Analysis of Body Mass Index in Romania's School Population

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Abstract

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Nowadays, childhood obesity is a negative phenomenon recognized worldwide. A consequence of a sedentary lifestyle doubled by unhealthy eating habits, obesity can affect deeply the personality of a child. The numerous warning signals of the experts have generated educational measures in many countries, either by national projects or regional and local initiatives. As the BMI is one of the relevant indicators for the health of the younger generation, this paper tackles the BMI level of the Romanian school population in the 1st, 5th, 9th and 12th grades. For the purpose of this study, we analyzed data collected from measuring the somatic indicators (height and weight) of 124,000 students from all regions of the country, in rural and urban areas. The BMI values were analyzed and compared based on the grade and gender, according to the above-mentioned variables. The results of this study highlighted a number of trends in the evolution of this index from one age to another, and its relationship with the environment of children. Coupled with the results of other research in the field, the study aims to bring forth and to the attention of the authorities the importance of exercise in children's lives and the need for an appropriate educational setting.

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1. Problem statement

Obesity continues to be today one of the first consequences of a sedentary lifestyle, often associated with inadequate dietary habits. The main way to identify the obesity risk or obesity is by measuring the body mass index (BMI). (Guo et al, 1994; Mei et al., 2002) Mei et al. (2002) have demonstrated that the BMI has greater validity in comparison to other methods of body screening (Rohrer index, weight/ height ratio) for both the identification of underweight and overweight in children aged 2 to 9 years. The body mass index is calculated by dividing the weight by height squared (kg / m^2); a BMI of 25-29 defines the subject as overweight, while a BMI > 30 defines obesity.

Child obesity is currently considered a public health problem, because its prevalence is steadily increasing, and the negative consequences of this condition are manifested not only in childhood, but they also expand into adulthood, when cardiovascular diseases occur (congestive heart failure, hypertension, myocardial infarction or stroke), joint ailments and some types of diabetes, respiratory disorders, orthopaedic ailments, sleep apnoea, negative emotional states, and lower intellectual capacity. (Halkjær, Holst, & Sørensen, 2003)

The increased interest in obesity research is a consequence of the fact that it has a negative influence on the personality of children. Once they reach the age of adolescence, youth and adulthood, they will have self-esteem issues, increased risk of cardiovascular diseases (in adults aged between 30 and 74 years), infertility and reduced life expectancy. These are also the reasons why many studies show periodically the changes recorded in the BMI levels of different age groups, by gender and living conditions. The results are often associated with changes which are recorded in the dietary habits and lifestyle of the population. (Rich-Edwards et al., 1994; Stevens et al., 1998)

The BMI values in childhood are a strong predictor of morbidity and mortality in adulthood, and this is revealed by the significant correlations between the BMI at different ages. The prediction is excellent for 18-year-olds, good for 13-year-olds, and only moderate for childhood ages (below 13 years old). Studies have shown that 18-year-old adolescents with excess weight have a risk of obesity in adulthood ranging between 34% for men and 37% for women. (Guo et al., 1994)

As obesity is widespread at this age because of unhealthy eating and sedentary life, specialists are observing the evolution of the increasing mass weight in different regions of the world. Thus, an interesting classification of the percentages of obese people (BMI over 30) has emerged, based on information provided by studies from different countries of the world. Japan and Korea have the fewest obese persons in the world (only 3.2% of the population is obese), while the United States are at the other extreme, being the country with the highest number of obese persons (30.6%). The high body mass index (BMI) among children and adolescents continues to be a public health issue in the United States. For example, between 1999 and 2006, the prevalence of the BMI at or above the 95th percentile (the "obesity level") tripled among school-age children and adolescents, and remained high for about 17% of boys and girls, regardless of race. (Ogden, Carroll, & Flegal, 2008)

A study carried out in Portugal, in the years 2002-2003, found that 20.3% of children were overweight and 11.3% of children were obese. These results indicate an incidence of overweight/ obesity of 31.5%. Girls had a higher percentage of overweight than boys. The same situation is found in other Mediterranean countries such as Spain (30%), Greece (31%) and Italy (36%). These high values require a national intervention program to control childhood obesity (Padez et al., 2004).

According to data from a study conducted in Spain on young adults, 25 and 30 BMI values correspond to percentiles 80 and 97 in males, and 85 and 97 in females. A secular trend of growth was observed among population with a non-proportional increase of weight to height ratio (BMI) values, particularly for those corresponding to the 97th percentile. (Carrascosa Lezcano et al., 2008)

In Greece, among children in primary education, 59.4% of the participants had a normal BMI, 25.8% were overweight and 14.8% were obese, without significant differences between genders. (Tokmakidis, Kasambalis, & Christodoulos, 2006)

An interesting study was conducted in 2005, in Bucharest, on a group of 1,100 subjects, in order to identify the trend of childhood obesity onset in relation to the weight of the parents. The anthropometric data of parents and the socio-economic conditions had an important role, determining the role of the living conditions of a family in the evolution of children's BMI. It has been found that children with at least one overweight parent (in most cases, the father) tend to become overweight too. Overweight was found in a ratio of 50-80% in children and parents from families with high economic level. (Milici et al., 2007)

According to a study conducted by Eurostat (European Statistical Office) in Romania, 7.7% of men and 9.5% of the female population is obese. The same study reveals that one Romanian in three is overweight and one in four is obese. Overall, in Romania there are 3.5 million obese, according to a study conducted by the company Abbot Laboratories.

In 2006, in Stockholm, at the European Ministerial Conference on Obesity, WHO launched the COSI project - European Childhood Obesity Surveillance Initiative. The study started in 2007 and so far has focused subjects from 18 countries, including Romania, since 2012. In Romania, the study was conducted for the age group 8.0-8.9 years and revealed that the percentage of normal weight in girls (71.06%) is by 5.82% higher than the percentage of normal weight in boys (65.24%), while the prevalence of obesity in 8-year-old boys (15.03%) is by 6.79% higher than the prevalence of obesity in girls of the same age (8.24%). The prevalence of overweight in 8-year-old children in Romania is 15.11%, and the prevalence of obesity is 11.64%. Most of the children included in the study had a normal weight, irrespective of the area of residence (urban 64.15%, semi-urban 71.21%, and rural 72.20%). A quarter of the children living in the semi-urban area were overweight or obese. The highest percentage of obese children was found in urban areas (13.15%), followed by those living in rural areas (10.18%) and semi-urban areas (9.85%). (Nicolescu, 2013)

1.1. Purpose

The aim of this paper is to present the most recent trends in the body mass index (BMI) among Romanian children and adolescents in the 1st, 5th, 9th and 12th grades, from 26 counties (representing all development regions). Considering that the evaluation reflects the students' development level, the environmental and educational influences, this paper shows some comparative results achieved in similar studies conducted worldwide.

The study shows the results of the research on this topic conducted within the project *Evaluation of bio-motor potential of the school population from Romania* (2011-2012, MCTS, UNEFS). The research consisted in evaluating the bio-motor potential of students in the grades aforementioned through a set of tests to assess the motor skills (speed, strength, stamina, coordination abilities), functional abilities (Ruffier test) and the somatic development (height, weight, BMI).

2. Research methodology

2.1. Objectives

The following topics were tackled in this study: centralizing data from 28 counties; statistical processing of the results achieved by students during the somatic measurements; comparing the results obtained in this study with similar results recorded in Romania in previous studies, and with the results of other studies carried out in other countries.

2.2. Methods

Data from these measurements were statistically processed (SPSS 17.0), and the findings highlighted values of the indicators of the central tendency (arithmetic mean) and of the dispersion (coefficient of variation). Also, the ANOVA test was applied to determine the significance of the difference between BMI values recorded by students in the 28 counties of Romania, split by gender (male and female). To highlight the normal weight, we used the BMI percentile calculation, a function showing the tendency to overweight of the tested children.

2.3. Subjects

The results analysed in this paper come from the somatic evaluation of 115,000 students (45,127 boys and 69,873 girls) in the 1st, 5th, 9th and 12th grades, aged 7-8, 11-12, 15-16 and 18-19 years.

2.4. Results

Table 1 comprises values of the arithmetic mean, the coefficient of variation (Cv) and the percentiles, indicating the percentage of the normal weight population within the investigated sample.

Table 1. Values of the arithmetic mean, coefficient of variation and the percentage of children with normal weight, BMI/ county

County	Gender	BMI 1st grade			BMI 5th grade			BMI 9th grade			BMI 12st grade		
		X	< 25	Cv	X	< 25	Cv	X	< 25	Cv	X	< 25	Cv
Alba	F	16.35	97.2%	21.57	18.43	95.1%	20.20	19.28	92.5%	17.69	20.74	95%	13.74
	M	16.77	97.5%	19.81	18.72	90.2%	19.19	22.28	80%	19.36	22.91	80%	14.69
Bacau	F	15.84	99.4%	17.22	17.42	99.4%	15.29	17.49	93.1%	15.29	21.09	95.4%	12.01
	M	16.13	98.9%	17.42	17.78	99%	14.49	20.31	93.6%	14.77	22.19	85.9%	13.48
Bihor	F	16.28	99.8%	17.25	18.20	96.5%	17.81	20.70	93%	13.13	20.52	96.5%	10.15
	M	16.75	98%	18.62	18.56	94%	18.23	21.75	88.1%	1.04	22.69	82%	12.73
Bistrita	F	15.84	98.9%	16.55	17.78	97.4%	17.64	20.50	93.3%	14.35	20.91	92.9%	13.94
	M	15.94	99.3%	16.34	17.89	97.5%	17.27	20.38	93%	14.28	21.96	87.5%	14.21
Botosani	F	15.68	99.6%	16.12	18.08	97.1%	16.84	20.31	95.8%	12.10	21.58	87.2%	12.74
	M	16.05	99.5%	15.54	18.60	94.5%	18.22	21.15	90.8%	13.00	21.79	80.5%	12.72
Braila	F	17.15	99.4%	12.55	18.53	95.6%	16.17	20.59	92.3%	14.00	20.44	92.9%	13.72
	M	17.27	99.1%	13.45	18.73	94.8%	16.45	20.91	87.5%	14.98	22.47	84.5%	13.26
Bucuresti	F	16.76	99%	15.87	19.38	92%	17.74	19.75	93.7%	16.03	19.96	91.7%	17.69
	M	17.50	97.5%	17.81	19.47	93%	18.12	21.05	83.5%	17.65	23.25	67%	18.87
Buzau	F	15.99	100%	13.00	18.88	94.2%	18.88	21.25	88.1%	16.60	21.64	91.2%	12.84

	M	13.15	99.9%	15.08	19.28	92.6%	19.55	21.31	90.6%	15.96	21.89	89.9%	13.87
Calarasi	F	16.01	99%	17.70	18.34	96.5%	17.89	20.24	94.4%	13.65	20.87	92.4%	14.16
	M	16.54	98.7%	18.40	18.37	95.6%	17.82	20.58	94.5%	14.52	22.75	77%	15.40
Caras-Severin	F	15.51	100%	3.29	18.79	95.2%	18.05	21	86.3%	17.9	21.22	93.4%	13.74
	M	15.46	100%	2.78	19.53	93%	17.62	20.9	87.1%	20.0	22.15	84.5%	14.89
Constanta	F	17.27	94.5%	23.23	18.14	96.9%	16.90	20.51	92.6%	15.60	21.10	93%	12.90
	M	17.64	94.7%	24.58	18.36	97%	16.15	20.85	90.2%	13.82	22.51	93.1%	13.05
Dolj	F	16.22	99.4%	15.58	18.41	95.5%	17.55	19.60	95.1%	15.51	20.42	93.5%	14.08
	M	16.58	98.5%	16.20	18.67	95.3%	17.61	20.88	89.6%	15.35	21.65	89.4%	14.02
Galati	F	16.40	95.9%	20.23	18.50	95.1%	18.09	20.63	93.4%	12.87	20.68	93.2%	12.85
	M	16.76	97.1%	19.35	18.59	94.3%	19.51	21.03	90.2%	13.59	21.97	87.9%	12.16
Gorj	F	16.04	98%	20.43	17.58	99.2%	16.07	19.22	98.1%	12.46	20.20	98.7%	11.01
	M	16.14	98.4%	36.31	17.37	97.2%	18.55	19.69	96.4%	13.56	20.20	98.7%	11.03
Hunedoara	F	16.90	97.9%	18.08	18.77	92.9%	20.20	20.92	89.3%	17.18	20.81	91.8%	13.35
	M	16.19	99.6%	15.34	18.70	94.1%	18.78	21.33	87.1%	15.73	22.25	87.5%	11.57
Ialomita	F	16.98	99.6%	12.65	20.06	86.7%	28.92	21.65	86.8%	25.68	23.44	81%	31.94
	M	17.22	99%	14.42	19.39	89.5%	25.36	22.64	80.6%	29.16	24.40	76.7%	36.2
Iasi	F	16.18	99.1%	15.96	17.73	97.2%	17.26	20.35	94.9%	12.42	20.93	94.3%	12.13
	M	16.31	98.9%	40.08	17.84	96.8%	23.57	20.96	93.2%	13.12	22.43	85.6%	14.31
Mehedinti	F	15.84	99.2%	16.79	18.20	95.4%	19.20	20.04	95.8%	12.57	19.89	95.3%	12.77
	M	16.11	98.7%	17.59	18.40	94.5%	19.64	21.30	89.1%	13.92	21.69	87.9%	14.27
Mures	F	16.16	98.9%	18.15	18.29	95.3%	18.45	20.63	92.3%	14.26	20.99	91.1%	13.76
	M	16.54	99.3%	16.73	18.34	94.5%	19.14	20.67	89.3%	15.24	22.74	78.1%	16.65
Neamt	F	16.22	99.8%	15.72	18.04	95.2%	19.99	20.48	94.3%	13.36	21.12	93%	12.79
	M	16.82	98.2%	17.60	18.42	94.4%	19.71	21.07	94.1%	13.09	22.78	85.1%	12.80
Salaj	F	16.42	98.3%	20.63	18.31	92.6%	23.10	20.64	91.5%	16.74	20.13	97.3%	17.55
	M	16.72	98.9%	18.47	18.37	93.9%	20.92	21.92	91.1%	79.87	23.40	71%	18.98
Satu Mare	F	16.38	99.5%	16.32	18.76	95.2%	16.80	20.99	90.7%	15.72	20.75	90.2%	15.68
	M	16.92	98.3%	17.17	19.04	92.5%	17.96	21.62	87.6%	15.05	23.03	75.9%	16.12
Sibiu	F	15.76	98.4%	20.74	16.80	95.28%	31.80	20.69	91.1%	15.25	20.84	92.4%	14.43
	M	26.50	99.3%	20.47	18.30	97.2%	16.12	21.02	90.3%	15.84	22.83	78.9%	16.73
Suceava	F	15.98	100%	15.69	18.59	96.5%	18.08	20.71	95.6%	12.33	21.15	83.9%	14.01
	M	16.60	98.9%	17.21	18.77	93.5%	19.00	20.83	91.7%	13.66	22.02	89.7%	13.25
Teleorman	F	16.85	100%	14.48	18.03	96.5%	17.27	20.64	95.6%	13.40	21.86	83.7%	16.93
	M	16.17	98.9%	14.82	18.86	93.5%	19.95	20.90	91.3%	16.15	22.44	89.98%	13.97
Timis	F	16.53	97.5%	22.86	18.36	97.3%	16.62	20.73	94.3%	13.55	20.79	93.3%	14.25
	M	16.87	95.5%	21.21	18.34	95.5%	19.36	21.65	92.5%	13.35	22.41	86.8%	18.71
Tulcea	F	15.24	100%	16.46	17.83	96.5%	17.62	20.74	90.1%	13.81	21.93	89.1%	13.24
	M	15.79	100%	16.46	18.11	96.7%	17.29	21.12	85.9%	14.44	22.84	83.5%	13.37
Vaslui	F	16.71	100%	12.42	17.70	96.7%	17.97	20.26	97.2%	11.35	20.76	95.5%	11.66
	M	16.52	100%	15.14	17.98	96.7%	15.38	22.12	86.6%	11.66	22.46	87.6%	10.75

From the analysis of results by grade, it appears that the BMI values for girls are ranging between 15.24 and 17.27 (1st grade), 17.42 and 20.06 (5th grade), 19.22 and 21.65 (9th grade), and 19.89 and 22.91 (12th grade). For boys, the values are ranging between 13.15 and 26.50 (1st grade), 17.34 and 19.53 (5th grade), 20.31 and 22.64 (9th grade), and 20.20 and 24.40 (12th grade). In all counties, the

average BMI level is within normal limits, except for the 1st grade boys from Sibiu, where data indicate a trend to overweight (in the investigated sample).

Important information on the BMI values is obtained from calculating the percentiles, which illustrate the frequency of cases in the normal weight range. While in the 1st and 5th grades the values of the normal weight percentages are relatively equal, in the upper grades, there is a clear trend to overweight among boys. Table 1 shows that the percentage of normal BMI values in the 1st grade girls is ranging between 94.5 and 100%; in the 5th grade, it ranges between 92% and 99.2%; in the 9th grade, it is between 86.3% and 97.2%; in the 12th grade, it is between 83.7% and 98.7%. For boys, the BMI values range between 95.5% and 100% in the 1st grade, between 90.2% and 97.5% in the 5th grade, between 80% and 96.5% in the 9th grade, and between 71% and 98.7% in the 12th grade. It should be noted that the percentage of normal weight is lower in boys than girls, especially in grades 9th and 12th. The values of the difference between the two genders/ grades are represented in Chart 1. The percentages are higher in boys, with averages ranging from 0.28% (1st grade) to 8.10% (12th grade).
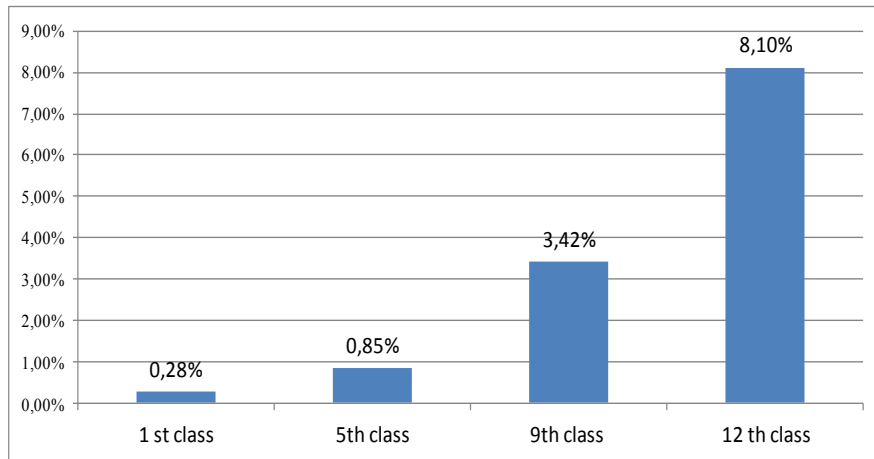

Chart 1. The difference between normal weight percentages in boys and girls/ grades

In Chart 2, we can see the average percentages among children with elevated BMI levels, which indicate overweight (> 25). For both genders, these values increase progressively from one grade to another, and the levels are higher in boys compared to girls.
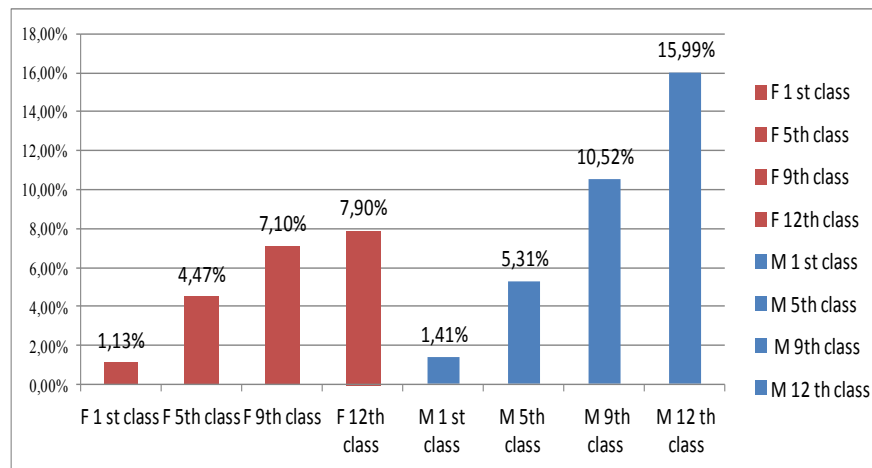
Chart 2. Percentages of children with a tendency to being overweight by grade/ gender

Table 1 reveals that the values ranging between 10 and 20% of the coefficients of variation for both genders, in all counties, indicate an average homogeneity of the BMI for the studied age groups. By applying significance tests for the difference between the coefficients of variation, it has resulted that the values registered in girls and boys are not significant at $p = 0.05$.

3. Discussions and conclusions

From the analysis of the data presented previously, it appears that the population of the target group has a BMI in the normal range in most cases. In 7-8 years old children, girls and boys, the values of this indicator can be 100% normal (Buzau, Teleorman, Tulcea, Vaslui counties). Comparing these results with the data from the literature confirms the trend to overweight in boys compared to girls. The average difference between genders, in the four grades studied, varies between 2% (1st grade) and 7% (12th grade). Regarding the age group for which we identified reference data in the literature (8 to 9-year-olds), we have found that the data obtained are lower, namely in children aged 7-8 years the overweight trend is lower.

Moreover, the percentage of overweight increased from one grade to another, confirming the data from literature, according to which in ontogenesis the risk of exceeding the optimum weight increases as a result of the amplified action of the risk factors.

The values obtained are consistent with data from the literature (Carrascosa Lezcano et al., 2008), concerning the trend to overweight in boys compared to girls, and the increasing gap (in terms of this trend) between genders, with age. By comparing our data for the 12th grade with the available literature data, we found that the BMI values are weaker for boys but better for girls. Even under these circumstances, boys tend to go beyond the optimal weight.

However, the values we have obtained are better than those reported for the US adolescents (Ogden, Carroll, & Flegal, 2008) and those reported for primary school children in Greece. (Tokmakidis, Kasambalis, & Christodoulos, 2006)

The results of our study highlight that, in the investigated school population, the BMI values are in most cases in the range of normality. Percentages ranging from 1.13% (F) and 1.41% (M) in the 1st grade, 4.47% (F) and 5.31% (M) in the 5th grade, 7.10 (F) and 10.52% (M) in the 9th grade, and 7.90% (F) and 15.99% (M) in the 12th grade, indicate that the overweight trend in those children has rather small levels compared to other sources of literature that studied less numerous groups.

Although the BMI has certain limits, it remains one of the most relevant indicators for the population health. Future studies will highlight the relationship between the BMI, geographical environment and the standard of living of the population in a specific development region of Romania.

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