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Insight into the overweight and obesity risk in primary school children: A pilot study

O introspecție asupra riscului supraponderalității și obezității la copiii din școala primară: un studiu pilot

Ancuța Banu [1,2], Costela Şerban [3], Denis Şerban [4], Brigitha Vlaicu [1]
"Victor Babes" University of Medicine and Pharmacy Timişoara, Romania
[1] Faculty of Medicine, Department of Microbiology, Discipline of Hygiene
[2] Faculty of Dentistry, Department 2, Discipline of Maxillo-Facial Surgery
[3] Faculty of Medicine, Department of Functional Sciences, Discipline of Medical Informatics and Biostatistics
[4] Faculty of Medicine, Department of Microbiology, Discipline of Microbiology

Abstract

Background. Prevalence of childhood overweight and obesity has increased worldwide during the last decades, and longitudinal studies performed in Europe have shown that the prevalence of overweight and obesity is also increasing with age, from early childhood to adulthood.

Aims. The aim of the study was to follow the prevalence of these measures and to determine the change in the risk of overweight and obesity as children progress to early adolescence.

Methods. Weight and height were measured during a follow-up of 35.9 +/- 8 months in 123 primary school children, who were 6.63 +/- 0.63 years old at the initial evaluation. Height, weight and BMI were converted to z-scores depending on age and gender using WHO methodology.

Results. An increase in the prevalence of overweight and obesity during follow-up in both genders was observed. Using initial BMI-for-age and gender z-scores categories, we demonstrated that children who were overweight and obese at the initial evaluation had a higher growth rate per month during the follow-up period, when compared to normal weight children, with a large effect size. Regarding the height growth rate, no significant differences were observed between initial BMI categories. Using BMI categories at follow-up, we found that children who were overweight in the follow-up had significantly lower mean BMI z-scores at the initial evaluation, with a large effect size.

Conclusions. These results explain the increased risk of overweight and obese children in becoming obese adults and can be used as a starting point for targeted multilevel interventions in our effort to fight obesity.

Key words: overweight, obesity, primary school children, BMI, growth rate

Rezumat

Premize. Prevalența supraponderabilității și a obezității în copilărie a crescut la nivel mondial în ultimele decenii, iar studiile longitudinale efectuate în Europa au arătat că prevalența obezității și a excesului de greutate este, de asemenea, în creștere pe măsura înaintării în vârstă, din copilăria timpurie până la maturitate.

Obiective. Studiul a urmărit modificările prevalenței supraponderabilității și a obezității pentru copiii de școală primară și determinarea riscului acestor măsuri pe măsura avansării spre adolescența timpurie.

Metode. Greutatea și înălțimea au fost măsurate consecutiv la o durată de 35,9 +/- 8 luni la 123 de copii cu vârsta de 6.63 +/- 0.63 ani la evaluarea inițială. Înălțimea, greutatea și IMC au fost convertite în scoruri z în funcție de vârstă și sex, folosind metodologia OMS.

Rezultate. A fost observată o creștere a prevalenței supraponderabilității și a obezității la reevaluare, la ambele sexe. Folosind categoriile scorurilor z IMC pentru vârstă și sex inițiale, am demonstrat că copiii supraponderali și obezi la evaluarea inițială au avut o rată de creștere mai mare pe lună pe parcursul perioadei de urmărire, în comparație cu copiii cu greutate normală, cu un efect de mărime crescută. În ceea ce privește rata de creștere în înălțime, nu au fost observate diferențe semnificative între categoriile inițiale IMC. Utilizând categoriile IMC la reevaluare, am constatat că elevii care au fost supraponderali în follow-up au avut scoruri z ale IMC semnificativ mai mici la evaluarea inițială.

Concluzii. Aceste rezultate explică riscul crescut al copiilor supraponderali și obezi de a deveni adolescenți obezi și pot fi folosite ca punct de pornire pentru intervenții specifice pe mai multe niveluri în efortul nostru de combatere a obezității.

Cuvinte cheie: supraponderali, obezi, copii de școală primară, IMC, rata de creștere.

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Address for correspondence: Victor Babes" University of Medicine and Pharmacy; Discipline of Medical Informatics and Biostatistics, Spl. Tudor Vladimirescu No. 14, Postal Code: 300172, Timişoara, Romania
E-mail: costela.serban@umft.ro
Corresponding author: Costela Serban, costela.serban@umft.ro

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Introduction

The prevalence of overweight and obesity in children and adolescents has increased over the last 40 years (Ng et al., 2014; Bac et al., 2012). Studies have shown that in the same population, the prevalence of overweight and obesity is increasing by age groups from childhood to adulthood (Wijnhoven et al., 2014). Previous (Whitaker & Dietz, 1998; Field, 2005), and recent longitudinal designs (Petkeviciene et al., 2015; Riedel et al., 2014) have demonstrated that overweight and obese children and adolescents are likely to become overweight and obese adults. Obesity is accompanied by a high risk of development of several pathologies, and even if a few decades ago diseases such as metabolic syndrome, cardiovascular diseases, type 2 diabetes and its complications in eye and kidney, obstructive sleep apnea, infertility, asthma, orthopedic complications, psychiatric diseases and cancers were specific to obese adults, now health consequences of obesity can start as early as childhood (Kelsey et al., 2014).

The aim of this study was to observe the natural prevalence of higher than normal z-scores categories of BMI-for-age, weight-for-age and height-for-age during a follow-up in primary school children and to seek differences in the growth rate between initial BMI categories, following the hypothesis that growth rate is increased in overweight and obese children, which could be a contributing reason behind the increasing prevalence of overweight and obesity by age groups.

Material and methods

The data represents partial measures and results of a study that investigates quantitative measures of oral and dental health, teeth eruption incidents and accidents, dento-maxillary aesthetics, anthropometric variables and nutritional status in relation to self-perceived image and self-esteem related to body image. The main study design received the approval of the Ethics Committee of "Victor Babes" University of Medicine and Pharmacy Timișoara, as it belongs to a PhD study registered at this institution. Participants were included after parents and children gave their informed consent regarding participation. We used only those participants who had complete anthropometric measurements of weight and height evaluated in a repeated measures design.

Research protocol

a) Period and place of the research

Examinations related to the PhD study were performed in the medical office of Middle School no 30 in Timisoara and in the Ambulatory Service of Oral and Maxillo-Facial Surgery of Timișoara City Hospital. The measurements were made by a medical team in the school's medical office, as part of the children's annual medical monitoring. The first evaluation started in November 2011 and lasted until May 2013. The second evaluation began in January 2015 and lasted until May 2015.

b) Subjects and groups

We sampled 123 school pupils in Timișoara, Romania, with a mean age of 6.63 years +/- 0.63 (85.5 +/- 6.6 months), of which boys represented 55.3% (68). We performed anthropometric measurements initially and at follow-up up after an average period of 35.9 +/- 8.0 months. The distribution of genders by age at the initial evaluation (p=0.361) and by the mean duration for follow-up (p=0.806) was homogeneous.

c) Tests applied

We initially registered the birth date, the date of evaluation and gender, and at each evaluation, weight and height were measured using standardized personnel and instruments. BMI (body mass index) was calculated according to the formula BMI=G (kg)/I $(m)^2$. For each evaluation, *z* scores were computed for weight, height and BMI according to age and gender. Weight, height and BMI were classified using the WHO Anthro software, version 3.2.2., January 2011 (1). Between evaluations, children did not participate in any diet and/or physical activity related systematic interventions. No nutritional regime was imposed, but the effect observed was a consequence of educational activity provided by school, medical activity from the medical office and family nutritional habits.

d) Statistical processing

The data were processed using IBM-SPSS 18, 2010. The value of statistical significance was set at $p < 0.05$. The mathematical values of tests were declared for significant comparisons. If tests were insignificant ($p >= 0.05$), only the value of significance (p) was reported. For tabulation of scale data, we reported the mean and standard deviation expressed to 2 decimals, and ordinal data were tabulated as percentage per group and presented with one decimal.

For ordinal or non-parametric data, we used the Mann-Whitney test for comparing 2 groups. For parametric comparison we used ANOVA, and repeated measures ANOVA and MANOVA tests were also employed.

Results

At the *initial evaluation*, using z-scores of *BMI-for-age* we found that 60.3% (41) of boys and 63.6% (35) of girls were classified as normal weight (-1; 1 SD), 11.8% (8) of boys and 12.7% (7) of girls were below the normal category (<-1 SD), and 27.9% (19) of boys and 23.6% (13) of girls were above the normal category (> 1 SD).

Using z scores of *weight-for-age*, 51.5% (35) of boys and 58.2% (32) of girls were in the normal category (-1; 1 SD), 4.4% (3) of boys and 12.7% (7) of girls were below the normal category (<-1 SD), and 44.1% (30) of boys and 29.1% (16) of girls were above the normal category of weight-for-age (> 1 SD). Using z scores of *height-for-age*, 55.9% (38) of boys and 50.9% (28) of girls were in the normal category (-1; 1 SD), 4.4% (3) of boys and 5.5% (3) of girls were in a lower than normal category (<-1 SD), and 39.7% (17) of boys and 41.7% (24) of girls were above the normal category of height-for-age (> 1 SD).

We looked for *differences between genders* in the classification for BMI-for-age, weight-for-age and height-for-age at the initial evaluation and we found that, only for weight-for-age categories, boys were significantly more frequently distributed in higher categories compared to girls, U=1455.5, z=-2.32, p=0.20, r=0.21, with a small effect size, this result indicating that boys had a higher weight in relation to age compared to girls.

At the initial evaluation of height-for-age and BMI-for-age categories we found no significant differences between genders, p=0.811 and p=0.470, respectively (Table I).

The mean age at *follow-up* was 121.9 +/- 10.8 months. The prevalence of normal weight according to BMI-for-age was 54.4% (37) for boys and 56.4% (31) for girls, the prevalence of underweight was 8.8% (6) for boys and 20.0% (11) for girls, the prevalence of overweight was 17.6% (12) for boys and 18.2% (10) for girls, and the prevalence of obesity was 19.1% (13) for boys and 5.5% (3) for girls. We observed that at follow-up, boys were significantly more frequently distributed to higher categories of *BMI* compared to girls, U=1467, z=-2.26, p=0.024, r=0.21, with a small effect size between genders.

A mixed between-within subjects analysis of variance was conducted to assess the impact of gender on z scores of BMI-for-age at the initial evaluation and follow-up. We could not find a main effect for time regarding the z-score of BMI-for-age, Wilks Lambda=0.993, p=0.369. There was also no significant interaction between gender and time, Wilks Lambda=0.97, p=0.054 (Table II & Fig. 1).

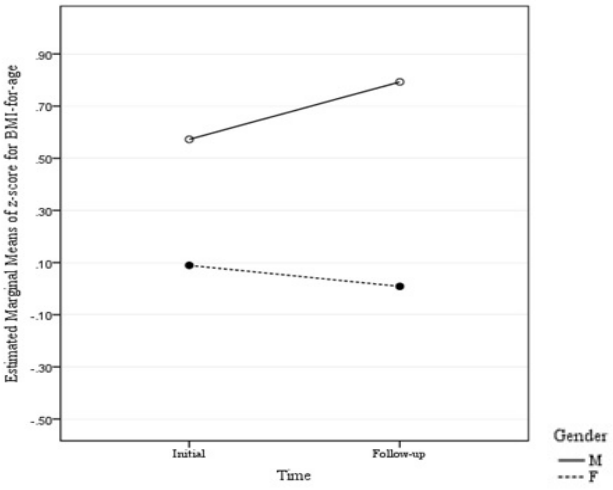

Fig. 1 – Evolution of mean z scores of BMI-for-age between initial evaluation and follow-up by gender.

Table II

Mean BMI and z-score of BMI-for-age at the initial evaluation and follow-up.

Measurements	Gender	Initial	Follow-up
BMI (mean+/- SD)	M	16.8 +/- 2.77	18.8 +/- 3.21
	F	15.8 +/- 2.16	17.2 +/- 2.82
	Total	16.3 +/- 2.55	18.1 +/- 3.13
z-score of BMI for age (mean+/- SD)	M	.6 +/- 1.47	.8 +/- 1.17
	F	.1 +/- 1.14	.0+/- 1.17
	Total	0.4 +/- 1.35	0.4 +/- 1.23

After splitting the data by BMI categories at follow-up, we found that students who were overweight at follow-up had significantly lower mean BMI-z-scores at the initial evaluation t (21)=-2.232, p=0.037, r=. For other BMI categories, the mean BMI-z-score did not differ statistically significantly between the initial evaluation and follow-up (Table III & Fig. 2).

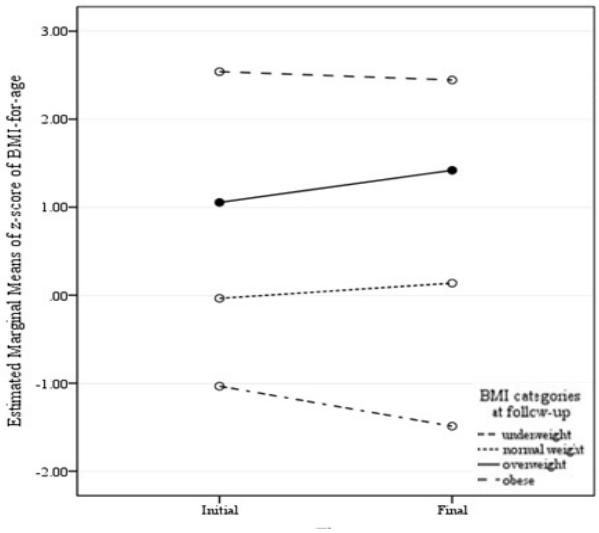

Fig. 2 – Evolution of mean z scores of BMI-for-age between initial evaluation and follow-up by BMI categories at follow-up.

Table I

Initial prevalence of height-for-age, weight-for-age and BMI-for-age categories.

Anthropometric categories	Gender	< -1 SD	(-1; 1) SD	(1;2) SD	>2 SD	Sig
Initial height for age categories	M	4.4%	55.9%	20.6%	19.1%	p=0.811
	F	9.1%	49.1%	25.5%	16.4%	
	Total	6.5%	52.8%	22.8%	17.9%	–
Initial weight for age categories	M	4.4%	51.5%	25.0%	19.1%	p=0.020
	F	12.7%	58.2%	23.6%	5.5%	
	Total	8.1%	54.5%	24.4%	13.0%	–
Initial BMI for age categories	M	11.8%	60.3%	14.7%	13.2%	p=0.470
	F	12.7%	63.6%	20.0%	3.6%	
	Total	12.2%	61.8%	17.1%	8.9%	–
Follow-up BMI for age categories	M	8.8%	54.4%	17.6%	19.1%	p=0.024
	F	20.0%	56.4%	18.2%	5.5%	
	Total	13.8%	55.3%	17.9%	13.0%	–

Table III

Mean difference of z-scores of BMI-for age by BMI categories at follow-up.

BMI categories at follow-up	N	Mean difference z-scores of BMI (Initial – Follow up)	Std error mean	95% Confidence Interval of the Difference		Sig
				Lower	Upper	
Underweight	17	.45471	.26873	-.11498	1.02439	0.110
Normal weight	68	-.17294	.09119	-.35496	.00908	0.062
Overweight	22	-.36545	.16374	-.70597	-.02494	0.037*
Obese	16	.09563	.23542	-.40617	.59742	0.690

* Sig difference p<0.05

We calculated a mean growth rate in weight and height per month and wanted to investigate if the weight and height growth rate per month was influenced by initial BMI-for-age categories and gender; therefore we used a two-way between-groups multivariate analysis to investigate differences in weight and height growth per month by gender and BMI categories. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance and covariance matrices, multicollinearity, and no serious violations were noted. There were statistically significant differences between BMI categories on the combined variables, $F(6)=4.2$, $p<0.001$, Wilks Lambda=0.811, eta squared=0.1. Between sex categories, the difference on combined variables was not statistically significant, $p=0.136$.

When the results of the dependent variables were considered separately, the only difference to reach statistical significance was weight growth per month by BMI categories, $F(3)=8.32$, $p<0.001$, partial eta squared=0.178. After applying a Sidak correction, we further investigated this result and found out that compared to the normal category of BMI, overweight (mean difference=-0.105, SE=0.030, $p=0.001$) and obese children (mean difference=-0.126, SE=0.026, $p=0.021$) significantly gained more weight per month. The difference between the normal category of BMI and the lower than normal category was not significant in relation to the accumulated weight per month (mean difference=0.015, SE=0.030, $p=0.997$).

Height growth per month by BMI categories showed no statistically significant differences, $p=0.748$ (Table IV & Fig. 3).

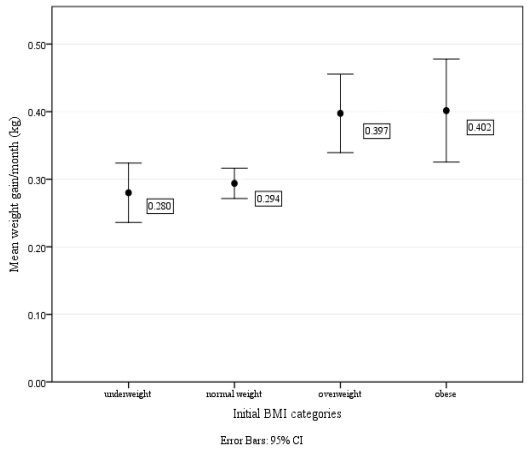

Fig. 3 – Mean weight gained per month (kg) by BMI categories.

Discussions

For our group, at the initial evaluation made at a mean age of 7 years +/- 8 months, the prevalence of overweight was 17.1% and the prevalence of obesity was 8.9%. The follow-up evaluation was made at a mean age of 10 +/- 11 months and showed a 17.9% prevalence of overweight and a 13.0% prevalence of obesity. The prevalence of overweight increased by 0.81% with 95% CI (0.14; 4.46) and that of obesity by 4.7% with 95% CI (1.75; 9.17). This rise in overweight and obesity by age groups was also observed in other epidemiological studies with different designs conducted in Europe (Wijnhoven et al., 2014; Brettschneidera et al., 2015; Finucane et al., 2015). For the age of 7, the prevalence of overweight and obesity found in our sample was exceeded by reports from countries such as Greece, Hungary, Ireland and Portugal. In a German study, the authors observed an increase in the prevalence of overweight and obesity until 2004, followed by a constant evolution or even a reduction in prevalence between 2004 and 2008, as a consequence of preventive measures initiated in the 1990s (Moss et al., 2012). No direct intervention regarding healthy eating, dieting or sports activities was targeted in our group during the follow-up. In the absence of adequate measures, we estimate an increase of prevalence.

At the initial evaluation, excess in body weight predominated in boys (44.1%), being significantly higher compared to girls (29.1%). Similar results were recently obtained by Greek researchers (Kotanidou et al., 2013), but in their case the difference in excess weight prevalence between genders was less than 3%.

When we used the whole group, evolution of z-scores of BMI for age was not influenced by time or gender. Children who were overweight at follow-up had significantly lower z-scores of BMI for age at the initial evaluation, while all other categories (underweight, normal weight and obese) had similar mean z-scores at the initial evaluation and follow-up. The explanation for the significant difference of z-scores of BMI-for age in overweight children at follow-up, when compared to initial values, is that in our sample the major shift was from normal weight to overweight. For children who were obese at follow-up, there was no significant change in mean z-scores, implying the fact that children who were obese by the time they finished primary school were already obese when they started

Table IV

Difference in weight and height per month by initial BMI categories.

BMI Categories	Difference in weight/month[1]			Difference in height/month[2]		
	Mean +/- Std. Deviation	95% Confidence Interval for Mean		Mean +/- Std. Deviation	95% Confidence Interval for Mean	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
< -1 SD (n=15)	.280 +/- .0793	.236	.323	.462 +/- .1094	.402	.523
(-1; 1) SD (reference) (n=76)	.293 +/- .0981	.271	.316	.487 +/- .1163	.460	.513
(1; 2) SD (n=21)	.397* +/- .1278	.339	.455	.505 +/- .0884	.465	.545
> 2 SD (n=11)	.401* +/- .1134	.325	.477	.467 +/- .0910	.406	.529
Total (n=123)	.319 +/- .1123	.299	.339	.485 +/- .1087	.466	.504
Total (n=123)	.319 +/- .1123	.299	.339	.485 +/- .1087	.466	.504

[1] Calculated as [(Final weight-Initial weight)/ follow-up months]

[2] Calculated as [(Final height-Initial height)/ follow-up months]

*Sig difference $p<0.05$, compared to reference

primary school. These results underline the importance of starting weight interventions even before primary school, in kindergarten.

Although the z-scores of BMI-for-age did not statistically significantly change between the initial evaluation and follow-up, we consider that the rise in overweight and obesity prevalence is clinically significant, because it demonstrates a continuous increase in prevalence in the absence of interventions targeted to tackle obesity.

At follow-up, there was a significant difference between boys and girls related to distribution to BMI categories, boys being distributed to higher categories, with a small effect size.

In order to standardize growth rate by months of follow-up, we calculated a growth rate for weight and height per month, although it is clear that the children's growth rate is not constant during the year. We demonstrated that growth in kg per month was significantly higher in overweight (mean growth=0.397 kg/month) and obese (mean growth=0.402 kg/month) compared to normal weight children at the initial evaluation (mean growth=0.294 kg/month). Growth in kilograms per month was not statistically significant between the normal weight and underweight categories (mean growth=0.280 kg/month).

The growth rate in length per month was not statistically significant between initial BMI categories. Gender did not influence the weight or height growth rate.

These results offer an explanation for the rise in overweight and obesity prevalence between age groups in children, as seen in several pan-European trials (Wijnhoven et al., 2014; Wijnhoven et al., 2013; Ogden et al., 2012), children with excess in body weight being prone to accumulate more weight, compared to normal weight children.

Conclusions

1. We found out that children who are overweight and obese by the time they are in primary school have a high risk of maintaining this unhealthy weight and even accumulate more unhealthy weight by the time they finish primary school, unless they receive interventions targeted for healthy living, calories control and increase in physical activities.

2. Our findings from this pilot study can motivate and offer a background for the development of lifestyle interventions that can be implemented in kindergartens and schools, with the aim of reducing overweight and obesity prevalence.

Conflicts of interests

The authors declare no conflict of interests.

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