



Relationship between Habitual Physical Activities and Hypertension in Bengali Male Adolescents

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Background: High blood pressure during childhood and adolescence increases the risk of hypertension (HTN) in adulthood. Physical activity (PA) is considered as key component for the prevention and treatment of HTN. Thus the aim of our study was to assess the relation between habitual physical activity and prevalence of HTN among male adolescents.

Methods: The present cross sectional school-based study was conducted among male students aged 12-18 years. Height, weight and blood pressure were recorded. Information on the frequency and duration of habitual PA and sedentary activities in 24 hours was obtained from self-administered questionnaire. Total activity score were calculated by weighing the activity level. Results are described as mean values \pm standard deviations. Habitual PA and prevalence of HTN were evaluated using bivariate logistic regression analysis. The significance level of the tests were considered at a level of 0.05.

Results: Duration of cycling, total duration of moderate activities and 24 hour total activity score was significantly higher whereas duration of very light activity and sleeping significantly lower in hypertensive group than non-hypertensive counter-part. SBP significantly positively correlated with

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duration of cycling, total duration of moderate activities and very light activities and negatively correlated with duration of sleep and other moderate activities except cycling. On the other hand DBP was significantly and negatively correlated with sleeping duration. Very light activities and daily sleeping duration more than 10 hours caused an increase of the prevalence of HTN. Daily 1-2 hour moderate PA reduces but long duration increases the prevalence of HTN.

Conclusion: Regular habitual PA with moderate duration, restriction of very light activities and optimum sleep should be practiced in everyday life to avoid increased BP level.

Keywords: Hypertension; physical activity; sleep; cycling; mobile phone; TV watching.

1. INTRODUCTION

High blood pressure or hypertension (HTN) is a commonest non communicable disease. It is a silent threat to the health of people all over the world. In children and adolescent HTN is an emerging public health issue. It is asymptomatic in children and adolescence hence remain undiagnosed. Untreated HTN in adolescents persists into adulthood. There is strong evidence of tracking of high BP from childhood to adulthood [1,2]. Thus early detection and intervention for HBP among children and adolescents are gaining importance in recent years.

Physical activity is now considered as polypill because of its preventive and therapeutic effects in slowing cardiovascular aging and lowering global burden of cardiovascular disease [3,4]. Based on this evidence experts in the USA and Canada recommended that children and adolescents reduce their cardiovascular risk by limiting sedentary activities and engaging in moderate to vigorous activity. Physical inactivity is strongly positively associated HTN and increase physical activity is effective in the treatment of high blood pressure [5,6]. Moderate to vigorous intensity physical activity associated with lower incidence of HTN among white men [7]. Interventional studies have demonstrated that physical activity protects against high blood pressure in adults [8]. Mixed findings were obtained in relationship between physical activity and blood pressure in youth [9,10]. Yet a large cross-sectional study demonstrated an inverse relationship between daily engagement in physical activity and odds of being hypertensive in youth ages 8 – 17 [11]. Physical activity may play an important role in prevention of HTN, however the dose response relation between physical activity and risk of HTN in adolescent's age group is debatable [12]. In spite of clinical significance of high blood pressure in adolescent relationship between physical activity and prevalence of HTN have not been studied in

Bengali adolescent. Thus the purpose of the present cross-sectional study was to assess the relationship between habitual physical activity and risk of HTN.

2. MATERIALS AND METHODS

2.1 Study Population

The present study was conducted among adolescent school students having standard class VI to class XII aged 12-18 years from five schools in West Bengal, India during their school hours. The prior written permission of school authority was taken. Written consent from the parents of students experimented in the study was obtained. 665 male students were included in this study. Students having age less than 12 years or more than 18 years, Sex other than male, those who were taking regular drugs or hormonal therapy and suffering from chronic disorders including diabetes mellitus, clinically established hypertension, liver cirrhosis and kidney disease were excluded from the study.

2.2 Questionnaire

A self-administered questionnaire having questions related to their age, different life style, daily activities with duration, sleeping duration and family history readings diabetes, kidney disease, congenital heart defect, myocardial infarction and/or stroke.

2.3 Measurement of Blood Pressure

Blood pressure was measured using digital oscillometric blood pressure monitor (Omran). Before recording the blood pressure students were allowed to wait for 10 minutes in a sitting positions to relieve their restlessness and anxiety [13]. Each student was then called one by one and pressure was measured in the sitting posture in the right upper arm. The cuff size was based on circumference of the upper arm of participants [14]. Two readings were taken at 2 minute

intervals and their mean was taken as subject's blood pressure. In the case when the differences of two readings were above 5mmHg a third reading was taken. The final reading would be based on the average of all readings taken. Normotensive, elevated blood pressure and hypertension was defined on the basis of American Academy of Paediatrics Guideline- [15]. In adolescent aged 12 years systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) $\geq 90^{\text{th}}$ percentile but $< 95^{\text{th}}$ percentile or 120/80 (whichever is lower) is considered as elevated blood pressure and SBP and/or DBP $\geq 95^{\text{th}}$ percentile plus 12 mm Hg or 130/80 (whichever is lower) as hypertension. In adolescent 13 years and older SBP and/or DBP 120/ <80 to 129/ <80 is considered as elevated blood pressure and 130/80 or above as hypertension.

2.4 Anthropometric Measurements

Prior to the weight and height measurement subjects were asked to remove their shoes and heavy clothing. Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a flat surface and adjusted with '0' mark. Now the subject was requested to step on it in bare feet. Weight was recorded to the nearest 0.5kg.

For the measurement of height subjects were asked to stand still and quiet and erect position, hanging their arms freely and keeping their head aligned in the Frankfort plane. The measurements were recorded to the nearest 0.1 cm for each subject using anthropometric rod [16]. BMI was calculated from the height and weight using following equation: $\text{BMI (kg/m}^2\text{)} = \text{weight (kg)} / \text{height}^2 \text{ (m)}$.

2.5 Physical Activity Assessment

Information on the frequency and duration of PA (cycling, Playing outdoor games, walking), time spent in very light activities (watching TV programs, using mobile phone for communication, whatsapp chatting, playing online games and listening songs), time spent in light activities (study related activity and regular personal activities) and time spent in sleeping was retrieved from study questionnaire. Total activity score were calculated by weighing the activity level in the following manner. Time spent in sleeping and in the very light activity categories was multiplied by factor 1, light activity

by factor 2, moderate activity by three and heavy activity by factor four [17]. Physical activity score for all total activity was calculated by summation of these scores.

2.6 Statistical Analysis

Results are described as mean values \pm standard deviations (SD). Pearson's correlation coefficient was used to determine the relationship between blood pressure with duration of habitual activities and total daily physical activity score. Numerical data were compared using independent samples of t-test. The prevalence of HTN was presented as frequency and percentage. Habitual physical activity and prevalence of HTN were evaluated using bivariate logistic regression analysis. Statistical significance was determined at p value <0.05 .

3. RESULTS

Age wise blood pressure level and BMI of study population was given in Table 1. In our previous study we reported that Both SBP and DBP significantly positively correlated with BMI.

Among study population 17.29% are hypertensive, 10.22% are pre-hypertensive and rest are normotensive. On the basis of age maximum percentage of hypertensive was noted in 18 years age group and minimum in 14 years age group (Table 2).

Habitual activities of study population categorized into following type:

1. Moderate activity (cycling)
2. Other moderate activities (outdoor games and sports and walking)
3. Very light activities (watching TV programs, using mobile phone for communication, whatsapp chatting, playing online games and listening songs)
4. Light activities (study related activity and regular personal activities)
5. Sleeping

Correlation between habitual activities and BP level of hypertensive and non-hypertensive group of adolescents was represented in Table 3. For hypertensive and non-hypertensive adolescents significant positive correlation was noted between SBP and daily time spent in cycling and average daily time spent in very light activities and negative correlation with daily time spent in

other moderate activities and sleeping. In DBP significant negative correlation was noted with sleeping duration of hypertensive and non-hypertensive adolescents. Only in non-hypertensive group DBP had significant negative correlation with daily time spent in cycling and positive correlation with time spent in very light activities like mobile phone use. Daily total

activity score significantly correlated with SBP of hypertensive adolescents.

Comparison of habitual activities between hypertensive and non-hypertensive group was given in Table 4. All type of activities differ significantly between these two groups except moderate activities.

Table 1. Characteristics of the study sample

Age (year)	n	SBP (mm Hg)	DBP (mm Hg)	BMI (kg/m ²)
12	82	105.12 ± 12.88	73.78 ± 12.61	16.69 ± 3.82
13	82	102.74 ± 12.02	69.04 ± 11.74	16.81 ± 3.67
14	152	108.31 ± 14.60	68.99 ± 10.42	18.84 ± 4.58
15	98	115.78 ± 12.25	73.05 ± 6.48	19.14 ± 4.15
16	84	117.31 ± 14.47	71.93 ± 10.96	20.14 ± 4.27
17	58	117.29 ± 12.31	74.63 ± 11.07	19.98 ± 3.73
18	109	124.50 ± 15.26	76.98 ± 10.18	21.80 ± 4.04

Table 2. Blood pressure status of study population

Age (year)	No	Normotensive	Pre-hypertensive	Hypertensive
12	82	63	8	11 (13.41)
13	82	67	4	11 (13.41)
14	152	130	5	17 (11.18)
15	98	72	9	17 (17.35)
16	84	55	13	16 (19.05)
17	58	36	10	12 (20.69)
18	109	59	19	31 (28.44)
Total	665	482 (72.48)	68 (10.23)	115(17.29)

*Data in parentheses indicate percentage

Table 3. Correlation of blood pressure with habitual physical activity

Parameters	Non-hypertensive group		Hypertensive	
	SBP	DBP	SBP	DBP
Cycling	0.151***	(-)0.115*	0.213***	(-)0.031 ^{ns}
Other moderate activity	(-)0.155***	0.012 ^{ns}	(-) 0.088*	(-)0.055 ^{ns}
Cycling & other physical activity	0.058 ^{ns}	0.005 ^{ns}	0.098*	(-)0.053 ^{ns}
TV and mobile phone use	0.190***	0.132***	0.154***	0.053 ^{ns}
Sleeping	(-)0.177***	(-)0.124*	(-)0.147 ***	(-)0.139***
Daily activity level	0.001 ^{ns}	0.006 ^{ns}	0.102*	0.054 ^{ns}

*** p<0.001; **P<0.01; *p<0.05; ns= insignificant

Table 4. Comparison of blood pressure and habitual activities of non-hypertensive and hypertensive group

Parameter	Non-hypertensive	Hypertensive	p
N	550	115	
SBP (mm Hg)	108.46 ± 13.91	131.67 ± 15.81	<0.001*
DBP (mm Hg)	68.92 ± 7.71	88.73 ± 12.22	<0.001*
Cycling (hour/day)	1.428 ± 1.375	1.678 ± 1.304	<0.001*
Other moderate activity (hour/day)	1.342 ± 1.226	1.296 ± 1.117	>0.05**
Cycling & other moderate activity(hour/day)	2.771 ± 1.818	2.975 ± 1.827	<0.01*
TV and mobile phone use(hour/day)	2.545 ± 1.812	3.000 ± 2.020	<0.001*
Sleeping(hour/day)	8.040 ± 1.403	7.41 ± 1.70	<0.001*
Daily activity level(hour/day)	41.257 ± 3.308	42.114 ± 3.639	<0.02*

*Statistically significant, ** insignificant

Bivariate analysis was done to evaluate habitual physical activity factors and prevalence of HTN. Risk of HTN was significantly lower in adolescents those spent up to 1 hour daily for cycling in respect to cycle non-users. However cycling more than 2 hour daily increases risk of HTN.

Daily moderate activity like walking, running and involve in outdoor games decreases risk of HTN than non-active adolescent. Minimum risk was noted in adolescents those involve in moderate activity 1-2 hour daily. Least risk of HTN was observed in adolescent those spent 1-2 hours for combine activity of cycling and other moderate activities.

Very light activity like TV programs watching, mobile phone use etc. affects blood pressure level adolescents. Prevalence of HTN increases with increasing daily time spent in such very light activities in compare to those do not spent time for such activity (Table 6) as odd ratio increases with increasing very light activities.

Sleeping duration has correlation with systolic and diastolic blood pressure. About 50% of study population spent 8 to 10 hour daily for sleeping. Prevalence of HTN was noted in adolescent spent less than 8 hour/day or more than 10 hour/day (Table 7) as odd ratio was significant in both the cases. Thus inadequate or excessive sleeping increase the prevalence of HTN.

Results of bivariate analysis for Total daily physical activity score and incidence of HTN was represented in Table 8. Considering lowest score as reference risk decreases with increasing activity score. However, very high physical activity score increases risk of HTN.

4. DISCUSSION

Cardiovascular disease is a progressive disease begin early in life [18,19]. HTN is most important contributing agent to the cardiovascular disease-induced morbidity and mortality. Elevated blood pressure in childhood increases the risk of HTN in adulthood [20]. In our previous study we reported that Both SBP and DBP were significantly positively correlated with BMI [21]. In our present study Both SBP and DBP were significantly higher in hypertensive group in respect to non-hypertensive counterpart. Significantly higher BMI in hypertensive group may be a factor of higher SBP and DBP. The

relationship between blood pressure and physical activity in adults is well established but in children and adolescents such relationship is inconsistent. Thakor et al. [22] found that outdoor playing significantly correlated with SBP of adolescent boys aged 10-13 years. Klesges et al (1990) found no consistent relationship between blood pressure and various childhood activities [23]. Thus present study was undertaken to find out the impact of habitual physical activity on prevalence of HTN.

Time spent in moderate physical activities like outdoor playing and walking etc. and cycling significant positively correlated with SBP of hypertensive and non-hypertensive group of adolescents. Risk of HTN was significantly lower in adolescents those spent up to 1 hour daily for cycling in respect to cycle non-users. However cycling more than 2 hour daily increases risk of HTN. Daily moderate activity like outdoor playing, walking and running decreases risk of HTN than non-active adolescent. Minimum risk was noted in adolescents those involve in moderate activity 1-2 hour daily. Least risk of HTN was observed in adolescent those spent 1-2 hours for combine activity of cycling and other moderate activities. Thus relative to no physical activity, moderate activity 1-2 hour daily significantly decreases odd ratio as well as prevalence of HTN. Like moderate activity daily total activity score has inverse relation with the risk of HTN up to a certain level. Moderate activity above 2 hour daily and daily total physical activity score above 46 increase risk of HTN. Thus volume of activity may be consider as important determinant of blood pressure level. Our observations coincides with previous observation of Leary et al. [12]. In our study, subjects who self-reported engaging moderate physical activity were less likely to be hypertensive. This results supports previous observation [24].

Very light activity like TV programs watching, mobile phone use etc has significant impact on blood pressure level. Risk of HTN increases with increasing time spent in such light activities. Sleeping duration has significant correlation with BP level. Odd ratio was more among adolescent suffer in sleep deprivation (sleeping duration below 8 hour/day) or spent daily above 10 hour in sleeping. According to previous report regular physical activity and restriction of sedentary activities are important measure for prevention of HTN among children and adolescents [9]. From this study we concluded that regular moderate physical activity, restriction of very light activities

Table 5. Bivariate analysis of association between cycling and other moderate activities with incidence of hypertension

Activity	Duration	Odds ratio	95% CI	p
Cycling (minute/day)	0	1	-----	Ref
	1 to 60	0.502	0.286 to 0.882	0.0166*
	61 to 120	0.600	0.314 to 1.482	0.1230
	Above 120	0.793	0.424 to 1.482	0.4668
Other moderate activities (minute/day)	0	1	-----	Ref
	1 to 60	0.507	0.298 to 0.861	0.0120*
	61 to 120	0.493	0.273 to 0.890	0.0189*
Cycling & other moderate activities (minute/day)	0	1	-----	Ref
	1 to 60	0.392	0.196 to 0.787	0.0084*
	61 to 120	0.401	0.204 to 0.790	0.0082*
	121 to 180	0.568	0.309 to 1.045	0.0690
	181 to 240	0.894	0.443 to 1.805	0.7551

* statistically significant

Table 6. Bivariate analysis of association between times spent in very light activities and incidence of hypertension

Daily time spent in very light activities	Odds Ratio	95% CI	p
0	1	-----	Ref
Up to 2 hour	2.118	1.042 to 4.302	0.0380*
2 to 4 hour	2.276	1.029 to 5.037	0.0404*
Above 4 hour	2.485	1.114 to 5.544	0.0262*

* Statistically significant

Table 7. Bivariate analysis of association between sleeping duration and incidence of hypertension

Daily sleeping duration	Odds Ratio	95% CI	p
8-10 hour	1	-----	Ref
Below 8 hour	1.600	1.023 to 2.499	0.0395*
Above 10 hour	2.839	1.590 to 5.071	0.0004*

* Statistically significant

Table 8. Bivariate analysis of association between total daily activity and incidence of hypertension

Total activity score	Odds Ratio	95% CI	p
37 to 40.0	1	-----	Ref
40.1 to 43.0	0.589	0.356 to 0.974	0.0391*
43.1 to 46.0	0.550	0.304 to 0.993	0.0479*
Above 46.0	1.584	0.867 to 2.895	0.1346

*indicate statistically significant

and adequate sleep are important practice to prevent hypertension.

5. CONCLUSION

On the basis of our finding, we concluded that regular moderate physical activity (such as cycling, walking, outdoor games and sports etc.),

decreasing very light activities (such as watching TV programs, using mobile phone for communication, whatsapp chatting, playing online games and listening songs) and adequate sleep (8-10 hour/day) are important practice to prevent hypertension. Physical activity with long duration was associated with higher prevalence of HTN. Thus Physical activity should be

practiced at a moderate duration (1-2 hour) in everyday life to prevent development of blood pressure in the hypertensive range.

CONSENT AND ETHICAL APPROVAL

The study was non-invasive. The prior written permission of the Institutional authority was taken. The written informed consent was obtained from the study participants and their parent after the purpose of the study was explained. Participants were informed that the data obtained from them would be kept confidential.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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