9 (2) (2020) 116 - 121

Journal of Physical Education, Sport, Health and Recreations

http://journal.unnes.ac.id/sju/index.php/peshr

Evidence of Hypertension in Healthy Children and Its Association with Body Composition and Aerobic Capacity

Aaron Azzu Tetteh[1]✉, Monday Omoniyi Moses[2]✉

Department of Sports and Exercise Science, Faculty of Allied Health Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana[12]

Article History

Received 27 April 2020
Accepted June 2020
Published June 2020

Keywords:
children; hypertension; obesity; aerobic capacity

Abstract

Hypertension is mostly associated with adulthood and old age with little attention on children. This study provided evidence of hypertension in healthy children and its association with body composition and aerobic capacity (VO_2max). 266 healthy children aged 8-11 years were recruited for the study. Blood pressure, heart rate, body mass index (BMI), basal metabolic rate (BMR), fat free mass, bone mass, visceral fat, total body water (TBW), and VO_2max were measured. 18.79% were pre-hypertensive and 9.40% overweight at least, while 65.42% underweight. Correlation between blood pressure and $maxVO^2$ was significant ($P < 0.05$). VO_2max significantly correlate with body mass index ($r = -.415$, $P < 0.05$), fat mass ($r = -.385$, $P < 0.05$) negatively and visceral fat ($r = -.267$, $P < 0.05$) and positive with fat free mass ($r = .385$, $P < 0.05$) and bone mass ($r = .077$, $P < 0.05$). Gender differences were significant in BMR, TBW, VO_2max and heart rate ($P < 0.05$). Evidence of hypertension in relatively healthy children is a clarion call to avert unprecedented decline in future life expectancy rate. Physical activity interventions are suggested antidotes to avert the risk factors of hypertension and excess body fat in children.

How to Cite

Tetteh, A. A.,&Monday Omoniyi Moses, M. O., (2020). Evidence of Hypertension in Healthy Children and Its Association with Body Composition and Aerobic Capacity. *Journal of Physical Education, Sport, Health and Recreation,* 9(2), 116-121.

© 2020 Universitas Negeri Semarang

✉ **Correspondence address :**
E-mail: azzutetteh@gmail.com
momoses@knust.edu.gh

p-ISSN 2460-724X
e-ISSN 2252-6773

INTRODUCTION

There is the evolution of high blood pressure in childhood and adolescence as a significant health issue concerning cardiovascular health (Flynn, Kaelber, Baker-Smith, Blowey, Carroll, & Daniels, 2017). Studies have shown the presence of high blood pressure at any case from childhood to adulthood is related with subclinical arterial damage and emphasize the significance of early and continuous prevention(Flynn, Kaelber, Baker-Smith, Blowey, Carroll, Daniels, et al., 2017; Stabouli & Kotsis, 2018). The prevalence of cardiovascular disease has increased substantially over the past two decades in younger population and reduced cardiopulmonary fitness is associated with increased cardiovascular disease (Ho, 2018; Richards et al., 2013; Townsend, Nichols, Scarborough, & Rayner, 2015).

Physical inactivity and obesity in children and adolescents are considered as independent risk factors for the development of lifestyle related disorders like coronary artery disease, diabetes, hypertension in later life (Sharma, Subramanian, & Arunachalam, 2013). Childhood obesity is one of the most serious public health challenges of the 21st century and reported over a decade as global problem affecting many low- and middle-income countries, particularly in urban settings (Abass & Moses, 2013). The prevalence continue to increase at an alarming rate (Haua-Navarro, 2016).

Body composition and aerobic fitness are frequently used in association with each other, and it is often implied that these physiological parameters are strongly inter-related. Study had shown body fatness and aerobic fitness as risk factors for future health outcome (Sharma, Kamal, & Chawla, 2016) but it is unclear whether these effects are related to one another or are independent risk factors(Farman & Majeed, 2019), although they have independently separate health effects of aerobic fitness and fatness (Sharma, Kamal, & Chawla, 2016).

Cardiorespiratory endurance is most important when considering the incidence of coronary heart disease (CHD) (Watanbe, Nakadomo, & Maeda, 1994). Cardiorespiratory fitness has been evaluated by the amount of oxygen (O_2) that can be taken up by the working muscles during maximal exercise (Watanbe, Nakadomo, & Maeda, 1994). Previous pertinent studies indicated body mass, fat free mass, % body Fat, and body surface area, are the best predictor of vo^2max(Devonshire et al., 2016; Shachar et al., 2017). Studies have suggested that regular physical activity and cardio respiratory fitness confer a reduction in the risk of coronary heart disease (CHD) and overall mortality in healthy subjects(Møller et al., 2014; Richards et al., 2013).

Assessment of body composition of children is of great significance as it shows the health status of the population in the future(Shachar et al., 2017). High body fat percentage and low levels of cardiovascular fitness are cardiovascular risk and poor physical performance indicators. Placing considerable attention on body composition with emphasis on body fat percentage and its effect is a major health problem.

Hypertension in hospitalised children with chronic health conditions has been reported(Pretty, O'Leary, Cairney, & Wade, 2013; Townsend et al., 2015), but active children in primary schools are often regarded as healthy without anticipation for hypertension. This study hence seeks to (1) determine hypertension incidence among primary school children, (2) compare body composition [body mass index, visceral fat, muscle mass, total body water, bone mass, fat mass, fat free mass and basal metabolic rate] with blood pressure, heart rate and maximum oxygen consumption in primary school children, (3) compare the body composition and maximum oxygen consumption of children based on gender.

METHODS

This is a correlational study of non-experimental quantitative method. 266 pupils aged between 7 and 11 years were recruited from two private primary schools with the use of convenience sampling of non-probability technique. Permission was obtained from the authorities of schools, class teachers and parents of the participants who met the inclusion. Participants who were in primary school and between the ages of 7 and 11 but diagnosed of cardiovascular diseases, cardio-respiratory diseases or any musculoskeletal injury were excluded.

Measurements

Blood Pressure

Automatic blood pressure monitor, model: M2 Basic, HEM-7120-E (Omron Healthcare Co. Ltd., Kyoto, Japan) was used to measure resting blood pressure (Systolic and Diastolic) and heart rate. Participants were seated upright in a back supported chair with the removal of any obstruction or occlusion of the circulation above the cuff site. The cuff was placed on the left arm, 2.5 cm above the antecubital space, with the palm facing up and the air bladder directly over the brachial artery.

Hypertension prevalence (the proportion of individuals having an abnormal elevated arterial blood pressure) was obtained with the use of an online calculator (www.mercksmanual.com/medical-calculators/BloodPressurePercentBoys.html) to calculate blood pressure percentile for boys and (www.mercksmanual.com/medical-calculators/BloodPressurePercentGirls.html) for the girls. Age, height, systolic and diastolic blood pressures were imputed to calculate percentile for blood pressure and height. The calculator determined whether a child has a healthy blood pressure for his/her height, age and gender. The calculator automatically adjusts for differences in height, age and gender, while calculating height percentile along with blood pressure percentile.

According to (U.S. Department of Health and Human Services, 2005) the results from the calculator is interpreted in **Table 1**.

Table 1. Normative Value for blood pressure percentile

Condition	SBP or DBP Percentile*
Normal	<90th
Prehypertension	90th to < 95th or if BP exceeds 120/80 even if <90th up to < 95th percentile**
Stage I Hypertension	95th – 99th plus 5 mmHg
Stage II Hypertension	>99th plus 5 mmHg

*For gender, age and height measured on at least 3 separate occasions; if SBP and DBP categories are different, categorize by the higher value.

** This occurs typically at 12 years old for SBP and at 16 years old for DBP.

***Parents and children trying to modify the eating plan to the DASH eating plan could benefit from consultation with a nutritionist.

****More than one drug may be required.

Body Composition

The procedure used to obtain body composition parameters in this study had been reported (Doku et al., 2019). Height was measured and recorded in metre to one decimal place. Weight (kg), body mass index (kg/m^2), basal metabolic rate (kcal), bone mass (kg), body fat mass (%), fat free mass (%), visceral fat (%), and total body water (l) were measured with the use of Taylor's Body fat analyzer, scale-5742 (Taylor Precision Products Inc., Las Cruces, NM, USA).

Maximal Oxygen Uptake

Queens' college step test was used to predict participants' maximal aerobic capacity. The participants stepped up and down on the 43.3cm step board at a rate of 22 steps per minute for females and 24 steps per minute for males using a four step cadence, 'up, up, down, down' for 3 minutes. Heart rate counted for 15 seconds was measured 5 seconds after the 3 minutes have elapsed. The 15 seconds reading was multiplied by 4 to obtain beats per minute (bpm) value which was used to calculate VO^{2}max. Formula for calculation VO^{2}max was 111.33-(0.42xHB) for males and 65.81-(0.1847xHB) for females where HB is the heart beats per minute that was obtained by multiplying the 15seconds pulse reading by 4.

Statistical Analysis

Data collected was analysed using IBM Statistical Package for Social Sciences (SPSS) version 23.0. The results were expressed in frequency counts, percent, mean and standard deviation (SD). Pearson product moment correlation (PPMC) was used to correlate body composition, blood pressure and heart rate to VO$_2$max (ml/kg/min). Mean difference between boys and girls was analyzed using independent sample t-test. P-value of < 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Table 2. Demographic Characteristics of Participants

Variables		Gender		Total Freq. (%)
		Males Freq. (%)	Females Freq. (%)	
	Underweight	109 (40.98%)	65 (24.44%)	174 (65.42%)
	Healthy	21 (7.89%)	46 (17.29%)	67 (25.18%)
	Overweight	4 (1.50%)	15 (5.64%)	19 (7.14%)
	Obese	1 (0.38%)	5 (1.88)	6 (2.26%)
Total		135 (50.75%)	131 (49.25%)	266 (100.00%)
	Minimum	Maximum	Mean, Standard Deviation	
Age (years)	8	11	9.49, 1.15	
Height (m)	1.25	1.62	1.39, 0.74	
Weight (kg)	22.90	67.70	35.92, 9.57	

BMI (kg/m2)	13.50	30.40	18.29, 3.72
BMR (kcal)	1015.00	1595.00	1223.10, 118.37
Bone Mass (kg)	14.83	14.87	14.85, 0.01
Body Fat Mass (%)	5.00	40.50	19.65, 8.90
Fat Free Mass (%)	59.50	95.00	80.35, 8.90
Visceral Fat (%)	1.00	3.00	1.56, 0.67
Total Body Water (l)	21.53	37.73	27.24, 3.59
VO2max (ml/kg/min)	24.44	67.65	45.93, 11.32
SBP (mmHg)	62.00	180.00	104.94, 20.62
DBP (mmHg)	48.00	117.00	68.96, 14.18
Heart Rate (bpm)	56.00	96.00	81.61, 9.05

Key: Basal Metabolic Rate (BMR), Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 2 showed that 174 (65.42%) were underweight, 19 (7.14%) overweight and 6 (2.26%) obese.

Table 3. Evidence of Hypertension

Gender	NORMAL Freq. (%)	Pre-Hypertensive Freq. (%)	Hypertensive Freq. (%)	Total
Males	114 (42.86%)	15 (5.64%)	6 (2.25%)	135(50.75)
Females	102 (38.35%)	18 (6.76%)	11 (4.14%)	131(49.25)
Total	216 (81.21%)	33(12.40%)	17 (6.39%)	266(100.00)

Table 4. Correlation of Body Composition, Blood Pressure, Heart Rate and maxVO_2

		Age	Height	Weight	BMI	BMR	BM	FM	FFM	VF	TBW	VO2max	SBP	DBP
Height	r	.704**												
	P value	.000												
Weight	r	.519**	.635**											
	P value	.000	.000											
BMI	r	.340**	.348**	.929**										
	P value	.002	.002	.000										
BMR	r	.532**	.709**	.876**	.784**									
	P value	.000	.000	.000	.000									
BM	r	.273*	.177	.020	-.035	.076								
	P value	.014	.115	.861	.755	.504								
FM	r	.182	.079	.734**	.896**	.549**	-.054							
	P value	.106	.487	.000	.000	.000	.636							
FFM	r	-.182	-.079	-.734**	-.896**	-.549**	.054	-1.000**						
	P value	.106	.487	.000	.000	.000	.636	.000						
VF	r	.050	-.063	.442**	.614**	.352**	-.056	.744**	-.744**					
	P value	.658	.580	.000	.000	.001	.622	.000	.000					
TBW	r	.567**	.730**	.891**	.775**	.949**	.100	.540**	-.540**	.346**				
	P value	.000	.000	.000	.000	.000	.377	.000	.000	.002				
VO2max	r	-.184	-.124	-.407**	-.415**	-.094	.077**	-.385**	.385**	-.267*	-.037			
	P value	.102	.275	.000	.000	.406	.049	.000	.000	.016	.746			
SBP	r	-.196	-.043	.099	.128	.067	-.026	.132	-.132	.008	.083	-.021		
	P value	.081	.702	.383	.256	.552	.819	.244	.244	.944	.462	.853		
DBP	r	-.273*	-.162	-.201	-.162	-.132	.143	-.109	.109	-.099	-.114	.197	.709**	
	P value	.014	.150	.074	.120	.243	.204	.365	.335	.384	.315	.080	.000	
HR	r	.190	.291**	.186	.135	.260*	.052	.137	-.167	.132	.243*	-.070	-.061	.027
		.091	.009	.099	.169	.020	.647	.138	.138	.243	.030	.535	.589	.813

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). r = PPMC

Table 5. Comparison of Body Composition, Blood Pressure and maxVO2 Based on Gender

	Males		Females		T value	P value
	Mean	SD	Mean	SD		
Age (years)	9.56	1.14	9.41	1.16	1.831	.069
Height (m)	1.39	0.67	1.38	0.82	1.676	.096
Weight (kg)	35.66	9.21	36.21	10.06	-.205	.838
BMI (kg/m2)	18.14	3.74	18.45	3.74	-.487	.633
BMR (kcal)	1256.7	123.1	1187.82	103.38	4.415	.000*
Bone Mass (kg)	14.85	0.01	14.85	0.01	1.909	.058
Body Fat Mass (%)	18.89	8.16	20.45	9.65	-.865	.388
Fat Free Mass (%)	81.11	8.16	79.55	9.65	.865	.388
Visceral Fat (%)	1.56	0.71	1.56	0.64	.006	.996
Total Body Water (l)	28.59	3.50	25.83	3.14	5.914	.000*
VO2max (ml/kg/min)	54.33	9.01	36.32	3.73	20.24200	.000*
SBP (mmHg)	105.49	24.76	104.36	15.43	-.098	.922
DBP (mmHg)	71.46	15.55	66.33	12.25	1.524	.129

The main aim of the study was to provide evidence of hypertension in healthy children and its association with body composition and aerobic capacity (VO_2max). **Table 2** showed that 174 (65.42%) of the participants were underweight where males were worse affected, 19 (7.14%) were overweight and 6 (2.26%) obese where females were victims. Our finding in consistent with outcome of current study on the assessment of under nutrition using composite index of anthropometric failure among under five children of tribal population with 94.7% male and 72.1% female were under weight(Prabhakar, Kumarasamy, & Dhanapal, 2019)

5.64% of male in this study were pre-hypertensive while 2.25% were hypertensive as compared to 6.76% pre-hypertensive and 4.14% hypertension in female. There is significant agreement between the finding of our study and previous study where the percentage of the prehypertension and hypertension was higher in female compared to male (Farman & Majeed, 2019).

Considering VO_2max and body composition (BMI, basal metabolic, fat mass, visceral fat and total body water) showed a negative correlation which means as these body composition parameters increase, VO_2max decreases. Bone mass and fat free mass showed positive correlation with VO_2max which means as the parameters increase, heart rate also increases. Comparing fat free mass to heart rate showed negative correlation which means as it increases, heart rate decreases. BMI, basal metabolic, fat free mass, visceral fat, total body water and bone mass showed positive correlation with heart rate which all increases with heart rate.

Considering systolic blood pressure and body composition (BMI, basal metabolic, fat free mass, visceral fat and total body water) showed positive correlation which means as these body composition parameters increase, SBP increases. Bone mass and fat free mass showed negative correlation with SBP which means as the parameters increase, heart rate also decreases.

Findings showed complete inverse correlation of SBP when DBP was pitched against body composition (BMI, basal metabolic, fat mass, visceral fat and total body water) with negative correlation which means as body composition parameters increase, DBP decreases. Bone mass and fat free mass showed positive correlation with DBP which means as the parameters increase, heart rate also increases.

Our finding revealed that males significantly had better BMR, total body water and VO_2max as compared to females whereas females had heart rate. Nutritional or dietary imbalanced (Acquah, Darteh, Amu, & Adjei, 2019; Farman & Majeed, 2019) as well as little or no care attention to male and too much care for female children may suggest some of the reasons for our findings(Isacco & Miles□Chan, 2018; Manna, 2018).

CONCLUSION

Evidence of hypertension in relatively healthy children is a clarion call to avert unprecedented decline in future life expectancy rate. Hypertension with imbalanced body fat is a possible risk factor for developing cardiovascular comorbidities later in middle and old age. Given the current obesity trend and observations of a decline in daily energy expenditure among children, improving cardiorespiratory fitness in children by engaging in physical activities require red.

REFERENCES

Abass, A. O., & Moses, M. O. (2013). Aerobic and Progressive Resistance Exercise Effects on Body Composition of Primary School Children in Ibadan, Nigeria. British Journal of Education, Society & Behavioural Science, 3(2), 163-173.

Acquah, E., Darteh, E. K. M., Amu, H., & Adjei, D. K. A. (2019). Predictors Of Underweight In Children Under-Five Years In Ghana. Ghana Medical Journal, 53(1), 71–78.

Devonshire, A. L., Hager, E. R., Black, M. M., Diener-West, M., Tilton, N., & Snitker, S. (2016). Elevated Blood Pressure In Adolescent Girls: Correlation To Body Size And Composition. BMC Public Health. https://doi.org/10.1186/s12889-016-2717-6

Doku, A. O., Moses, M. O., Acheampong, I. K., Gyamfi, I., Agbavor, C., Akwa, L. G., … Deku, P. D.-G. (2019). Physiological, Anthropometric Parameters, And Balance Skill Response Of Healthy Bankers To Fitness Training. Journal of Exercise Rehabilitation, 15(2), 242–248.

Farman, W. H., & Majeed, H. M. (2019). Overweight and Obesity Among Children and Adolescents in Baladrouz City. Diyala Journal of Medicine, 16(2), 31–38.

Flynn, J. T., Kaelber, D. C., Baker-Smith, C. M., Blowey, D., Carroll, A. E., Daniels, S. R., … Urbina, E. M. (2017). Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. https://doi.org/10.1542/peds.2017-1904

Haua-Navarro, K. (2016). Overweight and obesity. Gaceta Medica de Mexico.

Ho, K. J. (2018). Cardiovascular diseases. In Nutritional Aspects of Aging: Volume 2. https://doi.org/10.1201/9781351075145

Isacco, L., & Miles□Chan, J. L. (2018). Gender□specific Considerations In Physical Activity, Thermogenesis And Fat Oxidation: Implications For Obesity Management. Obesity Reviews, 19, 73–83.

Manna, S. (2018). Body Fluid: Distribution and Measurement. In In Review of Physiology (pp. 1. – 23).

Møller, N. C., Tarp, J., Kamelarczyk, E. F., Brønd, J. C., Klakk, H., & Wedderkopp, N. (2014). Do extra compulsory physical education lessons Mean More Physically Active Children - Findings From The Childhood Health, Activity, And Motor Performance School Study Denmark (The CHAMPS-study DK). International Journal of Behavioral Nutrition and Physical Activity. https://doi.org/10.1186/s12966-014-0121-0

Prabhakar, R., Kumarasamy, H., & Dhanapal, A. (2019). Assessment Of Under Nutrition Using Composite Index Of Anthropometric Failure Among Under Five Children Of Tribal Population. International Journal of Community Medicine and Public Health, 6(5), 2056–2063.

Pretty, C., O'Leary, D. D., Cairney, J., & Wade, T. J. (2013). Adverse Childhood Experiences And The Cardiovascular Health Of Children: A cross-sectional study. BMC Pediatrics. https://doi.org/10.1186/1471-2431-13-208

Richards, J., Foster, C., Thorogood, M., Hillsdon, M., Kaur, A., Wickramasinghe, K. K., & Wedatilake, T. (2013). Face-To-Face Interventions For Promoting Physical Activity. Cochrane Database of Systematic Reviews. https://doi.org/10.1002/14651858.CD010392

Shachar, S. S., Deal, A. M., Weinberg, M., Williams, G. R., Nyrop, K. A., Popuri, K., … Muss, H. B. (2017). Body Composition As A Predictor Of Toxicity In Patients Receiving Anthracycline And Taxane-Based Chemotherapy For Early-Stage Breast Cancer. Clinical Cancer Research. https://doi.org/10.1158/1078-0432.CCR-16-2266

Stabouli, S., & Kotsis, V. (2018). Diagnosis Of Hypertension In Children And Adolescents: 2019 Update. Hellenic Journal of Atherosclerosis, 9(4), 111–120.

Townsend, N., Nichols, M., Scarborough, P., & Rayner, M. (2015). Cardiovascular disease in Europe - Epidemiological update 2015. European Heart Journal. https://doi.org/10.1093/eurheartj/ehv428.