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ORIGINAL ARTICLE

Prevalence and associated factors of true hypertension among primary school children in the Klang Valley: a cross - sectional study

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Introduction

Hypertension is an important risk factor for cardiovascular disease and there is an increasing risk of development of hypertension among children. Our study aims to determine the prevalence of true hypertension and its associated factors among primary school children in the Klang Valley region.

Methods

A self-administered questionnaire was used which explores the socio-demographic background, past medical history, family history & lifestyle characteristics of the participants. Diagnosis of hypertension were based on standard protocol. Data analysis was done using SPSS v26.0.

Results

This study involved 251 respondents. The prevalence of true hypertension among primary school children is 2%. Significant determinant of true hypertension were higher body mass index (BMI), children living with single parent and being of Indian ethnicity. It was found that Indians had 55 times higher odds of having true hypertension compared to Malays (95%CI =1.47-2061.87, p = 0.03). It was also found that children from households with a single parent had 85 times higher odds of having true hypertension compared to households with both parents (95%CI = 2.68-2537.53, p = 0.01). In addition, those with a higher BMI had 1.4 times higher odds of having true hypertension (95%CI = 1.06-1.43, p = 0.018).

Conclusion

The prevalence of true hypertension is similar to the rates reported globally. This provides an insight where regular BP monitoring in children should be advocated amongst healthcare professionals, especially amongst children having risk factors for the development of hypertension.

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INTRODUCTION

Hypertension is an important risk factor for cardiovascular disease. The latest National Health and Morbidity Survey (NHMS) for non-communicable disease (NCD) risk factors in 2019 showed an overall prevalence of raised blood pressure of 30% among adults 18 years and above.\(2013\)1

Arterial hypertension is less common among children compared to adults. However, there is an increasing concern regarding elevated blood pressure (BP) among children due to its close association with the obesity epidemic and cardiovascular dysfunction which often tracks into adulthood.[2] Children with elevated BP are at a two to three fold increased risk of developing essential hypertension in young adulthood.[3-5] Furthermore, there is evidence of adverse outcomes associated with childhood arterial hypertension such as carotid artery thickening, left ventricular thickening, urinary protein excretion and hypertensive retinopathy. The most significant long-term consequence of elevated BP in childhood is the continuation of hypertension into adulthood, therefore causing cardiovascular, cerebrovascular and renal disease in later life.[6-7]

Globally, a systematic review done in 2019 showed that the prevalence of hypertension and pre-hypertension among children aged below 19 years are 4% and 9.6%, respectively.[8] However, in countries geographically closer to Malaysia the figures are much higher. For example, hypertension among adolescents in China and India was reported to be 26.2% and 20.1% respectively.[9-10] There are a few studies that have been done in Malaysia over the last ten years that examined the prevalence of elevated blood pressure among the younger age group population. The first study was carried out in 2008 among seven- and eight-year-old primary school students in Kota Kinabalu by Chong et al to investigate the prevalence of obesity and its association with childhood hypertension. In this study, 13.4% of the students were found to be hypertensive on a single visit.[11] The subsequent study was conducted in 2012 among primary school students in the suburban areas of Selangor by Sreeramareddy et al. The prevalence of elevated blood pressure was 13.4% in this study.[12] The latest study was published in 2019, among children attending pre-schools in Kuching, Sarawak. The results that were based on a single measurement showed that 9.6% of the participants were found to have elevated blood pressure.[13] The results of these three studies in Malaysia may not represent the prevalence of true hypertension among primary school students as they were not done based on standard protocol as defined by the American Academy of Paediatrics.

Therefore, this study aims to determine the prevalence and associated factors of true hypertension among primary school students in the Klang Valley, Malaysia to fill up this important research gap.

METHODOLOGY

DEFINITION OF HYPERTENSION IN CHILDREN

Arterial hypertension in children is defined by elevation of at least three blood pressure (BP) measurements above the 95th centile at different visits, adapted for age, height and sex.[14] In 2017, the American Academy of Paediatrics (AAP) updated its clinical practice guideline for the screening and management of high BP in both children and adolescents.[2] In children younger than 13 years, elevated blood pressure is defined as BP ≥ the 90th percentile for age, height, and sex, and hypertension is defined as BP ≥ the 95th percentile.[2] Stage 1 hypertension is defined as BP ≥ 95th percentile to < 95th percentile + 12 mm Hg, or 130/80 to 139/89 mm Hg (whichever is lower).2 Stage 2 hypertension, meanwhile is defined as BP ≥ 95th percentile + 12 mm Hg, or ≥ 140/90 mm Hg (whichever is lower).[2]

Study Design

This was a prospective cross-sectional study conducted among primary school children attending primary care clinics. Data was collected between November 2020 to March 2021.

Inclusion And Exclusion Criteria

The inclusion criteria were primary school children from Standard 1 to Standard 6 attending primary care clinics. The exclusion criteria were students without parental consent, children with body temperature ≥ 38.0 degrees Celsius, and children with a pain score ≥ 4/10 and very unwell.

Sample Size Calculation

Sreeramaddy et al reported that the prevalence of hypertension was 13.4%.[12] We estimated the sample size using the prevalence of 13.4% by this formula: $n = n(1-n)\ (Z/E)^2$. Where n = prevalence of interest; Z = critical standard normal value for a two-tailed test = 1.96 (95% confidence); E = absolute precision required on either side of the proportion = 0.05%. The required sample size was 267 considering a 50% non-response rate. The higher non-response rate selected for this study was in response to possible difficulty in coming for follow-up or repeat measurements in view of COVID-19 pandemic.

Instrument

A self-administered questionnaire consisting of 5 parts was used. Part A to D was filled in by the parents of the respondents. Part E was a pro forma for the investigators to fill in. The questionnaire was prepared in both Bahasa Malaysia and English and validated by a panel of experts consisting of two

paediatricians, two family medicine specialists, and one statistician. Face validation of the questionnaire was conducted in 30 patients prior to the pilot test. The questionnaire was also subjected to internal consistency analysis, which showed a Cronbach alpha level of 0.80.

Digital oscillometric BP device that were validated for use in children with appropriate cuff sizes was used for screening. Every BP machine was calibrated and validated daily by comparing the measurements to an aneroid sphygmomanometer. Measurements were taken by the investigators. The child was asked to be seated for at least 5 minutes before taking the blood pressure measurement. Height, weight and waist circumferences were also measured using the standard method. BMI was calculated by dividing the weight in kg by the height in metres squared (kg/m^2). BMI was used as the sole measure of obesity.

Data Collection

The participants were selected via convenient sampling. The parent/guardian consent form and patient information sheet were given to the selected students and their parents during the visit to the clinic.

When the mean systolic BP was above the 90th centile, the child's blood pressure was measured again within 2 weeks during the second follow-up visit through the auscultatory method. A subsequent third blood pressure measurement was taken within another 2 weeks during the third follow-up visit if both the first and second blood pressure measurements were above the 90th centile through the auscultatory method. A minimum of three readings with a blood pressure ≥ 95th centile will be required to confirm the diagnosis of true hypertension. All those diagnosed with hypertension were referred to the paediatrician for further management.

Ethical Approval

Ethics approval was obtained from Medical Research & Ethics Committee of Ministry of Health Malaysia on 8th September 2020 (Approval No. KKM/NIHSEC/P20-1290.

Data Analysis

All statistical analysis was done using the Statistical Package for Social Sciences (SPSS version 25.0). The true proportion of those screened and confirmed to have hypertension was computed. Continuous data were described as mean and standard deviation if the distribution was normal. However, when the data has a skewed distribution, median and interquartile range (25-75th percentiles) were used. Categorical data were reported as proportions (percentage) and frequency.

Chi-square test or Fisher exact tests were used for the categories or dichotomous predictors. Factors associated with having true elevated blood pressure were also determined using logistic regression analysis. All analyses were done with 95% confidence intervals (CI), and the level of significance was set at $p<0.05$.

RESULTS

A total of 267 respondents were approached of which 251 agreed to participate, giving a response rate of 94.0 %. Among those, 16 did not come for repeat measurement of blood pressure. Data from these 251 respondents were used for analysis.

Table 1 shows the socio-demographic data of the participants. The mean age was 8.72 +/- 1.75 years (age range 7-12 years). The normality test for age showed a normal distribution. There were more male participants compared to female participants (53.8 % vs 46.2 %). Malay participants formed the highest respondent (86.1 %), followed by Indian (9.2%), Chinese (3.2%), and those from other ethnic groups (1.6%). The majority of the participants' parents were married (87.6%) ; only 12.4% were either divorced,

Table 1 *Socio-demographic profile of participants (n=251)*

Variable	n (%)
Age years (Mean +/- SD)	8.72 (+/- 1.75)
7	94 (37.6%)
8	39 (15.6%)
9	36 (14.4%)
10	30 (12.0%)
11	25 (10.0%)
12	26 (10.4%)
Gender	
Male	135 (53.8%)
Female	116 (46.2%)
Ethnicity	
Malay	216 (86.1%)
Indian	23 (9.2%)
Chinese	8 (3.2%)
Others	4 (1.6%)
Marital status of parents/carer	
Married	219 (87.6%)
Single parent *(divorced/widowed/unmarried)*	31 (12.4%)
Number of children	
1	16 (6.4%)
2-3	145 (58.0%)
4 or more	89 (35.5%)
Gross Income	
Less than RM 5000	149 (60.3%)
RM 5001-10,000	64 (25.9%)
More than RM 10,001	34 (13.8%)
Highest education level in parents	
None - Primary	6 (2.4%)
Secondary	75 (30.4%)
Tertiary	166 (67.2%)

widowed or unmarried. Most of the participants came from a household with three or less siblings compared to 64.4 %with more than three siblings (35.5%). Majority of the participants ,60.3 %, came from lower income households of less than RM 5000 compared to middle gross family income (25.9%) and higher gross family income of more than RM 10000 (13.8%). Only 2.4 % of participants' parents had no or primary education, whereas most parents had secondary education (30.4 %) or more (67.2 %).

Table 2 shows the medical history, family history and lifestyle characteristics of the respondents. The majority of the participants were healthy (94.3%) with only 5.7% of the participants having underlying medical illness. Most of the participants, 87.3 % had never been examined for high blood pressure compared to those who had (5.7%) in the past. Majority of them had a family history of hypertension (58.8 %), followed by heart disease (25.5%), stroke (21.3%), and chronic kidney disease (11.6%).

In terms of lifestyle attributes, most of the participants had inadequate sleep of less than 9 hours (65.2%) compared to those who had normal sleep hours (34.8%). Majority of the participants had a screen time exposure of more than 2 hours (75.1%) compared to 2 hours or less (24.9%). Correspondingly, most of the respondents ,68.1% exercised less than 4 hours weekly compared to those who did (31.9%). About 40% of the participants were exposed to passive smoking in their house. Majority of the participants had consumed fast food in their diet (88.0%). This study found that 5 children out of 251 had hypertension, giving a prevalence of 1.99%.

Table 2 *Medical history, family history and lifestyle characteristics of the respondents (n=251)*

Variable	N (%)
Chronic disease	
Yes	14 (5.7%)
No	234 (94.3%)
Examined for high blood pressure	
Yes	31 (12.7%)
No	213 (87.3%)
Family history of chronic disease	
Hypertension	143 (58.8%)
Stroke	52 (21.3%)
Heart Disease	62 (25.5%)
Chronic Kidney Disease	28 (11.6%)
Adequate sleep	
Less than 9 hours	163 (65.2%)
9 hours or more	84(34.8%)
Exposure to screen time	
2 hours or less	62 (24.9%)
More than 2 hours	187 (75.1%)
Exercise weekly	
Less than 4 hours	171 (68.1%)
4 hours or more	79 (31.9%)
Exposure to passive smoking	
Yes	99(39.6%)
No	151(60.4%)
Regular fast-food consumption	
Yes	221 (88.0%)
No	30 (12.0%)

Table 3 shows the association between socio-demographic characteristics, family history and lifestyle factors of the participants and the presence of true hypertension. Those who were found to be hypertensives were of older mean age (9.40 ± 1.52 years old vs 8.71 ± 1.75 years old, p=0.383). Majority of those found to have true hypertension were males (2.2%, p=1.000) and Indians (13.0%, p=0.016). Most of the children who were found to be hypertensives came from a single parent household (12.9%, p=0.001). Majority of the hypertensive participants came from a family with 2-3 siblings (2.8%, p=0.751) and with parents that had a secondary education level (2.7%, p=0.689). Family history of chronic kidney disease was noted most frequently in participants who were found to have true hypertension (3.6%, p=0.459).

In terms of lifestyle characteristics, participants who were found to be hypertensive had a higher mean body mass index (BMI) (28.40 ± 7.76 kg/m^2 vs 17.25 ± 4.57 kg/m^2, p<0.001). Those who were found to be hypertensive had more sleep of 9 hours or more (3.4%, p=0.345), 2 hours or less exposure time to screen (2.1%, p=1.000) and weekly exercise of more than 4 hours (2.5%, p=0.652). Majority of the participants with true hypertension had exposure to passive smoking (2.6%, p=0.651) and consumed fast food regularly (2.3%, p=1.000).

Therefore in univariate analysis, the only factors that were found to be statistically significant with the presence of true hypertension were ethnicity, parent's marital status & BMI (p value < 0.05) (Table 3).

These 3 significant factors (ethnicity, parent's marital status & BMI) were entered into the multiple logistic regression analysis to determine the determinants of the presence of true hypertension (Table 4). In terms of ethnicity, it was found that Indians had 55 times higher odds of having true hypertension compared to Malays, and this association is statistically significant (95%CI =1.47-2061.87, p = 0.03). It was also found that households with a single parent had 85 times higher odds of having true hypertension compared to households with married parents and this association is also statistically significant (95%CI = 2.68-2537.53, p = 0.01). In terms of BMI, those with a higher BMI had 1.4 times higher odds of having true hypertension compared to those with a lower BMI and this association was also statistically significant (95%CI = 1.06-1.43, p = 0.018).

Table 3 *Association between socio-demographic characteristic, family history & lifestyle of the participants and the presence of true hypertension*

Variable	Presence of true hypertension		T-test/ Chi square or Fisher's Exact test	p value
	Yes	No		
Age	9.40 ± 1.52	8.71 ± 1.75	- 0.87	0.383
Gender			-	1.000
Male	3 (2.2%)	132 (97.8%)	(Fisher's Exact Test)	
Female	2 (1.7%)	114 (98.3%)		
Ethnicity				0.016
Malay	2 (0.9%)	214 (99.1%)	10.379	
Chinese	0 (0.0%)	8 (100.0%)	(Fisher's Exact Test)	
Indian	3 (13.0%)	20 (87.0%)		
Others	0 (0.00%)	4 (100.0%)		
Marital status of parents/carer				0.001
Married	1(0.5%)	218(99.5%)	- (Fisher's Exact Test)	
Single Parent	4(12.9%)	27 (87.1)		
Number of children				0.751
1	0 (0.0%)	16 (100%)	0.68	
2-3	4(2.8%)	141(97.2%)	(Fisher's Exact Test)	
4 or more	1(1.1%)	88(98.9%)		
Gross Income				1.000
RM 5000	4(2.7%)	145 (97.3%)	0.51	
RM 5001-10000	1(1.6%)	63 (98.4%)	(Fisher's Exact Test)	
>RM10001	0(0.0%)	34 (100%)		
Highest education level in parents				0.689
None- Primary	0(0.0%)	6 (100%)	0.98	
Secondary	2(2.7%)	73 (97.3%)	(Fisher's Exact Test)	
Tertiary	3(1.8%)	163 (98.2%)		
Family history of chronic disease				
Hypertension	2(1.4%)	143(98.6%)	- (Fisher Exact test)	0.404
Stroke	0(0.0%)	52(100%)	- (Fisher Exact test)	0.587
Heart Disease	0(0.0%)	62(100%)	- (Fisher Exact test)	0.333
Chronic Kidney Disease	1(3.6%)	27(96.4%)	- (Fisher Exact test)	0.459
BMI	28.40 ± 7.76	17.25 ± 4.57	T Value: -5.320	<0.001
Adequate sleep			-	0.345
Less than 9 hours	2(1.2%)	161 (98.8%)	(Fisher's Exact Test)	
9 hours or more	3(3.4%)	84 (96.6%)		
Exposure to screen time			-	1.000
2 hours or less	4(2.1%)	183 (97.9%)	(Fisher's Exact Test)	
More than 2 hours	1(1.6%)	61(98.4%)		
Exercise weekly			-	0.652
Less than 4 hours	3(1.8%)	168 (98.2%)	(Fisher's Exact Test)	
4 hours or more	2(2.5%)	77 (97.5%)		
Exposure to passive smoking			-	0.651
Yes	1(1.0%)	98 (99%)	(Fisher's Exact Test)	
No	4(2.6%)	147 (97.4%)		
Regular consumption of fast food			-	1.000
Yes	5(2.3%)	216 (97.7%)	(Fisher's Exact Test)	
No	0 (0.0%)	30 (100%)		

DISCUSSION

In this study, we found that the prevalence of true hypertension among primary school students was about 2%. This prevalence was almost similar to the systematic review and meta-analysis done by Song et al in 2018 among Southeast Asian population which was 3.10%.[8] The same study also showed a global pooled prevalence was 4%.[8] The slightly lower prevalence could be due to the location where we obtained our sample, which is Klang Valley, Malaysia's most urban area. Prevalence of hypertension among adults in Malaysia in the past three National Health and Morbidity Surveys has been shown to be higher in the rural areas instead.[15-16]

Body mass index (BMI) has been found to be a significant determinant of true hypertension among primary school children in this study. This has been shown in almost all international systematic reviews and local studies.[8,11-12,17-18] Besides that, being obese was shown to be significantly related to both abnormal systolic and diastolic BP during the first visit in this study as well. This shows that obesity is the one of the main health issues that needs to be addressed to reduce the risk of children developing true hypertension.

Among adults, the prevalence of hypertension in Malaysia is highest among Bumiputeras from East Malaysia followed by the Malays and the Indians.[19]However, in our study, Indian ethnicity has been shown to be a determinant of the presence of true hypertension. The prevalence of obesity in our study was also highest among the Indians, thereby contributing to the excess risk towards developing true hypertension.

Another significant association to true hypertension in this study is children living with single parents. 4 out of the 5 children with true hypertension in our study are living with single parents. Scharte et al have shown there are increased health risk among children living with single parents.[20] In sub analysis of our study, prevalence of obesity was also higher in children living with single parents.

This is one of the few first studies which looks at the prevalence of true hypertension among primary school students and its associated factors in Malaysia, as other previous studies done only focus on elevated BP. The BP measurement was done according to guidelines using a calibrated digital Oscillometric BP device with the appropriate paediatric sized cuff. Children who presented with elevated BP (>90th centile) during the first visit were given appointments on 3 separate occasions, 2 weeks apart, to confirm the diagnosis of true hypertension. This is done in accordance with the 2017 Academy of Paediatrics Guidelines.[2]

In view of the limitations of traveling & recruitment of samples in school during the Covid-19 pandemic, this study only focused on participants around the Klang Valley area and walk-in non acute cases visiting the selected government health clinics. The study was also conducted in clinics located in the urban area only, thereby limiting its generalisability.

We recommend that future studies should include more states nationwide to get a more accurate national hypertension prevalence among these target groups. Regular BP monitoring should be encouraged and advocated amongst healthcare practitioners, especially amongst children with risk factors such as Indian race, living with single parents & higher BMI, which were found to be significant determinants of true hypertension in this study. Targeted intervention strategies should be implemented in children with identified risks which includes health education and risk reduction interventions to reduce serious long-term morbidity and mortality.

CONCLUSION

Prevalence of true hypertension in Malaysia is 2%. Factors found to be associated with the prevalence of true hypertension were Indian race, living with single parents & having a higher BMI.

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Table 4 *Determinants of the presence of true hypertension*

Variable	Odds ratio	95% Confidence interval	p value
Ethnicity			
Malay	ref	ref	ref
Chinese	0.0	0.0	0.999
Indian	55.00	1.467-2061.878	0.030
Others	0.00	0.00	0.999
Marital status			
Married	ref	ref	ref
Single parent	85.187	2.680-2537.531	0.010
BMI	1.433	1.064-1.433	0.018

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