Original Article

Morning Exercise at School and Sedentary Activities are Important Determinants for Hypertension in Adolescents

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Abstract

Background: This study was performed to determine the association of Pre–hypertension/hypertension (pre-HTN/HTN) with leisure-time activities and morning exercise at school in a sample of Iranian adolescents. **Methods:** This secondary study has done using data of 1992 adolescents participated in of Isfahan Healthy Heart Program. The outcome variable was having/not having pre-hypertension/hypertension (pre-HTN/HTN). The students with Blood pressure (BP) between 90th to 95th percentiles were considered as positive pre-HTN and students with BP >95th percentile were considered as positive HTN. Students with pre-HTN or HTN were considered as positive pre-HTN/HTN. The asked leisure-time activities were categorized in three group including first (ping-pong, basketball, and volleyball), second (football, walking, and bicycling) and sedentary activities (watching TV, studying, and computer gaming), using factor analysis. **Results:** The prevalence of pre-HTN and HTN was 16.1% and 6.7%, respectively. Based on multiple logistic regression pre-HTN/HTN was associated just with sedentary activities and morning exercise at school. Odds Ratio (95% confidence interval) for sedentary activities and morning exercise at school was 1.51 (1.13–2.01) and 0.63 (0.44–0.89), respectively. **Conclusion:** We observed adolescents who engaged in morning exercise at school had lower prevalence of HTN while those who spent more times on sedentary activities were in higher risk for HTN. We suggest to permanent holding of morning exercise and educational programs on healthy lifestyle skills for adolescents by schools.

Keywords: *Adolescent, hypertension, Iran, Leisure activities*

Introduction

Although hypertension (HTN) was been a rare problem in childhood in past descends, nowadays it is becoming a source of concern in children and adolescents.[1] Considering the correlation between HTN in childhood and HTN and cardiovascular morbidities in adulthood, it is essential to prompt diagnosis and management of HTN in childhood.[2] According to some evidences, the incidence of HTN in children and adolescents is increasing.[3,4] The prevalence of adolescent's HTN reported in various studies changes from 3% to 5% in United States[4] to 24.9% in Southern Africa.[5]

Internationally, it has been found that levels of physical activity (PA) decrease with age in adolescence.[6] De Moraes *et al*.[6] found that the incidence of pre-HTN and HTN was high in European children; low levels of PA was a risk factor for developing HTN and maintenance of sedentary behaviors increased the risk of developing HTN after two years of follow-up.[6] These results suggest that regular PA should be promoted and sedentary behavior should be discouraged in children to prevent HTN and its consequences in adulthood.[7] Much evidence suggests that leisure-time PA for 150 minutes or more per week can have substantial health benefits for an individual. Having moderate-intensity exercise for 15 minutes per day or 90 minutes per week might be beneficial, even for individuals at risk of cardiovascular disease.[8] The American Heart Association recommends that children and youths should participate in moderate-to-vigorous PA at least 60 minutes per day for cardiovascular health promotion.[9] However, it has been reported that 80% of 13–15 year-olds

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worldwide do not achieve this amount of PA per day.[10] Studies showed reduced tendency among students to be physically active and this can be an alarm for the future health of any society.[11]

According a study in Iran, prevalence of overweight/obesity in adolescents is high.[12] In this study several factors like moderate leisure-time PA, sedentary activities like computer using, higher levels of parental education and studying in private schools were related to obesity/overweight. Among these factors, the independent positive relationship of leisure-time PA with overweight/obesity should be attributed to insufficient intensity of PA or suppression of PA's beneficial effects by a higher intake of food.[12] However, few studies have done with focusing on PA among Iranian adolescents. So, we performed this study to determine status of leisure-time PA and morning exercise at school and their relationships to Pre–hypertension/hypertension (pre-HTN/HTN) in a sample of Iranian adolescents.

Methods

This secondary study has done using data of a part of Heart Health Promotion from Childhood (HHPC) project,[13] which is one of ten projects of Isfahan Healthy Heart Program (IHHP).[14] IHHP with a quasi-experimental design was a comprehensive community-based program for prevention and control of cardiovascular diseases and promotion of healthy lifestyle. This program was performed during 2000 to 2007 in three phases. More details about this study are presented elsewhere.[14]

Outcome variables in present study were pre-HTN (yes/no), HTN (yes/no), and pre-HTN/HTN (yes/no). According to,[15] the students with Blood pressure (BP) between 90th and 95th percentiles were considered as pre-hypertensive and students with BP >95th percentile were considered as hypertensive. Students with pre-HTN or HTN were considered as positive pre-HTN/HTN.

BP was measured twice, after the participant sat comfortably for 5 minutes, with an appropriately sized cuff on the right arm by an examining physician using a mercury column sphygmomanometer (Korotkoff phases I and V). Time interval between two measurements was five minutes. The mean of these two determinations was used to express the individual's systolic and diastolic BP.

Other variables were age (years), gender, education grade (middle/high school), residency (urban/rural), regular morning exercise in school (yes, no), body mass index (BMI), psychological distress (yes, no), leisure-time activities: watching TV (yes, no); studying (yes, no); computer gaming (yes, no); ping-pong (yes, no); basketball (yes, no); volleyball (yes, no); football (yes, no); walking (yes, no); and bicycling (yes, no), and time consumed on these activities.

BMI was calculated as weight divided by height squared (kg/m^2). Height and weight measurements were performed for each student according to standardized guideline.[16] The participants were asked to wear light clothes and to take off their shoes. They stood upright on a scale after that it had been reset. Height and weight of participants were measured to the nearest 0.1 cm and 0.1 kg, respectively. Participants were classified as normal weight (BMI <90th percentile), overweight (BMI ≥90 to 95th percentile), and obese (BMI ≥95th percentile.[17]

Psychological distress was measured with the 12-item General Health Questionnaire (GHQ-12). Students with score 4 or more on this scale (GHQ-12 ≥4) were considered as psychological distressed.

The unit for time consumed on leisure-time activities was minutes per week except for watching TV that was asked by unit of hours per day.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from both participating students and their parents or guardians. Participation was on a voluntary basis. Data collection occurred before the start of the school day. The Ethics committee at the Isfahan Cardiovascular Research Institute approved the study protocol.

Statistical analysis

We used SPSS for Windows 15.0 (SPSS Inc., Chicago, IL, USA) for data analysis. Continuous and categorical variables were expressed as mean ± standard deviation (SD) and number (%), respectively. Independent T-test was used for comparing the time consumed on various leisure-time activities between males and females. We used factor analysis (FA) to categorize leisure-time activities. Suitability of variables for FA was checked by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett test of sphericity. A KMO index higher than 0.5 and a significant result for Bartlett test was considered as essential prerequisites for FA according to Williams *et al*.[18] We compared the prevalence of pre-HTN/HTN by categorical variables using Chi-squared test. Multiple logistic regression was used for adjusted assessment of relationship between of pre-HTN/HTN and leisure-time activities.

Results

A total of 1992 students [978 females (49.1%) and 1014 males (50.9%)] participated in this study. Mean ± SD; range for age, BMI and GHQ-12 score were 14.46 ± 1.8; 11–21 years old, 12.04 ± 3.74; 12.04–37.95 kg/m^2 and 2.92 (2.01); 0–12, respectively. Majority of participants were urban residents (76.9%), middle school students

(52.2%), without psychological distress (69.90%), and with normal BMI (82.20%). Among the participants, 345 students (17.3%) engaged regular morning exercise at school.

The time consumed on various leisure-time activities by gender is presented in Table 1. According to these findings, the boys, as compared with girls, significantly spent more times on computer gaming, ping-pong, football, walking, bicycling. On the other hand, the time consumed on studying was significantly higher in girls, as compared with boys. There was no statistical significant difference between two groups about other activities.

Suitability of leisure-time activity variables for FA was checked by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett test of sphericity. Considering a KMO 0.62 and a significant *P* value for Bartlett test (X^2 = 1529.685, $P < 0.001$), we were allowed to FA. In this analysis three components with Eigenvalue >1 covered 43.7% of total variance. As shown in Table 2, activities with maximum loading factor on first, second and third components were (ping-pong, basketball, and volleyball), (football, walking, and bicycling;) and (watching TV, studying, and computer gaming), respectively. We divided each component into three groups (tertiles) for next analyses. For simplification, we named first, second and third components as first group PA, second group PA, and sedentary activities, respectively.

Table 1: Comparison of the leisure-time consumed on various activities by sex in adolescents, Isfahan, Iran

Activity type	Consumed time		*P**
	Female Mean±SD	males Mean±SD	
Watching TV (h/d)	3.27±1.71	3.16±1.59	0.147
Studying (m/w)	463.19±551.06	206.06±289.34	0.001
Computer gaming (m/w)	117.38±258.96	152.5±300.07	0.005
Ping-pong (m/w)	2.87±23.43	18.36±93.13	0.001
Basketball (m/w)	10.89±36.29	12.10±53.86	0.561
Volleyball (m/w)	21.05±45.71	17.41±57.21	0.120
Football (m/w)	3.9±22.14	141.39±176.59	0.001
Walking (m/w)	115.51±114.80	158.21±135.72	0.001
Bicycling (m/w)	8.00±34.93	82.36±157.63	0.001
Morning exercise (m/w)	53.68±34.84	59.24±34.67	0.943

SD: Standard deviation, (h/d): Hours per day, (m/w): Minutes per week. *Independent T-test

Table 2: Factor Loading Matrix for Leisure-time Activities in adolescents, Isfahan, Iran

Activity type	First component	Second component	Third component
Ping-pong	0.86	.	.
Basketball	0.78	.	.
Volleyball	0.73	.	.
Football	.	0.64	.
Walking	.	0.57	.
Bicycling	.	0.55	.
Watching TV	.	.	0.79
Studying	.	.	0.45
Computer gaming	.	.	0.25

The prevalence of pre-HTN and HTN among students was 16.1% and 6.7%, respectively. Students with pre-HTN were significantly older compared with students without pre-HTN (mean ± SD age: 14.6 ± 1.8 versus 13.9 ± 1.6, $P < 0.001$). The prevalence of pre-HTN/HTN in terms of student's characteristics is presented in Table 3. As shown, the prevalence was significantly higher among boys, students with middle school grade; urban residency status; obese BMI level and without morning exercise at school compared with their counterparts, respectively. Students with psychological distress had higher prevalence of pre-HTN/HTN. However, this difference was not statistically significant.

The prevalence of pre-HTN/HTN significantly increased according to tertiles of sedentary activities from first to third tertile. In terms of first group PA, students in second tertile had highest prevalence of pre-HTN/HTN. The tertile with highest prevalence of pre-HTN/HTN for second group PA was first. However, there was no significant difference in terms of tertiles of first and second groups PA.

We assessed relationships of leisure-time consumed on various activities and having morning exercise at school with pre-HTN/HTN using logistic regression. We assessed these relationships in 4 models including crude, adjusted for age and sex, adjusted for age, sex and residency and adjusted for age, sex, residency, BMI and GHQ-12 score. The results are presented in Table 4. As shown, in all models, having pre-HTN/HTN was associated just with leisure-time consumed on sedentary activities and morning exercise at school. As students who spent the highest leisure-time on sedentary activities (tertile 3) had significantly higher odds for pre-HTN/HTN compared with reference group [students who consumed the lowest leisure-time on sedentary activities (tertile 1)]. In other hand, having regular morning exercise at school had a significant protective effect on pre-HTN/HTN.

Discussion

We estimated prevalence of Pre-HTN and HTN in adolescents and assessed their relationship with activities in leisure-times and morning exercise at school in this study.

The prevalence of pre-HTN and HTN among studied adolescents was 16.1% and 6.1%, respectively. Forth phase of CASPIAN study, a national survey conducted on Iranian adolescents in 30 provinces, estimated prevalence of pre-HTN and HTN 3.13% and 3.75%, respectively, in 2011–2012.[19] In another cross-sectional study on 5620 students aged 6–12 years in northeast of Iran, the prevalence of pre-HTN and HTN was 7.44% and 6.82%

respectively.[3] A school-based cross-sectional study on 1000 Indian students estimated prevalence of pre-HTN and HTN 24.5% and 0.6%, respectively.[20] Discrepancy between prevalence of pre-HTN and HTN in our study compared with other studies on Iranian adolescents can be attributed to different age of studied participants. The age of our participants ranged between 11 and 21 while it was between 6 and 12 in study conducted on northeast Iranian adolescents.[3] Mean age of participants in this study was also higher than the CASPIAN study (14.46 versus 11.47 years).[19] In another study on Iranian adolescents with mean age 15.67 (a nearer one to mean age of participants in current study), prevalence of pre-HTN and HTN are estimated 13.9% and 19.4%, respectively.[21]

Table 3: Prevalence of Pre-HTN/HTN by adolescent's characteristics, Isfahan, Iran

Variables		Pre-HTN/HTN*	
		n (%)	*P*†
Sex	Girl	200 (20.8)	0.02
	Boy	254 (25.2)	
Education grade	Middle school	284 (27.6)	<0.001
	High school	170 (18.0)	
Residency	Urban	378 (24.8)	0.001
	Rural	76 (17.0)	
Psychological distress	No	310 (22.4)	0.25
	Yes	144 (24.8)	
BMI category	Normal	333 (20.5)	<0.001
	Over weight	74 (31.1)	
	Obese	45 (42.9)	
Morning exercise at school	No	402 (24.1)	0.007
	Yes	49 (16.8)	
Sedentary activities	Tertile 1	121 (19.6)	0.022
	Tertile 2	147 (23.6)	
	Tertile 3	162 (26.2)	
FGPA	Tertile 1	142 (22.8)	0.951
	Tertile 2	146 (23.5)	
	Tertile 3	142 (23.1)	
SGPA	Tertile 1	159 (25.6)	0.204
	Tertile 2	137 (22.0)	
	Tertile 3	134 (21.8)	

HTN: Hypertension, BMI: Body mass index, FGPA: First group physical activities (ping-pong, basketball, volleyball), SGPA: Second group physical activities (football, walking, bicycling) and sedentary activities (watching TV, studying, computer gaming). *Blood pressure >90 Percentile. †Chi-square test

One of factors with significant association with pre-HTN/HTN in this study was gender. The boys had significantly higher prevalence of pre-HTN/HTN compared with the girls. This is consistent to previous studies.[19-22] Qaddumi *et al*.[22] attributed this difference to protective effects of estrogen in girls. This justification can be applicable for present study as a result of being participants in puberty age.

Adolescents who resided in urban regions had a significantly higher prevalence of pre-HTN/HTN than their counterparts resided in rural regions. Similar to present study, in a cross-sectional study on 810 adolescents in Bangladesh, prevalence of hypertension was significantly higher in urban compared with rural residents.[23] In another study on 2467 school children aged 11–17 years in Ludhiana, sustained HTN was more prevalent in urban than rural areas.[24] This difference is observed even between semi-urban and urban resided adolescents.[25] It seems disparities in lifestyle patterns between urban and rural residents play important role in differences in pre-HTN/HTN prevalence between them. Unhealthy food habits, particularly dietary regimens rich in fast-foods, and low PA that are increasing following the urbanization, predispose adolescent to chronic disease like HTN.[23,25,26]

Adolescents in middle school grade had significantly higher prevalence of pre-HTN/HTN compared with their

Table 4: Crude and Adjusted Association between Pre-HTN/HTN with Leisure-times Consumed on Various Activities and Morning Exercise at School, in adolescents, Isfahan, Iran‡

Variables		Crude	Model 1	Model 2	Model 3
Leisure-time consumed on FGPA	Tertile 1 (Reference)				
	Tertile 2	1.07 (0.81,1.39)‡	1.24 (0.94,1.64)	1.26 (0.95,1.68)	1.20 (0.91,1.60)
	Tertile 3	1.06 (0.81,1.39)	1.26 (0.95,1.67)	1.25 (0.95,1.66)	1.16 (0.87,1.54)
Leisure-time consumed on SGPA	Tertile 1 (Reference)				
	Tertile 2	0.84 (0.64,1.08)	0.95 (0.72,1.27)	1.00 (0.75,1.33)	0.98 (0.73,1.31)
	Tertile 3	0.85 (0.65,1.10)	0.92 (0.70,1.22)	0.96 (0.73,1.27)	0.99 (0.75,1.33)
Leisure-time consumed on sedentary activities	Tertile 1 (Reference)				
	Tertile 2	1.24 (0.94,1.63)	1.21 (0.92,1.60)	1.23 (0.93,1.63)	1.25 (0.94,1.66)
	Tertile 3	1.41 (1.07,1.85)*	1.48 (1.11,1.95)*	1.51 (1.14,2.00)*	1.51 (1.13,2.01)*
Morning exercise at school	No (Reference)				
	Yes	0.69 (0.49,0.97)*	0.58 (0.41,0.82)*	0.59 (0.42,0.84)*	0.63 (0.44,0.89)*

HTN: Hypertension, FGPA: First group physical activities (ping-pong, basketball, volleyball), SGPA: Second group physical activities (football, walking, bicycling) and sedentary activities (watching TV, studying, computer gaming). Model 1: Adjusted by age, sex. Model 2: Adjusted by age, sex, and residency. Model 3: Adjusted by age, sex, residency, body mass index, General Health Questionnaire score. ‡Odds Ratio (95% confidence interval). *P<0.05

counterparts in high school grade. Similarly, in a study in Palu city, Indonesia, students in junior high school level had a higher mean systolic blood pressure compared with students in senior high school levels.[27] We guessed this unexpected finding may be due to changing of attitudes following getting older. When a school-age child understands importance of fitness in health preservation and looking prettier, he/she will make more attempts for weight control and other healthy behaviors like healthier diets and more PA. William *et al*.[28] has schematically indicated that the importance of health, fitness and behavioral components of PA increase as age of school-age youths increase from 3 to 4 years to 17–18 years. However, we suggest to test this hypothesis by well-designed large-scale studies in future.

We observed that the girls significantly spent more time on sedentary behaviors including studying than the boys while the boys spent more time on sport activities including ping-pong, foot-ball, walking, and bicycling than the girls. These findings are in line to other studies. In a school-based cross-sectional study on 2888 adolescents aged 14–19 years in Saudi Arabia, boys significantly spent more times on PA either in leisure-times or in non-leisure-times compared with the girls.[29] Also in a cohort study on 1,589 Danish adolescents, proportion of subjects who spent more weekly hours on PA was higher in the boys than the girls.[30] In addition, maintenance of PA during adolescence has been significantly more probable in boys than girls.[31]

There was an incremental trend in prevalence of pre-HTN/HTN according to BMI categories from normal to obese. This finding is observed in multiple studies.[21,26,32,33] Some proposed mechanisms for relationship between obesity and increased blood pressure are excessive activation of sympathetic nervous and renin–angiotensin systems, insulin resistance, and cancelation atherogenic process following reduction of endothelial-dependent dilation and arterial compliance.[21] Regarding the HTN in adolescence is a predictor for HTN in adulthood,[21] it is essential to design programs aimed to reduce obesity in adolescents.

In consistency to previous studies,[22,34,35] current study indicated the adolescents with morning exercise at school had significantly lower prevalence of pre-HTN/HTN. This noticeable finding can be used as a tool for forcing school managers to hold morning exercise for students in schools. In other hand, students who spent their leisure-times on sedentary activities including computer gaming, watching TV or studying were in higher risk for pre-HTN/HTN even after adjustment of confounding effects of age, sex, residency, BMI and psychological distress. In a survey on adolescents 12-19 years aged, the researchers observed a significant preventive role for PA and healthy diet on metabolic syndrome.[36] According a review, sedentary activities in school-age youths should be reduced to <2 hours per day as a way to increasing of PA and health promotion.[28] Therefore, it can be concluded that schools can play an important role in these areas too. It seems setting up educational programs aimed encouraging students to spend more times on PA than sedentary activities and consuming healthy foods, particularly in attractive multimedia formats, can be influential in control of risk factors of cardio-vascular diseases in adolescents including HTN.

Conclusion

This study indicated an alarming status for hypertension in Iranian adolescents. We observed adolescents who engaged in morning exercise at school had lower prevalence of HTN while those who spent more times on sedentary activities were in higher risk for HTN. We suggest to permanent holding of morning exercise and educational programs on healthy lifestyle skills for adolescents by schools.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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References

1. Okpokowuruk FS, Akpan MU, Ikpeme EE. Prevalence of hypertension and prehypertension among children and adolescents in a semi-urban area of Uyo Metropolis, Nigeria. Pan Afr Med J 2017;28:303.
2. Ladapo T, Fajolu I, Adeniyi O, Ekure E, Maduako R, Jaja T, *et al*. Blood pressure to height ratio as a screening tool for prehypertension and hypertension in adolescents. Niger J Clin Pract 2016;19:401-6.
3. Ebrahimi H, Emamian MH, Hashemi H, Fotouhi A. Prevalence of prehypertension and hypertension and its risk factors in Iranian school children: A population-based study. J Hypertens 2018;36:1816-24.
4. Falkner B, Lurbe E, Schaefer F. High blood pressure in children: Clinical and health policy implications. J Clin Hypertens 2010;12:261-76.
5. Kemp C, Pienaar AE, Schutte AE. The prevalence of hypertension and the relationship with body composition in Grade 1 learners in the North West Province of South Africa. SAJSM 2011;23:117-22.
6. Currie C, Zanotti C, Morgan A, Currie D, De Looze M, Roberts C, *et al*. Social determinants of health and well-being

among young people. Health Behaviour in School-aged Children (HBSC) study: international report from the 2009/2010 survey. World Health Organization 2012.
7. De Moraes ACF, Carvalho HB, Siani A, Barba G, Veidebaum T, Tornaritis M, *et al*. Incidence of high blood pressure in children—effects of physical activity and sedentary behaviors: The IDEFICS study: High blood pressure, lifestyle and children. Int J Cardiol 2015;180:165-70.
8. Wen CP, Wai JPM, Tsai MK, Yang YC, Cheng TYD, Lee M-C, *et al*. Minimum amount of physical activity for reduced mortality and extended life expectancy: A prospective cohort study. Lancet 2011;378:1244-53.
9. Steinberger J, Daniels SR, Hagberg N, Isasi CR, Kelly AS, Lloyd-Jones D, *et al*. Cardiovascular health promotion in children: Challenges and opportunities for 2020 and beyond: A scientific statement from the American Heart Association. Circulation 2016; 134:e236-55.
10. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U, *et al*. Global physical activity levels: Surveillance progress, pitfalls, and prospects. Lancet 2012;380:247-57.
11. Chaput J-P, Klingenberg L, Rosenkilde M, Gilbert J-A, Tremblay A, Sjödin A. Physical activity plays an important role in body weight regulation. J Obes 2011;2011:1-11.
12. Hajian-Tilaki K, Heidari B. Prevalences of overweight and obesity and their association with physical activity pattern among Iranian adolescents aged 12–17 years. Public Health Nutr 2012;15:2246-52.
13. Nouri F, Feizi A, Mohammadifard N, Sarrafzadegan N. Isfahan Healthy Heart Program, sample size and sampling structure: A comprehensive report. J Isfahan Med Sch 2016;33:2152-66.
14. Sarraf-Zadegan N, Sadri G, Malek-Afzali H, Baghaei M, Mohammadi-Fard N, Shahrokhi S, *et al*. Isfahan Healthy Heart Programme: A comprehensive integrated community-based programme for cardiovascular disease prevention and control. Design, methods and initial experience. Acta Cardiol 2003;58:309-20.
15. Genovesi S, Antolini L, Giussani M, Brambilla P, Barbieri V, Galbiati S, *et al*. Hypertension, prehypertension, and transient elevated blood pressure in children: Association with weight excess and waist circumference. Am J Hypertens 2010;23:756-61.
16. Kelishadi R, Mohammadifard N, Sarrazadegan N, Nouri F, Pashmi R, Bahonar A, *et al*. The effects of a comprehensive community trial on cardiometabolic risk factors in adolescents: Isfahan Healthy Heart Program. ARYA Atheroscler 2012;7:184-90.
17. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Vol. 177. Champaign, United States: Human Kinetics Books Champaign; 1988.
18. Williams B, Onsman A, Brown T. Exploratory factor analysis: A five-step guide for novices. Aust J Paramedicine 2010;8:1-13.
19. Fallah Z, Qorbani M, Motlagh ME, Heshmat R, Ardalan G, Kelishadi R. Prevalence of prehypertension and hypertension in a nationally representative sample of Iranian children and adolescents: The CASPIAN-IV study. Int J Prev Med 2014;5(Suppl 1):S57-64.
20. Amma GM, Vasudevan B, Akshayakumar S. Prevalence and determinants of prehypertension and hypertension among adolescents: A school based study in a rural area of Kerala, India. Int J Res Med Sci 2017;3:58-64.
21. Rafraf M, Gargari BP, Safaiyan A. Prevalence of prehypertension and hypertension among adolescent high school girls in Tabriz, Iran. Food Nutr Bull 2010;31:461-5.
22. Qaddumi J, Holm M, Alkhawaldeh A, Albashtawy M, Omari OA, Batiha A-M, *et al*. Prevalence of hypertension and pre-hypertension among secondary school students. Int J Adv Nurs Stud 2016;5:240-5.
23. Taleb MA, Ahmed MM, Sharmin KN, Islam D. Blood pressure and its associated factors: A comparative study among rural and urban adolescents in Bangladesh. Int J Res Med Sci 2016;4:4778-87.
24. Mohan B, Kumar N, Aslam N, Rangbulla A, Kumbkarni S, Sood NK, *et al*. Prevalence of sustained hypertension and obesity in urban and rural school going children in Ludhiana. Indian Heart J 2004;56:310-4.
25. Ejike CE, Ugwu CE, Ezeanyika LU. Variations in the prevalence of point (pre) hypertension in a Nigerian school-going adolescent population living in a semi-urban and an urban area. BMC Pediatr 2010;10:13.
26. Omisore AG, Omisore B, Abioye-Kuteyi EA, Bello IS, Olowookere SA. In-school adolescents' weight status and blood pressure profile in South-western Nigeria: Urban-rural comparison. BMC Obes 2018;5:2.
27. Halim W, Tjahjadi S, Madjid B, Chaeriadi V, Patellongi I. Blood pressure and body mass index profile of elementary, junior high, and senior high in Palu City, Central Sulawesi, Indonesia: An epidemiological study. J Hypertens 2016;34:e170.
28. Strong WB, Malina RM, Blimkie CJR, Daniels SR, Dishman RK, Gutin B, *et al*. Evidence based physical activity for school-age youth. J Pediatr 2005;146:732-7.
29. Al-Sobayel H, Al-Hazzaa HM, Abahussain NA, Qahwaji DM, Musaiger AO. Gender differences in leisure-time versus non-leisure-time physical activity among Saudi adolescents. Ann Agric Environ Med 2015;22:344-8.
30. Poulsen PH, Biering K, Andersen JH. The association between leisure time physical activity in adolescence and poor mental health in early adulthood: A prospective cohort study. BMC Public Health 2015;16:3.
31. Rangul V, Holmen TL, Bauman A, Bratberg GH, Kurtze N, Midthjell K. Factors predicting changes in physical activity through adolescence: The Young-HUNT Study, Norway. J Adolesc Health 2011;48:616-24.
32. Eyam Eberechukwu L. Types of obesity and its effect on blood pressure of secondary school students in rural and urban areas of cross river state, Nigeria. IOSR J Pharm 2013;3:60-6.
33. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of hypertension in children and adolescents. JAMA 2007;298:874-9.
34. Lurbe E, Agabiti-Rosei E, Cruickshank JK, Dominiczak A, Erdine S, Hirth A, *et al*. European society of hypertension guidelines for the management of high blood pressure in children and adolescents. J Hypertens 2016;34:1887-920.
35. Ewald DR, Haldeman LA. Risk factors in adolescent hypertension. Glob Pediatr Health 2016;3:1-26.
36. Pan Y, Pratt CA. Metabolic syndrome and its association with diet and physical activity in US adolescents. J Am Diet Assoc 2008;108:276-86.