Evaluating of the predictors of high blood pressure in children and adolescence: Findings from Iranian health care system reform plan

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Abstract

Background: to evaluate the role of dietary pattern and life style associated factors in predicting hypertension among overweight and obese pediatrics.

Methods : In the current cross-sectional study, 425 overweight and obese children and adolescents aged 6 to 18 years were enrolled. The predictors of blood pressure considering patterns of fruits, vegetables, dairy products, fast food or junk food intake and meal consumption and also life style habits including hours of watching TV and physical activity, anthropometric indices were included in the scoring algorithm.

Results : The results of final model of hierarchical linear regression showed that SBP and DBP had directly significant correlation with age ($p<0.001$, $p<0.001$) and BMI ($p<0.005$, $p<0.007$) respectively. Moreover, DBP was in significant correlation with fruit consumption of less than 2 serving per day versus never consumption ($p=0.014$, $B= 0.444$), fruit consumption of more than 2 serving per day versus never consumption ($p=0.014$, $B= 0.480$), and vegetable consumption less than 3 serving per day versus never consumption ($p=0.045$, $B= -0.374$). Also, results showed that DBP had significant correlation with fast foods /junk foods consumption of 1-2 items per week versus almost every day consumption ($p= 0.047$, $B=-0.177$). This final model could predict 32.1% of hypertension by SBP and DBP ($R2 =0.321$).

Conclusion : According to our findings, consumption of lower vegetables and fruits, higher amounts of fast foods, higher age and BMI could be potent predictors of high blood pressure among Iranian children and adolescents. Key words: hypertension, children, adolescents, Iranian health care reform system

Background

Childhood obesity has emerged as one of the most serious public health problems in the world. The increasing prevalence of childhood obesity has led to the emergence of multiple critical obesity-related comorbidities that not only menace the health of those affected but also put pressure on the health care system [1]. Blood pressure (BP) is one of the most important problems affecting obese children and adolescents. The prevalence of hypertension (HTN) in obese children ranges from 19% to 22%, compared to 4% to 6% in normal weight children [2]. However, the prevalence of HTN among Iranian children and adolescents was estimated to be 8.9% in overall [3]. Giving that, currently Iran is undergoing a nutritional transition [4] and nutritional transition in developing countries has led to overweight and obesity problems and their subsequent problems in spite of the lack of adequate growth in children [5], therefore, it seems that Iranian children are at higher risk of developing cardiovascular disease risk factors where the obesity-related HTN may play a significant role. Studies show that HTN is significantly associated with the combination of genetic, environment, behavioral and dietary factors [6]. Menghetti et al, in a study among 2007 healthy children and adolescents demonstrated that obese children and adolescents had higher risk of developing HTN apparently four times greater than normal weight subjects. They also indicated that, children who performed little physical activity spent many afternoon hours in front of the

television and/or computer and these children and adolescents, also had an unhealthy diet eating behaviors. They also demonstrated that fruit and salad consumption has a protective effect against hypertension [7]. The National Heart Lung and Blood Institute's Growth and Health Study, which followed 2185 girls over ten years, demonstrated that consuming more than two servings of dairy and more than three servings of fruits and vegetables daily is associated with lower BP in childhood and a 36% lower risk of developing high blood pressure (HBP) by young adulthood [8].

Since the 1970s, the National Heart, Lung, and Blood Institute has recommended measurement of BP in healthy children as part of routine health maintenance , Programs that combine diet and physical activity can have a beneficial effect on SBP, as is shown in several studies designed to prevent childhood obesity and address cardio-metabolic risk factors [9].

The Iranian health care reform plan with the goal of improving health systems of Iran affiliated with the Ministry of Health and Medical Education began its works by May 15, 2014, with three main approaches of: financial protection of the people, creating justice in access to health care services as well as improving the quality of health care services. In the health care reform plan, the nutritional pattern rating is evaluated by examining variables such as anthropometric information, several demographic factors, dietary intakes and lifestyle pattern. In the current report, we hypothesized that SBP and DBP both increase with sedentary lifestyle behaviors, increased age, increased consumption fast foods and reduced consumption of fruit, vegetable, dairy products and frequent meals in childhood and teens, who may be more likely than adults to adopt modern lifestyle behaviors associated with hypertension. However, developing a model which considers these factors in a combined model not in isolate form, could best predict a usual life style module. In our review of literature, all of available studies have examined the relationship between HTN with physical activity, dietary intake and lifestyle behavior separately, therefore, in the current study, as a part of Iranian health care system reform plan, we assessed the correlation between known nutritional and lifestyle associated risk factors of blood pressure in a life-style scoring algorithm among children and adolescents.

Methods

The present study is a descriptive cross-sectional study that was performed in 2018, using the Sib system (https://sib.tbzmed.ac.ir/home/) related to the health care reform plan investigating the anthropometric information, demographic factors, dietary intakes and lifestyle associated factors in 425 overweight and obese children and adolescents (254 males and 179 females), 6 to 18 years old, referred to Shahid-Bakeri Health center in Tabriz that selected by using convenience sampling method. The Shahid-Bakeri Health care center is a large health care system representative of the population of four distinct with difference socioeconomic status. The inclusion criteria were: aged 6 to 18 years and being overweight or obese. The exclusion criteria were renal or liver disease, diabetes, heart disease, thyroid dysfunctions, pregnancy and smoking and taking steroid medications. The parental and adolescents consent obtained for this study. Demographic information and detailed diet history were recorded by expert dietitian via direct interview with the participants and parents. Weight was measured to the nearest

100 g (Seca gmbh & co, Germany). Height was measured using a stadiometer (with an error rate of 0.1 cm) and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured on left arm at the heart level after at least 5 minutes of resting in sitting position and two recordings, separated by at least 1 min were made and the mean value was used. Physical activity, dietary intake and lifestyle behaviors were assessed according the health care system reform plan. The health care system reform plan is currently being implemented in Iran's primary health care system. One of the issues in this system is the implementation of a nutrition screening program in different age groups including our target population of 6-18 years old. The children and adolescents were undergoing yearly clinic visits using interviews, nutrition screenings, specific dietary intake and lifestyle behavior assessment, and anthropometric and blood pressure measurement. High blood pressure was defined according to the fourth report of the diagnosis and treatment of hypertension in American children and adolescents by gender-specific blood pressure tables[10]. Accordingly, SBP and DBP < 90 percentile considered as normal, ≥ 90 percentile and < 95 percentile as prehypertension and ≥ 95 percentile considered as hypertension. Also, overweight and obesity was defined as having +1Z score< BMI <+2 Z-score and BMI > + 2 Z score respectively. To assess the nutrition screening algorithm considers the amount of intake of different food groups, dietary habits were used, physical activity, as well as anthropometric measurements and body mass index. The questions in the Sib system are a tool for initial assessment of the nutrition pattern of the referrals to the health centers as the first level of service delivery by age groups. Nutrition pattern criterion evaluated by consumption of fruits, vegetables, dairy products, the frequent meals, fast food / junk food, as well as physical activity and hours of watching TV/ PC. The questionnaire, that use in the Iranian health care system reform plan has been used based on reliability and validity. Then, the questionnaire developed, tested and validated by the experts and university professors that way, CVR outcomes for all questionnaire items were good, and, the CVI overall was acceptable in terms of proportionality, transparency, and simplicity. Cronbach's alpha coefficient was good. The results confirmed the reliability of the questionnaire over time and approved by the Ministry of Health and Medical Education of Iran [11]. The questionnaire contained 7 questions. The first, second and third option of each question has 0, 1 and 2 scores respectively. The details of questions are provided in Table 1. The total scores of all questions are summed up and the life style algorithm final score ranges between 0 to14.

Statistical Analysis: The data were expressed as mean (SE) and frequency (%) for quantitative and qualitative variables, respectively (nominal or ordinal). The BMI was categorized as quartile as follows: BMI < 22.20, 22.20-25.22, 25.22-28.79 and ≥ 28.79 kg/m^2. Normality of data was confirmed based on three criteria; SD less than half of the mean, Kurtosis in the range of ± 3, and Skewness in the range of ±1.5. Data analysis was performed using statistical software STATA (MP 4.2 potable 2017). Using the univariate and Hierarchical linear multivariable regression models, the effect of SBP and DBP predictors was studied separately and adjusted with other variables, respectively.

We classified the variables into groups according to the Hierarchical Multivariable Linear Regression Model and examined the factors based on the three models. First, we examined the R-squared of each group to determine the priority of entering the groups into the model. The group of food habits (daily consumption of dairy products, fruits, vegetables, fast food and the number of meals and snacks) had R-squared =0.0348 and the group was related to the underlying factors (gender, age, BMI and type of obesity or overweight) had R-squared = 0.0277 and physical activity and watching TV / PC had R-squared =0.0281. Therefore, based on the R-squared of each group, the first priority was related to the underlying factors model, the second model was similar to the first model additional adjustment for the group of food habits and the final model was same as previous further adjusting to the physical activity and watching TV/ PC.

Result

The characteristics of the participants (children and adolescents with overweight and obesity) are presented in Table 2. Among 425 participants (254 boys and 179 girls), 86.12% of them had normal BP, 9.41% prehypertension and 4.47% hypertension. In general, 19.88% of them had prehypertension and hypertension. Table 3 shows the mean SBP and DBP in participants; according to lifestyle scoring algorithm (food intake and physical activity). In the boys, elevated SBP and DBP were associated with increased consumption of fruits, vegetables; while reduced SBP and DBP was in parallel of reduced consumption of fast foods. Accordingly, reduced SBP values were associated with reduced TV/PC watching. In the girls, reduced SBP and DBP values was associated with reduced consumption of fast foods, TV/PC watching and increased physical activity. Moreover, reduced SBP was associated with increased vegetables consumption. Table 4 shows the correlation between SBP and DBP with underlying variables, lifestyle and dietary intake using the Pearson and Spearman statistical analysis. In this table, we considered the correlation between the effective variables supposed to blood pressure separately and without modifying other variables in the form of Univariate model. The results show that by examining each of the predictors separately, SBP and DBP had positive correlation with BMI and physical activity and inverse correlation with watching TV/PC. Also, DBP, had positive correlation with consumption of fruit. All of these correlations were significant. Given that, the effect of any variable can be influenced by one or a group of variables, so we used the Hierarchical regression model in the final step.

Table 5 presents the predictors of blood pressure among obese and overweight children and adolescents according to their lifestyle associated factors according to the results of univariate regression. In our other assay, we examined all these predictors in three models with Hierarchical analysis (Table 5) and it has been shown that, in the first model containing gender, age, BMI and being overweight or obese, SBP and DBP had significant correlations with age and BMI directly, and this model could predict 28.1% of hypertension by SBP (R2 = 0.281) and 27.5% of hypertension by DBP (R2 =0.275). In the second model, we included the consumption of fruit, vegetable, dairy products, fast foods /junk foods, meals or snacks, and, nutritional screening score in addition to the variables included in the first model. The results showed that SBP and DBP had significant associations with age and BMI. Moreover, DBP had direct correlation with fruit's consumption. This model could predict 30.7% of hypertension of SBP (R2 =0.307) and 30.3%

of hypertension of DBP (R2 =0.303) in this age groups. In the third model, we included the watching TV/PC and physical activity in addition to the variables included in the second model. The results of the final model showed that SBP had significant positive correlation with age (p<0.001, B=0.344) and BMI (p=0.005, B=0.212). DBP had also significant correlations with age (p<0.001, B= 0.327), BMI (p=0.007, B=0.207), fruit consumption < 2 serving per day versus never consumption (p=0.014, B= 0.444), fruit ≥ 2 serving versus never consumption (p=0.014, B=0.480), and vegetable consumption < 3 serving versus never consumption (p=0.045, B= -0.374), vegetable consumption ≥ 3 serving versus never consumption (p=0.038, B= 0.439) respectively. DBP had also significant correlations with fast foods /junk foods consumption of 1-2 items per week versus almost every day consumption (p= 0.047, B=-0.177). This final model could predict 32.1% of hypertension (R2 =0.321).

Discussion

In the context of a rapidly growing prevalence of obesity in childhood, we evaluated the important predictors of hypertension across childhood. Pediatric hypertension has undergone shift from secondary hypertension (mostly caused by renal disease) to essential hypertension (as the main cause of hypertension in childhood and adolescence) [12]. The factors related to primary hypertension in children were different for systolic and diastolic hypertension. In the present study, age and BMI were the main predictors of SBP, while age and BMI with higher intakes of fruit and fast foods were in positive and significant association and higher intake of vegetables was in negative and significantly association with DBP. The univariate analysis showed a significant correlation among adiposity indicators and sedentary lifestyle (lower physical activity and spent many time for watching TV/PC) with SBP and DBP, whereas, higher intake of fruit, also, associated with DBP in this children and adolescents. In this study, we went through a hierarchical linear multivariable regression model to examine the effect of each of the predictors in a model on other variables. In accordance to our findings, Dong et al also reported that increased prevalence of hypertension is associated with higher body mass index among 943 128 participants aged 7 to 17 years [13]. Similar results were also observed in the Zeberio et al study indicating a positive association between SBP and BMI in school-aged children [14]. Higher concentrations of circulating inflammatory cytokines have also been shown to be associated with the atherosclerotic process, and CRP is one of the most susceptible indicators in obese Japanese children [15]. Increased carotid artery intima-media thickness (C-IMT) is associated with hypertension in children [16]. A study in healthy children mean aged 10.5±1.1 showed that CRP was a significant independent predictor of C-IMT and flow-mediated vasodilation [17].

Similar to our results, some studies have also demonstrated that a rise in the blood pressure is associated with increased age in children and adolescents [14, 18]. Several reports also indicated the possible role of puberty as an important determinant in the association between obesity and hypertension among adolescents specially girls. This might also explain the increase prevalence of hypertension with increased age [19]. Barba et al reported that in the period close to the completion of puberty, the association between age and BP becomes more evident among girls [18]. In the study of Oliveros and colleagues, the prevalence of prehypertension and stage 2 of hypertension was higher

among younger compared with older children, while stage one of hypertension was more prevalent among older children [20]. Among the dietary factors that influenced the nutritional pattern score in the current study, a positive correlation between hypertension and increased consumption of fruit groups and fast food /junk food consumption, and inverse correlation between hypertension and vegetable groups was observed. Increased fast food consumption containing high amounts of salt, sugar, and fat, is associated with increased obesity state [21, 22]. Studies showed that high levels of fats, sugars, and salt intake of fast foods are one of the other possible reasons of increased blood pressure in children and adolescents [23, 24].

Although the possible role of increased salt and sodium consumption in the pathogenesis of hypertension has been clarified, however, recently the role of other dietary factors, food pattern and lifestyle habits in increasing blood pressure has also been focus of interest. Stamler et al. showed that in addition to sodium, several other nutrients including calcium, magnesium, potassium, and fiber are also involved in the pathogenesis of hypertension [25]. One meta-analysis of 56 studies on the effect of sodium restriction on blood pressure showed that sodium restriction could be beneficial among elderly individuals with hypertension, however, its beneficial effects are low among people with normal blood pressure [26].

The higher sodium and energy contents of fast and junk foods are possible underlying reason of the association between fast food consumption and hypertension.

Numerous studies have shown that higher intakes of fruits, vegetables and dairy products could have an effective role in prevention of childhood hypertension due to several nutrients including potassium, magnesium, calcium and fiber [27, 28]. The positive association between fruits intake and hypertension in our study in contrast with several previous studies, could be attributed to the difference in study design, target group characteristics such as age or gender distribution [27], or taken fruit and vegetables as a one group with no separation of them [28]; while we analyzed fruits and vegetables separately in two independent groups. Moreover, 100% fruit juices are also considered as fruit groups and are likely to increase blood pressure by increasing consumption of fructose-rich fruit juice.

Consumption of 100% fruit juices might be associated with hypertension through several possible biological mechanisms including increased energy intake and weight gain, and increased uric acid production [29] which is also associated with elevated blood pressure. Also, consuming whole fruits in high amounts can increase weight due to increased energy intake. Therefore, it could be suggested to study the effects of whole fruits and fruit juices separately in further researches.

No significant correlation was found between blood pressure and dairy products in the current study. Greater intakes of dairy products were associated with lower SBP in white but not black children and teens in Dellavalle et al. study, suggesting that greater dairy products intake alone might be not beneficial for all races [30].

In the current report, 43.53% of participants consumed more than 5 meals per day; however, there was no significant relationship between meals and hypertension. Some studies showed that the prevalence of obesity declined by increased number of meals [31]. Donin et al. showed that more snacks and meal consumption leads to obesity and cardiovascular problems in children [32]. Also, Toschke et al studied 4370 children aged 5-6 years, and found that the prevalence of obesity declines by increasing the number of meals [31]. In the final regression model, we did not observe any significant correlation between blood pressure and physical activity or watching TV/PC. Torrance et al demonstrated that 40 minutes of moderate to vigorous aerobic-based physical activity 3-5 days/week is required to reduce blood pressure in obese children [33]. TV commercials influence the food choices of children in different ways. Using their highfalutin and vivid messages, they encourage people to buy the advertised products [34]. A program comprising screening, early detection and health promotion through school health programs may help to prevent future complications of hypertension [35]. Although in the current study we observed a correlation between blood pressure and television viewing and physical activity in the univariate regression, however these associations had been vanished by including several confounders into the model.

Limitations

Several factors are possible limitations of the current reports; first of all, was the family history of hypertension has not been considered in the current study. Secondly, the effects of other food items including the amount of salt and fat intake had not been considered.

Conclusion

It can be concluded that in the children and adolescent population, pathogenesis of higher blood pressure is a process influenced by age, higher BMI and life style factors like dietary intake. Therefore, it could be suggested that by increasing the age of children and closely to puberty period, especially in overweight and obese children and adolescents, controlling their weight and encouraging the consumption of more vegetables and recommending less fast food consumption could be a preventive strategy against hypertension.

Abbreviations

BP: blood pressure; HTN: hypertension; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; C-IMT: carotid artery intima-media thickness; TV/PC: television/physical activity

Declarations

Acknowledgment

wish to thank the participants in this trial. The authors have no conflicts of interest to report

Authors' contributions

SHT conducted the analysis and wrote the first draft of the paper, and was coinvestigator responsible for devising on methods and study design. MAJ conducted the analysis and wrote the first draft of the paper, and was coinvestigator responsible for devising on methods and study design. MAF conducted the analysis and wrote the first draft of the paper, and was coinvestigator responsible for devising on methods and study design. FP was coinvestigator responsible for in preparing samples for data preparation and the first draft of the paper. All authors contributed with the interpretation of the results and read and approved the final manuscript.

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Availability of data and materials

The related data and material will be available upon request to the corresponding author.

Ethics approval and consent to participate

This study was approved by IR.TBZMED.REC.1397.692 code by the Ethics Committee of Tabriz University of Medical Sciences. Written informed consent was obtained from participants and parents.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Question	Food group		Score
1	Daily fruit consumption	No consumption or occasionally consumption	0
		< 2 serving	1
		≥ 2 serving	2
2	Daily vegetable	No consumption or occasionally consumption	0
		< 3 serving	1
		≥ 3 serving	2
3	Dairy product consumption	No consumption or occasionally consumption	0
		< 3 serving	1
		≥ 3 serving	2
4	Daily fast foods /junk foods consumption	Almost every day	0
		One or two such items a week	1
		Rarely (repetitively less than the weekly)	2
5	Frequency of daily meal consumption (e.g. main meals and snacks)	≤ 2	0
		3-4 meals	1
		≥ 5 meal	2
6	TV/PC using time	> 2 hours	0
		about 2 hours	1
		<2 hours	2
7	Physical activity per week (Defining as 60 minutes of moderate and severe physical activity every time and divided in different days of the week)	No targeted physical activity in the week	0
		< 420 minutes /week	1
		≥ 420 minutes/week	2

Table 1. The life style algorithm scoring details in the health care reform plan

Table 2. General characteristics of the participants

Variables	Subgroups	Total participants n (%)	Boys n	Girls n
Gender		425	254	179
BMI quartiles	1st	106 (25.12)	64	42
	2nd	105 (24.88)	64	41
	3rd	105 (24.88)	54	51
	4th	106 (25.12)	62	43
Blood pressure	Normal	366 (86.12)	208	158
	Prehypertension	40 (9.41)	27	13
	Hypertension	19 (4.47)	10	9
Fruit	Rarely/never	5 (1.18)	3	2
	< 2 serving / day	70 (16.47)	38	32
	≥ 2 serving / day	350 (82.35)	205	145
Vegetable	Rarely/never	8 (1.88)	4	4
	< 3 serving / day	126 (29.65)	66	60
	≥ 3 serving / day	291 (68.47)	176	115
Dairy product	Rarely/never	6 (1.41)	3	3
	< 3 serving / day	104 (24.47)	49	55
	≥ 3 serving / day	315 (74.12)	194	121
Fast foods /junk foods	almost every day	37 (8.71)	16	21
	1-2 items/ week	103 (24.24)	67	36
	rarely	285 (67.06)	163	122
Meals/snacks	≤ 2meals/ day	12 (2.82)	4	8
	3-4 meals/ day	288 (53.65)	139	89
	≥ 5 meals/ day	185 (43.53)	103	82
Watching TV/ PC	> 2 hours/ day	171 (40.24)	101	70
	2 hours/ day	88 (20.71)	54	34
	<2 hours/ day	166 (39.06)	91	75
Physical activity	Without targeted physical activity	72 (16.94)	31	41
	< 420 minutes/ week	182 (42.82)	105	77
	≥ 420 minutes/week	171 (40.24)	110	61

BMI; body mass index

Table 3. The mean systolic and diastolic blood pressure in participants; according to lifestyle(food intake and physical activity)

Lifestyle (food intake and physical activity)	Boys (n= 254)			Girls (n= 179)		
	n	SBP Mean ± SE	DBP Mean ± SE	n	SBP Mean ± SE	DBP Mean ± SE
Fruit						
Rarely/never	3	86.66 ±5.77	46.66±5.77	2	100±0	60±0
< 2 serving / day	38	97.36±13.54	60±10.06	32	101.56±11.46	63.87±10.31
≥ 2 serving / day	205	100.78±14.35	63.12±9.65	145	99.77±10.88	61.79±8.47
Vegetable						
Rarely/never	4	97.5±17.07	60.25±15	4	103.75±7.5	62.5±5
< 3 serving / day	66	97.57±15.22	60.30±1.14	60	103.41±12.02	64.4±9.40
≥ 3 serving / day	176	101.19±13.78	63.23±9.59	115	98.23±10	60.95±8.37
Dairy product						
Rarely/never	3	90±0	56.66±5.77	3	103.33±5.77	63.33±5.77
< 3 serving / day	49	103.16±13.52	64.38±9.1	55	102.38±11.02	64.07±8.29
≥ 3 serving / day	194	99.56±14.43	62.03±10.05	121	99.06±10.79	61.32±8.97
Fast foods /junk foods						
almost every day	16	101.25±14.88	60.53±11.57	21	102.38±11.02	64.28±11.64
1-2 items/ week	67	100.52±12.09	62.66±60.71	36	101.44±13.55	62.88±9.37
Rarely	163	99.90±15.07	62.48±1018	122	99.30±10	61.55±8.03
Meals/snacks						
≤ 2meals/ day	4	105 ±17.32	65±17.32	8	105±9.25	65±9.25
3-4 meals/ day	139	100.39±14.07	62.19±9.70	89	99.74±10.83	61.11±8.97
≥ 5 meals/ day	103	99.66±14.50	62.66±9.87	82	100±11.16	62.98±8.49
Watching TV/ PC						
> 2 hours/ day	101	102.02±13.08	62.97±9.62	70	101.25±11.53	63.57±9.33
2 hours/ day	54	97.03±12.42	60.37±9.85	34	100.29±10.51	61.32±6.43
<2 hours/ day	91	99.94±16.31	63.07±10.10	75	99.13±10.57	61.18±9.11
Physical activity						
Without targeted physical activity	31	93.06±13.27	57.58±10.15	41	101.70±9.19	63.29±9.32
< 420 minutes/ week	105	102.38±15.56	64.38±11.41	77	101.58±12.41	62.85±8.71
≥ 420 minutes/week	110	100.04±12.54	62±7.48	61	97.13±9.41	60.47±7.40

TV/PC, Television/ personalcomputer

Table 4. Univariate regression coefficients between systolic and diastolic blood pressure with high blood pressure predictors in obese children and adolescents

(DBP(mmHg				(SBP(mmHg				Predictor variables
R2	[95% Conf. Interval]	p	Coefficient	R2	[95% Conf. Interval]	p	Coefficient	
							Referent	**BMI quartile 1
0.2040	-0.78,3.78	0.197	1.50	0.2080	0.79, 7.06	**0.014**	3.93	BMI quartile 2
	4.79,9.35	**>0.001**	7.07		6.81,13.08	**>0.001**	9.50	BMI quartile3
	8.28,12.83	**>0.001**	10.55		12.39,18.64	**>0.001**	15.51	BMI quartile 4
							Referent	Overweight
0.0005	-1.70,2.78	0.636	0.54	0.0015	-1.84,4.32	0.430	1.24	Obesity
0.0003	-2.27,3.35	0.706	0.54	0.0080	-0.24,7.46	0.066	3.61	Nutrition screening pattern
							Referent	Fruit consumption rarely or never / day
0.0153	1.24,18.29	**0.025**	9.77	0.0058	-4.84,19.05	0.225	7.28	Fruit < 2 serving / day
	2.27,18.86	**0.013**	10.57		-3.03,19.87	0.149	8.42	Fruit ≥ 2 serving / day
							Referent	Vegetable consumption rarely or never / day
0.0000	-7.01,6.52	0.943	-0.24	0.0002	-9.56,9.03	0.955	0.26-	Vegetable< 3 serving / day
	-6.81,6.49	0.962	-0.16		-9.74,8.54	0.897	0.60-	Vegetable ≥ 3 serving / day
							Referent	Dairy consumption rarely or never / day
0.0138	-3.51,11.96	0.284	4.22	0.0128	-4.66,16.61	0.227	5.97	Dairy< 3 serving / day
	-5.86,9.32	0.655	1.73		-7.74,13.14	0.611	2.70	Dairy ≥ 3 serving / day
							Referent	Fast foods /junk foods consumption almost every day
0.0012	-3.63,3.47	0.965	-0.08	0.0033	-5.92,3.83	0.673	1.04-	Fast foods /junk foods 1-2 items/ week
	-3.99,2.49	0.650	-0.75		-6.69,2.20	0.322	2.24-	Fast foods /junk foods rarely
							Referent	≤ 2 meals or snacks/day
0.0053	-8.71,2.25	0.248	-3.22	0.0043	-12.39,2.67	0.206	4.85-	3-4 meals or snacks / day
	-7.70,3.32	0.436	-2.18		-12.77,2.39	0.179	5.18-	≥ 5 meals or snacks / day
0.0003	-0.43,0.31	0.740	-0.06	0.0029	-0.80,0.24	0.268	2.90-	Nutritional pattern rating

							Referent	Watching ***TV/ PC > 2 hours/day
0.0095	-4.90,-0.05	**0.045**	-2.47	0.0120	6.65,0.004	**0.050**	3.32-	Watching TV/ PC 2 hours/ day
	-3.00,0.01	0.333	-0.99		-4.80,0.72	0.147	2.04-	Watching TV/ PC < 2 hours/ day
							Referent	does not any targeted physical activity
0.0169	0.31,5.43	**0.028**	2.87	0.0171	0.53,7.75	**0.024**	4.05	Physical activity < 420 minutes/ week
	-1.96,3.20	0.636	0.622		-2.53,4.57	0.573	1.01	Physical activity ≥ 420 minutes/ week

**Body mass index ***Television/personal computer

Table 5. Blood pressure predictors of obesity and overweight children and adolescents according to lifestyle (food intake and physical activity)

Model	Predictor variable	SBP (mmHg)			DBP (mmHg)		
		p	B	R^2	p	B	R^2
1	Sex	0.754	-0.130	0.281	0.537	-0.025	0.275
	Age	**<0.001**	0.354		**<0.001**	0.356	
	BMI	**0.005**	0.213		**0.007**	0.205	
	Overweight	Referent					
	Obesity	0.747	-0.016		0.547	-0.031	
2	Sex	0.538	-0.026	0.307	0.286	-0.045	0.303
	Age	**<0.001**	0.356		**<0.001**	0.342	
	BMI	**0.005**	0.215		**0.007**	0.208	
	Overweight	Referent					
	Obesity	0.761	-0.015		0.545	-0.013	
	Fruit consumption rarely or never / day	Referent					
	Fruit < 2 serving / day	0.142	0.259		**0.009**	0.465	
	Fruit ≥ 2 serving / day	0.059	0.334		**0.003**	0.533	
	Vegetable consumption rarely or never / day	Referent					
	Vegetable< 3 serving / day	0.404	-0.147		0.159	-2.250	
	Vegetable ≥ 3 serving / day	0.345	-0.168		0.149	-0.258	
	Dairy consumption rarely or never / day	Referent					
	Dairy< 3 serving / day	0.549	0.145		0.463	0.144	
	Dairy ≥ 3 serving / day	0.692	0.079		0.828	0.043	
	Fast foods /junk foods consumption almost every day	Referent					
	Fast foods /junk foods 1-2 items/ week	0.085	-0.135		0.090	-0.134	
	Fast foods /junk foods rarely	0.055	-0.174		0.081	-0.159	
	≤ 2meals or snacks/day	Referent					
	3-4 meals/ day	0.659	-0.058		0.597	-0.070	
	≥ 5 meals/ day	0.306	-0.144		0.424	-0.089	
	Nutritional pattern rating	0.796	0.022		0.656	0.038	
3	Sex	0.537	-0.026	0.321	0.248	-0.049	0.321
	Age	**<0.001**	0.344		**<0.001**	0.327	
	BMI	**0.005**	0.2121		**0.007**	0.207	
	Overweight	Referent					
	Obesity	0.723	-0.018		0.459	-0.039	
	Fruit consumption rarely or never / day						
	Fruit < 2 serving / day	0.154	0.256		**0.014**	0.444	
	Fruit ≥ 2 serving / day	0.096	-0.324		**0.014**	0.480	
	Vegetable consumption rarely or never / day	Referent					
	Vegetable< 3 serving / day	0.217	-0.229		**0.045**	-0.374	
	Vegetable ≥ 3 serving / day	0.189	-0.277		**0.038**	-0.439	
	Dairy consumption rarely or never / day	Referent					
	Dairy< 3 serving / day	0.432	0.169		0.525	0.130	
	Dairy ≥ 3 serving / day	0.719	0.081		0.972	-0.007	
	Fast foods /junk foods consumption almost every day	Referent					
	Fast foods /junk foods 1-2 items/ week	0.080	-0.156		**0.047**	-0.177	

Fast foods /junk foods rarely	0.118	-0.212	0.060	-0.255
≤ 2meals or snacks/day	Referent			
3-4 meals/ day	0.423	-0.118	0.262	-0.165
≥ 5 meals/ day	0.237	-0.217	0.204	-0.233
Nutritional pattern rating	0.724	0.103	0.344	0.277
Watching TV/ PC > 2 hours/day	Referent			
Watching TV/ PC 2 hours/ day	0.169	-0.093	0.059	-0.128
Watching TV/ PC < 2 hours/ day	0.786	0.034	0.479	-0.089
does not any targeted physical activity	Referent			
Physical activity < 420 minutes/ week	0.169	0.116	0.329	0.081
Physical activity ≥ 420 minutes/ week	0.880	0.020	0.622	-0.066

BMI, body mass index; TV/ PC, television/personal computer; the test of Hierarchical regression was performed.