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ORIGINAL ARTICLE

Obesity-associated Hypertension among Primary School Children in Sarawak: A Cross-sectional Study

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ABSTRAK

Hipertensi merupakan isu kesihatan awam yang penting yang memberi kesan ke atas populasi kanak-kanak. Tujuan kajian ini adalah untuk menentukan prevalens tekanan darah tinggi dan kaitannya dengan obesiti di kalangan kanak-kanak berumur 6-12 tahun di divisyen Kuching, Sarawak. Ia merupakan kajian keratan rentas menggunakan persampelan rawak berlapis. Data dikumpulkan menggunakan alat antropometrik dan monitor tekan darah digital. Data dianalisa menggunakan SPSS versi 20. Sejumlah 1314 responden mengambil bahagian. Sejumlah 36.9% dari jumlah sampel didapati mempunyai berat badan berlebihan dan obes, 31% mempunyai lemak yang lebih dan obes, 29% mempunyai ukur lilit pinggang yang abnormal dan 32.8% mempunyai ratio pinggang-tinggi yang abnormal. Sebanyak 22.1% responden didapati berada dalam peringkat pra tekanan darah tinggi dan tekanan darah tinggi. Terdapat perbezaan signifikan antara lelaki dan perempuan dalam berat badan berlebihan dan obes, lemak badan yang berlebihan dan obes dan ratio pinggang-tinggi. Pribumi Sarawak didapati mempunyai risiko yang paling tinggi dalam penyakit darah tinggi, dan paling ramai dalam berat badan dan lemak badan yang berlebihan dan obes, dan juga ukur lilit pinggang dan ratio pinggang-tinggi yang abnormal. Bagi mereka yang mempunyai penyakit darah tinggi, mereka didapati mempunyai berat badan dan lemak badan yang berlebihan dan obes, dan juga ukur lilit pinggang dan ratio pinggang-tinggi yang abnormal. Pemeriksaan untuk faktor risiko yang berpotensi harus dijalankan di peringkat umur yang muda untuk mengurangkan masalah penyakit kronik di dewasa. Ukuran tekanan darah harus dilakukan dalam pemeriksaan fizikal rutin untuk mengenalpasti kanak-kanak yang berisiko tinggi untuk rujukan selanjutnya.

Kata kunci: hipertensi, kanak-kanak, obesiti, ratio pinggang-tinggi

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ABSTRACT

Hypertension has been recognised as an important public health issue, affecting paediatric population. This study aimed to determine the prevalence of hypertension and its relationship with obesity among different ethnic, gender primary school children in Kuching division, Sarawak. It was a cross-sectional study using multistage sampling. Data was collected using anthropometric equipment and digital blood pressure monitor. Data was analysed using SPSS version 20. A total of 1314 respondents participated. 36.9% of the respondents were overweight and obese, 31% were overfat and obese, 29% had abnormal waist circumference and 32.8% had abnormal waist-height ratio (WHtR). About 22.1% of the respondents were found to be in pre-hypertension and hypertension stage. There were significant differences in overweight and obese, overfat and obese, WHtR between males and females. Indigenous Sarawak reported to have the highest number of hypertensive at risk, overweight and obese, overfat and obese, abnormal waist circumference and WHtR. Those respondents who were hypertensive were found to be overweight and obese, overfat and obese, with abnormal waist circumference and WHtR. Screening of potential risk factors at a young age would help to reduce the incidents of chronic disease in the adulthood. Blood pressure measurement should be included in the routine physical examination, to identify high risk children for further investigation.

Keywords: children, hypertension, obesity, waist-height ratio

INTRODUCTION

Hypertension has been recognised as an important public health issue, affecting adult population as well as paediatric population. A recent school survey carried out locally indicated that 12.23% of the children were pre-hypertensive and 13.4% hypertensive. The mean systolic blood pressure and diastolic blood pressure were higher among those children who were overweight and obese (Screeamareddy et al. 2013).

Untreated and persistent elevation in blood pressure in children can lead to further complications in adulthood (Bijlsma et al. 2014). Longitudinal study showed that initial childhood blood pressure level was one of the strong predictors of adult blood pressure (Klumbiene et al. 2000; Oh & Hong, 2019). Hypertension is not uncommon among children. As its diagnosis requires the use of standardised growth charts based on age, gender and height, and is not a routine health monitoring process, the detection is often limited to symptomatic condition, which explained why childhood hypertension is often under reported (Muntner et al. 2004).

It was reported by the American Pediatric Association that 1 in 4 obese American children are hypertensive (Kreabs et al. 2003). In Asia, similar

findings were found where overweight and obese was associated with increased risk of hypertension and pre hypertension in children and adolescents with proportion ranging from 3 to 22% (Cao et al. 2012; Kim et al. 2006).

Detecting high blood pressure at children age can help to prevent and control hypertension in adulthood. Community-based and population studies have reported that there is a strong relationship between anthropometric measurement and blood pressure in children (Muntner et al. 2004; Sarganas et al. 2018). One of the predictors of hypertension is obesity, which can be measured using body mass index (BMI), waist circumference (WC) and waist-to-height ratio (WHtR). Using anthropometric measurement can be an efficient strategy for the detection and control of hypertension as it does not require trained personnel to conduct the measurement. Once detected as high risk cases, the children can be further referred for clinical evaluation.

As far as our concern, the study on hypertension among primary school in Malaysia is limited with one study carried out in Peninsular Malaysia (Screeamareddy et al. 2013) and another one in Sabah, East Malaysia (Chong et al. 2011). However, these studies did not relate obesity related indicators in the determination of hypertension at risk. In addition, with the ethnic diversity in Sarawak, this study would provide as an insight as how differences in environmental and cultural in relation to prevalence of hypertension in children.

Given the importance of understanding hypertension in children, the goal of this study was to determine the prevalence of hypertension and its relationship with obesity in this population. The study also attempts to explore the difference in race/ethnic group, geographical location and gender in relation to hypertension.

MATERIALS AND METHODS

This was a cross-sectional study using multistage sampling method. There were 49 schools in Kuching Division, Sarawak, Malaysia where the district of Kuching has (42 schools), Bau (3 schools), Lundu (2 schools) and sub district Sematan (2 schools). Using cluster sampling method, 6 schools in Kuching district, 2 schools each from Bau and Lundu. Schools were selected randomly from each of the district/ sub-district proportionally. Once the school was identified, simple random sampling method was used to select one class each from primary 1-6, if there were more than 1 class per primary class. If there was only one per primary class, this class would be selected automatically. Students who may have injury or condition that may affect them standing on their foot or obvious limb length discrepancy were excluded from the study. We also excluded those who were diagnosed with hypertension as they might be on treatment that may underestimate the blood pressure reading.

Sample size was calculated using PS power and sample size calculation software. Based on the prevalence

of childhood hypertension and pre hypertension in a local study (Screeamareddy et al. 2013) 25.6%, using 2 proportion sample size calculation, considering the prevalence of not more than 10% increase than that of 2013, the minimum sample size needed was 675. The expectant dropout rate was 30% with 1.5 design effect, therefore, the needed sample size for this study was 1316 samples.

Permission to carry out the study was granted from the Ministry of Education and State Department of Education. Prior to the date of the data collection, the researchers would visit the schools to distribute the informed consent form. The parent/guardian would fill-up a short questionnaire on socio-demographic information if they agreed to allow their children to participate in the study. On the day of the data collection, all respondents were gathered at the hall or classroom for anthropometric and blood pressure measurement.

For anthropometric measurement, height and weight were measured twice using a Seca 213 mobile stadiometer and Seca Sensa 804 digital body fat scale, respectively. Both measurements were taken to the nearest 0.1 unit. BMI was calculated and plotted onto BMI-for-age percentiles charts for both genders based on the 2007 WHO reference. Body fat percentage was measured using a TANITA SC-240MA portable body composition analyser. The classification of underfat, normal body fat, overfats and obese was based on Gallagher (1996). Waist circumference (WC) was measured using a measuring tape to the nearest 0.1 cm based on average readings of two measurements. The cut-off point for classification of abnormal abdominal fat was based on 90th percentile for Malaysian children as recommended by Poh et al. (2011). Waist-to-height ratio (WHtR) was calculated by dividing the waist circumference value with height. A WHtR value equal to or <0.5 was considered healthy.

Blood pressure was measured using the Omron HBP-1100 Professional Portable Blood Pressure Monitor with pediatric cuff size of 20.5-28 cm. For validation, the reading from Omron HBP-1100 was validated in comparison with mercury BP set before every visit

Table 1: Socio-demographic characteristic of the respondents (N=1314)

	n (%)
Gender	
male	637 (48.50)
female	677 (51.50)
Location	
urban	732 (55.70)
rural	582 (44.30)
Age (year)	
6	44 (3.30)
7	177 (13.50)
8	204 (15.50)
9	214 (16.30)
10	251 (19.10)
11	255 (19.40)
12	169 (12.90)
Race	
Malay	647 (49.20)
Chinese	249 (18.90)
Iban	171 (13.00)
Bidayuh	206 (15.70)
Others	41 (3.10)

Table 2: Health profile of the respondents (N=1314)

	n (%)	Mean (SD)
Body Mass Index (kg/m^2)		18.85 (6.30)
Thinness	72 (5.50)	
Normal	757 (57.60)	
Overweight	185 (14.10)	
Obese	300 (22.80)	
Body fat percentage		20.45 (12.49)
under fat	541 (41.20)	
Normal	366 (27.90)	
Overfat	101 (7.70)	
Obese	306 (23.30)	
Waist circumference		65.63 (12.31)
Normal (<90th)	933 (71.00)	
Abnormal (>90th)	381 (29.00)	
Waist-to-height ratio (WHtR)		0.49 (0.07)
Healthy (0.5)	883 (67.20)	
Abnormal (>0.5)	431 (32.80)	
Pre-hypertension	178 (13.50)	
Hypertension	107 (8.10)	
Systolic Blood pressure		105.36 (11.59)
Diastolic blood pressure		59.41 (8.77)

to the school. Blood pressure was measured twice at the interval of 1 minute. If the mean blood pressure for both systolic and diastolic was above 95th percentile, third reading will be taken after 2 weeks. Classification of hypertension was based on The Forth Report of the Task Force on Blood Pressure Control in Children (NHLBI, 2004) as the same classification were recommended in the management of hypertension in children and adolescent in Malaysia (MOH, 2013), where pre-hypertension is classified as equals or exceeds the 90th percentile for a normotensive child of the same age, sex, and height, or is below the 95th percentile but exceeds 120/80 mm Hg (either SBP exceeds 120 mm Hg, or DBP exceeds 80 mm Hg, or both). Hypertension is classified as persistent BP that equals or exceeds the 95th percentile for a normotensive child of the same age, sex, and height. Data was entered and analysed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive and inferential statistical analyses were used to answer the research objectives. For all analysis, the confidence interval was set at 95%, and a p-value of 0.05 was considered to be statistically significant.

The study was approved by the Medical Ethical Committee of Universiti Malaysia Sarawak (ref:

Table 3: Health profile according to geographical location (N=1314)

	n(%)		P value
	Urban (n=732)	Rural (n=582)	
Blood pressure			0.08
Normal	584 (79.78)	445 (76.46)	
Hypertension	148 (20.22)	137 (23.54)	
BMI classification			0.92
Thinness	35 (0.68)	37 (6.36)	
Normal	420 (57.38)	337 (57.90)	
Overweight & obese	277 (37.84)	208 (35.74)	
Body fat classification			
Under fat	303 (41.39)	238 (40.89)	0.82
Normal	199 (27.19)	167 (28.69)	
Overfat & obese	230 (31.42)	177 (30.41)	
WC classification			0.26
Normal	514 (70.22)	419 (71.99)	
Abnormal	218 (29.78)	163 (28.01)	
WHtR classification			0.09
Healthy	480 (65.57)	403 (69.24)	
Abnormal	252 (34.43)	179 (30.76)	

UNIMAS/TNC(AA)-03.02/06-11 Jld.3(38) and the Ministry of Education both at national and state level. All the parents/guardians of the respondents were informed regarding the research via research information sheet and granted their permission by signing the informed consent form prior to the day of data collection.

RESULTS

A total of 1314 respondents participated in this study (response rate of 99.8%), with higher percentage found in females, urban schools, Malays. The details are found in Table 1.

Table 2 presents the health profile of the respondents. There were 36.9% of the respondents overweight and obese, 31% with overfat and obese, 29% with abnormal waist circumference and 32.8% with abnormal WHtR. In terms of blood pressure, 13.5% of the respondents were found to be in pre-hypertension stage and 8.1% in hypertension stage.

In terms of geographical location, there were more hypertensive at risk, overweight and obese, overfat and obese respondents in urban compared to rural schools. There were also more urban respondents with abnormal waist circumference and waist-to-height ratio. Nevertheless, none of these indicators were significant difference between urban and rural schools (Table 3).

While considering genders, there were more males with hypertensive at risk, overweight and obese, overfat and obese, abnormal waist circumference,

Table 4: Health profile according to gender (N=1314)

	n(%)		P value
	Male (n=637)	Female (n=677)	
Blood pressure			0.11
Normal	489 (76.77)	540 (79.76)	
Hypertension	148 (23.23)	137 (20.24)	
BMI classification			<0.01
Thinness	25 (3.92)	47 (6.94)	
Normal	340 (53.38)	417 (61.60)	
Overweight & obese	272 (42.70)	213 (31.46)	
Body fat classification			<0.01
Under fat	267 (41.92)	274 (40.47)	
Normal	128 (20.09)	238 (35.16)	
Overfat & obese	242 (37.99)	165 (24.37)	
WC classification			0.20
Normal	445 (69.86)	488 (72.08)	
Abnormal	192 (30.14)	189 (27.92)	
WHtR classification			<0.01
Healthy	387 (60.75)	496 (73.26)	
Abnormal	250 (39.25)	181 (26.74)	

and WHtR compared to females. However, only BMI, body fat, and WHtR were reported to be significant difference between gender (Table 4).

Based on Table 5, Indigenious Sarawak were reported to have the highest number of hypertensive at risk, overweight and obese, overfat and obese, abnormal waist circumference and WHtR, compared to Malay and Chinese. All differences were found to be significant except for blood pressure.

Table 6 showed the anthropometric profile based on hypertensive at risk. Those respondents who were hypertensive at risk were found to be overweight and obese, overfat and obese, with abnormal waist circumference and WHtR.

DISCUSSION

Despite the prevalence of prehypertension and hypertension in this study, it was found to be 13.5% and 8.1%, respectively, lower than other local studies (pre-hypertension 12.23%, hypertension 13-14%) (Screeamareddy et al. 2013; Chong et al. 2011), the prevalence of overweight and obesity (36.9%), overfat and obese (31.0%), abnormal waist circumference (29.0%) and waist-to-height ratio (32.8%) was high among the respondents. Literature reported that obesity itself can be the main factor that is strongly associated with hypertension, carried a relative risk of 14.7 for systolic hypertension after adjustment for family history (Salman et al. 2011).

Table 5: Health profile according to Ethnic group (N=1314)

	n(%)			P value
	Malay (n=647)	Chinese (n=248)	Indigenous Sarawak (n=419)	
Blood pressure				0.59
Normal	511 (79.00)	197 (79.44)	321 (76.61)	
Hypertension	136 (21.00)	51 (20.56)	98 (23.39)	
BMI classification				<0.01
Thinness	44 (6.80)	10 (4.03)	18 (4.30)	
Normal	406 (62.75)	129 (52.02)	222 (52.98)	
Overweight & obese	197 (30.45)	109 (43.95)	179 (42.72)	
Body fat classification				<0.01
Under fat	314 (48.53)	77 (31.05)	150 (35.80)	
Normal	168 (25.97)	82 (33.06)	116 (27.68)	
Overfat & obese	165 (25.50)	89 (35.89)	153 (36.52)	
WC classification				<0.01
Normal	491 (75.89)	167 (67.34)	275 (65.63)	
Abnormal	156 (24.11)	81 (32.66)	144 (34.37)	
WHtR classification				<0.01
Healthy	471 (72.80)	155 (62.50)	257 (61.34)	
Abnormal	176 (27.20)	93 (37.50)	162 (38.66)	

Table 6: Anthropometric measurement according to hypertensive at risk (N=1314)

	n(%)		P value
	Normal (n=1029)	Hypertension (n=285)	
BMI classification			<0.01
Thinness	62 (6.00)	10 (3.50)	
Normal	644 (87.70)	93 (32.60)	
Overweight & obese	303 (29.40)	182 (63.90)	
Body fat classification			<0.01
Under fat	481 (46.70)	60 (21.1)	
Normal	303 (29.40)	63 (22.10)	
Overfat & obese	245 (23.8)	162 (56.80)	
WC classification			<0.01
Normal	801 (77.80)	132 (46.3)	
Abnormal	228 (22.80)	153 (53.70)	
Waist-to-height ratio (WHtR)			<0.01
Healthy	761 (73.96)	122 (42.81)	
Abnormal	268 (26.04)	163 (57.19)	

At the geographical area, the findings showed that although more urban respondents were found to be overweight and obese, with percentage of fat at the overfat and obese level, abnormal waist circumference and WHtR (30 to 38%), the difference was not significant. The high prevalence of obesity observed in rural areas is felt to be due to the epidemiological transition that comes with urbanization. Like any urban lifestyle, rural community is facing the same lifestyles that come with increased consumption of high calorie and fat diet, easier accessibility to fast food outlets, increased sedentary lifestyle that involved more television viewing and internet surfing. All these can increase the risk of obesity (Belue et al. 2009).

Similar findings also appeared between genders, where male respondents had higher prevalence in all anthropometric indicators ranging from 30% to 43% compared to females. Consistent with findings by Poh et al. (2011), Ying-Xiu et al. (2013) and McCarthy & Ashwell (2006), male respondents were reported to have higher percentage of overweight and obese, abnormal body fat, waist circumference and WHtR. Male respondents were also reported to have higher prevalence of hypertension although the difference with female respondents was found to be insignificant. It was argued that such difference was due to biological and psychosocial factors (Kaur et al. 2005). Studies among adult population showed similar pattern where men had higher systolic blood pressure than women in the 18-39 age group, regardless of race and ethnicity (Cutler et al. 2008). One obvious pattern found was the prevalence of obesity related indicators was higher among male respondents compared to female respondents, which suggested higher prevalence of hypertension is related with higher prevalence of obesity. This finding was consistent with other studies, where being overweight and obese was associated with the increased likelihood of hypertension (Urrutia-Rojas et al. 2006).

Between ethics groups, except for BMI, Indigenous Sarawak group had the highest prevalence of overfat and obese, abnormal waist circumference and WHtR (34% to 39%). The findings indicated there might be interaction between genetics, environmental and lifestyles in relation to higher obesity risk (Chong et al. 2014). However, a local study among Malay population found that there was no association of Leptin gene variants and body weight status (Amiratul Athirah et al. 2018. The findings of this study also reported highest rate of hypertension among the ethnic groups, though the difference between ethnic groups was found insignificant. Higher blood pressure level was reported to be related to race/ethnic group, where prevalence of hypertension was higher among African American and Hispanic school-age children as compared to Caucasian children (Rosnar et al. 2000). As this was a critical attempt in understanding the difference in hypertension among different ethnic groups in Sarawak, particularly among the indigenous groups, the findings would provide potential research area

in the future as whether this was related to genetic background. Nevertheless, it was obvious that the Indigenous Sarawak group had the significant higher prevalence of obesity related indicators except for BMI compared to Malay and Chinese respondents.

The significant associations were found between hypertension and obesity related indicators (BMI, body fat, waist circumference and WHtR), consistent with other studies (Screeamareddy et al. 2013; Klumbiene et al. 2000; Cao et al. 2012; Chong et al. 2011; Salman et al. 2011; Kaur et al. 2005; Urrutia-Rojas et al. 2006; Rosnar et al. 2000). Such findings indicated the potential use of anthropometric measurement as the indicator for hypertension.

This study had several limitations. It was a cross-sectional study design, therefore it could not rule out the causation between variables. In addition, as we did not assess the pubertal status of our respondents, the data should be interpreted with caution. This is because timing of pubertal maturation plays a role in elevated blood pressure. As this study was carried out in Kuching division, therefore the findings cannot be generalized beyond those in similar groups.

CONCLUSION

As a conclusion, it is clear that hypertension in children has emerged as an important public health issues that is closely related to obesity epidemic. It is important to note that hypertension and obesity are modifiable risk factors for non-communicable diseases such as cardiovascular disease. Therefore, screening of potential risk factors at a young age would help to reduce the incidents of chronic disease in the adulthood. It is pertinent to include blood pressure measurement in the children's routine physical examination, especially among those who are overweight. The high risk children need to be referred for clinical diagnosis for further management.

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REFERENCES

Amiratul Athirah, S., Wan Rohani, W.T., Aryati, A. 2018. Effects of leptin gene variants on obesity and its attributes in Malay population. *Med & Health* **13**(2): 58-71.

BeLue, R., Okoror, T.A., Iwelunmor, J., Taylor, K.D., Degboe, A.N., Agyemang, C., Ogedegbe, B. 2009. An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective. *Global Health* **5**: 10.

Bijlsma, M.W., Blufpand, H.N., Kaspers, G.J., Bokenkamp, A. 2014. Why pediatricians fail to diagnose hypertension: a multicenter survey. *J Pediatr* **164**(1): 173-7.

Cao, Z.Q., Zhu, L., Zhang, T., Wu, L., Wang, Y. 2012. Blood pressure and obesity among adolescents: a school-based population study in China. *Am J Hypertens* **25**(5): 576-82.

Chong, H.L., Soo, T.L., Rasat, R. 2011. Childhood obesity-prevalence among 7 and 8 years old primary school students in Kota Kinabalu. *Med J Malaysia* **67**(2): 147-50.

Chong, P.N., Teh, C.P., Poh, B.K., Noor, M.I. 2014. Etiology of obesity over the life span: ecological and genetic highlights from Asian countries. *Curr Obes Rep* **3**(1): 16-37.

Cutler, J.A., Sorlie, P.D., Wolz, M., Thom, T., Fields, L.E., Roccella, E.J. 2008. Trends in hypertension prevalence, awareness, treatment, and control rates in United States adults between 1988-1994 and 1999-2004. *Hypertension* **52**(5): 818-27.

Gallagher, D., Visser, M., Sepulveda, D., Pierson, R.N., Harris, T., Heymsfield, S.B. 1996. How useful is body mass index for comparison of body fatness across age, sex and ethic groups? *Am J Epidemiol* **143**(3): 228-39.

Kaur, A., Kaur, P., Kaur, N., Kumari, K., Sidhu, S. 2005. Variation in blood pressure among school children of Amritsar (Punjab). *The Anthropologist* **7**(3): 201-4.

Kim, H.M., Park, J., Kim, H.S., Kim, D.H., Park, S.H. 2006. Obesity and cardiovascular risk factors in korean children and adolescents aged 10-18 years from the Korean National Health and Nutrition Examination Survey, 1998 and 2001. *Am J Epidemiol* **164**(8): 787-93.

Klumbiene, J., Sileikiene, L., Milasauskiene, Z., Zaborskis, A., Shatchkute, A. 2000. The relationship of childhood to adult blood pressure: longitudinal study of juvenile hypertension in Lituatnia. *J Hypertens* **18**(5): 531-8.

Krebs, N.F., Jacobson, M.F., American Academy of Pediatrics Committee on Nutrition. 2003. Prevention of pediatric overweight and obesity. *Pediatrics* **112**(2): 424-30.

McCarthy, H.D., Ashwell, M. 2006. A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message – 'Keep your waist circumference to less than half of your height'. *Int J Obes* **30**(6): 988-92.

Muntner, P., He, J., Cutler, J.A., Wildman, R.P., Whelton, P.K. 2004. Trends in blood pressure among children and adolescents. *JAMA* **291**(17): 2107-13.

National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. 2004. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics* **114**: 555-76.

Oh, J.H., Hong, Y.M. 2019. Blood pressure trajectories from childhood to adolescence in pediatric hypertension. *Korean Circulation Journal* **49**(3): 223-37.

Poh, B.K., Jannah, A.N., Chong, L.K., Ruzita, A.T., Ismail, M.N., McCarthy, D. 2011. Waist circumference percentiles for Malaysian children and adolescents aged 6.0-16.9 years. *Inter J Pediatr Obes* **6**(3-4): 229-35.

Rosnar, B., Prineas, R., Daniels, S.R., Loggie, J. 2000. Blood pressure differences between blacks and whites in relation to body size among US children and adolescents. *Am J Epidemiol* **151**(10): 1007-19.

Sarganas, G., Rosario, A.S., Niessner, C., Woll, A., Neuhauser, H.K. 2018. Tracking of blood pressure in children and adolescents in germany in the context of risk factors for hypertension. *Inter J Hypertens* **2018**: 8429891,

Salman, Z., Kirk, G.D., DeBoer, M.D. 2011. High rate of obesity-associated hypertension among primary school children in Sudan. *Int J Hypertens* **2011:** 629492

Screeamareddy, C.T., Chew, W.F., Poulsaeman, V., Boo, N.Y., Choo, K.B., Yap, S.F. 2013. Blood pressure and its associated factors among primary school children in suburban Selangor, Malaysia: A cross-sectional survey. *J Family Community Med* **20**(2): 90-7.

Urrutia-Rojas, X., Egbuchunam, C.U., Bae, S., Menchaca, J., Bayona, M., Rivers, P.A., Singh, K.P. 2006. High blood pressure in school children: prevalence and risk factors. *BMC Pediatrics* **6**: 32.

Ying-Xiu, Z., Ya-Lin, L., Jin-Shan, Z., Zun-Hua, C., Jing-Yang, Z. 2013. Distributions of waist circumference and waist-to-height ratio for children and adolescents in Shandong, China. *Eur J Pediatr* **172**(2): 185-91.

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