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ORIGINAL

Hypertension, lifestyle, and nutritional status of participants in the Study of Cardiovascular Risks in Adolescents in the Federal District

Hipertensão arterial, estilo de vida e estado nutricional de participantes do Estudo de Riscos Cardiovasculares em Adolescentes no Distrito Federal

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ABSTRACT

Objective

To estimate the prevalence of hypertension in participants of the Study of Cardiovascular Risks in Adolescents in Federal District, Brazil, and to investigate the factors related to lifestyle and nutritional status.

Methods

Lifestyle, economic, and demographic variables were obtained using a self-administered questionnaire. Anthropometric data and blood pressure measurements were collected according to a standardized protocol. Descriptive statistics was

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used to know the distribution of the investigated parameters in relation to the outcome. The association between hypertension and the variables of interest was investigated by hierarchical multivariate analysis using Poisson regression, considering $p<0.05$.

Results

We evaluated 2,646 adolescents with a mean age of 14.9 years. The prevalence of hypertension was 8.0% (95%CI 6.8-9.3). Studying in schools in the rural region (PR=2.1; 95%CI 1.4-3.3), having obesity (PR=4.0; 95%CI 2.5-6.3), male sex (PR=2.2; 95%CI 1.6-3.0) and age over 15 years (PR=1.4; 95% CI 1.0-1.9) were factors associated with a higher prevalence of hypertension. School feeding consumption was a protective factor (PR=0.7; 95%CI 0.6-0.9).

Conclusion

The prevalence of arterial hypertension was 8% and was associated with male sex, age at least 15 years, attendance in rural schools, and obesity. The consumption of school feeding was a protective factor.

Keywords: Adolescent. Hypertension. Life Style. Obesity. School Feeding.

RESUMO

Objetivo

Estimar a prevalência de hipertensão arterial em participantes do Estudo de Riscos Cardiovasculares em Adolescentes no Distrito Federal, investigando fatores relacionados ao estilo de vida e ao estado nutricional associados.

Métodos

Variáveis de estilo de vida, econômicas e demográficas foram obtidas por questionário autopreenchido. Os dados antropométricos e a aferição da pressão arterial foram coletados de acordo com protocolo padronizado. Empregou-se estatística descritiva para conhecer a distribuição dos parâmetros investigados em relação ao desfecho. A associação entre hipertensão arterial e as variáveis de interesse foi investigada pela análise multivariada hierárquica por meio da regressão de Poisson.

Resultados

Foram avaliados 2.646 adolescentes, com média de idade de 14,9 anos. A prevalência de hipertensão arterial foi 8,0% (IC95% 6,8-9,3). Estudar em escolas da região rural (RP=2,1; IC95% 1,4-3,3), ter obesidade (RP=4,0; IC95% 2,5-6,3), ser do sexo masculino (RP=2,2; IC95% 1,6-3,0) e ter idade maior ou igual a 15 anos (RP=1,4; IC95% 1,0-1,9) foram fatores associados a maiores prevalências de hipertensão. O consumo de alimentação escolar apresentou-se como um fator de proteção (RP=0,7; IC95% 0,6-0,9).

Conclusão

A prevalência de hipertensão arterial foi 8% e se associou com o sexo masculino, idade maior ou igual a 15 anos, estudar em escolas da zona rural e ter obesidade. O consumo de alimentação ofertada pelas escolas foi identificado como fator de proteção.

Palavras-chave: *Adolescentes. Hipertensão. Estilo de vida. Obesidade. Alimentação Escolar.*

INTRODUCTION

Adolescence is marked by several biological and behavioral changes, including the formation of habits and adoption of lifestyles. At this stage, there are risk behaviors reflected in adolescents' interaction with the socially and culturally constructed environment [1]. Thus, alcohol, tobacco, and illicit drug experimentation and use, as well as inadequate nutrition and physical inactivity, are frequent [2]. Such behaviors increasingly become risk factors for chronic Non-Communicable Diseases (NCD) at early ages, affecting family organization and health systems [3].

These NCD include high blood pressure, which is a disease of multifactorial origin characterized by high and persistent blood pressure levels. Although it is more frequent in adults, its diagnosis has been increasing in recent years in the pediatric population [4]. A systematic review with data from Brazilian

adolescents collected until 2012 showed a prevalence of 8.0%, while in the Study of Cardiovascular Risks in Adolescents (ERICA), a national school-based survey conducted between 2013 and 2014, it was 9.6% [5,6].

Several factors contribute to the occurrence of Systemic Arterial Hypertension (SAH) in adolescence and its continuation into adulthood. Factors subject to intervention, such as obesity; inadequate diet, with emphasis on the high consumption of sodium and fat present in ultra-processed foods; physical inactivity; consumption of alcoholic beverages; and tobacco use, among others, are directly associated with its incidence. [7,8]. In Brazil, there was also an association of characteristics of the school food environment with the disease, highlighting the possible harm of selling food in cafeterias and the benefits of providing school meals [9].

Some studies have investigated not only different factors associated with SAH but also the magnitude of these associations, contributing to the understanding of the phenomenon and to the identification of key elements in public policies useful for prevention and intervention. The population of the Federal District has not been subject of analysis on the subject, which could improve surveillance and support health actions. Therefore, this study aimed at estimating the prevalence of SAH in ERICA participants in the Federal District, investigating factors related to associated lifestyle and nutritional status.

METHODS

This study is part of ERICA, with an observational, cross-sectional design, which investigated the health of adolescents in cities with more than 100,000 inhabitants and capitals. Data from the Federal District collected between September and November 2013 were analyzed.

The ERICA sample was designed to estimate a prevalence of 4% with a maximum error of 0.9% and 95% confidence for each of the 12 estimation domains considered, defined by the combination of six age groups (12 to 17 years old) and the two sexes at birth, in cities with at least 100,000 inhabitants. The Federal District is the only Federation Unit whose research population is included in the outlined design since its only city, *Brasília*, has more than 100,000 inhabitants and a geographical area identical to the Federation Unit. Thus, 43 schools were selected: 33 public (two in rural areas) and 10 private schools. Subsequently, each school had three combinations of shifts (morning/afternoon) and years, and in each of these combinations a class, thus composing a sample of 129 classes. Other details about sample design and selection in Brazil were previously described by Vasconcellos *et al.* [10].

Study of Cardiovascular Risks in Adolescents evaluated all adolescents from the selected classes who agreed to participate in the study. Those with physical or mental disabilities, pregnant, and outside the eligible age group (12 to 17 years) were excluded [10].

The questionnaire used was self-administered using a Personal Digital Assistant (PDA) electronic data collector [11]. The analyzed variables and their response categories were: (a) Demographic and economic data: sex (female/male), age (<15 years/≥15 years), school location (rural/urban), administrative dependence of the school (public/private), and skin color (white, brown or black, Asian, indigenous). Administrative dependence was used as proxy of the economic class of the adolescents; (b) Food-related behaviors: The following questions were evaluated: "Do you eat the meal offered by the school?", "Do you buy snacks at the school cafeteria?", "Do you eat breakfast?", "Do you eat lunch and/or dinner watching television?", "Do you eat snacks while watching television?", "Do you eat snacks using the computer or playing video games?", and "Does your father or mother or guardian have lunch and/or dinner with you?". Any frequency reported was considered a positive response (yes), while "no" and "never" were considered negative responses (no). As for water consumption, the questions were: "How many glasses of water do you drink in a day?", with the following response options: "I don't drink water", "1 to 2 glasses a day", "3 to 4 glasses

a day", and "At least 5 or more glasses a day"; (c) Cigarette use: "In the last 30 days (one month), on how many days did you smoke cigarettes?" Any frequency reported was considered as a positive response for use in the previous 30 days (yes), while "never smoked" and "no day" were considered a negative response (no); (d) Alcoholic beverage consumption: "In the last 30 days (one month), on how many days did you have at least a glass or a dose of alcoholic beverages?" Any frequency reported was considered as a positive response for consumption in the previous 30 days (yes), while "never drank" and "no day" were considered a negative response (no); (e) Physical activity: The version of the Self-Administered, Physical Activity Checklist used was adapted to ERICA and validated in studies with Brazilian adolescents [12]. The adolescents were classified as active (including insufficiently active) when they practiced physical activity ≥1min/week, and inactive when they practiced physical activity = 0min/week; (f) Sexual maturation: This variable was collected through a self-evaluation of the stages of sexual maturation by the adolescents according to the criteria proposed by Tanner [13]. The evaluation consisted of visualizing color figures, considering the development of female breasts, male genitalia, and pubic hair in both sexes. Stages 1, 2, and 3 were classified as non-pubescent and stages 4 and 5 as pubescent.

Weight was measured using a Leader® digital scale and height using an Alturaexata® portable stadiometer [14]. Nutritional status: Body Mass Index (BMI) was calculated by the ratio between weight (kg) and the square of height (m). The nutritional status was defined based on the reference curves of the World Health Organization using the BMI for age and sex. The cutoff points adopted were: Z-score <-3 (very low weight), Z-score ≥-3 and <-2 (underweight), Z-score ≥-2 and ≤1 (normal weight), Z-score >1 and ≤2 (overweight), and Z-score >2 (obesity) [15]. Waist circumference: Waist circumference was measured using a Sanny® fiberglass anthropometric tape with 1 mm precision and 1.50m length. The circumference was measured considering the midpoint between the upper edge of the iliac crest and the lower edge of the rib [16]. Measurements were duplicated and the mean value was used in the analysis [11]. The measure was considered high when equal to or greater than the 90th percentile of the population studied.

An electronic oscillometric device (OMRON® - HEM 705-CPINT) was used [17]. The measurements were taken with the adolescent seated, with their back supported, feet on the floor, and their straight arm supported at heart level. Three measurements were taken with an interval of three minutes between them, and the mean of the last two measurements was considered [11].

For classification, adolescents with systolic and diastolic blood pressure with a percentile <90 for their height, sex, and age were defined as normotensive; if systolic or diastolic blood pressure was between the 90th and 95th percentiles or blood pressure >120/80mmHg, but with a percentile lower than 95, they were defined as pre-hypertensive; and if blood pressure corresponded to the percentile >95, as hypertensive [18].

Study of Cardiovascular Risks in Adolescents was designed from a complex sample, and the analyses were performed with STATA® software version 14.2 using the "svy" command. Sample weight was calibrated using the variables age, sex, and sample stratum.

For descriptive analysis, the estimated prevalence of the studied characteristics and their relationship with SAH were presented as proportions and 95% confidence intervals (CI95%). As for the analytical phase, the crude prevalence ratio was calculated using the Poisson regression to evaluate the association between SAH and the parameters of interest. A significance of $p<0.20$ was considered to select variables for the next phase.

Finally, a multivariate analysis was conducted according to the hierarchical theoretical model (Figure 1), with variables grouped into three blocks: distal, intermediate, and proximal. Initially, the variables at the distal level were analyzed as a block. Those with $p<0.05$ were fixed for the next step, when the block of intermediate variables was added, and those with $p<0.05$ were fixed again. In the last step, the block of variables proximal to those that remained at the previous levels was added. The final model was then composed by significant associations adjusted by the variables fixed at the conceptual levels [19].

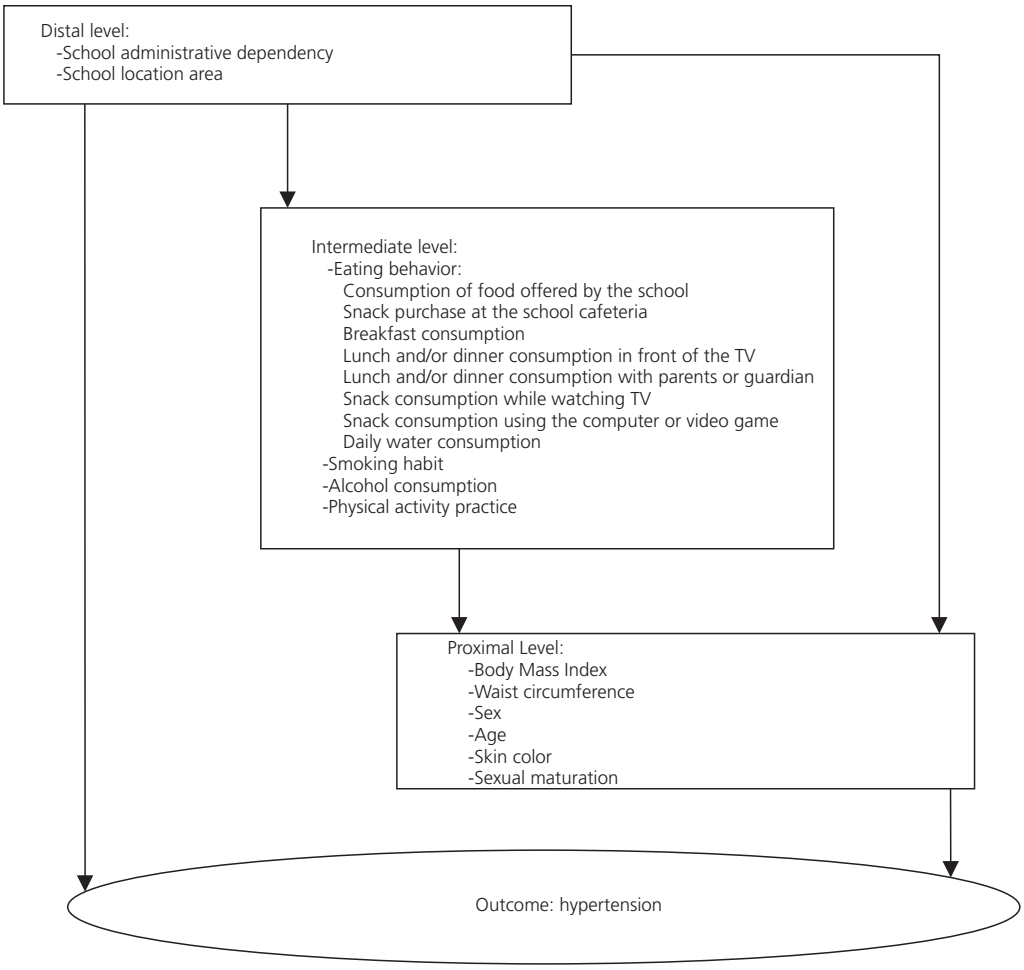

Figure 1 – Hierarchical theoretical model of factors associated with arterial hypertension in adolescents in the Federal District.

Study of Cardiovascular Risks in Adolescents was conducted in the Federal District after the project was approved by the Human Research Ethics Committee of the School of Medicine, *Universidade de Brasília* (CAAE No. 05185212.2.2005.5540), under number 303.532-0. Students' parents or guardians were informed about the project and the methodology used in the study. All students in the project presented a signed informed consent form.

RESULTS

A total of 2,646 students from the Federal District were evaluated, with a mean age of 14.9 years. Most adolescents were enrolled in public schools, in urban areas, and self-declared to be brown or black. The prevalence of pre-hypertension was 13.3% (CI95% 11.5-15.4) and of SAH 8.0% (CI95% 6.8-9.3), being higher in male adolescents, rural students, and those aged more than 15 years.

Just over half of the evaluated adolescents did not consume the meals offered by the school. Considering only students from public schools, 40.7% (CI95% 33.7-48.0) declared that they did not consume school meals (data not shown in tables). The analysis of the variables corresponding to adiposity showed that 14.5% (CI95% 12.8-16.4) of the adolescents were overweight and 6.8% (CI95% 5.5-8.4)

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Table 1 – Distribution of characteristics of adolescents aged between 12 and 17 years in the Federal District and prevalence of arterial hypertension. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

Characteristics	Prevalence of adolescents		Prevalence of hypertension	
	%	CI95%	%	CI95%
School administrative dependency				
Public	69.3	51.7-82.6	7.7	6.2-9.4
Private	30.7	17.3-48.2	8.6	6.9-10.5
School location area				
Urban	94.2	77.6-98.6	7.5	6.4-8.7
Rural	5.8	1.3-22.3	15.2	8.8-24.8
Sex				
Women	50.1	-	4.5	3.3-6.0
Men	49.9	-	11.4	9.4-13.8
Skin color				
White	36.0	31.3-40.8	8.1	6.1-10.7
Brown or black	58.6	53.8-63.2	8.0	6.5-9.8
Asian	2.6	1.9-3.3	4.0	1.5-9.8
Indigenous	0.4	0.2-0.8	14.8	3.5-44.7
Did not answer	2.4	1.9-3.0	7.6	2.7-19.1
Age				
< 15 years old	52.0	-	7.2	5.7-8.8
≥ 15 years old	48.0	-	8.9	7.1-10.9
Sexual maturation[1]				
Not pubescent	18.6	16.3-21.2	6.8	4.3-10.4
Pubescent	81.4	78.7-83.6	8.3	6.9-9.7
Physical activity[2]				
Insufficiently active/active	75.1	72.8-77.1	9.0	7.5-10.6
No physical activity	24.9	22.8-27.1	5.0	3.5-6.9
Consumption of food offered by the school				
No	53.0	45.2-60.7	8.8	7.3-10.4
Yes	47.0	39.2-54.7	7.1	5.5-9.0
Snack purchase at the school cafeteria				
No	13.4	9.3-18.8	5.6	3.3-9.1
Yes	86.6	81.1-90.6	8.4	7.1-9.7
Breakfast consumption				
No	19.1	15.9-22.5	8.4	6.2-11.2
Yes	80.9	77.4-84.0	7.9	6.5-9.4
Lunch consumption in front of the TV				
No	17.9	15.8-20.3	10.5	7.5-14.4
Yes	82.1	79.6-84.1	7.4	6.1-8.8
Dinner consumption in front of the TV				
No	19.6	16.6-22.9	9.9	7.0-13.8
Yes	80.4	77.0-83.3	7.5	6.1-9.0
Lunch consumption with parents or guardian				
No	16.6	15.1-18.1	5.9	3.8-9.0
Yes	83.4	81.8-84.8	8.4	6.9-10.0
Dinner consumption with parents/guardians				
No	11.5	10.0-13.0	4.9	2.5-9.1
Yes	88.5	86.9-89.9	8.4	7.0-9.9
Snack consumption while watching TV				
No	13.7	11.8-15.6	10.1	6.9-14.3
Yes	86.3	84.3-88.1	7.7	6.4-9.0
Snack consumption using the computer or playing video game				
No	29.0	26.2-31.8	8.2	6.0-10.9
Yes	71.0	68.1-73.7	7.9	6.4-9.6

Table 1 – Distribution of characteristics of adolescents aged between 12 and 17 years in the Federal District and prevalence of arterial hypertension. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

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Characteristics	Prevalence of adolescents		Prevalence of hypertension	
	%	CI95%	%	CI95%
Daily water consumption				
Does not drink water	1.2	0.7-1.8	7.2	1.6-26.9
1 to 2 glasses a day	18.9	16.5-21.4	6.3	3.8-10.1
3 to 4 glasses a day	35.0	32.0-38.1	7.6	6.0-9.4
At least 5 or more glasses a day	44.9	40.9-48.8	9.0	7.1-11.3
Tobacco use in the last 30 days				
No	93.7	92.1-95.0	8.0	6.8-9.4
Yes	5.3	4.0-6.8	6.7	2.5-16.8
Does not know/remember	1.0	0.4-2.1	8.1	2.0-27.4
Consumption of alcoholic beverages in the last 30 days				
No	74.6	71.5-77.4	8.1	6.9-9.2
Yes	22.2	19.7-24.7	7.2	5.0-10.3
Does not know/remember	3.2	2.2-4.5	11.3	5.4-22.0
Nutritional status[3]				
Very low/low weight	3.1	2.5-3.7	5.4	1.5-17.3
Normal	75.6	73.1-77.7	4.4	3.3-5.7
Overweight	14.5	12.8-16.4	17.8	14.3-21.8
Obesity	6.8	5.5-8.4	27.8	17.4-41.3
Waist circumference				
≤p90 (82.25cm)	94.5	92.9-95.7	6.7	5.7-8.0
>p90 (82.25cm)	5.5	4.2-7.0	28.7	18.2-42.1

Note: [1]Puberal stadiometer classified according to the Tanner's pubertal stage, with levels 4 and 5 being advanced stages [13]. [2]Insufficiently active/active ≥1 min/wk; No physical activity =0 min/wk; [3]Nutritional status classified by body mass index by age, based on the Z-score, indicated for children and adolescents according to the WHO recommendations [16].

were obese. The highest prevalence of SAH was observed in adolescents with overweight, obesity, and high waist circumferences. The distribution of the other characteristics of the studied adolescents and the prevalence of SAH in relation to these parameters are shown in Table 1. The prevalence of the parameters related to lifestyle and nutritional status in the adolescents with and without hypertension is shown in Table 2.

Table 2 – Lifestyle and nutritional status of adolescents with and without hypertension in the Federal District. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

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Characteristics	Adolescents with hypertension		Adolescents without hypertension	
	%	CI95%	%	CI95%
Consumption of food offered by the school	41.7	31.5-52.6	47.4	39.7-55.1
Snack purchase at the school cafeteria	90.6	84.1-94.6	86.2	80.5-90.4
Breakfast consumption	79.9	73.1-85.3	81.0	77.3-84.2
Lunch consumption in front of the TV	76.4	69.3-82.2	82.5	79.9-84.8
Dinner consumption in front of the TV	75.5	67.2-82.2	80.8	77.2-83.8
Lunch consumption with parents or guardian	87.7	80.2-92.5	83.0	81.5-84.3
Dinner consumption with parents/guardians	93.0	86.8-96.3	88.1	86.3-89.6
Snack consumption while watching TV	82.8	75.9-87.9	86.6	84.5-88.4
Snack consumption using the computer or video game	70.2	61.7-77.5	71.1	68.0-73.9
Daily water consumption				

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Table 2 – Lifestyle and nutritional status of adolescents with and without hypertension in the Federal District. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

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Characteristics	Adolescents with hypertension		Adolescents without hypertension	
	%	CI95%	%	CI95%
Does not drink water	1.1	0.2-4.8	1.2	0.7-1.9
1 to 2 glasses a day	14.9	9.5-22.5	19.2	16.6-22.1
3 to 4 glasses a day	33.3	26.6-40.7	35.2	32.1-38.3
At least 5 or more glasses a day	50.7	41.6-59.6	44.4	40.3-48.4
Tobacco use in the last 30 days	4.4	1.5-11.6	5.3	4.0-6.8
Alcoholic beverage consumption	20.1	15.1-26.1	22.4	19.8-25.0
Physical inactivity[1]	15.5	11.3-20.9	25.7	23.5-28.0
Nutritional status[2]				
Very low/low weight	2.1	0.5-7.0	3.2	2.5-3.8
Normal	41.7	32.0-51.9	78.5	76.3-80.5
Overweight	32.5	25.4-40.3	13.0	11.3-14.7
Obesity	23.8	14.8-35.9	5.3	4.1-6.8
Waist circumference	19.7	11.7-31.2	4.2	3.2-5.5

Note: [1]No physical activity =0 min/wk; [2]Nutritional status classified by body mass index by age, based on the Z-score, indicated for children and adolescents according to the WHO recommendations [18].

Crude regression analysis results are highlighted in Table 3. The following data were selected for multivariate analysis: school region, consumption of the food provided by the school, purchase of snacks in the school cafeteria, consumption of lunch and/or dinner in front of the TV, consumption of lunch and/or dinner with parents or guardians, consumption of snacks while watching TV, physical activity, BMI, sex, age, and skin color (p<0.20).

Table 3 – Association between characteristics of adolescents and schools and arterial hypertension in the Federal District. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

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Characteristics	Crude analysis		*p*-value
	PR	CI95%	
School administrative dependency			
Public	Ref		
Private	1.1	0.8-1.4	0.461
School location area			
Urban	Ref		
Rural	2.0	1.1-3.4	0.011
Sex			
Women	Ref		
Men	2.5	1.7-3.6	<0.001
Skin color			
White	Ref		
Brown or black	0.9	0.6-1.4	0.930
Asian	0.4	0.1-1.3	0.147
Indigenous	1.8	0.4-6.8	0.371
Did not answer	0.9	0.3-2.6	0.883
Age			
<15 years old	Ref		
≥15 years old	1.2	0.9-1.6	0.133

Table 3 – Association between characteristics of adolescents and schools and arterial hypertension in the Federal District. Cardiovascular Risk Study in Adolescents, Brazil, 2013-2014.

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Characteristics	Crude analysis		*p*-value
	PR	CI95%	
Consumption of food offered by the school			
No	Ref		
Yes	0.8	0.6-1.0	0.123
Snack purchase at the school cafeteria			
No	Ref		
Yes	1.5	0.9-2.4	0.109
Breakfast consumption			
No	Ref		
Yes	0.9	06-1.3	0.722
Lunch consumption in front of the TV			
No	Ref		
Yes	0.7	0.4-1.0	0.073
Dinner consumption in front of the TV			
No	Ref		
Yes	0.7	0.4-1.1	0.178
Lunch consumption with parents or guardian			
No	Ref		
Yes	1.4	0.8-2.3	0.181
Dinner consumption with parents/guardians			
No	Ref		
Yes	1.7	0.8-3.4	0.123
Snack consumption while watching TV			
No	Ref		
Yes	0.8	0.5-1.1	0.170
Snack consumption using the computer or playing video game			
No	Ref		
Yes	0.9	0.6-1.3	0.841
Daily water consumption			
Does not drink water	Ref		
1 to 2 glasses a day	0.9	0.1-3.9	0.856
3 to 4 glasses a day	1.0	0.2-4.7	0.948
At least 5 or more glasses a day	1.2	0.2-5.5	0.766
Tobacco use in the last 30 days			
No	Ref		
Yes	1.0	0.9-1.0	0.989
Alcoholic beverage consumption			
No	Ref		
Yes	1.0	0.9-1.1	0.406
Physical inactivity[1]			
No	Ref		
No physical activity (yes)	0.6	0.3-0.7	0.002
Obesity[2]			
No	Ref		
Yes	4.3	2.5-7.1	<0.001
Sexual maturation[3]			
Not pubescent	Ref		
Pubescent	1.2	0.7-1.9	0.414

Note: [1]Insufficiently active/active ≥1 min/wk; no physical activity =0 min/wk; [2]Nutritional status classified by body mass index by age, based on the Z-score, indicated for children and adolescents according to the WHO recommendations [16]; [3]Puberal stadiometer classified according to the Tanner's pubertal stage, with levels 4 and 5 being advanced stages [13]. PR: Prevalence Ratio; Ref: Reference category.

Table 4 – Association between characteristics of adolescents and schools with arterial hypertension among school adolescents participating in the Study of Cardiovascular Risk in Adolescents, Federal District, Brazil 2013-2014.

Characteristics	Model 1		Model 2		Model 3		Final Model	
	PR	CI95%	PR	CI95%	PR	CI95%	PR	CI95%
Distal level								
School location area								
Urban	Ref		Ref		Ref		Ref	
Rural	2.0*	1.1-3.4	2.1*	1.1-3.9	2.2**	1.4-3.2	2.2*	1.4-3.3
Intermediate level								
Consumption of food offered by the school								
No			Ref		Ref		Ref	
Yes			0.7*	0.5-0.9	0.7*	0.6-0.9	0.7*	0.6-0.9
Snack purchase at the school cafeteria								
No			Ref					
Yes			1.4	0.8-2.2				
Lunch consumption in front of the TV								
No			Ref					
Yes			0.8	0.5-1.2				
Dinner consumption in front of the TV								
No			Ref					
Yes			0.7	0.5-1.4				
Lunch consumption with parents/guardians								
No			Ref					
Yes			1.2	0.7-2.0				
Dinner consumption with parents/guardians								
No			Ref					
Yes			1.5	0.7-3.0				
Snack consumption while watching TV								
No			Ref					
Yes			0.7	0.5-1.2				
Physical inactivity[1]								
No			Ref		Ref		Ref	
No physical activity (yes)			0.6*	0.4-0.8	0.7	0.5-1.0	0.7	0.5-1.0
Proximal level								
Obesity[2]								
No					Ref		Ref	
Yes					4.0**	2.5-6.3	4.0**	2.5-6.3
Sex								
Women					Ref		Ref	
Men					2.2**	1.6-3.0	2.2**	1.6-3.0
Skin color								
White					Ref			
Brown or black					1.0	0.7-1.3		
Asian					0.6	0.1-1.4		
Indigenous					1.6	0.4-0.5		
Did not answer					0.8	0.2-2.3		
Age								
<15 years old					Ref		Ref	
≥15 years old					1.4*	1.1-1.9	1.5*	1.1-1.9

Note: *$p<0.05$, **$p<0.001$; Model 1: Characteristic of distal level x hypertension; Model 2: Characteristic of distal level retained by statistical significance characteristic of the intermediate level x hypertension; Model 3: Characteristics of distal and intermediate levels retained by statistical significance characteristic of the proximal x hypertension level; Final Model: Characteristics of all levels retained x hypertension; [1]Insufficiently active/active ≥1 min/wk; no physical activity = 0 min/wk; [2]Obesity classified by body mass index by age, based on Z-scores WHO, 2007 [16]; PR: Prevalence Ratio; Ref: Reference category.

The final model showed that consuming the food offered by the school (PR=0.7; CI95% 0.6-0.9) was a protective factor for SAH. On the other hand, studying in schools in the rural region (PR=2.1; CI95% 1.4-3.3), having obesity (PR=4.0; CI95% 2.5-6.3), being male (PR=2.2; CI95% 1.6-3.0), and being aged 15 years or older (PR=1.4; CI95% 1.0-1.9) were risk factors (Table 4).

DISCUSSION

The results of this study showed a high prevalence of SAH in adolescents in the Federal District. As for associated factors, male adolescents, with obesity, from rural areas, and aged 15 years or older were most affected by the disease. However, consuming school meals can be considered a protective factor in the age group analyzed.

Adolescents who consumed school meals had a 30% lower prevalence of SAH compared to their peers, regardless of a diagnosis of obesity. The *Programa Nacional de Alimentação Escolar* (PNAE, National School Feeding Program) is responsible for providing meals at schools free of charge, particularly for public school students in Brazil and in the Federal District. In this study, about 70% of the adolescents studied in schools with meals offered by the PNAE. The PNAE guidelines enforce restriction of unhealthy food, food that are high in sodium and saturated fats, as well as sugary drinks [20,21]. A study using the National School Health Survey database (PENSE-2015) reported that students consuming meals offered by the school through the PNAE were less likely to consume ultra-processed snacks, sweets, and soft drinks. However, students who had cafeterias in schools were more likely to consume these products [22].

Schools are environments of great importance for the implementation of public policies aimed at promoting healthy lifestyles. Encouraging healthy eating and physical activity in the school environment contributes to a decrease in the prevalence of overweight, insulin resistance, and hypercholesterolemia in adolescents [23]. In this study, a wide-ranging and long-term program such as the PNAE, whose actions are outlined under the technical responsibility of professional nutritionists, proved to be important in this context, helping strengthen the school's capacity to implement actions that promote better health conditions for students.

The prevalence of hypertension in adolescent students in the Federal District was 17.8% in those who were overweight and 27.8% in those who were obese. These results are higher than those found in the national sample of the study, in which 17.8% of hypertension was estimated in those with obesity [6]. Adolescents from other parts of the world also have similar characteristics, with a study on 7,457 Lithuanians aged 12 to 15 years showing that overweight, obesity, and abdominal obesity were associated with hypertension [24]. A systematic review with a meta-analysis conducted on 341,281 children and adolescents in China showed that elevated BMI was the main risk factor for the occurrence of high blood pressure [25].

The reduction of the prevalence of overweight or obesity in adolescents can lead to blood pressure reduction. Changes in lifestyle and eating habits, such as increased fruit, vegetable, and fiber consumption, as well as physical activity, contribute to reducing BMI [26]. Although this study found no association of hypertension with markers such as physical inactivity, tobacco use, screen time, and alcohol consumption, the combination of these variables is related to higher prevalence of above-normal BMI as well as general and abdominal obesity, which may increase the incidence of hypertension throughout life [27].

Male sex was associated with hypertension in this study. This result corroborates previous findings [5]. Sex hormones may be related to differences between the sexes. Increased plasma testosterone levels during

puberty may be related to the higher prevalence of SAH in males, as this hormone has a pro-hypertensive action. On the other hand, estrogen, an abundant sex hormone in females, has an anti-hypertensive effect and may provide cardioprotective action from puberty to menopause [28].

The higher prevalence of hypertension in older adolescents (>=15 years) may also be related to hormonal changes and rapid growth during puberty. Blood pressure more frequently increases in the pubertal spurt period, and decreases in the post-pubertal period [29]. In a systematic review with a global meta-analysis published in 2019, the prevalence of SAH was 4.3% in 6-year-old children, 7.8% in 14-year-old adolescents, and 3.2% in 19-year-olds [4]. These facts reinforce the importance of monitoring blood pressure in early life, especially during puberty.

Adolescents in rural areas had a prevalence ratio of hypertension twice as high as those in urban areas. The high prevalence of hypertension in rural areas may be a consequence of changed lifestyle habits, globalization-related behavioral changes and technology and industrialization advances, and food transition, which favors the consumption of ultra-processed foods with high energy density and high sodium content [30]. However, this study sample was not designed to represent the rural population of the Federal District, which limits the ability to make inferences.

Other limitations should be considered regarding the inferences made in this study. Due to the cross-sectional design, it does not allow the extrapolation of cause and effect. The prevalence of SAH may be overestimated, since blood pressure was measured in just one instance. These measurements should be performed on different occasions for clinical diagnosis. In addition, the instrument used to collect individual variables was self-administered, which may lead to memory and information bias due to the interpretation of the questions.

Despite the aforementioned limitations, ERICA was a robust study recognized for its careful planning and field assessment execution. Method standardization, professional training, and use of validated equipment were implemented. In addition, the collected variables underwent a quality control process, which led to the replacement of equipment and evaluators when necessary. Furthermore, the careful weighting and calibration of the data, in addition to a well-designed sampling plan, provide greater confidence in the representativeness of the results.

CONCLUSION

The prevalence of hypertension in adolescents in the Federal District was estimated at 8% and was associated with being male, aged 15 years or older, studying in rural schools, and having obesity. The consumption of food offered by schools was a protective factor. Thus, encouraging the consumption of meals offered in a planned manner in the school environment can be an important tool to form healthy eating habits and prevent SAH. The importance of frequent blood pressure monitoring is highlighted in this population for early diagnosis and timely treatment.

CONTRIBUTORS

N.O. SOUSA contributed to data analysis and interpretation and manuscript writing. A.B. OKAMURA contributed to data analysis and interpretation and relevant critical review of intellectual content. V.S.S. GONÇALVES, E.S. DUTRA, and K.M.B. CARVALHO contributed to project conception, data interpretation, and performing a critical review of the manuscript's content. All authors take responsibility for all aspects of the study, guaranteeing the accuracy and completeness of any part of it after having approved the final version.

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