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# Child and adolescent hypertension – a public health matter. The point of view of a family medicine team

Valeria **Herdea** [1,2], Ileana **Brinza** [2]*, Liliana **Chitanu** [2], Raluca **Ghionaru** [2], Laura **Comnea** [2], Petruta **Tarciuc** [1,2], Diana **Herdea** [3], Smaranda **Diconescu** [4]

[1] Department of Family Medicine, George Emil Palade University of Medicine, Pharmacy, Science and Technology, Targu Mures, Romania
[2] Romanian Association for Pediatric Education in Family Medicine (AREPMF), Bucharest, Romania
[3] Department of Pediatric Cardiology, Sf. Ioan Hospital, Bucharest, Romania
[4] Department of Pediatrics, Gr. T. Popa University of Medicine and Pharmacy, Iasi, Romania

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## Abstract

High blood pressure (HBP) is a global public health issue. The disease affects over 1 billion people, 1 in 4 men, 1 in 5 women, 60% people over 60, and causes 7.1 million deaths annually. Between 4–24% of children and adolescents may have hypertension. Our working hypothesis was that in schoolchildren between 6–21 years old, with a family risk of hypertension, obesity, diabetes, mental illness, there is a correlation between obesity and pathological blood pressure values (BP). Our purpose was to evaluate the role of health education in controlling risk factors, and our objectives were identifying the personal risk factors of the participants, mapping the familial risk factors allow to prepare the "Family Predictive Model" and develop the educational strategy for a healthy lifestyle in the 6–21 age group. Between 2017–2021, an observational, prospective study was carried out in primary health care with two study stages, targeting the educational intervention. Two groups of 36 children were monitored: female/male ratio – 2/1, urban/rural – 33/3. Monitored parameters: weight (W), height (H), blood pressure (BP), body mass index (BMI), personal, intrafamilial, and environmental risk factors that can influence children's health were assessed. Families were involved as well. We found that the cardio-metabolic pathology of the child and adolescent can be influenced by family history, that overweight/obesity in the context of persistence of environmental risk factors may associate child hypertension, and that early education for a healthy lifestyle, accessible from school age, can be an effective mechanism for controlling the evolution towards chronic diseases.

**Keywords:** child hypertension, obesity, intrafamilial risk map, intrafamilial predictive model.

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* Correspondence to: Ileana BRINZA, MD,
Romanian Association for Pediatric Education in Family Medicine (AREPMF). Phone: +40745504529;
E-mail: lucbrinza@yahoo.com

Key Messages

- The annual check-up performed by the family doctor allows the early identification of blood pressure adverse changes in children and adolescents.
- The evaluation of the family risk factors allows the elaboration of a predictive family model.
- Healthy lifestyle educational programs designed for children and adolescents may be the basis for effective prevention of chronic diseases in the future adult.

## Introduction

High blood pressure (HBP) is a global public health problem. The disease affects over 1 billion adults, 1 in 4 men, 1 in 5 women, 60% of people over 60, and causes 7.1 million deaths annually. The disease severity also results from the risk of significant hypertension complications during life: myocardial infarction, stroke, chronic kidney disease. Subsequent cardiovascular and renal diseases and hypertension remain among the leading causes of death in Europe, with the economic costs of healthcare for these diseases reaching approximately 1 billion euros per year [1]. By comparison, a variable percentage between 4–24% of children and adolescents may have hypertension [2, 3]. In 2013, international studies brought relevant data on the incidence and prevalence of hypertensive disease globally. The PURE study (The Prospective Urban Rural Epidemiology Study) conducted in 17 countries reported the prevalence of hypertension for the 35–70 age group at 40.8%, of which 46% of participants were aware of the disease, 32% were treated, and only 13.2% controlled [4]. Similar data were reported by Chow *et al.* [5].

According to the Guide for screening and management of hypertension in children and adolescents of the American Academy of Pediatrics in 2017, there is an increase in childhood hypertension prevalence, especially concerning overweight and obesity. The prevalence of hypertension varies from 3.8% to 24.8% in young people with overweight and obesity, with wide variations depending on the geographical area, economic and social conditions, access to health and medical services. The majority reported prevalence is approximately 4%. The frequency is higher in the Hispanic population and the black race. Major risk factors: family history of hypertension, low birth weight/prematurity. Genetic predisposition, obesity, and dyslipidemia remain serious factors that influence BP values in children and adolescents. In recent years, there has been an increase in the prevalence of essential hypertension in the 17–18 age group. In young children under 5 years of age, cases of secondary hypertension remain predominant [3].

In Romania, the SEPHAR I–IV studies were carried out between 2005–2021. The main objectives were the evaluation of the prevalence and incidence of hypertension at the country level, in representative groups, the evaluation of major cardiovascular risk factors in the adult population of Romania, awareness of the disease and its possible consequences, the rate of treatment, and control of hypertensive patients as well as the total cardio-vascular risk. Cardiovascular disease causes over 62% of all deaths in Romania, with a share of 26.6% of the total number of disability-adjusted life years (DALY) and 33% of the total number of DALY due to non-communicable diseases (DALY- unit measuring the burden of disease, equal to the number of years of life lost due to premature death caused by that disease) [6].

An observational, cross-sectional study, published in “Cardiology in the young” in 2013, conducted in Timis County in 2011, shows that for children aged 7 to 18 years, assessed in school, the prevalence of overweight and obesity was 14% and 11.8%, respectively. Children from rural areas had a higher prevalence of overweight and obesity (27.9%) than urban areas (24.9%). A prevalence of 9.1% (9.5% in males and 89% in females) was observed for hypertension grade 1 or 2; 6.5% of children had prehypertension (8.4% in boys and 5% in girls). Only 7.1% of normal-weight children and adolescents had hypertension, while only 3.1% were in the underweight category [7]. According to research conducted by the National Institute of Statistics in Romania, in 2016, 24.5% of children aged between 5 and 19 years belonged to the category of juvenile obesity.

The data from the offices of family physicians from Romania, resulting from the quarterly reports sent to the authorities, constitute a relevant argument for this high-risk situation. For children born in 1995, at the 10-year assessment (2005), the percentage of overweight children reached about 15%. At the 10-year evaluation of children born in 2005, the percentage exceeded 20% (2015). The year 2020 brings up an extremely worrying percentage of around 25% overweight adolescents (BMI >27) [8].

At the European level, serious efforts are being made to create a research network dedicated to assessing the incidence and prevalence of hypertension in children and adolescents, possible measures to prevent the risk of chronic cardiovascular disease in adulthood: COST Action HyperChildNET aims to train a European network of researchers, clinicians, doctors, health economists, decision-makers, patients, regulators, nutrition and pharmaceutical companies and internationally renowned medical device manufacturers involved in understanding the factors that cause high BP in children to propose and implement corrective and preventive actions both globally and locally [9].

The international guidelines and protocols in force find their equivalent in continental or national practice guides, tailored to a country's specific algorithms or a medical echelon (doctors, nurses) [10–13].

*Working hypothesis* – In schooled children, between 6–21 years old, with intrafamilial risk of hypertension, obesity, diabetes, mental illness, there is a correlation between obesity and pathological blood pressure values (BP).

Scope – establishing the role of health education in the control of major cardio-metabolic risk factors.

*Objectives:*

- Determining the personal risk factors of the participants;
- Mapping of intra-familial risk factors – the "Intrafamilial Predictive Model";
- Evaluation of the educational strategy for a healthy lifestyle in schoolchildren aged 6–21.

## Material and Methods

The Romanian Association for Pediatric Education in Family Medicine (AREPMF) has developed an educational project for applied prevention dedicated to children and adolescents from families that struggles with risk factors such as hypertension, obesity, dyslipidemia, diabetes, mental illness. The study was conducted between 2017–2021 in two stages: stage I (2017–2018) and stage II (2019–2021).

## Study Design and participants

### Phase I of the study (2017–2018) – resume

The program "My family's school" for health education, conducted between October 2017 and April 2018, included an observational, prospective study at the level of primary care, including a total of 72 children aged 6–21, in school, included in two groups, each of 36 children and adolescents: the study and control groups. The program ended with the educational intervention.

Two children in each group interrupted their schooling due to obesity, secondary depression and family problems. As a result of the efforts of the medical staff, teachers and parents, the four children managed to resume school. However, they reached the age of 21 at the end of the observational study, although 18 years was initially set as the age at which the schooling process ends. Instead of excluding them from the study, we highlighted the efforts of the interdisciplinary team that led to the recovery of these children and decided to use their data in the study.

Selection of participants: 2 months prior to the study (August-September 2017), children who were found to be overweight/obese, in the order of presentation to the office, for usual prophylactic or curative consultations, that were accompanied by at least one parent/relative, were informed about the study and its educational program to improve the lifestyle of the child and his/her family. From approximately 150 children and informed relatives, 36 children entered the study- 24% expressed the desire to join a preventive educational program. For the control group, children were selected in the order of presentation to the office for usual consultations during the two weeks following the end of admission to the first group of children in the study group. In both groups, the female/male ratio was 2/1, and the rural/urban ratio was 3/33. Mirrored age and sex criteria were selected compared to the study group participants. Participants in the control group received only general information about the study: follow-up method, clinical evaluation of the children (weight- G, height- H, Body Mass Index- BMI, blood pressure- BP), and general recommendations about diet, exercise, leisure activities (outdoors sport).

*Inclusion criteria:*

1. Patients of the medical office since birth
2. Parental agreement to participate in the study
3. BMI>27, percentile >85–95%
4. Respecting the scheduled visits established with the medical staff
5. Minimum 2 generations registered at the same medical office care*

*Exclusion criteria:*

1. Patients taken over after the age of 3 in the medical office care
2. Lack of parental consent to participate in the study
3. BMI < or >27
4. Inconsistent participation or absence from scheduled medical visits
5. Minimum 2 generations registered at the same medical office care*

* In both groups, the participants had at least 2 known family generations, registered at the same office (parent-child), in order to allow the demonstration of the existence of family risk factors.

The study group benefited from 3 visits to the family doctor, medical counseling, and personalized educational interventions. The control group also benefited from 3 visits to the family doctor and general medical advice. In both groups, the children answered a medical history interview (involving the presence of at least one parent) and clinical consultation for each participant. The children were clinically examined three times during this period: visit 1 (V1) – October 2017, visit 2 (V2) after 3 months – January 2018, visit 3 (V3) 6 months after the first visit – April 2018. At each visit, the clinical parameters were recorded: W – weight (kilograms), H – height (meters), SBP – systolic blood pressure, DBP – diastolic blood pressure (mmHg), BMI (calculated). The following data were obtained from the medical history of participants:

– personal physiological history;
– personal medical history;
– collateral (family) history.

## General risk factors evaluation

Intrafamily risk factors data include family and child lifestyle:

1. Family conditions: hypertension, dyslipidemia, myocardial infarction, diabetes, mental illness (predisposing factors), premature births/macrosomia;
2. Conditions related to the child's life and living environment: poor sanitation, inadequate nutrition, excessive red meat diet, fast food, canned food, smoked foods, excess salt, smoking, alcohol, drugs, psycho-affective insecurity (environmental determinants factors).

Data were taken during the anamnesis. Based on the anamnesis, the medical staff assessed the potential risks that the child may have in the family and simulated an Intrafamily Risk Map which includes a description of the diseases for which the participant may have a genetic predisposition.

An Intrafamily Predictive Model (IPM) was adopted for each child. IPM is the number of risks the child has - risks identified within the family + clinically detected personal risk factors of the child + environmental factors that may influence the child's health + measures required to prevent/slow down/eliminate the development of potential chronic diseases in the adult age of the participant (personalized health education program).

The educational measures of prevention applied to the study group matched the intrafamilial risk profile of the patients: recommendations for periodic medical examinations, awareness of the importance of controlling intra-family risk factors adapted to the level of understanding of the child and the family of origin:

- education in order to adopt a diet appropriate to the age and growth period (low or normal lipidic content, normal carbohydrate content, normal proteic content, micro-nutrients, fibers etc);
- education for outdoor exercising- minimum 60 minutes daily;
- physical exercises adapted to the capacity of each participant;
- recommendations for avoiding tense situations, such as intra-family conflicts;
- avoidance of negative emotional states (school, community);
- parents spending time with the child (minimum one family meal a day – 30 minutes daily);
- reducing the hours spent by the child in front of the computer or phone.

The parents of the children were also involved within the limits of their availability to spend free time with their children for at least 60 minutes a day (one family meal and accompanying the children during their sports activity – 30 minutes daily). The parents received the educational material in the form of a simple language and clear notions in Romanian.

The control group benefited from generally valid preventive recommendations: age-appropriate nutrition, daily exercise, reduced consumption of semi-prepared foods, avoidance of emotional stress.

## Statistical analysis for stage I (2017–2018)

The analyzed parameters were BMI, SBP, DBP, age, height. In the study group (2017–2018), the BMI value exceeded the 90$^{th}$ percentile. There were increases in the value of SBP of the monitored children correlated with increased BMI for more than half of the children.

At the beginning of the study, 23 (63.8%) of the 36 children enrolled had blood pressure values above the normal age limit, of which 10 children had high BP values, 10 children had stage I hypertension, and 3 had stage II hypertension. Only 1 in 3 children had normal BP values.

For the control group – 32 of the 36 children were classified according to BMI value in the overweight/obesity category. In one child out of 3, the measured blood pressure values were above the normal limit, being included in stage I hypertension. In the study group, 9 children out of 36 had macrosomia, 5 of the children had been born prematurely. The data regarding weight/gestational age in the control group showed that most than 24 children had a normal weight at birth and gestational age above 37 weeks.

## Age and BPS correlations

The recorded and analyzed data were compared with the CDC nomograms and the data from the Clinical Practice Guideline for Screening and Manage-

**Table 1.** Registered values for age and SBP, 2018.

| Age and SBP 2018 | |
|---|---|
| Pearson's coefficient (R) | 0.469020439 |
| Number of patients observed in the study (N) | 36 |
| T-test correlation value (T) | 3.096552204 |
| Degree of freedom (Df) | 34 |
| P value | 0.003907949 |

ment of High Blood Pressure in Children and Adolescents by Flynn *et al.*, 2017 [3]. The p-value $<0.003$ is statistically significant as the BP values obtained exceed the values allowed by the Guidelines for the age of the children in the study group. For the 2017 data, there were no statistically significant results obtained for the rest of the correlations (Table 1).

## Interpretation of Stage I results of the 2017–2018 study

At the end of the three medical visits and 6 months of observation, the following were registered:

- average 10% weight loss in children; reduction of systemic BP values on average by 15 mmHg in girls and 10 mmHg in boys;
- average daily sports activity – 60 min;
- the time spent with the family by the child increased by approximately 30 min/day

Partial results, including the study of 2017–2018, were published in the Romanian Journal of Pediatrics No. 3/2018, Amaltea Medical Publishing House, and the European Journal of Pediatrics in 2019. The study resume was also included in the volume Lifestyle Medicine and Chronic Diseases, published in 2020, Medical Publishing House [14–16].

## Phase II of the 2018–2021 study - The follow-up program

*Working hypothesis* – obesity of children and adolescents of the 6–21 age group, in families that struggle with risk of hypertension, obesity, diabetes, mental illness, combined with the prolonged action of predisposing environmental risk factors, could be the cause of the appearance of pathological values of blood pressure for those children.

*Scope and Objectives* – similar to the first part of the study

*Study design and participants* – the Follow-up Program was designed to be applied for 3 years, from 2019 to 2021.

- 2019 – The two initial study groups were maintained with the same school-age children. Parameters that were similar to those from stage I were registered and monitored.
- 2020 – As a result of the pandemic caused by the SARS COV-2 infection and the state of emergency declared in Romania between March 16 and May 15, 2020, the systematic evaluation of the groups of children was temporarily stopped. The study was resumed a year later, in April 2021. In 2020, the participants benefited only from occasional telephone counseling from the medical staff. Data obtained in 2020 were not used for the study.
- 2021 – the study was resumed with all the criteria set out above.

Summarizing, the second stage recorded only the results of 2 evaluations: April 2019 and April 2021. At each medical check-up, the clinical parameters were recorded again: W – weight (kilograms), H – height (meters), BPS – systolic blood pressure, DBP-diastolic blood pressure, BMI – body mass index (calculated).

A significant percentage of children also benefited from laboratory investigations and interdisciplinary exams in that period. As these were not performed in all children, the data were not used in the study. Weight was metrologically evaluated using scales, and height was measured using standardized measuring devices.

Assessments were made using the CDC nomograms:

- Overweight – body mass index $>85^{th}$ percentile and $<95^{th}$ percentile, calculated for children of the same age and sex.
- Obesity – body mass index $>95^{th}$ percentile for children of the same age and sex.
- In order to correlate the measured parameters (W and H), the CDC recommendations were applied.
- Body mass index (BMI) – anthropometric index resulting from the calculated ratio BMI=W/H2, where W, weight (Kg), H, height (meters) – screening tool used to initiate a counseling strategy of the evaluated persons.
- BMI depends on gender and age. It is not a diagnostic tool, the registered values being specific to the particularities of sex and age-induced changes and growth. The determination of BMI in children brings information about its future profile in adulthood (a factor with a potential risk prognostic role).
- Blood pressure was measured with standardized semi-automatic sphygmomanometers, metrologically verified. The arm cuff

was adapted to the age of the subjects and the circumference of their arm. BP was measured by trained medical staff – nurse, resident physician, or family medicine specialist. The measurement and interpretation of BP were performed following the recommendations of the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents, Flynn *et al.*, 2017 [3], as well as the Pediatric Hypertension – A guideline update, Benenson *et al.*, 2020 [11].

The measurement method was explained to the participants according to the level of understanding corresponding to their age, using simple language to reduce the stress induced by the medical staff (white coat), the agitation and anxiety of the child, as well as the accompanying parent. The children were invited to sit for 5 minutes on the chair with the semi-flexed arm resting on a table, at the height of their precordial area, legs parallel (not crossed) (Table 2).

## Results of phase II study

Statistical analysis – In phase II of the study – the Follow-up Program, the data obtained in 2019 and 2021 were analyzed comparatively between the two years and compared to those from phase I of the study (2017–2018). The values obtained were interpreted according to the BP Guide (Flynn *et al.*, 2017 [3]). Descriptive statistical analysis methods and Pearson's coefficient were applied. The statistical data was completed using SPSS version 20.0.

**BMI**

*Study group*

- 2017 – in the study group, BMI values (27–50.3) were >95$^{th}$ percentile; 50% of the BMI values were >30.
- 2019 – 11 children (30%) out of 36 children had BMI values above 27 (27.3–35.6).
- 2021 – 30% of children maintained their BMI over the value of 27.

Comparing the BMI values from 2017 with those from 2021, we can easily observe that they are 20% lower at the end of the study.

*Control group*

- 2017 – 33 children out of 36 had a BMI value >27. Out of these, 14 had a BMI value >30.
- 2021 – 28 out of 36 had a BMI value >27. Out of these, 7 had a BMI value >30.

**SBP – Systolic Blood pressure**

*Study Group*

- 2019 – 3 children out of 36 had SBP >125 mmHg (8%)
- 2017 – 17 children out of 36 had SBP >125 mmHg (47%)
- 2021 – 7 children out of 36 had SBP >125mmHg (19%)

In 2017, we had 17 children with high systolic BP. Comparing with the data from 2021, just 7 children remained with high systolic BP.

*Control Group*

- 2017 – 19 children out of 36 had SBP >125 mmHg (>50%)
- 2021 – 13 out of 36 had SBP >125 mmHg (36%)

**DBP – Diastolic Blood Pressure**

*Study Group*

- 2017 – 28 children put of 36 had DBP >80mmHg (77.7%)
- 2019 – 14 children out of 36 had DBP >80mmHg (38%)
- 2021 – 19 children out of 36 had DBP >80mmHg (52.7%)

The persistence of high BP values for many years can be translated into high diastolic BP values and a greater risk for cardiovascular chronic disease development.

**Table 2.** Updated definitions of BP categories and stages according to [3].

| | BP | BP |
|---|---|---|
| **Age category** | <13 years | >13 years |
| **Normal value** | <90$^{th}$ percentile | <120/80 mmHg |
| **High BP** | ≥90, <95$^{th}$ percentile<br>≥120 <130/<80 mmHg | ≥120 <130/<80 mmHg |
| **HBP stage I** | ≥95, <95$^{th}$ percentile+12 mmHg<br>130/80 to 139/89 mmHg | ≥130 <140/≥ 80 <90 mmHg |
| **HBP stage II** | ≥95$^{th}$ percentile + 12 mmHg, or<br>≥140/90 mmHg | >140/90 mmHg |

BP – blood pressure; HBP – high blood pressure.

 

*Control Group*

- 2017 – 28 children out of the 36 had DBP >80 mmHg
- 2021 – 5 children out of the 36 had DBP >80 mmHg

In 2021, the SBP values remained high in the study group only in the case of 7 children out of 36 (19%), while the DBP values remained high for 19 children out of 36 (52%).

In 2020, children went through the specific conditions imposed by the pandemic: online school, physical inactivity, stress overeating, foods with a high glycemic index, conditions of social and emotional insecurity, physical and verbal violence within the family, family abandonment, divorce, modest family income and so forth. The values of W and BP were taken over mostly by the medical staff in the teleconsultation/telemedicine system, without being able to perform rigorous monitoring, according to the principles set out above, which is why the data recorded in 2020 were not used in this study.

In 2021, the systematic clinical examinations of children and the educational program carried out between 2017–2019 were resumed:

*The study group*

- 19 children (52.7%) of the 36 had DBP values corresponding to stage I hypertension.
- 1 of 5 children had SBP values corresponding to stage I HBP.
- 1 of 3 maintained the BMI level above the obesity value (>95$^{th}$ percentile).

*The control group*

- 21 out of 36 children (58%) had BMI values over 27. Also, 1 out of 5 children had SBP and DBP values corresponding to stage I HBP.

Statistical analysis did not reveal statistically significant correlations, given the small number of cases studied (36). Pearson's Correlation Coefficient was applied to observe the relationship between BMI and SBP, BMI and DBP. The values of R indicated that there is a weak positive correlation between BMI and SBP (the more one value increases, the other increases as well) (Table 3).

**Table 3.** Registered values for age, BMI and SBP, 2021.

| BMI and SBP, 2021 | |
|---|---|
| **Pearson's coefficient (R)** | 0.108696284 |
| **Number of patients observed in the study ( N)** | 36 |
| **T-test correlation value (T)** | 0.637580466 |
| **Degree of freedom (Df)** | 34 |
| **P value** | 0.528017468 |

However, even though p-values were under the significance of threshold for the relationship between BMI and SBP in 2021 (p=0.52), the study can be replicated on a larger sample in the next step of the research and ensure validity and fidelity of the data obtained. Nonetheless, the data draw attention to the relationship between BMI and age, analyzed longitudinally in a group of preadolescents and adolescents. Some of them – 23 (63%) have extreme values compared to the standard weight according to their age.

## Discussion

### Main findings

The study participants are represented by children in the full process of growth and development: age, W, H, BMI are constantly changing. The parameters vary with sex and age. There is a relationship between the family history of cardiovascular and metabolic pathology and the risk of obesity in school-aged children, observations similar to those already published in the literature [2, 3, 7].

Environmental risk factors may play an aggravating role in increasing BMI and BP values in school children. A fluctuation of BP values can be observed depending on the evolution of BMI. The results converge towards data obtained from similar national [7] and international studies [12, 13, 17–20]. In overweight/obese children, the SBP values initially increase.

Maintaining a high BMI for age (over the 90$^{th}$ percentile) can induce over time (1–4 years in our clinical observation) the onset and installation of high DBP values for the corresponding age. Again, our data are comparable with other international studies [12, 13].

Given the existence of a genetic predisposition, environmental risk factors that influence the child's development: social and family psycho-emotional insecurity, unbalanced diet in micro- and macronutrients essential for children's development, the amount of salt consumed, can influence the early development of cardiometabolic diseases.

### Key points

- average BMI loss of 20% in children from 2017 to 2021;
- reduction of systolic BP values with 28%, on average, between 2017 and 2021;
- reduction of diastolic BP values with 25%, on average, between 2017 and 2021;
- average daily sports activity – 60 min;
- changed dietary habits,

- the time spent by the child with the family increased by approximately 30 min/day;
- healthy lifestyle educational programs.

## Clinical cases

### 1. Boy, 13 years and 6 months old

Personal physiological history – fetal macrosomia, birth weight of 4300 g.

Personal medical history – repeated bronchiolitis.

Collateral (family) history- obesity, hypertension, dyslipidemia, smoker (father) and obesity, hypertension (mother).

*Environmental factors*

- unbalanced diet;
- computer addiction >12 hours daily;
- difficult community-based adaptation;
- psycho-affective insecurity (parental divorce, severance of relations with the father).

*Stage I of the study*

V1 – October 2018. The patients was 13 years and 6 months old. W=172 kg, H=189 cm, BMI=50.3, SBP=150, DBP=90. Diagnosis at presentation: Transient ischemic attack. Left facial paresis. Obesity. Depression. Stress reaction. Computer addiction. School dropout.

V2 – January 2018. W=165 kg, H=185 cm, SBP=140, DBP=70, BMI=48.2.

V3 – April 2018. W=156 kg, H=186, SBP=120, DBP=70, BMI=45.1.

In 2018, the patient had bariatric surgery (gastric sleeve) and lost 65 kg.

*Stage II of the study*

2019 – April. Age=15 years old. W= 91 kg, H=187 cm, SBP=120, DBP=80, BMI=26.6

2020 – April. Weight fluctuations during the pandemic. W=98–120 kg (yo-yo effect).

2021 – April. Age=17 years old, W=90 kg, H=187cm, BP=120/80 mmHg.

The patient resumed the schooling process with good results and now exercises daily for 60 minutes under the guidance of a multidisciplinary team that involves a psychologist, nutritionist, cardiologist, and bariatric surgery specialist. He also received supportive behavior from the mother and the school community.

### 2. Boy, 7 years old, urban area

Personal physiological history – fetal macrosomia, birth weight of 4100 g.

Personal medical history – repeated bronchiolitis, enterocolitis, recurrent adenoiditis.

Collateral (family) history – obesity (father) and hypertension (mother).

*Environmental factors*

- unbalanced diet, lack of daily outdoors exercising, difficult community-based adaptation, poor school results. The parents denied the situation in the first stage.

*Stage I of the study*

V1 – October 2018. Age=7 years, W=75 kg, H=150, BMI=33.3, SBP=130, DBP=90.

Diagnosis: Uninvestigated thyroid dysfunction (parental refusal). Obesity. Hypogonadism in etiological observation (uninvestigated -parental refusal). Depressive syndrome. Phone addiction.

V2 – January 2018. W=72 kg, H=151 cm, SBP=120, DBP=55, BMI=31.6.

V3 – April 2018. W=66 kg, H=151 cm, SBP=110, DBP=60, BMI=28.9.

With the reduction of BMI values, the SBP value decreased as well.

*Stage II of the study*

2019 – April. Age=8 years and 6 months. W=64kg, H=153 cm, SBP=110, DBP=80, BMI=27.3.

2020 – April. Weight fluctuations during the pandemic. W=98–100 kg.

2021 – April. Age=11 years old. W=69 kg, H=153 cm, BP=120/80 mmHg, BMI=29.5.

DBP remained high during 2021 at every medical check-up. The patient had a difficult schooling process. The mother is in denial of her child's problems, did not implement seriously the lifestyle changes recommended by the medical staff.

## Particularity of study

The pandemic was a turning point of the study; the outbreak of the COVID-19 pandemic greatly reduced the contact of the medical staff with the patients monitored in the study for over a year.

For children and teenagers, the pandemic year meant physical inactivity, online schooling, computer or telephone addiction. Children and adolescents have gone through long periods of social isolation, faced with appetite disorders, depression and anxiety, sleeping disorders, school drop-out, and poor online school results.

In the period of 2020–2021, 4 teenagers dropped out of school – two from the study group and two from the control group. They need to follow long-term psychotherapy in order to be able to reintegrate into the school community. These children lose years of their lives, lose contact with their colleagues, need to repeat classes, face depression and anxiety. For their family, they became a burden, and for the community, this means long-term costs.

Regarding the research team, the pandemic meant losing important data and stopping gathering data for more than a year for our observational. However, more importantly, we lost the continuity of the educational program developed with children, adolescents, and their families. Any drop-out of an educational intervention will impact the special needs of a children's health.

## Strength and limitations

Our study has many limitations.

*Limitations related to the group of monitored children:*

- being a small group, it does not allow correlations with relevant statistical significance for large population groups.
- the study did not include all patient investigations, which could have raised the value of the study's observations. All clinical or paraclinical parameters that were not found in all children were excluded from the study.
- a possible bias – in both groups, two adolescents who were over the age of the group remained in the study. Those subjects lost years of school due to school drop-out, surgery, or serious depression caused by family separation. The decision to keep these subjects within the group was due to their inclusion in the school category (up to the 12$^{th}$ grade), as established in the working hypothesis.

*Limitations related to the healthcare personnel*

- The management of cases such as those presented in the study has shortcomings due to the people involved in the care process. Primary health care has limited human resources, often includes only a doctor and a nurse, without a psychologist, nutritionist, physiotherapist, or social worker. It cannot cover the real needs of the patient, such as health education, recovery programs or adequate age-related mental hygiene/health, or other complex patient problems. Another shortcoming of this system is the lack of financial sustainability of the care process that these cases require: from the psychologist to bariatric surgeon and the complex postoperative recovery that follows.

*Strengths of the study*

- Our study draws attention to the importance of early education for adopting a healthy lifestyle, addressed to the child and his family, not just to a child with special needs. Obese children are struggling not only with the disease itself, but they need to be able to face the community because in a community of children, being obese means being often marginalized, excluded, isolated. Controlling environmental risk factors remains to be done together in a team comprising the child, parent and health care provider.
- Mapping family risk factors allows the medical team to prepare an Intrafamilial Predictive Model and apply a personalized, early preventive intervention for the child.

## Conclusions

The cardio-metabolic pathology of the child and adolescent can be influenced by family history.

In the context of persistence of environmental risk factors, overweight/obesity may associate child hypertension.

Early education regarding a healthy lifestyle, accessible from a school age, can be an effective mechanism for controlling the evolution towards chronic diseases.

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### Supplementary data

Additional data can be obtained from the authors upon request.

### Ethical approval

The study complied with the Romanian legislation (Law 190/2018) and the General Data Protection Regulation (GDPR) 679/2016. The study was conducted with the approval of the Ethics Committee of the AREPMF (no. 16 SNI/12.03.2017).

### Conflict of interest

The authors confirm that there are no conflicts of interest.

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