THE INCIDENCE OF EXCESS WEIGHT AND OBESITY ASSESSMENT AMONGST THE POPULATION OF THE CHILDREN FROM LESZNO USING VARIOUS RESEARCH METHODS

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Abstract:

Introduction: Owing to the significance of the issue of obesity perceived from the angle of public health, the tendencies of changes in the incidence of obesity in children and teenagers ought to be carefully monitored. As long as there is a consensus regarding the criterion of excess weight and obesity in adults, there is no agreement as to the obesity criterion regarding children and teenagers.

Objectives: The aim of this research was to assess the incidence of excess weight and obesity by means of various methods in the children from the district of Leszno, and to determine the correlation among the methods applied.

Material and methods: The research embraced 419 children aged 10 and 11 in year IV of primary schools in Leszno, and the following methods were adopted: the body mass index [BMI] interpreted by OLAF's growth charts, the Cole's index and the BIA analysis.

The results: The results reveal that the BMI value above the norm can be found in high proportion of the 10 and 11- year – old children from the Leszno schools, which depends on the interpretation of the BMI: 33,4 % - according to the OLAF growth charts and 27,5 % according to the Cole's method. The occurrence of statistically characteristic correlation among the obesity assessment methods was observed.

Conclusions: Not only do the findings confirm the occurrence and intensification of the phenomenon of excess weight and obesity in children but simultaneously, they indicate the need to apply standardized criteria and methods of the assessment of the body mass correctness. The research shows the Cole's method as less restrictive when defining the level of excess weight in children (compared with the OLAF`s charts) and, at the same time correlated more strongly with the indicated level of fatty tissue.

INTRODUCTION

Obesity has been a significant health problem called "the epidemic of the XXI century" for contemporary societies. The WHO states that in 2005 the excess weight problem concerned 1,6 billion people, whereas obesity – 400 million adults worldwide [23]. But what seems to be particularly alarming is the fact that this phenomenon is becoming more intense among children and teenagers.

Within the last decade a great number of research aiming at determining the incidence of excess weight and obesity in children and teenagers in Poland has been carried out. It has

been found that excess body mass occurred ranging from a few to several percent of the population under research, whereas the obesity problem concerned a few percent of the subjects. Owing to the importance of the problem from the public health's point of view (medical, psychological, economic consequences) the tendencies of changes in the incidence of obesity in children and teenagers ought to be carefully monitored. However, the assessment of the excess body mass in school children is not as simple to carry out as it may seem. As long as there is a consensus regarding the criterion of excess weight and obesity in adults, there is no agreement as to this criterion regarding children and teenagers. [5].

For adults, the value of BMI ranging from 25,0 to 29,9 kg/m2 is interpreted as excess weight, and above 30,2 kg/m2 as obesity. For children, however, the BMI value changes substantially with age. To assess the extent of excess weight in children and teenagers, growth charts or BMI growth tables, both in terms of gender and age have been used.

In many countries, the national BMI values charts are available. In Poland, the researchers use various criteria of excess weight and obesity. Some treat the BMI ≥ 90 as excess weight, whereas ≥ 97 as obesity [3,14], others take 85 and 95 centile respectively for critical values [10,12,17]. Applying this method to assess obesity in children and teenagers in a reliable way requires producing valid, adjusted to the population studied – growth charts. Even small differences at a BMI cut-off point may result in huge differences in the incidence of obesity assessment if the cut-off points intended for the population of another country were used.

This has been one of the arguments put forward by opponents of using international BMI values for assessing obesity in children and teenagers. [21].

In the obesity diagnostics, it is extremely important to determine mass and locate the fatty tissue in the organism [20]. In the population research, anthropometry regarding the body's height, mass, waist and hips circumference have been used. The value of these features, provided that appropriate patterns were applied, allow us to calculate anthropometric indexes, interpreted depending on the subjects` age and gender [2,6,9,13,15,16,18,19,22].
The most frequently followed are:

1. The measurement of the skin fold thickness
2. The Cole's index – applied in younger children
3. BMI (Body Mass Index) – growth charts
4. WC (Waist Circumference) – the waist's size
5. WHR (Waist to Hip Ratio) - ratio waist/hips
6. WHtR (Waist to Height Ratio).

However, to assess body composition, Computer Tomography (CT), Magnetic Resonance Image (MRI), Bioelectrical Impedance Analysis (BIA) or X-ray absorptiometry are used. [2,9]. The Bioelectrical Impedance Analysis (BIA) based on the difference in conducting electric current in the water and fat intervals is measured (with) hydrated fatless tissue. Due to non-invasiveness and simplicity of operating the apparatus, this was the method applied in this study supported by Body Mass Index and Cole's index.

THE AIM OF THE STUDY

The aim of the study was to make an assessment, having followed various methods, of the incidence of excess weight and obesity in children from Leszno. The main goal was accomplished through solving the following research tasks:

1. by stating if, and to which extent within the subject group the problem of excess weight and obesity occurs, determined with the help of body mass index BMI interpreted on the basis of the OLAF growth charts and the Cole's index.
2. by determining whether among the respondents, the correlation occurs between the incidence of excess weight and obesity assessment methods.

a. between the BMI interpreted on the basis of the OLAF growth charts and the Cole's index
b. between the BMI and the fatty tissue level distinguished with the help of BIA.

THE MATERIAL AND METHODS

The research embraced 419 children (including 207 boys and 212 girls) aged 10 and 11. It was carried out in September 2014, in year IV of primary schools in Leszno.

All the respondents had their height and body weight measured according to the screening tests standards [24]. The student's anthropometric measurement results were compared with relevant for their age and gender indexes, constituting the norms for the Polish population. To achieve this, growth charts and BMI value tables – according to OLAF were applied [8]. They are the outcome of the Polish research project called OLAF, aiming at working out the norms of blood pressure in the population of children and teenagers, as well as updating the reference systems of the height, body weight and body mass index.

In the OLAF project 17 573 children and teenagers took part nationwide at 416 (primary, middle and secondary) schools from 2007 – 2009. The findings show valid, relevant to the population of school children and teenagers growth charts in terms of height, body weight and body mass index which enable to detect early-stage physical disorders as well as the state of proper eating [11].

The Body Mass Index was calculated as follows:

BMI = mass (kg)/height (m^2)

The results interpretation was based on the BMI assessment criteria for children and teenagers up to the age of 18 using the BMI growth charts (according to OLAF) – criteria according to the WHO, where:

- <3 centiles – considerable weight deficiency
- <10-3 centiles – weight deficiency
- <25-10 centiles – slimness
- 25-75 centiles – correct weight (the scope of narrow norm)
- >75-90 centiles – tendency to become overweight
- >90-97 centiles – overweight
- >97 centiles – obesity [7].

Another way of assessing correct body mass in children is the Cole's and partners method [4], which proposes relevant to age and gender "cut off points" to classify obesity and excess weight out of international schedules of the BMI. The method, also called Cole's standards, was developed based on the measurements of children and teenagers in 6 countries: Brazil, Great Britain, the Netherlands, Hong Kong, Singapore and the USA and published in 2000 by the International Obesity Task Force. Cole and partners framed the BMI changes curves going through the values equaled 25,0 and 30,0 at the age of 18, for women and men. This method was recommended by IOFT, EU Platform on Diet, Physical Activity and Health for adopting when the need to assess the incidence of occurrence of excess weight and obesity in children and teenagers under 18 arises. The examined children had also a level of fatty tissue determined through assessing the body composition with BIA using the BIA analyzer from AKERN [1]. The AKERN BIA – 101 analyzer has a CE0051 certificate and meets the requirements of MDD 93/42 EEC directive in the scope of medical equipment. The body composition analyzer AKERN enables a detailed analysis of the body composition in a safe and non-invasive way, even in children aged 2. Owing to the use of the latest technology, the device shows resistance and reactance as the value of measurement, which allows achieving such parameters as phase angle and intracellular and extracellular water. The phase angle's value allows determining the degree of emaciation of the patient's organism and controlling health and physical recovery. The measurement taken with AKERN is held in a lying

position. The results of the body composition components are presented in absolute values as a mass unit (kg) and as a percentage of total body mass (%). Having examined the fatty tissue, the interpretation was found in a table of the range of fatty tissue level for children, according to the producer's recommendations. It was assumed, according to the manual, that the values above 20% in girls, and above 18% in boys prove excessive fatty tissue in the organism since the norm for girls is 16-20 % and 15-18% for boys.

THE OUTCOME

The outcome shows that the BMI value within the norms concerns over 45 % of the respondents (the interpretation according to OLAF charts) and over 64% (interpretation according to Cole). However, what seems to be alarming is the number of children with excess body mass. The BMI above the norms refers to 33,41% children examined through OLAF and 27,5 % with the Cole's method. Nonetheless, we must remember that the growth charts include the following classifications: tendency to become overweight – 18, 85 %, excess weight – 11,69%, and obesity – 4,06 %. Table 1 shows the proportion of children qualified for a suitable BMI category according to both methods. It contains the BMI criteria according to Cole and partners` classification, which were marked respectively: (-3) considerable emaciation, (-2) emaciation, (-1) undernourishment, (0) normal, (1) excess weight, (2) obesity.

Table 1. The BMI classification results interpreted with both methods: the OLAF growth chart and Cole's index

Cole / chart	BMI Cole's (-3)		BMI Cole's (-2)		BMI Cole's (-1)		BMI Cole's (0)		BMI Cole's (1)		BMI Cole's (2)		total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
considerable deficiency	1	0,24	7	1,67	2	0,48	0	0,00	0	0,00	0	0,00	10	2,39
deficiency	0	0,00	0	0,00	15	3,58	0	0,00	0	0,00	0	0,00	15	3,58
slimness	0	0,00	0	0,00	9	2,15	53	12,65	0	0,00	0	0,00	62	14,80
normal	0	0,00	0	0,00	0	0,00	192	45,82	0	0,00	0	0,00	192	45,82
tendency to become overweight	0	0,00	0	0,00	0	0,00	25	5,97	54	12,89	0	0,00	79	18,85
excess weight	0	0,00	0	0,00	0	0,00	0	0,00	44	10,50	5	1,19	49	11,69
obesity	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	12	2,86	12	2,86
total	1	0,24	7	1,67	26	6,21	270	64,44	98	23,39	17	4,06	419	100,00

The comparison of the number in each category indicates that according to Cole, the underweight group consists of underweight and slim children, according to the charts. The "normal "criterion, according to Cole, comprises slim children, about the norm and with tendency to become overweight. In the "excess weight and obesity" category, according to Cole, the children with the tendency to put on weight, also overweight and obese ones are found, according to the chart. The shifts between adjacent categories might be observed. According to Cole, normal are slim children and those with the tendency to be overweight, according to the charts (Fig.1).

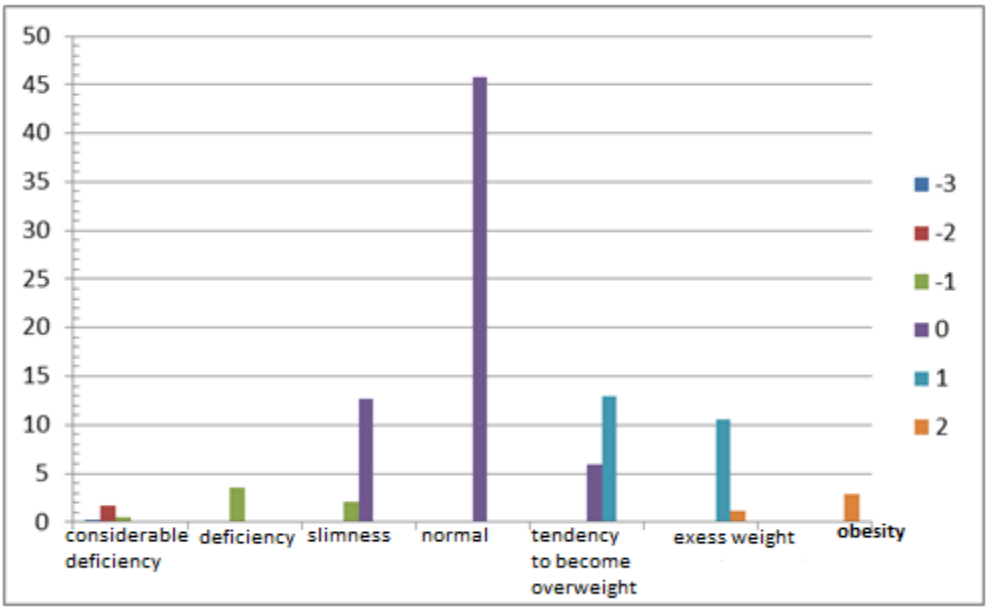

Fig. 1. The juxtaposition of the percentage occurrence frequencies of the BMI category determined with the help of the Cole's method [(-3), (-2), (-1), (0), (1), (2)] at the background of the BMI category in the charts` interpretation

If separate BMI categories interpreted by Cole are combined to make three categories: emaciation and undernourishment (-1), normal (0), excess weight and obesity (1) (table 2), these categories and the BMI categories according to the chart are variables dependent and correlated with one another positively at the $p \leq 0{,}0001$ level (table 3). This dependence was shown owing to the statistics Chi^2, whereas the statistics Chi^2NW (the greatest credibility) also confirmed it at the significance level $p \leq 0{,}0001$, however, the Spearman`s R rang statistics revealed a linear positive dependence between these two interchangeables. (table 3). Moreover, the percentage frequencies of the methods applied were presented graphically (Fig.2).

Table 2. The number and percentage comparison of the two methods of the body mass correctness assessment

Cole's / charts	(-1)		(0)		(1)		Total	
	N	%	N	%	N	%	N	%
considerable deficiency	10	2,39	0	0,00	0	0,00	10	2,39
deficiency	15	3,58	0	0,00	0	0,00	15	3,58
slimness	9	2,15	53	12,65	0	0,00	62	14,80
normal	0	0,00	192	45,82	0	0,00	192	45,82
tendency to become overweight	0	0,00	25	5,97	54	12,89	79	18,85
excess weight	0	0,00	0	0,00	49	11,69	49	11,69
obesity	0	0,00	0	0,00	12	2,86	12	2,86
groups total	34	8,11	270	64,44	115	27,45	419	100,00

Table 3. The dependence between BMI categories according to Cole and the categories according to the OLAF growth charts
(** - significant at the p≤0,001 level)

Statistics	p
Pearson`s Chi- squared	p=0,000**
Chi ^{2} NW	p=0,000**
Spearman`s R rang	p=0,000**

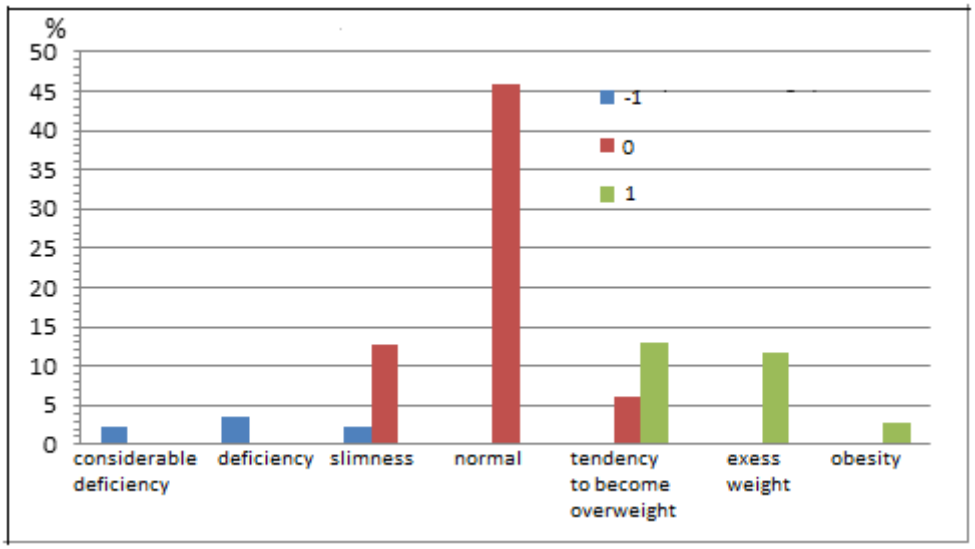

Fig. 2. The percentage comparison of the BMI category according to the two methods

Amongst 419 respondents, for 140 children the BMI determined on the basis of the charts` method was above the norm. The index's values were presented in table 1. The children whose BMI was above the norm had the level of fatty tissue examined with the BIA method. 9 children have normal level of fatty tissue, and all of them show the tendency to become overweight (100 %). The level of the fatty tissue above the norm was found in 131 people, including 53,44 % of the people with the tendency to become overweight, 37, 40 % with excess weight and 9,16 % with obesity (table 4). All of the respondents with obesity and excess weight have the level of the fatty tissue above the norm. The values of the fatty tissue level and the categories of the OLAF charts are dependent variables (table 5).

Table 4. The amount and percentage comparison of the body mass index interpreted on the basis of the OLAF chart, and the level of fatty tissue

OLAF charts	The level of fatty tissue normal		The level of fatty tissue above the norm		Total
	N	%	N	%	N
tendency to become overweight	9	100	70	53,44	79
excess weight	0	0	49	37,40	49
obesity	0	0	12	9,16	12
total	9	100	131	100	140

Table 5. The descriptive statistics of the correlation between BMI interpreted on the basis of the OLAF chart and the level of fatty tissue
(* - significant at the p≤0,05, ** significant at the p≤0,01 level)

Statistics	p
Pearson`s Chi- squared	p=0,024*
Chi ^{2} NW	p=0,005**
Spearman`s R rang	p=0,008**

The dependence between the level of fatty tissue and the categories of BMI, according to Cole was also assessed. In the interpretation of the BMI by the Cole's method, within the category "normal" there were also the children from the category "slim and with the tendency to become overweight", according to the charts (table 1). Despite the fact that among 419 children only 115 had the body mass index (according to the Cole's method) higher than normal, the level of the fatty tissue was assessed in 140 children including 25, for whom the value of BMI was normal according to Cole, but according to the charts` interpretation - in the "tendency to become overweight" category (table 2).

66,67 % of the respondents being placed within the norm limits according to Cole's category (table 6) were distinguished by the normal level of the fatty tissue, whereas 14,5% with the level of the fatty tissue above normal. Among the people falling into the category "excess weight and obesity" according to Cole, no less than 85,50 % had the level of the fatty tissue above the norm (table 6).

Table 6. The number and percentage comparison of the body mass index, interpreted on the basis of the Cole's method and the level of fatty tissue

Cole's	The level of fatty tissue normal		The level of fatty tissue above the norm		total
	N	%	N	%	N
norm	6	66,67	19	14,50	25
excess weight and obesity	3	33,33	112	85,50	115
total	9	100	131	100	140

Table 7. The descriptive statistics of the correlation between the body mass index according to Cole and the level of fatty tissue (** significant dependence at the p≤0,01 level)

Statistics	p
Pearson`s Chi- squared	p=0,00008**
Chi ^{2} NW	p=0,00071**
Spearman`s R rang	p=0,00005**

Table 8. Statistical characteristics for the BMI values depending on the level of fatty tissue

Fatty tissue level	BMI average	N	BMI standard deviation	BMI minimum	BMI maximum
0	19,89	9	0,98	18,86	21,80
1	22,08	131	2,21	19,22	33,34
total	21,94	140	2,22	18,86	33,34

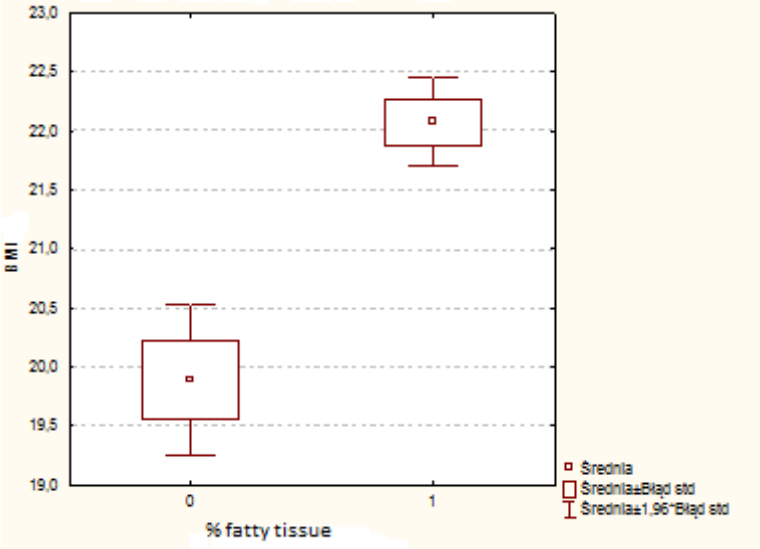

Fig. 3. A graphically represented image of the BMI values according to Cole depending on the level of fatty tissue

In order to find out whether the level of fatty tissue has a significant influence on the BMI variables (based on the Cole's method), the variance analysis was carried out. The analysis confirmed this significance at the p≤0,05 level (table 9). The values of the body mass index determined with the help of the Cole's method vary significantly depending on the level of fatty tissue, determined with the BIA.

Table 9. The variance analysis – the influence of the fatty tissue level on the BMI values

Variable	df	df error	F	p
BMI	1	138	8,65329	0,003830**

SUMMARY

The results of the research on 10 and 11 – year – old children from Leszno show that the BMI value demonstrating the norm refers to 45 % of the respondents (the interpretation according to the OLAF charts) and over 64% (interpreted according to the Cole`s index). However, the BMI value above normal concerns 33,4% of the respondents tested on the basis of the OLAF charts and 27% with the Cole's method. Despite the fact that the discussed interpretations of the BMI value (according to Cole and OLAF` charts) differ in terms of distinguished categories and their frequencies, the incidence of the category of both interpretations of BMI is statistically dependent, and this is a linear positive dependence. In order to confirm the legitimacy of applying various methods of obesity assessment, the correlation between them has been checked. The credibility of the methods applied has been confirmed by observing significant linear positive dependence at the p≤0,001 level between the body mass indexes in the charts` interpretation and Cole's interpretation as well as a significant dependence at the p≤0,01 level between the body mass index (interpreter according to both methods) and the level of fatty tissue. The greater affinity with fatty tissue show the body mass indexes, interpreted according to the Cole`s method (significant dependence at the p≤0,01 level) than the body mass indexes interpreted according to the OLAF charts (significant dependence at the p≤0,05 level). The research carried out a year before on 10 and 11-year-old children from the same region revealed the lower proportion of the children within the norm limits (41% according to the charts and 60% according to Cole) and a similar percentage of the children above the norm.

CONCLUSIONS

1. It is not an easy task to assess the body mass in children and teenagers as determining the incidence of obesity depends on the definition (norm) applied, the representativeness of the test, the duration of the research, different levels of centiles defining obesity and deriving from various schedules, and many other reasons hampering the comparison. The frequencies of excess weight and obesity occurrence are only credible if the same assessment criteria have been used.
2. The outcome of the research done in Leszno not only confirms the existence and escalation of the excess weight and obesity phenomena in children, but also indicates the necessity to apply standardized criteria and methods to assess the body mass correctly.
3. The research undertaken by us demonstrates that the Cole's method appears to be less restrictive while determining the level of excess weight and obesity in children. Simultaneously, the findings show a strong correlation of this method with the indicated level of fatty tissue.

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