Prevalence of hypertension and its associated risk factors among secondary school students in Duhok City

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Abstract

Hypertension can develop in early childhood and go unnoticed unless it is screened for specifically during this developmental stage. Detecting potential hypertension risk in children is critical to avoiding the serious, long-term complications associated with the condition. The purpose of this study was to investigate the prevalence of hypertension among schoolchildren aged 13 to 18, as well as the risk factors associated with it. A cross-sectional study included 565 students aged 13 to 18 from the Duhok region. The analysis used Chi square testing and logistic regression with JMP Pro 14.3.0 software. Of the 565 students from 32 schools chosen, 242 (42.80%) were male and 323 (57.2%) were female. Notably, 5.84% (n=33) were hypertensive. A significant correlation was found between hypertension prevalence and body mass index, as well as gender. There was no significant relationship found with other variables. Logistic regression revealed that high blood pressure was significantly associated with excess weight, obesity, and age. We concluded that there was an increase in the incidence of hypertension among high school students. Lifestyle changes appeared to play a role in hypertension development among this population. Routine school surveys are recommended to detect potential hypertension cases in children and adolescents, allowing for timely preventative interventions.

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Informed consent: the written consent forms were not applicable in this study because we collected the data of this study from the students, not patients.

Patient consent for publication: written informed consent was obtained from a legally authorized representative(s) for anonymized Students information to be published in this article.

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Introduction

Hypertension poses a significant global health challenge and stands as a primary contributor to coronary artery and cerebrovascular diseases. The year 2000 witnessed around one billion adults worldwide grappling with hypertension, a number anticipated to escalate to 1.56 billion by 2025.[1,2] This pervasive ailment entails substantial morbidity and mortality, silently endangering populations globally. Evidently, hypertension can trace its roots back to childhood, remaining concealed unless diligently sought out during this developmental phase. Thus, timely identification of hypertension and its triggers assumes paramount importance to forestall its complications.[3] Given the paucity of symptoms during childhood and adolescence, hypertension often evades detection during these formative years. Its prevalence escalates with age and adolescence, rooted in multifaceted factors such as genetics, race, geography, culture, and dietary habits.[3] Intriguingly, elevated blood pressure in this period foreshadows similar levels in adulthood and old age Our understanding of blood pressure in children and adolescents is far from being complete and the long-term natural history of blood pressure in this age group is still not well understood.[4]

Hypertension seldom manifests symptoms during early life, though the WHO does not advocate hypertension screening for children and adolescents. This study was undertaken due to a lack of data on adolescent hypertension prevalence in our country. Hypertension poses a substantial public health challenge among adults globally, with Iraq registering a 40.4% prevalence in a 2006 non-communicable disease risk factor survey.[5]

Insufficient information exists regarding blood pressure patterns and hypertension prevalence in Iraqi children and other

developing nations. Notably, a 2009 Najaf City study on school students found a 5.5% prevalence of high blood pressure while a 2002 Baghdad study on school-aged students reported a 1.7% hypertension prevalence.[6] Despite strides in hypertension detection and management in select countries, the global scenario concerning awareness, treatment, and control remains wanting.[1] To ensure public awareness and regulation of hypertension, early identification in life's initial stages becomes pivotal. Delayed recognition burdens not only individuals but also governments due to elevated treatment costs. This study seeks to unveil hypertension prevalence and associated risk factors among secondary school students in the Kurdistan Region, thereby contributing to our understanding of this critical health issue.

Materials and Methods

Study design

The study was carried out in secondary and high schools in Duhok provinces in the Kurdistan region (north of Iraq). A cross-sectional study design was used; the study was carried out from 3rd November 2021 to 10th April 2022. Ethical approval from the Directorate General of Health/ Duhok and Directorate General of Education/ Duhok was obtained. Consent was obtained from the respondents before the interview with their parent's consent.

Sampling technique

In this research, the target group comprised adolescents aged 13 to 18, encompassing both genders and attending school. It was crucial for respondents to be an accurate representation of the intended population. To ensure this, a comprehensive multistage sampling technique was employed. In the initial phase, Duhok City was categorized into two distinct zones through stratified sampling. Subsequently, a list of schools in each zone was compiled, from which a total of thirty-two government schools were arbitrarily chosen to adequately represent both male and female secondary education. This selection was carried out using a simple random sampling method, specifically the lottery approach. This resulted in a random yet representative subset extracted from the overall population, allowing for a more precise estimation of characteristics. The sample size, calculated at a 95% confidence level, was established as 565 students. Students who were excluded from participation included those taking study breaks and those whose parents withheld consent. Additionally, students with chronic medical conditions or those reliant on specific medications affecting blood pressure, like steroids, were also omitted from the study.

Instruments and data collection

The collection of data will involve the utilization of a questionnaire, meticulously crafted through an exhaustive analysis of preceding research and literature pertinent to the current study's subject matter. This questionnaire comprises two distinct segments for data compilation. The first section of the questionnaire will be administered through face-to-face interviews with the participants. The second part, on the other hand, will involve data collection from the parents of the participants.

Statistical methods

The demographic information of school children was depicted using numerical values and percentages. The occurrence rate of hypertension in school children was ascertained both in numerical counts and percentages. This was achieved by dividing the number of patients exhibiting various degrees of hypertension by the total count of school children and then multiplying by 100. The assessment of hypertension prevalence based on factors like age, gender, and other general characteristics was conducted through the utilization of the Pearson chi-squared test. Similarly, the connection between hypertension in school children and parental socio-demographic traits and their lifestyles was evaluated using the Pearson chi-squared test. To identify predictors of hypertension among school children, nominal logistic regression was employed. A p-value below 0.05 was deemed indicative of statistically significant differences. The statistical computations were conducted using JMP Pro 14.3.0 software.

Anthropometric measurements

Anthropometric measurements were conducted within the school setting. Each measurement was taken twice, and the average of the two readings was considered. For height measurement, participants were barefoot and measured using a portable stadiometer (Seca 213, Measuring range 20 - 200cm). Weight was recorded with participants wearing lightweight attire, employing a digital Heine portable scale accurate to the nearest 0.1kg. BMI was computed for each child by dividing their weight (in kg) by the square of their height (in meters) (kg/m^2). To gauge the appropriateness of participants' BMI values, reference data from the most recent anthropometric standards specific to their sex and age were sourced from the Centers for Disease Control and Prevention (CDC). These reference standards were used to establish percentiles for height, weight, and BMI, aiding in the assessment of participants' BMI in relation to their age and sex.[7]

Children were grouped into categories determined by these percentiles as outlined: Individuals below the 5th percentile were classified as underweight, those between the 5th percentile and less than the 85th percentile were considered to have a healthy weight, those between the 85th percentile and less than the 95th percentile were classified as overweight, and those equal to or surpassing the 95th percentile were categorized as obese. For adults aged 20 years and older (*i.e.*, children's parents), the classification was slightly different. Adults with a BMI ranging from 18.5 to less than 25 were labeled as having a normal weight, those with a BMI between 25 and less than 30 were identified as overweight, and individuals with a BMI of 30 or higher were categorized as obese.[8]

Blood pressure measurement

Blood pressure assessments were conducted using a standardized mercury sphygmomanometer, paired with a manually inflated cuff of appropriate size, and a stethoscope. Measurements were taken from the right arm while the child was in a calm sitting position for a minimum of 5 minutes to alleviate any anxiety. The researcher inquired about recent activities such as smoking, eating, exertion, or exercise within the last 30 minutes before participating in the study. The student was positioned comfortably, with their back supported, feet resting on the floor, the right arm properly supported, and the cubital fossa (elbow crease) aligned with the level of the heart. If the blood pressure reading equaled or exceeded the 90th percentile based on the child's age, gender, and height, the blood pressure measurement was repeated twice during the same visit. The average values for systolic blood pressure (SBP) and diastolic blood pressure (DBP) were utilized.

If the mean SBP and/or DBP readings were elevated during the initial visit, two additional blood pressure measurements were performed within a two-week timeframe. This multi-step approach ensured accurate and reliable blood pressure assessments, taking into consideration possible variations in measurements.

Results

The stuyd showed that 15.04% of the school children had abnormal blood pressure. The classes of abnrmal blood pressure were Elevated blood pressure (7.43%), Hypertensive (5.84%), Stage 1 hypertensive (0.71%), and Stage 2 hypertensive (1.06%). The children were males (42.83%) and females (57.17%). The childfree had different age groups from 13 to 18. They reside in urban (10.09%) and rural areas (89.91%) and had different family size (Table 1). The study showed that the prevalence of different classes of abnormal blood pressure was not statistically different based on the gender (p=0.0934), age groups (p=0.2338), residency (p=0.8967), and family size (p=0.7519; Table 2).

The study showed that the children who their fathers had lower level of education were more likely to have abnormal blood pressures (p=0.033). In addition, those children who had the obese fathers were more likely to have different classes of abnormal blood pressures (p=0.0421). The similar pattern was found for the children whose their fathers had hypertension (p=0.0345) an sleep apnea (p=0.0002). In terms of mothers, the similar pattern was found for the education and hypertension. Also, the children who had employee mother were more likely to have hypertension (Table 3). The stuyd showed that the children who sued the free fat in their food by the family were more liley to be affected by abnormal blood pressure (p=0.0375). In addition, the children who were obese were more liley to be affected by abnormal blood pressure compared ot those children with normal and underweight (p<0.0001; Table 4). The stuyd showed that the age and obeisty of the children predicted the blod prressure among secondary school chidlren (Table 5; Figure 1). The study did not show the signficnat diference of QoL among children with different classes of abnormal blood pressure (p=0.2103 Table 6; Figure 2).

Discussion

Although the occurrence of clinical hypertension among children is significantly lower compared to adults, substantial evidence indicates that the origins of essential hypertension can be traced back to childhood. Numerous epidemiological investigations have addressed blood pressure levels in children. However, there exists considerable diversity in the methodologies employed and in the criteria defining normal and elevated blood pressure. Just as in

Table 1. Prevalence of hypertension by age and gender among secondary school children.

General characteristics	Statistics no (%)
Hypertension	
Abnormal blood pressure	85 (15.04)
Normotensive	480 (84.96)
Hypertension	
Normotensive	480 (84.96)
Elevated blood pressure	42 (7.43)
Hypertensive	33 (5.84)
Stage 1 hypertensive	4 (0.71)
Stage 2 hypertensive	6 (1.06)
Gender	
Male	242 (42.83)
Female	323 (57.17)
Age groups	
13	74 (13.10)
14	122 (21.59)
15	89 (15.75)
16	98 (17.35)
17	76 (13.45)
18	106 (18.76)
Residency	
Urban	57 (10.09)
Rural	508 (89.91)
Family size	
1-3	79 (13.98)
4-6	337 (59.65)
7 and above	149 (26.37)

Table 2. Prevalence of hypertension by age and gender among secondary school children.

Characteristics (n=565)	Blood pressure no (%)					p
	Normotensive	Elevated blood pressure	Hypertensive	Stage 1 hypertensive	Stage 2 hypertensive	
Hypertension	480 (84.96)	42 (7.43)	33 (5.84)	4 (0.71)	6 (1.06)	
Gender						0.0934
Male	205 (84.71)	18 (7.44)	11 (4.55)	4 (1.65)	4 (1.65)	
Female	275 (85.14)	24 (7.43)	22 (6.81)	0 (0.00)	2 (0.62)	
Age groups						0.2338
13	66 (89.19)	6 (8.11)	2 (2.70)	0 (0.00)	0 (0.00)	
14	104 (85.25)	7 (5.74)	11 (9.02)	0 (0.00)	0 (0.00)	
15	73 (82.02)	10 (11.24)	4 (4.49)	1 (1.12)	1 (1.12)	
16	86 (87.76)	5 (5.10)	5 (5.10)	2 (2.04)	0 (0.00)	
17	59 (77.63)	8 (10.53)	6 (7.89)	0 (0.00)	3 (3.95)	
18	92 (86.79)	6 (5.66)	5 (4.72)	1 (0.94)	2 (1.89)	
Residency						0.8967
Urban	433 (85.24)	37 (7.28)	29 (5.71)	4 (0.79)	5 (0.98)	
Rural	47 (82.46)	5 (8.77)	4 (7.02)	0 (0.00)	1 (1.75)	
Family size						0.7519
1-3	65 (82.28)	7 (8.86)	6 (7.59)	1 (1.27)	0 (0.00)	
4-6	282 (83.68)	27 (8.01)	21 (6.23)	2 (0.59)	5 (1.48)	
7 and above	133 (89.26)	8 (5.37)	6 (4.03)	1 (0.67)	1 (0.67)	

Pearson chi-squared test was performed for statistical analyses.

adults, a variety of environmental and genetic factors impact children's blood pressure. As a result, it is crucial to conduct extensive population-based research efforts to gather standardized reference data concerning blood pressure levels in children. Symptoms arising from hypertension are infrequent during the early stages of life. Importantly, it should be highlighted that the World Health Organization (WHO) does not endorse routine blood pressure screening for children and adolescents.[9] Much like in adults, the blood pressure of children is impacted by various environmental and genetic factors. Consequently, it is essential to conduct population studies to gather standard reference data concerning blood pressure levels in children. In the early years of life, symptoms stemming from hypertension are uncommon. It's important to note that the World Health Organization (WHO) does not endorse rou-

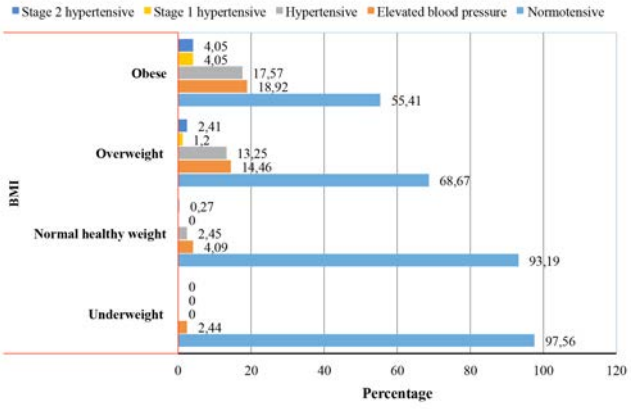

Figure 1. Prevalence of hypertension among children with different BMI.

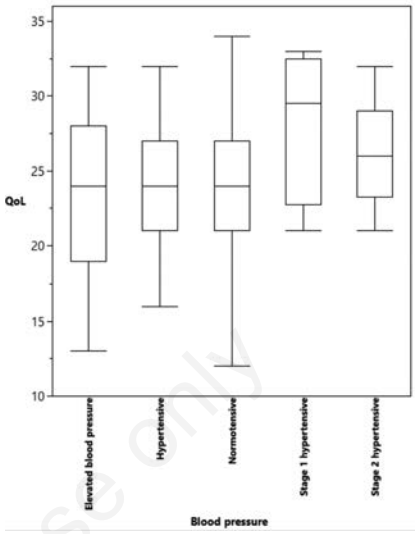

Figure 2. Comparisons of QoL among school children with blood pressure category.

Table 3. Association of school children blood pressure with socio-demographic characteristics of father.

Characteristics (n=565)	Normotensive	Elevated blood pressure	Hypertensive	Stage 1 hypertensive	Stage 2 hypertensive	p
			Blood pressure with father characteristics no (%)			
Education						0.0333
Illiterate	59 (86.76)	6 (8.82)	2 (2.94)	0 (0.00)	1 (1.47)	
Read and write	125 (86.21)	10 (6.90)	8 (5.52)	0 (0.00)	2 (1.38)	
Primary school	120 (91.60)	6 (4.58)	4 (3.05)	0 (0.00)	1 (0.76)	
Intermediately school	54 (75.00)	9 (12.50)	7 (9.72)	1 (1.39)	1 (1.39)	
Secondary	21 (75.00)	1 (3.57)	6 (21.43)	0 (0.00)	0 (0.00)	
Institute/college and above	89 (81.65)	10 (9.17)	6 (5.50)	3 (2.75)	1 (0.92)	
Overweight/obesity						0.0421
No	365 (87.53)	24 (5.76)	22 (5.28)	3 (0.72)	3 (0.72)	
Yes	115 (77.70)	18 (12.16)	11 (7.43)	1 (0.68)	3 (2.03)	
Hypertension						0.0345
No	381 (85.62)	36 (8.09)	23 (5.17)	1 (0.22)	4 (0.90)	
Yes	99 (82.50)	6 (5.00)	10 (8.33)	3 (2.50)	2 (1.67)	
Sleep apnea						0.0002
No	469 (85.27)	41 (7.45)	32 (5.82)	4 (0.73)	4 (0.73)	
Yes	11 (73.33)	1 (6.67)	1 (6.67)	0 (0.00)	2 (13.33)	
			Blood pressure and mother characteristics no (%)			
Education						0.0291
Illiterate	168 (85.28)	13 (6.60)	13 (6.60)	1 (0.51)	2 (1.02)	
Read and write	133 (90.48)	7 (4.76)	6 (4.08)	0 (0.00)	1 (0.68)	
Primary school	74 (81.32)	11 (12.09)	5 (5.49)	1 (1.10)	0 (0.00)	
Intermediately school	42 (91.30)	2 (4.35)	1 (2.17)	0 (0.00)	1 (2.17)	
Secondary	19 (90.48)	0 (0.00)	1 (4.76)	0 (0.00)	1 (4.76)	
Institute/college	38 (66.67)	9 (15.79)	7 (12.28)	2 (3.51)	1 (1.75)	
Occupation						0.0083
Housewife	431 (86.37)	33 (6.61)	28 (5.61)	2 (0.40)	5 (1.00)	
Employee	43 (71.67)	9 (15.00)	5 (8.33)	2 (3.33)	1 (1.67)	

Pearson chi-squared test was performed for statistical analyses. Non significnat factors were not presneted in this table.

tine blood pressure screening for children and adolescents.[10] Simultaneously, the notion of the cardiovascular continuum underscores the importance of adopting preventive measures at the earliest opportunity. Being aware of changes at a young age can trigger early preventive strategies, yielding favorable long-term outcomes. Our motivation for conducting this prevalence survey is the lack of data on hypertension prevalence among adolescents in our country. Hypertension, a significant contributor to coronary artery disease and stroke, originates in childhood. Screenings for hypertension, even in cases of borderline hypertension and when risk factors are present, can significantly enhance the quality of life for these children, helping them lead healthier lives.[11]

Table 4. Association of hypertension with lifestyle related factors among school children.

Life style factors (n=565)	Blood pressure no (%) Normotensive	Elevated blood pressure	Hypertensive	Stage 1 hypertensive	Stage 2 hypertensive	p
Exercise						0.3080
No	234 (83.27)	20 (7.12)	19 (6.76)	3 (1.07)	5 (1.78)	
Yes	246 (86.62)	22 (7.75)	14 (4.93)	1 (0.35)	1 (0.35)	
Smoking						0.1754
No	404 (85.05)	35 (7.37)	29 (6.11)	4 (0.84)	3 (0.63)	
Yes	76 (84.44)	7 (7.78)	4 (4.44)	0 (0.00)	3 (3.33)	
Sleep						0.8568
Short sleeper	18 (78.26)	2 (8.70)	2 (8.70)	0 (0.00)	1 (4.35)	
Normal sleeper	278 (84.76)	24 (7.32)	21 (6.40)	2 (0.61)	3 (0.91)	
Long sleeper	184 (85.98)	16 (7.48)	10 (4.67)	2 (0.93)	2 (0.93)	
Breakfast						0.2382
No	162 (88.04)	9 (4.89)	10 (5.43)	0 (0.00)	3 (1.63)	
Yes	318 (83.46)	33 (8.66)	23 (6.04)	4 (1.05)	3 (0.79)	
Lunch						0.6383
No	77 (81.91)	10 (10.64)	6 (6.38)	0 (0.00)	1 (1.06)	
Yes	403 (85.56)	32 (6.79)	27 (5.73)	4 (0.85)	5 (1.06)	
Dinner						0.4956
No	53 (89.83)	5 (8.47)	1 (1.69)	0 (0.00)	0 (0.00)	
Yes	427 (84.39)	37 (7.31)	32 (6.32)	4 (0.79)	6 (1.19)	
Snack						0.5333
No	218 (82.89)	22 (8.37)	16 (6.08)	3 (1.14)	4 (1.52)	
Yes	262 (86.75)	20 (6.62)	17 (5.63)	1 (0.33)	2 (0.66)	
Junk food						0.4753
No	41 (83.67)	6 (12.24)	2 (4.08)	0 (0.00)	0 (0.00)	
1-3 time a week	247 (84.30)	25 (8.53)	16 (5.46)	1 (0.34)	4 (1.37)	
> 3 times week	192 (86.10)	11 (4.93)	15 (6.73)	3 (1.35v	2 (0.90)	
Type of foods						0.5178
Fast food	40 (83.33)	2 (4.17)	4 (8.33)	1 (2.08)	1 (2.08)	
Homemade food	440 (85.11)	40 (7.74)	29 (5.61)	3 (0.58)	5 (0.97)	
Sugar sweeter beverage						0.8457
No	49 (84.48)	5 (8.62)	4 (6.90)	0 (0.00)	0 (0.00)	
Yes	431 (85.01)	37 (7.30)	29 (5.72)	4 (0.79)	6 (1.18)	
Salt consumption						0.6364
Mild to moderate	439 (85.08)	39 (7.56)	29 (5.62)	3 (0.58)	6 (1.16)	
Freely used by family	41 (83.67)	3 (6.12)	4 (8.16)	1 (2.04)	0 (0.00)	
Fat consumption						0.0375
Mild moderate	397 (85.38)	33 (7.10)	29 (6.24)	1 (0.22)	5 (1.08)	
Freely used by family	83 (83.00)	9 (9.00)	4 (4.00)	3 (3.00)	1 (1.00)	
Past medical history						0.9255
No	475 (84.82)	42 (7.50)	33 (5.89)	4 (0.71)	6 (1.07)	
Yes	5 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Past surgical history						0.4252
No	413 (84.46)	38 (7.77)	30 (6.13)	4 (0.82)	4 (0.82)	
Yes	67 (88.16)	4 (5.26)	3 (3.95)	0 (0.00)	2 (2.63)	
BMI						<0.0001
Underweight	40 (97.56)	1 (2.44)	0 (0.00)	0 (0.00)	0 (0.00)	
Normal weight	342 (93.19)	15 (4.09)	9 (2.45)	0 (0.00)	1 (0.27)	
Overweight	57 (68.67)	12 (14.46)	11 (13.25)	1 (1.20)	2 (2.41)	
Obese	41 (55.41)	14 (18.92)	13 (17.57)	3 (4.05)	3 (4.05)	

Pearson chi-squared test was performed for statistical analyses.

Prevalence of hypertension

In this current investigation, we present data pertaining to blood pressure readings from a representative group of 565 school children aged 13 to 18 in Duhok. Through a comprehensive analysis involving three distinct visits, each comprising triplicate blood pressure measurements, we identified that the overall prevalence of hypertension among this cohort, spanning ages 13 to 18, was 5.84%. The study sample encompassed individuals aged 13 to 18 years. These findings become particularly concerning when juxtaposed with the outcomes of other investigations, like the study conducted by Macedo *et al.* In their research, they examined the prevalence of hypertension in 889 children aged 5 to 18 in northern Portugal, specifically exploring its correlation with obesity. Their study reported an estimated hypertension prevalence of 5.2%, which is remarkably close to the prevalence observed in our study.[12] This value aligns well with our own findings concerning prevalence. Furthermore, the occurrence and frequency of hypertension among school children in Turkey have been subjects of investigation by numerous researchers. The hypertension rates have exhibited variations across studies conducted in various countries, including those carried out within Turkey. In the context of school children studied in Shimla, north India, the observed prevalence of hypertension was 5.9%. This rate of prevalence notably exceeded the predicted 5% prevalence of high blood pressure in children in the United States using the same criteria.[13]

Across the board, systematic reviews have reported varying estimates for hypertension in children, with Africa having a prevalence estimate of 5% and America showing a prevalence of 3.5%.[14] Another study in 2014 by Patel *et al.* from Bhopal documented a prevalence of hypertension at 5.36% In various regions of Africa, such as Ghana in West Africa and Tunisia in North Africa, prevalence rates of 6% and 9.6%, respectively, were documented by Addo et al. and Harrabi *et al.*[15] Similarly, in a study by Kidy *et al.*, the prevalence of hypertension was examined.[16]

The prevalence of hypertension reported in this study is consistent with the prevalence reported in the literature. The reason for the difference between the prevalence of hypertension in this study and those in the previous studies might be the usage of different age groups.[17] and maybe because of different food intake and lifestyles in different populations.

Relationship between BMI and hypertension

Blood pressure demonstrated a positive correlation with BMI (height and weight), and this association remained statistically significant (p=0.00) according to the results of our multivariate regression analysis. In our study, a notable trend emerged wherein

Table 5. Predictors of hypertension in school-aged children.

Predictors	Outcome: Blood pressure	P-value
BMI percentage		**0.00000**
Student Age		**0.00051**
Break fast		0.21217
Dinner		0.22074
Fat consumption		0.35812
Exercise		0.39232
Salt consumption		0.55886
Gender		0.64187
Type of foods		0.67822
Snack		0.71151
Family size category		0.76410
Junk food frequency		0.77417
Lunch		0.83531
Sugar sweeter beverage		0.83846
Smoking		0.86392
Residence		0.94736
Sleep duration category		0.99309

Nominal logistic regression was performed for statistical analyses.

Table 6. Association of blood pressure with quality of life among secondary school children.

Life style factors (n=565)	Blood pressure no (%)					p
	Normotensive	Elevated blood pressure	Hypertensive	Stage 1 hypertensive	Stage 2 hypertensive	
QoL	23.85 (4.31)	23.57 (5.23)	24.00 (4.18)	28.25 (5.25)	26.17 (3.71)	0.2103

The comparisons were not statistically Signiant by gender as well. ANOVA one-way was performed for statistical analysis.

the prevalence of hypertension heightened as BMI status increased, showcasing strong statistical significance. This finding reinforces the conclusions drawn by Jonathan *et al.*, underscoring the substantial risk factors that obesity and overweight represent in relation to hypertension.[18] This linkage, where higher blood pressure levels correspond with increased obesity rates, has been consistently documented in a multitude of reports.[19]

This study uncovered a notable pattern: the prevalence of elevated blood pressure grew consistently with higher BMI percentiles. This trend appears to indicate a connection that is not solely dependent on regular physical development. This observation implies that obesity functions as an autonomous risk factor for hypertension, underscoring its independent role in contributing to high blood pressure.[20] Our results confirm the findings of Erlingsdottir *et al.*[21] who showed an association between overweight/obesity and higher blood pressure. The mechanism whereby overweight/obesity may lead to higher blood pressure seems to be due to enhanced adipocyte secretion of adipokines and pro-inflammatory cytokines which may disrupt normal physiological function leading to increased blood pressure.[21]

Age and gender

In the current study, Age was not associated with hypertension. Similar findings have been documented by Oyewole and Oritogun.[22] but disagree with a Nigerian study that found age was associated with increases in blood pressure among adolescents, as well as the mid-adolescent age group (13-15 years).[23] The present study indicated that obese and overweight boys had a larger prevalence risk of high normal BP or hypertension than counterpart girls. The finding among Portuguese school adolescents aged 10-18 also showed a higher risk of being hypertensive among obese and overweight boys than girls.[24] In addition, the prevalence of hypertension in boys was greater than in girls, and this may be due to the role of testosterone in hypertension observed in males compared to non-menopausal women, which may explain the cause of hypertension in boys in this study.[25,26] The reason for girls having low blood pressure compared to boys may be attributed to estrogen and its protective effect on the cardiovascular system, because estrogen causes vasodilatation by modulating the function of vascular endothelial cells.[27,28] The other probable cause of high blood pressure in adolescents aged (12-18) years could be a persistent hyperactive sympathetic nervous system even at rest which increases the smooth muscle tone of the vessels increasing resistance and hence persistently elevating pulse rate, cardiac output and hence elevating blood pressure.[29,30]

Recommendations

Raising awareness among school students, particularly adolescents, regarding hypertension and its associated complications holds paramount importance. To achieve this objective, educational initiatives should be consistently organized by school authorities. These programs have the potential to inspire students to adopt healthier lifestyles and dietary habits. Additionally, such efforts can contribute to enhancing parents' understanding of hypertension, particularly when it is in its early stages. Screening procedures should be implemented to detect asymptomatic hypertension in children, with a specific focus on mitigating influential factors such as obesity. This can be accomplished by offering guidance on balanced diets and regular physical activity, both within the home environment and at schools. Parents should also be actively encouraged to integrate these measures into their children's routines. To this end, the Task Force on Blood Pressure Control in Children advocates for annual blood pressure measurements for all children aged 3 and above. These regular assessments hold significant value, as they can effectively identify hypertension in children. By collectively adhering to these practices, we can proactively address the issue of hypertension among the younger population.

Conclusions

This study showed that the prevalence of different classes of abnormal blood pressure was high in secondary school children in this region. The higher prevalence of hypertension among secondary school children was associated with being obese, using free fast in food, low level of education of parents. But being older and obesity predicted the prevalence of hypertension among secondary school children in this region.

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