (13.0)	0.70	(0.16–3.11)	0.632
Low vision	52 (81.2)	1.00			32 (78.0)	1.00			20 (87.0)	1.00		
Concomitant diseases												
No	47 (73.4)				29 (70.7)	1.00			18 (78.3)	1.00		
Yes	17 (26.6)	0.89	(0.45–1.74)	0.732	12 (29.3)	1.18	(0.49–2.85)	0.708	5 (21.7)	0.85	(0.26–2.78)	0.791
Other disabilities												
No	46 (71.9)	1.00			31 (75.6)	1.00			15 (65.2)	1.00		
Yes	18 (28.1)	0.60	(0.12–3.01)	0.732	10 (24.4)	0.47	(0.05–4.61)	0.510	8 (34.8)	0.94	(0.09–10.3)	0.960
Multiple disabilities												
Only visual impairment	46 (71.9)	1.00			31 (75.6)	1.00			15 (65.2)	1.00		
Visual and hearing impairment	3 (4.7)	0.84	(0.11–6.35)	0.866	1 (2.4)	0.42	(0.02–9.16)	0.577	2 (8.7)	1.57	(0.09–27.8)	0.754
Visual impairment and intellectual disability	13 (20.3)	2.99	(0.52–17.1)	0.215	8 (19.5)	5.25	(0.43–63.6)	0.188	5 (21.7)	1.54	(0.11–21.6)	0.746

CI- confidence interval; N- sample size; OR- odds ratio; p -probability value.

peers with intellectual disability.[42–45] Over 20% of our subjects with VI and ID had WHtR ≥0.5. Additionally, Salaun & Berthouze-Aranda[46] confirmed that of a group of schoolchildren, 26% of the boys and 36% of the girls with intellectual disability also reported abdominal obeisty.[46]

Some studies indicate that children and young adolescents are more likely to display excessive body weight because they have less physical activity.[47] Physical activity known to play an important role in preventing or reducing the psychological problems related to the impairment, and can also improve social involvement and quality of life.[48,49] Nonetheless, pupils who are blind or poor-sighted still encounter barriers to participation in physical activity[47] and Physical Education teachers, parents or guardians often lack the knowledge of how to engage children with VI in physical activity.[50] Additionally, few physical activity promotion initiatives exist which provide proper instructions in an accessible and understandable format for people with intellectual disability. Moreover, young people with intellectual disability face further limitations including expenditure for activity programs, transportation, family time constraints and general motivation.[45] The use of electronic entertainment and communication devices, especially during night time appears to be the one of the significant risk factors of obesity among children.[51–53] Moreover, screen time is also associated with the risk of obesity in all younger people, irrespective of the presence of any disability. Young people with visual impairment have been also found to be more engaged in using new media than their peers without disabilities.[54]

One limitation of the study is the small number of subjects. Almost half of the pupils studying in special school live in boarding houses and do not have daily contact with their parents. Another limitation is the lack of the biochemical sample assessment; samples were not taken from children who were blind or poor-sighed to save the stress associated with contact with unknown people. As no similar studies conducted in special schools for blind and low vision students in Poland have been carried out, it is difficult to generalize our findings. Moreover, there is a need to standardize waist-to-height ratios among children, adolescents and adults, including those with disabilities.

Conclusion

Our study confirms that abdominal obesity is a crucial health problem among students with visual impairment, especially in those who also have intellectual disability. There is a need to provide more studies of abdominal obesity according to gender differences among subjects with disabilities. Prevention programs aimed at reducing obesity among studied pupils from special school are needed. Practitioners in health promotion activities should cooperate with teachers, parents and guardians to provide resources and improve the health status and quality of life of children with disabilities, not only at a young age, but also throughout their life. In addition, people with disabilities should be provided greater access to innovative tools to allow greater health education opportunities.

Competing interests

The authors declare they have no competing interests.

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