ORIGINAL ARTICLE

Blood pressure profile for children aged 5 to 6 years and its associated factors – a cross-sectional study in Kuching district, Sarawak

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Abstract

Introduction: This study aimed to determine the blood pressure profile for preschool children in Kuching Sarawak and its relationship with sociodemographic characteristics, nutritional status and parental hypertension.
Methods: This was a cross sectional study conducted in a government preschool in Kuching district from January to June 2017. Data were collected using questionnaire as well as anthropometric and blood pressure measurements. Data were entered into and analyzed using SPSS Version 22.
Results: A total of 229 preschool children participated in this study (response rate of 81%). About 9.7% of the respondents were at risk for hypertension. The mean systolic blood pressure was 95.6 mmHg (SD=8.36), and the mean diastolic blood pressure was 59.9 mmHg (SD=6.09). Ten percent of the children were overweight and 7.4% were obese. Binary logistics regression analysis indicated that gender (Male: OR = 3.085, $p< 0.05$), parent's education level (comparing primary education and below with secondary education: OR = 4.88, $p<0.05$; comparing primary education and below tertiary education: OR = 7.63, $p<0.05$) and ethnicity (comparing Malay with Chinese: OR = 0.10, $p< 0.01$) were significantly associated with being at risk for hypertension.
Conclusion: The study showed that 9.7% of the children were at risk for hypertension and that 17.4% had abnormal body weights. Identifying and tackling the factors leading to these issues will help to improve and ensure a better quality of non-communicable disease programs offered in primary health clinics and school health programs.

Introduction

Hypertension is a major global public health issue and is the leading preventable cause of premature death worldwide, affecting developed, developing and under-developed countries.[1] It is a health condition in which the blood vessels have persistently raised pressure. In 2008, the worldwide prevalence of hypertension in adults aged 25 years and above was reported to be 40%.[1]

In Malaysia, the overall prevalence of hypertension among adults 18 years of age and older was 30.3%.[2] In 2010, hypertension was ranked as the leading single risk factor for the Global Burden of Disease.[3] Cardiovascular disease accounts for approximately 17 million deaths a year worldwide. At least 45% of these deaths were due to ischemic heart disease, while 51% were due to stroke.[1] Similarly, hypertensive-related diseases are still the leading cause of death in Malaysia, with ischemic heart disease and stroke accounting for 20.1% and 10.6% of the deaths respectively.[4]

In primary hypertension, there is a complex interplay between genetic, environmental and lifestyle factors. Although certain molecular genetics are linked with primary hypertension, the environmental factor and lifestyle disparities are still central to the development of primary hypertension.[5] Hence, the prevalence of primary hypertension is easily diagnosed. With the increasing prevalence of childhood obesity, hypertension is progressively diagnosed in children.[6]

Hansen et al.[7] in their cohort study of 14187 children and adolescents in US found that 3.6 % of children aged 3 to 18 years old were hypertensive. Manyike et al.[8] showed that the prevalence of hypertension is about 3% among children aged 3 to 5 years in Nigeria. Data on childhood hypertension in the local setting has highlighted that the prevalence of hypertension in primary schools is high. According to Chong et al.,[9] 14% of children aged 7 and 8 years old from Sabah were found to be hypertensive. This finding is consistent with a study done by Sreeramareddy et al.[10] among primary school children in Selangor, in which the prevalence

rates for pre-hypertension and hypertension were 12.23% and 13.4%, respectively. These findings indicate that the prevalence of childhood hypertension in the local setting is unexpectedly high. Without timely interventions, hypertension will cause great economic and social impacts nationwide.

If hypertension in children goes undiagnosed or is left untreated, it may lead to premature death, disability, personal and family disruptions, loss of income, and increased healthcare expenditures, all of which take a toll on families and communities. Although the diagnosis of hypertension in children can be challenging, as it requires more time to calm children down to obtain accurate blood pressure readings, regular check-ups will be beneficial in detecting hypertension in children. On the other hand, in view of the high prevalence of childhood hypertension locally, research on the blood pressure profile for preschool children is crucial. It will not only provide baseline data on the blood pressure profile but will also provide information on the prevalence of hypertension in this younger age group. With these findings, children who are at risk for hypertension can be referred for further investigation and treatment to prevent complications. Lifestyle modifications, such as weight control, maintaining an active lifestyle and changes in diet, can be recommended at the household and community level. At present, there are limited publications on the blood pressure profile for children aged five to six years, especially in the local setting.

Materials and Methods

This cross-sectional study was conducted in Kuching District from January to June 2017. Kuching District is one of the three administrative districts under the Kuching Division and has a total area of 4,560 square kilometers. Based on the Malaysian Census 2016 reports, Kuching District has a population of 660,000, consisting of Malays, Chinese, Ibans, Bidayuhs, Melanaus, Indians and others.

There are 49 pre-schools in Kuching District managed by the Kuching Combined Education Office. Other preschools are managed via community development cooperation, privately and by non-governmental organizations. Applications were sent to the Ministry of Education Malaysia and Sarawak State Education to seek approval to conduct this study. Based on the list provided by Sarawak State Education, only 45 schools fulfilled the minimum requirement of 15 students per class. Detailed data on the classes and the total number of students from each school was obtained from the principal of each school prior to data collection. Each of the classes consisted of 15 to 50 children.

Only healthy children aged 5 to 6 years old who were mentally able and without known cardiac and kidney diseases were included in the study. The information on the health status of the children was obtained from their parents prior to the selection of the participants.

Sample size estimation was done using the formula: $n = z^2 p (1-p)/ d^2$

Where n = sample size; z = critical standard normal value for a two-tailed test = 1.96 (95% confidence); p = anticipated population proportion with hypertension = 0.14;[8] d = absolute precision required on either side of the proportion = 0.05%. Using these values plus a design effect of 1.5 and an anticipated non-response rate of 5%, a sample size of 280 children was needed to conduct the study. The result of the effect size test indicated a medium effect size with Cohen's d=0.60 and r=0.30.

A multistage sampling technique was used. From the total of 45 preschools in the Kuching District, each school was placed into one of the threes cluster based on its municipality. From each cluster, the children from two randomly selected preschools were assigned to the sample for a total sample size of 280 or greater.

A set of pre-tested questions available in the Malay language and English was used for the questionnaire. The questionnaire consisted of a socio-demographic profile (age, sex, ethnicity, parent's marital status, parent's education level, parent's occupational status and total household income), past medical history and hypertension status for both parents.

Prior to the day of the children's anthropometric and blood pressure measurements, their parents received a respondent information sheet together with an informed consent form and the questionnaire to fill out. If the parents consented to participate, one of them signed the consent form and filled in the questionnaire.

The children's anthropometric data (weight and height) were obtained by the researchers and trained research assistants at their school.

For weight measurements, all children were instructed to wear minimal clothing, take off their shoes and stand still in the middle of a digital Omron Karada Scan weighing scale platform. Weights were read twice to the nearest 0.1 kg. Height was measured using a portable Seca body meter, with the children being told to be barefoot with their legs straight and to look straight ahead at the horizontal plane. Height measurements were taken twice to the nearest 0.1 cm. BMI was calculated based on the average readings and classified according to the BMI by age (z-score) where overweight > +1 SD and obese >+2 SD.[11] The process of taking anthropometric measurement went smoothly with the help of the teachers. The children were used to these routine measurements being taken through the school health programme.

Blood pressure was measured using an Omron HEM-7120 automatic blood pressure monitor with a pediatric cuff (pediatric cuff size: 17-22cm). The instrument was calibrated during each visit with a mercury sphygmomanometer (MDF Instruments). Blood pressure measurements were taken in the classroom, with each child being asked to rest in their seat for at least 5 minutes. Measurements were taken on the right arm at the level of the child's heart with the child's feet resting on the floor. A second reading was taken 30 minutes after the first reading. An average of the two readings for both systolic and diastolic blood pressure were used for analysis and classification of the blood pressure based on the recommendations of the National High Blood Pressure Education Program Working Group on Blood Pressure in Children and Adolescents.[12] According to the clinical guidelines,[11] children with an average systolic blood pressure (SBP) and diastolic blood pressure (DBP) less than the 90th percentile for their height are classified as having normal blood pressure. An average SBP or DBP level greater than or equal to the 90th percentile for height, but less than the 95th percentile, is classified as "high normal/ pre-hypertension" and considered to be an indication of higher risk of developing hypertension. To confirm hypertension in children, an average SBP or DBP that is greater than or equal to the 95th percentile for sex, age and height must be obtained on at least three separate occasions. For this study, as the measurement of blood pressure was done on one occasion, the term "at risk for hypertension" was used to classify an average SBP or DBP that is greater than or equal to the 90th percentile for sex, age and height. Children who were found to have hypertension at risk were referred to a doctor for further investigation and treatment.

The independent variables used in this study were age, gender, total household income, parental history of hypertension, body mass index, parents' education level and ethnicity. The dependent variable was being at risk for hypertension. The collected data were coded and analyzed using the IBM Statistical Package for the Social Sciences (SPSS), Version 22. Descriptive and inferential analyses were performed based on a p value <0.05 indicating significance. To determine factors associated with being at risk for hypertension, multiple logistics regression was employed using the forward, backward and step-wise approaches.

Ethical approval for this study was obtained from the Ethical Committee of University Malaysia Sarawak, and written permission to conduct this study was obtained from the Malaysia Ministry of Education and Sarawak State Education Department. Verbal consent was given by the headmaster of each selected school, and written consent was obtained from the participants' parents prior to data collection.

Results

A total of 229 children participated in the study, yielding a response rate of 81%. Participants' socio-demographic characteristics, blood pressure readings and BMIs as well as parental histories of hypertension are presented in **Tables 1** and **2**. About 9.6% of the participants were found to be at risk for hypertension. Further, 10% of them were found to be overweight and 7.4% were obese.

Table 1. Sociodemographic characteristics of the participants (N=229)

Characteristics	n (%)	Mean ± SD
Age group (years old)		
5[a]	78 (34.1)	
6[b]	151 (65.9)	
Gender		
Male	101 (44.1)	
Female	128 (55.9)	
Ethnicity		
Malay	80 (34.9)	
Iban and other Bumiputera	54 (23.6)	
Bidayuh	52 (22.7)	
Chinese	43 (18.8)	
Parents' education level		
Primary and below	25 (10.9)	
Secondary	124 (54.1)	
Tertiary	80 (34.9)	
Household income (MYR)		3303.9 ± 2510.84
Below 1500	63 (27.5)	
1500-3500	87 (38.0)	
Above 3500	79 (34.5)	

[a] born from 2/1/2012; [b] born from 2/1/2011 to 1/1/2012

Table 2. Blood pressure, BMI and parental history of hypertension (N=229)

	n (%)	Mean ± SD
BP categories		
Normal BP (<90th percentile)	207 (90.4)	
Hypertension at risk 90th-95th percentile >95th percentile	 17 (7.4) 5 (2.2)	
Systolic Blood pressure (mm/Hg)	207 (90.4)	95.55 (8.36)
Diastolic blood pressure (mm/Hg)	128 (55.9)	59.98 (6.09)
BMI (kg/m^2)		15.48 (2.28)
Normal	189 (82.5)	
Overweight	23 (10.1)	
Obese	17 (7.4)	
Family History of Hypertension[a]	16 (3.5)	

[a] Self-reported

Logistic regression was undertaken to examine the impact of age, gender, total household income, parental history of hypertension, BMI, parent's education level and ethnicity on being at risk for hypertension. **Table 3** shows the final model of the analysis, consisting of gender, parent's education level and ethnicity was statistically significant and provided good fit ($\chi^2(10,229)=30.346, p<0.001$). Further, it explained 11.9% (Cox and Snell R-square) of the variability in being at risk for hypertension.

Table 3. Binary logistics regression analysis for associated risk factors to hypertension at risk

	β	S.E.	Wald	df	Sig.	Odds Ratio (OR)	95% C.I. for Odds Ratio	
							Lower	Upper
Gender (ref=female)	1.127	0.532	4.49	1	0.034	3.09	1.09	8.75
Parents' education level (ref=primary and below)								
Secondary	3.214	1.096	8.592	1	0.003	4.88	2.90	8.38
Tertiary	2.032	0.924	4.832	1	0.028	7.63	1.25	13.69
Ethnicity (ref=Malay)								
Chinese	-0.233	0.845	7.624	1	0.006	0.10	0.02	0.51
Constant	-3.766	1.307	8.298	1	0.004	0.02		
Model chi-square	30.346***, df=10							
Hosmer and Lemeshow test	p-value>0.05							

β = regression coefficient; S.E.= standard error; C.I.=confidence interval

Discussion

The mean systolic blood pressure for the 5-year-old participants in this study was 92.67 (SD=8.02) mmHg, and the mean diastolic blood pressure was 57.42 (SD=5.51) mmHg. These values are similar to those obtained in a study by Rosner et al.,[13] in which the mean systolic and diastolic BPs for the 5-year-old participants were 93.4 mmHg and 56.6 mmHg, respectively. Sayeemuddin et al.[14] found that the mean systolic and diastolic pressures were 99.69 (SD=3.62) mmHg and 60.11 (SD=3.64) mm/Hg, respectively, for 6-year-old participants, which matches up well with the values measured in our study (mean systolic blood pressure of 92.67, SD=8.02 mmHg and mean diastolic blood pressure of 57.42, SD=5.51 mmHg).

Overall, 2.2% of the participants had at least one blood pressure reading above the 95th percentile, which is relatively similar to the prevalence rates of hypertension among preschool children in Nigeria found by Manyike et al.[8] and Odetunde et al.,[14] which were 3% and 1.9%, respectively. Local studies on hypertension among primary school children in Malaysia showed a higher prevalence of hypertension than that of preschool children, ranging from 13.9-14.0%.[9-10] The above-mentioned studies, with the exception of Manyike et al.,8 used the same reference value as the present study. Based on unpublished data on the hypertension prevalence among primary school children in Kuching Division carried out in 2017, 8.1% of the population was hypertensive. This far, there have been limited publications which have addressed the preschool children's blood pressure profile, making comparisons of the prevalence of hypertension in preschool children difficult. In addition, the differences in the methodologies used in blood pressure measurements, such as the type of device used, the number of measurements taken and the setting in which the blood pressure was measured, all contribute to the variations found in the prevalence of hypertension. This study used the average of two blood pressure readings, which is consistent with the method used in Odetunde et al.,[15] as well as the clinical guidelines for hypertension issued by the National High Blood Pressure Education Program Working Group on Blood Pressure in Children and Adolescents.[12] Many other factors, such as variations among racial groups related to geographic, dietary and cultural practices, may potentially contribute to blood pressure profile differences.

In terms of BMI for the participants' age group, this study showed that 10% of the participants were overweight and 7.4% of them were obese, in line with the prevalence rates discovered by Chong et al.[9] (2.5%) and Sreeramareddy et al.[10] (12.2%) among older children. The obesity rate was high, perhaps due to the rapid socio-economic development within the residential areas leading to sedentary behaviour and consumption of processed and nutrient-dense foods. However, the findings of this study, together with the available literature, indicate that the rate of childhood obesity in Malaysia is growing in a potentially important way.

Gender is well established as a factor that contributes to elevated blood pressure, particularly in older age groups.[16,17] However, for younger age groups (aged 3-5), studies by Manyike et al.[8] and Hamidu et al.[18] showed

that there were no gender differences in blood pressure. In this study, male participants were about three times more likely to be at risk for hypertension compared to the female participants. It is possible that this discrepancy could be rooted in obesity, as past studies involving children have associated hypertension with the prevalence of obesity.[8,18] In the present study, univariate analysis showed that there was a significant difference between male and female participants in terms of being overweight and obese (21.8% vs 14.8%). However, such a difference was not seen in the multivariate analysis.

The present study demonstrates that higher levels of parental education are associated with higher odds of being at risk for hypertension. This finding is consistent with the higher number of overweight and obese parents with higher levels of education in this study, indicating the relationship between obesity and hypertension. However, this result contradicts the findings of Sarikhani et al.,[19] who found that a lower prevalence of hypertension was associated with higher educational levels among adolescents in Iran. They further explained that parents with higher educational levels are associated with more positive health behaviors in terms of diet, i.e., using less processed food, salt, sugar and cooking oil, and healthier lifestyles, i.e., they encourage their children to be more physically active.

In a study by Rosner et al.,[13] differences were found in the mean blood pressures of different ethnic groups. In particular, the prevalence of hypertension was higher among African American and Hispanic school-aged children compared to Caucasian children. Although evidence of the association between hypertension and ethnicity has been documented in most of the studies in this area to date, the exact pathophysiology of the association is still unknown. Therefore, the complex interactions between genes, lifestyles and environment should be explored further.

There was no association found between children and parental hypertension in this study, contrary to the longitudinal study by Li et al.[20] Hansen et al.,[7] who studied the aggregation of familial hypertension in children, concluded that familial hypertension in children will be manifested once the children are about 8 to 10 years old. This conclusion could explain the insignificant finding in our study. A study by Simoneti et al.[21] also showed that a significant association exists between parental and childhood hypertension and explained the role of genetics in causing hypertension in childhood.

As this was a cross-sectional study, it could not determine the causation between the variables studied. Furthermore, the study participants were from preschools managed by the Ministry of Education only; therefore, the findings of this study cannot be generalized beyond this population. In addition, the under- or over-estimation of the prevalence of hypertension is common, as the results depend on the recruitment of the participants. Furthermore, the most accurate approach when determining a diagnosis of hypertension is based on at least three repeated measurements to confirm diagnosis, which is beyond the scope of this study. Nevertheless, the findings serve as a preliminary attempt to determine the prevalence of being at risk for hypertension and its associated factors.

Conclusions

The current study shows that 9.7% of children are at risk for hypertension and that 17.4% have abnormal body weights. Since these children are at cardiovascular risk, without timely interventions, they may be prematurely disabled. Health assessments through the school health program could include the measurement of blood pressure by trained school personnel. All cases of elevated blood pressure with or without any abnormal risk factor detected during screening should be reported to the parents and a referral to medical doctor for further investigation and management should be issued. Although the prevalence of being at risk for hypertension in this study was lower than the prevalence of childhood hypertension predicted by the WHO, this figure may continue to rise due to the increasing prevalence of obesity in our country. Since there have been limited publications on the preschool blood pressure profile, this study will help in providing data for new investigations and improving the understanding of the determinants of the blood pressure profile in children. Hence, it will be helpful in the development of public health strategies for prevention and treatment.

The results of this study can be utilized by public health practitioners to improve the quality of care provided to all children attending health care facilities and school

health programs. As childhood hypertension is under-diagnosed, greater efforts are needed to increase the awareness, and improve identification, of hypertension in children. Apart from health care professionals, parents should be encouraged to practice healthy lifestyles through improved diets and engaging their children in physical activity.

Competing Interest

This study did not receive any funding support. The authors declare that they have no competing interests.

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How does this paper make a difference to general practice?

- This study provides data for the further understanding of the blood pressure profile in preschool children.
- The results of this study can be utilized by public health practitioners to improve the quality of care provided to all children attending health care facilities and school health programs.

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