Health, Sports & Rehabilitation Medicine
Vol. 24, no. 2, April-June 2023, 73–77

Exploring the impact of urban food choices on malnutrition severity in teenage boys

Oana Anamaria Moldovan, Paula Mihaela Oniță, Roxana Maria Martin-Hadmaș
Community Nutrition and Food Safety Department, "George Emil Palade" University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Romania

Abstract

Background. Malnutrition is based on poor nutrition and in adolescents can increase the risk of many pathologies. The education in dietary behaviour is necessary. Are food choices important for the weight status?

Aims. The purpose of this study was to analyze the correlation between food and the level of malnutrition in a group of teenagers from the urban environment.

Methods. The current study used a questionnaire administered for a period of 3 days among students where they had to mention the foods, quantities and times of ingestion. The subjects had to go through a series of anthropometric measurements.

Results. Only 8.33% of participants met their caloric needs. Weight and BMI were positively associated with systolic blood pressure.

Conclusions. The diet of the teenagers from the analyzed study group is unbalanced and does not meet the real dietary requirements, the percentage of malnutrition being high.

Keywords: malnutrition, eating habits, adolescents, carbohydrates.

Introduction

Global malnutrition is increasingly common. This has to do with both a deficit and an excess or an imbalance in a person's intake of calories and/or nutrients (Saunders & Smith, 2010). Thus, malnutrition can occur both in malnourished people and in those who feed excessively. Adolescence represents an important stage in the development of eating behaviors (Stabouli et al., 2021). Young people make choices for themselves, and these are influenced by factors such as the environment they live in, the place where they study, and the people they interact with.

According to the World Health Organization (WHO) and the latest UNICEF report - "The State of the World's Children 2019: Children, Food and Nutrition", in the world:

a) 1.9 billion adults are overweight or obese and 462 million are underweight

b) among the children under the age of 5, 149 million are underdeveloped (too short for their age), 45 million are cachectic (too thin for their height) and 38.9 million are obese or overweight.

c) 340 million children (1 in 2) have vitamin deficiencies of vitamins and essential nutrients, such as iron and vitamin A.

d) 45% of deaths among children < 5 years old are related to malnutrition. They appear especially in low- and middle-income countries. At the same time, in these countries, the cases of overweight or obese children began to increase.

Material and method

Research protocol

The research was an observational study and it included students from "Emil Racovita Theoretical High School" Baia Mare, Romania.

a) *Period and place of the research*

The study was carried out at an educational institution (high school) from Baia Mare, Romania, from September 2022 to February 2023.

b) *Subjects and groups*

The study included students aged between 14 and 17 (N = 65), of which 24 also completed a food diary for one, two, or three days. The high school was selected to be located in the city, not in the suburbs, and the participants were under 18 years old. We received parental consent for their children to participate in the study and the school's consent to conduct the research there.

Received: 2023, May 9; *Accepted for publication:* 2023, May 17
Address for correspondence: "George Emil Palade" University of Medicine, Pharmacy, Science, and Technology of Târgu Mureş, Gheorghe Marinescu Street No. 38, 540139, Romania
E-mail: roxanahadmas@yahoo.com
Corresponding author: Martin-Hadmaș Roxana Maria; roxanahadmas@yahoo.com
https://doi.org/10.26659/pm3.2023.24.2.73

Copyright © 2010 by "Iuliu Haţieganu" University of Medicine and Pharmacy Publishing

c) *Applied tests*

Students from the involved high school completed a questionnaire that took them approximately 10 minutes. The questionnaire was completed through a link, where the students had to put their age, height, weight, their meals and the time that they were taken, and also the quantities of the ingested food. Parental consent and student approval were obtained before data collection. They also had to write the level of physical activity they had that day, their level of hydration, and their stress level. Besides that, every student went through an anthropometric exam, analyzing several variables: weight, height, skin folds: biceps, triceps, subscapular, suprailiac; circumferences: neck, abdominal, gluteal, and arm. The devices used for the measurements were ADE taliometer and scale (Hamburg, Germany) for the weight and height, GMA plicometer (Italy) for skinfolds measurement, IMDK pulse oximeter (Shenzhen, China) and Minut Blood pressure monitor (Hamburg, Germany). The Basal Metabolic Rate (BMR) was determined according to the Mifflin-St Jeor formula.

Every menu was analyzed and, the USDA database produced by the United States Department of Agriculture was used to calculate the calories, macronutrients, and micronutrients for every ingredient.

d) *Statistical processing*

The data were analyzed statistically using the GraphPad Prism 5.0 software. Descriptive statistical measures used were minimum and maximum values, means or medians, and standard deviations. For the inferential statistics, the Spearman test was used with a 95% (95% CI) confidence interval.

Results

The analysis of the 65 teenage boys included in the study evidenced that weight was not associated with protein or fats intake but was negatively and significantly associated with carbohydrate intake (Table I). The medium quantity of protein intake in a day was 55.87 grams, while de average necessary amount calculated for the group was 136.94 grams. Also, the medium intake of carbohydrates in a day was 166.8. The average necessary intake is 294.59 grams. For fats, the medium intake is 72.2 grams, and the necessary quantity is 82.12 grams (Table I).

Table I

Descriptive data of food ingestion (grams).

Indicator	Protein	Fat	Carbohydrate
Minimum	16.38	14.06	25.79
25% Percentile	35	46.43	132.6
Median	55.87	72.47	166.8
75% Percentile	84.46	98.2	247.3
Maximum	159.8	156.9	489.9
Mean	62.23	75.04	185.9
Necessary	136.94	82.12	294.59

Weight and BMI were observed to be statistically and positively associated with systolic blood pressure. The statistics also shows that there is a positive (r=0.4556; CI95%: 0.2953 to 0.5909) and - substantial connection (p=0.0049) between body mass index and diastolic blood pressure (Table II).

SBP (systolic blood pressure) is positively and statistically significantly associated with weight, BMI, all folds, all circumferences, percentage of muscle mass and basal metabolic rate (Table III). The data indicates a positive and substantial correlation (p<0.0001) in most cases.

After analyzing the data provided by the students, the results showed that 30 from 65 boys have weight problems, whether we are talking about underweight, overweight or

Table II

The association between weight/body mass index (BMI) and blood pressure.

Indicator	Parameter	Spearman r	95% confidence interval	P value (two-tailed)
Association between weight and blood pressure	Systolic blood pressure	0.4556	0.2953 to 0.5909	< 0.0001
	Diastolic blood pressure	0.2562	0.07453 to 0.4215	0.0049
Association between body mass index BMI and blood pressure	Systolic blood pressure	0.5092	0.3577 to 0.6346	< 0.0001
	Diastolic blood pressure	0.2072	0.02285 to 0.3779	0.0237

Table III

Associations between systolic blood pressure and other parameter.

Parameter	Spearman r	95% confidence interval	P value (two-tailed)
Weight	0.5092	0.3577 to 0.6346	< 0.0001
BMI	0.4556	0.2953 to 0.5909	< 0.0001
Biceps skinfold	0.19	0.004960 to 0.3625	0.0385
Triceps skinfold	0.1802	-0.005177 to 0.3537	0.0498
Subscapular skinfold	0.2534	0.07148 to 0.4189	0.0054
Suprailiac skinfold	0.3311	0.1554 to 0.4865	0.0002
Neck	0.4059	0.2386 to 0.5498	< 0.0001
Abdominal circumference	0.4608	0.3012 to 0.5952	< 0.0001
Gluteal circumference	0.4153	0.2493 to 0.5577	< 0.0001
Arm circumference	0.509	0.3575 to 0.6344	< 0.0001
Fat percentage	0.01567	-0.1701 to 0.2003	0.8657
Lean body mass	0.4797	0.3232 to 0.6107	< 0.0001
Basal metabolic rate	0.4852	0.3296 to 0.6151	< 0.0001

obesity (Table IV). From the analyzed subjects, only a percentage of 8.33% ensured the caloric requirement, while 91.6% didn't. 4.1% ensured the protein requirement, while 95.8% did not. The fats requirement was ensured for 4.1%, while 62.5% didn't get the needed quantity. 91.6% of the subjects didn't reach the required amount of carbohydrates, and just 4.1% managed to provide the needed amount. Only 4.1% exceeded the required quantity. After analyzing the food journals, we came to the conclusion that the most frequently consumed foods were white bread, white wheat flour and potatoes.

Table IV
Weight status.

Weight status	Number of subjects
Underweight	4.61%
Normal weight	53.84%
Overweight	35.38%
Obesity grade I	1.53%
Morbid obesity	1.53%

Discussion

After analyzing the data provided by the teenage students, it results that they do not get the necessary quantity of macronutrients. 53.84% are normal weight, 4.61% of the boys are underweight, 35.38% are overweight, 1.53% are obese of degree 1 and another 1.53% are morbidly obese.

75 percent of them consume only 86.48 grams of protein, while the calculated average required amount is 136.94 grams.

A French study conducted on the prevalence of overweight, obesity and underweight showed, based on their data, that in the year 2018, 10,27% of the boys who participated in the study were represented by boys with underweight, 73,55% by boys with normal weight, 12,83% with overweight and 3,35% with obesity (Vanhelst et al., 2022). Compared to the year of 2018, when the prevalence of overweight in the French group was 12,83%, in 2022, in our study we had 35% of overweight boys.

Data from another research indicates that 16.5% of the students participating in the study were overweight and 4.5% were obese. Approximately half of the students who are overweight and obese reported staying in the dormitory. Average BMI value in males is 23.1 kg/m2 and 22.3 kg/m2 in females. Male gender and the presence of an obese person in the family increase the risk of being overweight or obese (Tokaç, et al., 2021).

Obesity is associated with an increased risk of several adverse health outcomes in adolescents, including cardiovascular disease. Overweight and obese teenagers are at higher risk of developing high blood pressure, high cholesterol levels, or other cardiovascular problems (Farpour et al., 2015). Besides that, overweight and obese teenagers are mor e likely to have respiratory problems, such as asthma or sleep apnea, and also are more exposed to the risk of type 2 diabetes (Reinehr, 2019; Ford, 2005). Underweight teenagers are also at significant health risk, and it can lead to immune system dysfunction, mental health problems like anxiety and depression, and nutritional deficiencies (Dagnelie & Staveren, 1994; Golden et al., 2014; (1). According to some series of studies, insufficient consumption of macronutrients can harm the body. Insufficient carbohydrate consumption can have negative effects on an individual's health. As the primary source of energy, not reaching the needed quantity of carbohydrates can lead to decreased glycogen stores in the muscles and liver, resulting in fatigue and lower physical performance (Burke, 2015). More than that, not getting the needed quantity of carbohydrates can lead to inadequate nutrient intake, which can increase the risk of deficiencies and associated health problems. Low carbohydrate diets have been associated with an increase in cardiovascular disease, type 2 diabetes, and certain types of cancer (Hu et al., 2012; Nakamura et al., 2014). On the other hand, exaggerated carbohydrate consumption can lead to increased blood sugar glucose levels, insulin resistance, and weight gain (Samaha et al., 2003). For proteins, a higher intake than needed can increase the risk of kidney stones and the risk for cardiovascular disease (Taylor et al., 2010; Song et al., 2016), while an insufficient amount can lead to muscle loss and slower wound healing (Houston et al., 2008). A fat intake deficiency can reduce nutrients absorption and can also produce hormone imbalances, including problems in reproductive health (Henry & Clarke, 2008). A higher fat intake can lead to cardiovascular diseases such as coronary heart disease and can increase the levels of the inflammatory markers in the blood (Li et al., 2015; Calder et al., 2011).

A potential solution for an inadequate intake of nutrients is to engage in mindful eating practices. According to a study published in the American Journal of Clinical Nutrition, mindful eating practices, such as paying attention to hunger and fullness cues, can improve people's overall nutrient intake (Warren et al., 2017)

An Indian study showed that the global prevalence of childhood obesity has increased eightfold in the 5–19 y age group in the past four decades (Mittal & Jain, 2021). Also, a few studies found that, as the BMI distribution shifts upwards, the prevalence of underweight declines somewhat more slowly than the prevalence of obesity rises (NCD-RisCv, 2021).

It appears that the relationship between BMI and systolic pressure is significantly positively associated ($p=<0.0001$)

The minimum value for the systolic pressure observed was 100 mmHg and the highest 184 mmHg. The normal values for systolic pressure are between 100-130 mmHg (Javaudin et al., 2018). Our mean value was 132.6 mmHg. A study showed that the strength of association between the body mass index (BMI) and blood pressure (BP) varies with population and time. Mean systolic blood pressure (SBP) values decreased from 122.8 to 122.3 mmHg in the first year of the comparative study and gradually increased to 125.9 mmHg thereafter. The data showed that the BMI-BP association increased over time (coefficient of the interaction term > 0, $P < 0.001$). Moreover, as the BMI increased, the annual increase in BP and BP per unit BMI also increased. The association analysis between BMI and SBP resulted in an annual increase in the correlation coefficient (SBP: 0.257-0.495).

The study emphasized a continuous shift towards obesity in BMI distribution and intensifying BMI-BP association over time (Koh et al., 2022).

The data from another study showed that the odds ratios (ORs) for high BP were 1.27 (95% confidence interval [CI], 1.14-1.41; P < 0.001) in the 25th-49th percentile subgroup, 1.55 (95% CI, 1.39-1.73; P < 0.001) in the 50th-74th percentile subgroup, and 2.17 (95% CI, 1.92-2.46; P < 0.001) in the 75th-84th percentile subgroup, respectively, after adjustment for sex, age, race/ethnicity, height, and country (Wang et al., 2020).

Based on the data that our study provided, we observed that weight was statistically significantly and positively associated with systolic and diastolic blood pressure.

A study showed that children with elevated blood pressure or hypertension had significantly higher weight, BMI, WC, HC, fat mass, and fat-free mass values compared to participants with normotension, supporting the direct association between obesity and hypertension in this population (Wühl, 2019). All obesity-related variables showed statistical differences between the normotensive, elevated blood pressure, and hypertension groups for systolic and diastolic blood pressure ($p < 0.05$) (Koh et al., 2022). Hypertension is a common finding in children and increases the risk for future cardiovascular events (Tran & Urbina, 2020; Srour et al., 2019).

Our statistics showed that the maximum intake of carbohydrates in a day was 489.9 grams, while the mean value is 294.59. An etiological element that may contribute to the diverse condition and phenotypes of obesity is food addiction (Lennerz & Lennerz, 2018). Carbohydrates with a high glycemic index cause neurochemical and behavioral reactions that resemble addiction (Vella & Pai, 2016). The carbohydrate quantity and quality also have a vital function in the prevention and management of diabetes. Also, a study found a linear association between carbohydrate consumption and MetS risk with a corresponding OR of 1.026 (95% CI, 1.004-1.048) and with significant heterogeneity (I2 = 82.0%) at 5% energy intake from carbohydrates (Liu et al., 2019).

Conclusions

1. According to the analyzed study sample, a weight development problem was observed in 47.66% of the cases, while only 53.84% of the adolescent subjects included in the research were characterized by normal weight.
2. Poor anthropometric development was significantly influenced in our adolescent sample by carbohydrate intake, with no positive or significant association with protein or fat intake.
3. In our research, weight and body mass index were positively and significantly associated with systolic and diastolic blood pressure.
4. Only a percentage of 8.33% of the analyzed subjects managed to ensure the caloric requirement, while 91.6% did not.

Conflict of interests

The authors declare no conflict of interests.

Acknowledgment

Partial results from the paper are part of the first author's bachelor thesis.

References

Burke LM. Re-Examining High-Fat Diets for Sports Performance: Did We Call the 'Nail in the Coffin' Too Soon? Sports Med. 2015;45 Suppl 1(Suppl 1):S33-S49. doi:10.1007/s40279-015-0393-9.

Calder PC, Ahluwalia N, Brouns F, et al. Dietary factors and low-grade inflammation in relation to overweight and obesity. Br J Nutr. 2011;106 Suppl 3:S5-S78. doi:10.1017/S0007114511005460.

Dagnelie PC, van Staveren WA. Macrobiotic nutrition and child health: results of a population-based, mixed-longitudinal cohort study in The Netherlands. Am J Clin Nutr. 1994;59(5 Suppl):1187S-1196S. doi:10.1093/ajcn/59.5.1187S.

Farpour-Lambert NJ, Baker JL, Hassapidou M, et al. Childhood Obesity Is a Chronic Disease Demanding Specific Health Care--a Position Statement from the Childhood O esity Task Force (COTF) of the European Association for the Study of Obesity (EASO). Obes Facts. 2015;8(5):342-349. doi:10.1159/000441483.

Ford ES. The epidemiology of obesity and asthma. J Allergy Clin Immunol. 2005;115(5):897-910. doi:10.1016/j.jaci.2004.11.050.

Golden NH, Abrams SA; Committee on Nutrition. Optimizing bone health in children and adolescents. Pediatrics. 2014;134(4):e1229-e1243. doi:10.1542/peds.2014-2173.

Henry BA, Clarke IJ. Adipose tissue hormones and the regulation of food intake. J Neuroendocrinol. 2008;20(6):842-849. doi:10.1111/j.1365-2826.2008.1730.x.

Houston DK, Nicklas BJ, Ding J, et al. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. Am J Clin Nutr. 2008;87(1):150-155. doi:10.1093/ajcn/87.1.150.

Hu EA, Pan A, Malik V, Sun Q. White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review. BMJ. 2012;344:e1454. doi:10.1136/bmj.e1454.

Javaudin F, Desce N, Le Bastard Q, et al. Impact of pre-hospital vital parameters on the neurological outcome of out-of-hospital cardiac arrest: Results from the French National Cardiac Arrest Registry. Resuscitation. 2018;133:5-11. doi:10.1016/j.resuscitation.2018.09.016.

Koh HB, Heo GY, Kim KW, et al. Trends in the association between body mass index and blood pressure among 19-year-old men in Korea from 2003 to 2017. Sci Rep. 2022;12(1):6767. doi:10.1038/s41598-022-10570-9.

Lennerz B, Lennerz JK. Food Addiction, High-Glycemic-Index Carbohydrates, and Obesity. Clin Chem. 2018;64(1):64-71. doi:10.1373/clinchem.2017.273532,

Li Y, Hruby A, Bernstein AM, et al. Saturated Fats Compared With Unsaturated Fats and Sources of Carbohydrates in Relation to Risk of Coronary Heart Disease: A Prospective Cohort Study. J Am Coll Cardiol. 2015;66(14):1538-1548. doi:10.1016/j.jacc.2015.07.055.

Liu YS, Wu QJ, Xia Y, et al. Carbohydrate intake and risk of metabolic syndrome: A dose-response meta-analysis of observational studies. Nutr Metab Cardiovasc Dis. 2019;29(12):1288-1298. doi:10.1016/j.numecd.2019.09.003.

Mittal M, Jain V. Management of Obesity and Its Complications in Children and Adolescents. Indian J Pediatr. 2021;88(12):1222-1234. doi:10.1007/s12098-021-03913-3.

Nakamura Y, Okuda N, Okamura T, et al. Low-carbohydrate diets and cardiovascular and total mortality in Japanese: a 29-year

follow-up of NIPPON DATA80. Br J Nutr. 2014;112(6):916-924. doi:10.1017/S0007114514001627.

NCD Risk Factor Collaboration (NCD-RisC). Heterogeneous contributions of change in population distribution of body mass index to change in obesity and underweight. Elife. 2021;10:e60060. doi:10.7554/eLife.60060.

Reinehr T. Type 2 diabetes mellitus in children and adolescents. World J Diabetes. 2013;4(6):270-281. doi:10.4239/wjd.v4.i6.270.

Samaha FF, Iqbal N, Seshadri P, et al. A low-carbohydrate as compared with a low-fat diet in severe obesity. N Engl J Med. 2003;348(21):2074-2081. doi:10.1056/NEJMoa022637

Saunders J, Smith T. Malnutrition: causes and consequences. Clin Med (Lond). 2010;10(6):624-627. doi:10.7861/clinmedicine.10-6-624.

Song M, Fung TT, Hu FB, et al. Association of Animal and Plant Protein Intake With All-Cause and Cause-Specific Mortality [published correction appears in JAMA Intern Med. 2016 Nov 1;176(11):1728]. JAMA Intern Med. 2016;176(10):1453-1463. doi:10.1001/jamainternmed.2016.4182.

Srour B, Fezeu LK, Kesse-Guyot E, et al. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). BMJ. 2019;365:l1451.doi:10.1136/bmj.l1451.

Stabouli S, Erdine S, Suurorg L, Jankauskienė A, Lurbe E. Obesity and Eating Disorders in Children and Adolescents: The Bidirectional Link. Nutrients. 2021;13(12):4321. doi:10.3390/nu13124321.

Taylor EN, Stampfer MJ, Mount DB, Curhan GC. DASH-style diet and 24-hour urine composition. Clin J Am Soc Nephrol. 2010;5(12):2315-2322. doi:10.2215/CJN.04420510

Tokaç Er N, Doğan G, Meriç ÇS, Yılmaz HÖ, Öztürk ME, Ayhan NY. Prevalence of overweight, obesity and abdominal obesity in Health Sciences Faculty students. Clin Nutr ESPEN. 2021;46:466-470. doi:10.1016/j.clnesp.2021.09.008.

Tran AH, Urbina EM. Hypertension in children. Curr Opin Cardiol. 2020;35(4):376-380. doi:10.1097/HCO.0000000000000744.

Vanhelst J, Baudelet JB, Thivel D, Ovigneur H, Deschamps T. French youth trends in prevalence of overweight, obesity and underweight from 2008 to 2018. BMC Res Notes. 2022;15(1):208. doi: 10.1186/s13104-022-06091-3.

Vella SL, Pai N. What is in a name? Is food addiction a misnomer? Asian J Psychiatr. 2017;25:123-126. doi:10.1016/j.ajp.2016.10.022.

Wang M, Kelishadi R, Khadilkar A, et al. Body mass index percentiles and elevated blood pressure among children and adolescents. J Hum Hypertens. 2020;34(4):319-325. doi:10.1038/s41371-019-0215-x.

Warren JM, Smith N, Ashwell M. A structured literature review on the role of mindfulness, mindful eating and intuitive eating in changing eating behaviours: effectiveness and associated potential mechanisms. Nutr Res Rev. 2017;30(2):272-283. doi:10.1017/S0954422417000154.

Wühl E. Hypertension in childhood obesity. Acta Paediatr. 2019;108(1):37-43. doi:10.1111/apa.14551

Websites

(1) World Health Organization. Malnutrition. 2020. Available online at: https://www.who.int/news-room/questions-and-answers/item/malnutrition. Accessed April 8, 2023.