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ORIGINAL ARTICLE

Prevalence and associated factors of hypertension among primary school children: A cross-sectional study in Kuching, Sarawak

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Abstract

Introduction: Hypertension is an emerging health concern among children owing to its increasing prevalence and association with obesity. However, hypertension screening is uncommon, and childhood hypertension-related data are limited. This cross-sectional study determined the prevalence and associated factors of hypertension among primary school children in Kuching, Sarawak.

Methods: Standard procedures and validated equipment were used to measure blood pressure and anthropometric indicators. The body mass index (BMI)-for-age and waist-to-height ratio (WHtR) were calculated. Questionnaires were used to obtain family sociodemographic data and health history.

Results: A total of 1,314 children aged 6–12 years were enrolled, of whom 107 (8.1%) and 178 (13.5%) were hypertensive and pre-hypertensive, respectively. The chi-squared test indicated that hypertension was significantly associated with male sex ($P<0.05$), ≥1 standard deviation BMI-for-age ($P<0.001$), percentage of excess body fat (BF)($P<0.001$), 5th to 95th height percentile ($P<0.001$), >90th excess waist circumference (WC) percentile ($P<0.001$), >90th WHtR percentile ($P<0.001$), clerical, service, sales and skilled parental work ($P<0.05$), excess weight ($P<0.05$) and cardiovascular disease ($P<0.01$). Multivariate logistic regression analysis showed that the percentage of excess BF [odds ratio (OR): 4.84, 95% confidence interval (CI): 2.01–11.66] and excess WC (OR: 2.33, 95% CI: 1.15–4.72) were significantly related to hypertension after adjusting for sex and age.

Conclusion: The prevalence of hypertension among the study population is higher than that among children worldwide. Childhood hypertension-related factors must be identified to aid in routine blood pressure screening, which is crucial for early detection and intervention to reduce future morbidity burden.

Introduction

Hypertension is an emerging public health concern among children owing to its increasing prevalence and association with adulthood cardiovascular disease.[1] Globally, it affects 2–4% of children. An alarming increase in its prevalence of almost 80% within 15 years starting from the new millennium was noted.[2] Partly owing to the obesity epidemic, the concurrent increase in the prevalence of hypertension and obesity in children has triggered numerous studies to identify the link between both conditions.[3–5] Although the clinical manifestations of atherosclerosis are apparent from middle to late adulthood, the long asymptomatic phase of this pathological process indicates that the cardiovascular event has already begun in early childhood.[6]

The blood pressure (BP) during childhood can track to adulthood and is influenced by numerous genetic, biological, behavioural, environmental and social determinants. In combination with obesity, these factors interact with each other, making the pathophysiology of hypertension in obesity complex.[7,8]

Hypertension in children is usually asymptomatic until it evolves into the malignant phase or severe organ damage occurs.[9,10] However, identifying hypertension in children is challenging; this condition is often overlooked that many cases remain undetected despite guidelines for screening being available for >40 years.[11–13] Only 26% of children with a high BP consistent with hypertension have been documented in electronic medical records and subsequently diagnosed as hypertensive.[14]

Despite the plethora of studies on childhood hypertension conducted globally, only two published studies have specifically addressed Malaysian primary school children.[15,16] Therefore, this study was conducted to determine the prevalence and association of hypertension with the anthropometric indicators, sociodemographic data and parental health history of these children.

Methods

This cross-sectional study was conducted in a school setting using multistage sampling. From a sampling frame of 220 schools, 10 schools from 3 districts in Kuching Division were proportionately selected (Kuching District: 6/149 schools, Bau District: 2/40 schools and Lundu District: 2/31 schools). Six classes were selected randomly to represent each primary school from primary 1–6. Children with physical limitations were excluded, as they would require extensive assessment and different equipment for anthropometric and BP measurements, including a growth reference chart.

The Power and Sample Size Calculation Software version 2.1.31 was used to calculate the sample size based on the comparison of two means. To detect the precision of the prevalence of 2.5% with a power of 80% and an alpha of 0.05, we needed to include 452 participants from a sampling frame of 79,721 students. Standard deviations were estimated as 13.4% of the prevalence of hypertension in a previous local study.[16] A total of 1,086 participants were needed for this study, with an allowance of 20% for non-response.

On site, two repeated BP measurements (1-minute interval) were taken using OMRON Professional Blood Pressure Monitor HBP 1100. The equipment has been validated for use in children, and calibration via the auscultation method was performed prior to data collection. For each participant, an appropriate paediatric cuff was used accordingly to encircle at least 80% of the largest arm. When the first and second reading difference exceeded 5 mmHg, a third reading was taken, and the mean of all measurements was recorded.

Those with a BP below the 95th percentile was reported as non-hypertensive; below the 90th percentile, normotensive; and from the 90th to 95th percentile, normotensive and pre-hypertensive. The measurement was repeated after 2 weeks for those with a BP within or above the 95th percentile. Hypertension was defined as a systolic and/or diastolic BP within or above the 95th percentile for age, sex and height measured on more than one occasion; stage 1 hypertension, from the 95th to 99th percentile; and stage 2 hypertension, within or above the 99th percentile.[17]

All anthropometric measurements were obtained using standard procedures. The SECA 213 Portable Stadiometer was used to measure height. The SECA 201 Girth Tape was used to measure the waist circumference (WC) to the nearest 0.1 cm over the skin midway between the 10th rib and the iliac crest at the end of normal expiration. The reading was defined according to age- and sex-specific WC percentiles for Malaysian children.[18] Weight and percentage of body fat were measured using a bioelectrical impedance device (TANITA SC-240 Body Composition Analyzer) that has been validated for use in children.[19] Body mass index and waist-to-height ratio (WHtR) were calculated and categorised accordingly. Questionnaires were used to obtain data on socioeconomic family status, family history of cardiovascular (hypertension, heart disease, dyslipidaemia or diabetes mellitus) and kidney diseases, weight status and cigarette smoking habits.

Only children whose parents/guardians provided written consent were included in this study. Ethical approval was obtained from the Medical Ethical Committee of Universiti Malaysia Sarawak [UNIMAS/TNC(AA)-0302/06-11Jld.3(38)] and approval to conduct the study from the Ministry of Education of Malaysia [KP(BPPDP)603/5/JLD.10] and Sarawak State Education Department [JPS(W)/SK2P/(Lat)153/08/02/05/Jld.45(33)].

Statistical analysis was performed using the Statistical Package for the Social Sciences version 21. The significance level was set at $P<0.05$. Descriptive statistics were calculated for sex, family history, body mass index, percentage of body fat and BP. Partial correlation coefficients controlled for stature, age and sex were calculated to assess the correlation between BP, body fat and socioeconomic parameters. Linear regression models were used to assess the relationship between BP and percentage of body fat, fat pattern and sociodemographic parameters adjusted for age and sex. Logistic regression analysis was applied to determine whether the participants falling above the 90th WC percentile were more likely to have hypertension, overweight and a waist-to-hip ratio above the 90th percentile than those falling below the 90th WC percentile.

Results

A total of 1,314 primary school children were enrolled in this study. We identified 61 (4.6%), 46 (3.5%) and 178 (13.5%) children with stage 1 and stage 2 hypertension and pre-hypertension, respectively. The sociodemographic background and health profile of the respondents have been reported elsewhere.[20] The chi-squared test was used to determine the distribution and association of each potential predictor according to the hypertension status (**Table 1**).

Table 1. Sociodemographic data, parental health history and anthropometric factors associated with hypertension.

Variable	Non-hypertensive n (%)	Hypertensive n (%)	P value
Sex			**0.041***
Male	576 (47.7)	61 (57.0)	
Female	631 (52.3)	46 (43.0)	
Age (year)			**0.864**
<7	41 (3.4)	3 (2.8)	
7–8	165 (13.7)	12 (11.2)	
8–9	188 (15.6)	16 (15.0)	
9–10	193 (16.0)	21 (19.6)	
10–11	231 (19.1)	20 (18.7)	
11–12	236 (19.5)	18 (16.8)	
>12	153 (12.7)	17 (15.9)	
Ethnicity			**0.443**
Malay	592 (49.0)	55 (51.4)	
Chinese	235 (19.5)	14 (13.1)	
Bidayuh	184 (15.2)	22 (20.5)	
Iban	157 (13.0)	14 (13.1)	
Others	39 (3.2)	2 (1.9)	
Parental work classification			**0.036***
Manager and professional	224 (18.6)	31 (29.0)	
Technician and associate professional	143 (11.8)	15 (14.0)	
Clerical, service, sales and skilled worker	515 (42.7)	39 (36.4)	
Elementary worker	292 (24.2)	22 (20.6)	
Missing	33 (2.7)	**0 (0)**	
Highest parental educational level			**0.528**
No formal education	19 (1.6)	2 (1.9)	
Primary	75 (6.2)	5 (4.7)	
Secondary	734 (60.8)	58 (54.2)	
Post-secondary	200 (16.6)	21 (19.6)	
Tertiary	179 (14.8)	21 (19.6)	
Total monthly household income			**0.202**
≤RM 3,000	684 (56.7)	52 (48.6)	
RM 3,001–8,000	403 (33.4)	40 (37.4)	
≥RM 8,001	120 (9.9)	15 (14.0)	
BMI-for-age			**0.000***
Underweight (less than −2SD)	70 (5.8)	2 (1.9)	
Normal (−2SD to +1SD)	740 (61.3)	17 (15.9)	
Overweight and obese (more than +1SD)	397 (32.9)	88 (82.2)	
Percentage of BF			**0.000***
Low	528 (43.8)	13 (12.2)	
Normal	354 (29.3)	12 (11.2)	
High and obese	325 (26.9)	82 (76.6)	
WC			**0.000***
<90th percentile	903 (74.8)	30 (28.0)	
≥90th percentile	304 (25.2)	77 (72.0)	

Table 1. Continued			
Variable	Non-hypertensive n (%)	Hypertensive n (%)	P value
Height percentile			**0.000***
Short (≤5th percentile)	94 (7.8)	4 (3.7)	
Normal (5th to 95th percentile)	1050 (87.0)	88 (82.3)	
Tall (≥95th percentile)	63 (5.2)	15 (14.0)	
WHtR			**0.000***
Low risk (<90th percentile)	834 (69.1)	26 (24.3)	
High risk (≥90th percentile)	373 (30.9)	81 (75.7)	
Cardiovascular and kidney diseases			**0.005***
None	877 (72.7)	63 (58.9)	
One parent	261 (21.6)	32 (29.9)	
Both parents	69 (5.7)	12 (11.2)	
Overweight/obesity			**0.011***
None	1072 (88.8)	88 (82.2)	
One parent	110 (9.1)	12 (11.2)	
Both parents	25 (2.1)	7 (6.5)	
Smoking			**0.175**
No	809 (67.0)	77 (72.0)	
Yes	398 (33.0)	30 (28.0)	

BMI, Body Mass Index; BF, body fat; WC, waist circumference; WHtR, waist-to-height ratio; *P<0.05

To explore the underlying association between hypertension and the selected explanatory variables, we fitted a set of logistic regression models into this section. A univariate analysis was conducted for all factors that previously showed a significant association with hypertension. Multi-binary regression was applied and included all significant variables (P<0.2), including parental work classification, BMI-for-age, WC percentile, percentage of body fat, height percentile, WHtR, parental health history of cardiovascular (hypertension, high cholesterol level, diabetes mellitus or other heart problem) and kidney diseases and parental health history of overweight and obesity.

To determine the factors associated with hypertension, we used multiple logistic regression by applying forward, backward and step-wise approaches. As shown in Table 2, there were two significant factors in the multiple logistic regression model: WC percentile (P=0.024) and overweight or obesity based on the percentage of body fat (P=0.000).

Table 2. Estimates of the parameters of the logistic regression model for hypertension.

Variable	Regression coefficient B	Sig.	Exp(B)	95% CI for Exp(B)	
				Lower	Upper
Waist circumference	0.801	0.024	2.228	1.114	4.457
Percentage of body fat		0.000			
bodyfat_reg(1)	0.192	0.643	1.211	0.539	2.724
bodyfat_reg(2)	1.634	0.000	5.124	2.158	12.164
Constant	-3.704	0.000	0.025		

Each factor found to be significant in the model yielded a P value that varied depending on certain measures. From the model, the WC percentile (P<0.05) and overweight or obesity based on the percentage of body fat (P<0.05) were positively related to hypertension. Those with a WC above the 90th percentile had an increased risk for hypertension from 1 to e0.801 (2.228). Those with overweight or obesity based on the percentage of body fat had an increased risk for hypertension from 1 to e1.634 (5.124).

Variance inflation factors (VIFs) of both independent variables were tested to ensure the absence of multicollinearity between the percentage of body fat and WC. In the coefficient table, the VIF value for the percentage of body fat and WC was below 5.00 (VIF=2.2949), indicating that the assumption was met.

To assess the goodness-of-fit, we performed the Hosmer–Lemeshow test, which yielded a P value of 0.899, indicating no significant difference between the observed and expected probabilities and suggesting that the model fitted the data well (the null hypothesis of a good model fit to data was tenable). Adding a third confounder of familial factors did not change the outcome by 10% or more, indicating insufficient evidence of confounding; therefore, only two confounders were included in the final model.

After adjusting for sex and age, we found that the WC percentile and percentage of body fat were significantly associated with hypertension (Table 3).

The children with a WC within and above the 90th percentile had an odds ratio of 2.332 for hypertension [95% confidence interval (CI): 1.151–4.723] compared with the children with a WC below the 90th percentile after adjusting for sex and age. The children with obesity or overweight based on the percentage of body fat had an odds ratio of 4.835 for hypertension (95% CI: 2.005–11.656) compared with those with underweight after adjusting for sex and age.

Table 3. Final logistic regression model.

Variable	Regression coefficient B	Adjusted OR (95% CI)	Wald (df)	P value
Waist circumference				
<90th percentile		1		
≥90th percentile	0.847	2.332 (1.151–4.723)	5.526 (1)	0.019
Percentage of body fat				
Low and normal fat		1		
High fat and obesity	1.576	4.835 (2.005–11.656)	12.320 (1)	0.000

Constant: −3.778
The enter LR method was applied.
Neither multicollinearity nor interaction was found.

Discussion

The present study concluded that hypertension is not rare among apparently healthy primary school children in Kuching, Sarawak. The prevalence among the study population is higher than that among children globally[1,2] and Palestinian children[21] but lower than that among children in Sabah[15] and Selangor.[16] To the best of our knowledge, this is the first study to focus on hypertension among primary school children in Sarawak. The difference in the methodology used for BP measurements (BP reading taken on a single occasion using auscultation in previous Malaysian studies) could explain the variable finding, as noted by previous literature where the protocol of measuring BP in children varies vastly following different references and practices even in the same country.[1,2,8,10,17,22,23] Therefore, our findings need to be interpreted with caution.

The prevalence of hypertension was much higher at 20.1% on the first visit but declined tremendously to 8.1% on the second visit. This finding confirmed some previous concerns that BP measurements taken on a single occasion could overestimate the prevalence of hypertension among school children.[16] In another study conducted among 5,102 children in Texas, United States of America, the BP measurements were repeated thrice, and the prevalence of hypertension decreased by half after every screening session.[24] Repeated measurements caused regression to the mean, and accommodation effects or familiarisation with the equipment contributed to a more stabilised BP reading, excluding false-positive hypertension among children. Repeated measurements at different occasions also reduced the risk of other types of hypertension, including white coat hypertension.[25]

Among all associated factors investigated, obesity characterised by overall (percentage of BF) and localised (WC) adiposities was established as a risk factor of hypertension, consistent with previous findings among children of the same age group.[15,16,23] In a study conducted among pre-pubertal 8-to-9-year-old children in Southampton, United Kingdom, a high fat mass index was associated with more cardiovascular risk factors, including high systolic and diastolic BP, pulse rate and carotid–femoral pulse wave velocity.[26] In addition, visceral fat deposits release a larger quantity of free fatty acids into the liver than does subcutaneous fat, therefore increasing pro-inflammatory cytokine production. This explains why abdominal adiposity is a stronger risk factor for cardiovascular morbidity and mortality than total adiposity alone.[27]

The findings support the recommendation made in the Clinical Practice Guidelines for the Management of Hypertension (5th edition) that the BP of primary school children with obesity should be measured annually.[28] Therefore, early detection through routine BP screening among primary school children as recommended by local and international guidelines is crucial to prevent premature target organ damage and reduce the prevalence of hypertension among the general population in this country.[20,26–28] Accordingly, school compounds may be the best setting for routine screening of BP among children of these ages. Screening can be performed during yearly scheduled visits by school healthcare teams.

The ideal practice is to screen all children. However, the heavy workload and time constraint may overwhelm healthcare teams and hinder them in screening all students. Hence, targeted screening for children at risk and prioritising BP screening based on the WC and percentage of BF are strongly recommended. The WC could be more feasibly applied than the percentage of BF, as it is lower in cost, is easily measured and requires minimal training for measurement, making it suitable for large epidemiological studies or screening.

To date, primary hypertension is diagnosed after excluding the known causes of secondary hypertension.[22,29,30] However, the fact that none of our participants with hypertension have had a condition that may have contributed to a high BP prior to data collection does not conclude them as having primary hypertension. The possibility of other underlying factors contributing to the diagnosis of primary hypertension remains uncertain because although all our participants with hypertension were referred to the nearest health clinics and hospitals, no further feedback was received from them, and no further investigation was performed after the study survey.

Herein, the associated factors of hypertension included the sociodemographic parameters such as age, sex, race, family work group, educational background, total family income, family health history and anthropometric measures. In assessing adiposity among children even after adjustments for age and sex, the mature stage should also be considered a determinant or confounding variable. The absence of this datum constitutes a limitation of the study.

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Author contributions

Roslinda @ Zakiah bt Kangan (study design, data collection and analysis, publication write up)

Assoc Prof Dr Cheah Whye Lian (study design, data analysis, publication write up)

Assoc Prof Dr Helmy Hazmi (study design, data analysis, publication write up)

Ethical approval

Ethical approval was obtained from the Medical Ethical Committee of Universiti Malaysia Sarawak [UNIMAS/TNC(AA)-0302/06-11Jld.3(38)] and approval to conduct the study from the Ministry of Education of Malaysia [KP(BPPDP)603/5/JLD.10] and Sarawak State Education Department [JPS(W)/SK2P/(Lat)153/08/02/05/Jld.45(33)].

Conflicts of interest

All authors declare no conflicts of interest.

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Data sharing statement

Data is available upon request.

How does this paper make a difference in general practice?

- The study findings may assist in targeted screening of hypertension among children in public healthcare settings.
- The study findings can be utilised by public healthcare practitioners to improve the quality of care provided to all children attending healthcare facilities and participating in school healthcare programmes.

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