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Original Article

Magnitude and Correlates of Elevated Blood Pressure among Adolescent School Students Aged 15-19 Years in a Block of Murshidabad, West Bengal, India

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Abstract

Background: The prevalence of adolescent hypertension is on the rise due to multiplicity of certain risk factors, like obesity, unhealthy dietary behaviour, physical inactivity, tobacco use, alcohol addiction, and academic stress. The present study aimed to estimate the prevalence of elevated blood pressure and hypertension among adolescent school children and identify the factors influencing it.
Methods: The present observational, cross-sectional study was conducted in two higher secondary schools in a block of Murshidabad district, West Bengal, from February to April 2021. The subjects included 15 to 19-year-old school students. Multistage random sampling method was used for selecting a sample size of 183 adolescent school children. Data were obtained by interviewing the study participants, measurement of blood pressure and anthropometric measurements. Chi-squared test and binary logistic regression were used for bivariate and Multivariable data analysis, respectively, with P<0.05 as the level of significance.
Results: The mean of Systolic Blood Pressure and Diastolic Blood Pressure were 115.02+10.853 and 71.52+8.484 mm of Hg, respectively. The overall prevalence of elevated blood pressure and adolescent hypertension was 21.3% (95% CI 15.4-27.2). The prevalence was significantly higher among those with paternal education of above middle school (AOR=1.803, P=0.011), high socioeconomic status (AOR=3.16, P=0.02), and high Body Mass Index for their age (AOR=11.474, P<0.0001). Smart phone use (P=0.03) and family history of hypertension (P=0.029) were also found to significantly influence elevated blood pressure among the subjects in bivariate analysis.
Conclusions: Measurement of blood pressure, as a part of school health programme, should be given priority with emphasis on physical activity at school, health promotion to avoid unhealthy diet, and restricted smart phone use.

Keywords: Adolescent, Blood pressure, Correlates, Prevalence, School health

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1. Introduction

Hypertension or elevated blood pressure, being a major risk factor for cardiovascular diseases (CVD), accounts for 54% of strokes, 47% of ischemic heart disease (IHD), and 13.5% of deaths annually worldwide (1, 2). In 2002, Word Health Organization (WHO) declared that cardiovascular diseases would be the leading cause of death and disability in India by 2020 (3).

Adolescent hypertension is now a matter of public health concern. Tracking of blood pressure revealed that prehypertension among adolescents is strongly linked to the development of hypertension in their later lives. The prevalence of adolescent hypertension is on the rise due to multiplicity of certain risk factors, like obesity, unhealthy dietary behaviour, physical inactivity, tobacco use, alcohol addiction, and academic stress (4). The magnitude of adolescent hypertension in Indian studies ranged from 15.5%-24% (5-7). A systematic review conducted by Daniel and colleagues reported a pooled prevalence of 7.6% among Indian adolescents (8). The prevalence of adolescent hypertension was found to be 12.1% among rural school-going adolescents in West Bengal (9).

National Family Health Survey (NFHS) revealed that 4% of girls and 5% of boys were overweight in the age group of 15–19 years while 18.5% of them reported different forms of tobacco use. Moreover, 47% of late adolescents consumed fried food while 25.5% and 36% of boys and girls had intake of aerated drinks respectively (10). Since the silent nature of the disease hinders its early detection, identification of the correlates of adolescent hypertension is pivotal for its prevention.

In the face of an epidemiological transition, adoption of unhealthy lifestyle by adolescents is adding further to the global burden of noncommunicable diseases. The transition in lifestyle is pervasive across all socioeconomic strata. Certain behavioural risk factors, like addiction and some lifestyle-associated factors beginning in early adolescence, become conspicuous in late adolescence (11). Review of literature on adolescent hypertension revealed an urban skewness of studies in West Bengal with studies in rural settings being scant (12-14). There is scarce literature pertaining to hypertension in late adolescence in Murshidabad district of West Bengal. Against this backdrop, the present study aimed to estimate the prevalence of elevated blood pressure and hypertension among the adolescent students aged 15-19 years attending rural higher secondary schools in a block of Murshidabad district of West Bengal, India. This research also aimed to identify the factors influencing the disease among the study subjects.

2. Methods

The present observational, cross-sectional study was conducted in two higher secondary schools in a Block of Murshidabad district, West Bengal, from February to April 2021. The study population comprised late school-going adolescents aged 15 to 19 years. History taking and record review were undertaken to exclude secondary causes of hypertension prior to selection of the study subjects. However, none of them were found to be the same.

2.1. Sample Size

The sample size was calculated using the formula $z^{2}_{1-\alpha/2}$. p (1-p)/l^2. Considering the proportion (p) of adolescent hypertension as 12.6% from a study conducted in rural Bankura, located in West Bengal, India, as similar studies were not available from Murshidabad district (9), an error level (l) of 7%, the value of z as 1.96 at 95% confidence interval and design effect of 2, the sample size was estimated to be 174. The ultimate sample size was calculated as 183, considering a nonresponse rate of 5%.

2.2. Sampling Technique

A multistage sampling technique was adopted. From the list of blocks in Murshidabad district, one was selected randomly, and one Primary Health Centre was selected randomly from the block. Out of four higher secondary schools in that area, two were randomly selected. The number of students in the two schools were almost similar; therefore, an equal number of participants was considered from each school. The majority of the students in the age range of 15-19 years were recruited from classes IX to XII. However, since students' strength varied from classes IX to XII on account of school dropouts during the COVID-19 pandemic, the sample size was achieved by obtaining the desired number of subjects from each class according to probability proportional to size (PPS) sampling.

2.3. Study Variables

Study variables were sociodemographic variables including age, sex, religion, parents' occupation, parents' education, socioeconomic status and type of family. Additionally, lifestyle variables included types and duration of physical activity, Body Mass Index (BMI), dietary factors like consumption of fruits, vegetables, and junk food, family history of hypertension, addiction to tobacco and alcohol, sleeping hours, and use of smart phone. The outcome variable was blood pressure status of the school children.

2.4. Tools and Technique

Data were collected using a predesigned and pretested schedule. Aneroid sphygmomanometer with variable cuff sizes (22 to 26-cm and 25 to 35-cm arm circumference for thin to normal and obese subjects, respectively) (Rossmax GB101) was used to measure Blood Pressure. Height and weight were measured by bathroom weighing scale and measuring tape respectively; school and students' records and documents served as sources of information. The study techniques helped us to interview the study participants and measure their blood pressure and anthropometric characteristics.

The proposal was authorized by Institutional Ethics Committee (IEC MSD/MCH/PR/204/2020 dt 5.2.2020). Informed consent (assent) was sought from the study participants prior to the study. Written informed consent was also obtained from the parents of adolescents below 18 years.

Data regarding dietary intake was collected using a food frequency questionnaire. Family income was obtained from the school register. The weight was measured using bathroom weighing scale with a precision of 500 gm, and height using non-stretchable tape with a precision of 0.1 cm using standard techniques. Blood pressure was measured by the auscultatory method using an Aneroid sphygmomanometer and the average of two measurements was considered. The blood pressure instrument was standardized against a mercury sphygmomanometer. The same instruments were maintained throughout the study period.

2.5. Operational Definitions

Blood pressure status was measured according to the 2017 American Academy of Pediatrics' guidelines for adolescents up to 18 years (15).

For individuals at the age of 18 and above, Joint National Commission 8 guidelines were adhered for assessment of blood pressure status (16).

Socioeconomic status was assessed according to updated Modified B.G. Prasad Scale 2020 (17). Regarding physical activity, at least 60 minutes of moderate- to vigorous-intensity physical activity daily was considered adequately (18).

For nutritional status, BMI-for-age 5-19 years boys and girls of WHO was utilised. z score within –2SD and +1 SD was considered as *Normal range*, –2SD to –3SD as *Thinness* and <–3SD as *Severe thinness* whereas >1SD and >2SD were considered as *overweight and obesity,* respectively (19).

Fruit and vegetable intake were taken by 24 hours recall. Accordingly, junk food intake was considered *Occasional* when a subject consumed any junk food item <3days a week and *Frequent* when the same was taken >3days in the last week. Sweet intake was considered *Daily, Sometimes, or Never* respectively when the subject consumed sweets on all the 7 days, <3 days or none of the days in the last week.

Sleep was considered adequate when a subject reported more than or equal to 8 hours of sleep daily on a usual day while <8 hours of sleep was considered inadequate.

2.6. Data Analysis

Data were analysed in SPSS version 20.0 and described using means, standard deviation, and simple proportions. Inferential statistics comprised Chi-squared test, Kruskal Wallis ANOVA and multivariable regression. The significant variables in bivariate analysis were entered in binary logistic regression analysis and Adjusted Odds Ratio (AOR) was obtained using ENTER method. Hosmer-Lemeshow test was done to examine the goodness of fit of the model. P<0.05 was considered as the level of significance. 95% confidence interval and odds ratio were also estimated.

3. Results

The study was conducted among 183 late adolescent school goers within the age ranges of 15-19 years. Those who were acutely ill or having secondary causes were supposed to be excluded from the study. However, acutely ill students were not allowed in school at the time of the study, given the ongoing COVID 19 pandemic. Out of 183 study participants, the majority were in the age range of 15-17 years (79.8%). Furthermore, female subjects marginally outnumbered male ones (52.5% and 47.5%). The study participants reported that most of the parents had completed education up to middle school. They also claimed that most of their mothers had completed middle school (45.9%), and more than half of the fathers were unskilled labourers (58.5%) while the majority of the mothers were homemakers (96%). More than half (53%) of the study participants belonged to lower socioeconomic (Class IV and Class V) status.

Figure 1 reveals that 79% of the study participants had normal blood pressure, followed by 11%, 6%,

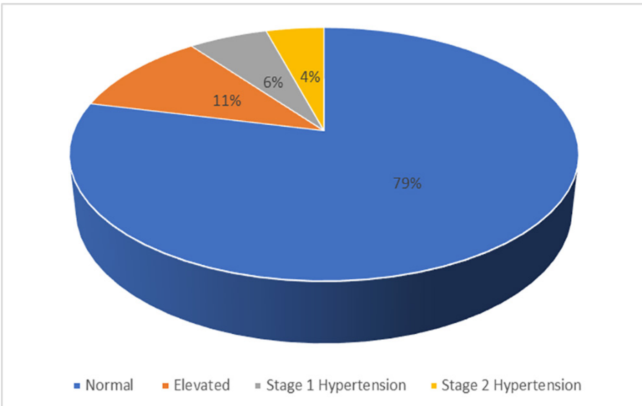

Figure 1: The figure shows the distribution of the study subjects according to blood pressure status.

and 4% who had elevated blood pressure, stage I, and stage II hypertension, respectively.

Table 1 shows that the mean of Systolic Blood Pressure and Diastolic Blood Pressure were respectively 115.02+10.853 and 71.52+8.484 mm of Hg. The mean of Systolic Blood Pressure gradually increased from the age of 15 to 19 whereas the mean Diastolic Blood Pressure was noted to be higher in 18 and 19 years. However, this difference was not found to be statistically significant (P=0.83 for Systolic Blood Pressure and P=0.05 for Diastolic Blood Pressure.).

Table 2 depicts the bivariate analysis of blood pressure status with pertinent sociodemographic and lifestyle variables. As seen, higher blood pressure status was significantly and positively correlated with paternal education of above middle school (P=0.001), higher socioeconomic class (P=0.001), BMI status of overweight or obesity, (P<0.0001) positive family history of hypertension (P=0.03), and use of smart phone (P=0.029).

Table 1: Mean of Systolic Blood Pressure and Diastolic Blood Pressure across different ages

Age (in years)	Mean of S.B.P (mm of Hg)	Range (mm of Hg)	Mean of D.B.P (mm of Hg)	Range (mm of Hg)
15	114.6±11.54	90-180	71.2±7.13	50-94
16	112.5±8.61	90-140	70.02±7.96	46-92
17	116.4±10.9	100-146	70.76±9.17	50-93
18	117.23±12.15	90-137	74.00±10.04	60-94
19	119.93±9.83	108-135	77.53±7.98	70-93
Overall	115.02±10.853	90-180	71.52±8.484	46-94

S.B.P: Systolic Blood Pressure, D.B.P: Diastolic Blood Pressure

Table 2: Bivariate analysis of pertinent variables with blood pressure status

Variable	Category	Blood pressure status		OR (95%CI)	P
		Normal No. %	Elevated B.P./ hypertension No. %		
Age (in years)	15-17 (n=146)	119 (81.5)	27 (18.5)	1 (Ref)	P=0.064
	>=18 (n=37)	25 (67.6)	12 (32.4)	2.11 (0.94-2.73)	
Gender	Male (n=87)	64 (73.6)	23 (26.4)	1 (Ref)	P=0.107
	Female (n=96)	80 (83.3)	16 (16.7)	1.21 (0.57-2.54)	
Education of father	Up to middle school (n=120)	103 (85.8)	17 (14.2)	1 (Ref)	P=0.001
	Above Middle school (n=63)	41 (65.1)	22 (34.9)	3.25 (1.56-6.74)	
Education of mother	Up to middle school (n=135)	110 (81.5)	25 (18.5)	1 (Ref)	P=0.128
	Above Middle school (n=48)	34 (70.8)	14 (29.2)	1.81 (0.84-3.86)	
Socio economic class	High (Class 1and 2) (n=33)	19 (57.6)	14 (42.4)	1 (Ref)	P=0.001
	Middle (n=53)	49 (92.5)	4 (7.5)	0.11 (0.03-0.37)	
	Low (Class 4& 5) (n=97)	76 (78.4)	21 (21.6)	0.35 (0.16-0.87)	
BMI status	Normal and underweight (n=164)	139 (84.8)	25 (15.2)	1 (Ref)	P<0.001
	Overweight and obesity (n=19)	5 (26.3)	14 (73.7)	15.5 (5.14-47.07)	
Physical activity status	Adequate (n=139)	114 (82.0)	25 (18.0)	1 (Ref)	P=0.051
	No/Inadequate (n=44)	30 (68.2)	14 (31.8)	2.12 (0.98-4.58)	
Intake of fruits in last 24hours	Yes (n=118)	98 (83.1)	20 (16.9)	1 (Ref)	P=0.052
	No (n=65)	46 (70.8)	19 (29.2)	1.91 (0.92-3.97)	
Intake of calorie dense food in the last week	Occasional (<3days a week) (n=52)	45 (86.5)	7 (13.5)	1 (Ref)	P=0.102
	Frequent (>3days a week) (n=131)	99 (75.6)	32 (24.4)	2.07 (0.85-3.84)	
Hours of sleep	Inadequate (<8hours) (n=74)	56 (75.7)	18 (24.3)	1 (Ref)	P=0.412
	Adequate (>=8hours) (n=109)	88 (80.7)	21 (19.3)	1.26 (0.62-2.56)	
Family history of Hypertension	Present (n=50)	34 (68.0)	16 (32.0)	2.25 (1.06-4.74)	P=0.030
	Absent (n=133)	110 (82.7)	23 (17.3)	1 (Ref)	
Smart phone use	Yes (n=58)	40 (69.0)	18 (31.0)	2.22 (1.07-4.61)	P=0.029
	No (n=125)	104 (83.2)	21 (16.8)	1 (Ref)	
Total		144 (78.7)	39 (21.3)	183 (100)	

BMI: Body Mass Index

Table 3: Multivariable regression of variables associated with elevated blood pressure and hypertension among adolescents

Variables	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	P
Education of father above middle school	1.803	1.143-2.844	0.011
Higher socioeconomic classes	3.160	1.184-8.436	0.02
Family history of hypertension	1.819	1.328-2.916	0.137
BMI status	11.474	4.34-49.8	<0.0001
Not using smart phones	0.819	0.320-2.098	0.678

BMI: Body Mass Index

Table 3 represents that paternal education of above middle school with Adjusted Odds Ratio (AOR) of 1.803 (1.143-2.844, P=0.011), higher socioeconomic status with AOR of 3.160 (1.184-8.436, P=0.022), and high BMI with AOR of 11.474 (95% CI 4.34-49.8, P<0.0001) were the important correlates of elevated blood pressure or hypertension among late adolescents, with the latter being the major correlate.

4. Discussion

Adolescent hypertension is a growing concern across the globe and India is no exception in the face of an epidemiological transition. Our study revealed a high prevalence of elevated blood pressure among the late adolescent rural school goers, which was chiefly influenced by high BMI. Adolescent hypertension is on the rise in tandem with the epidemics of sedentary lifestyle and obesity (20). The prevalence of elevated blood pressure and hypertension among late adolescents was much higher than that reported in studies contemplated in rural India and West Bengal (8, 9, 21-29). The closure of schools in the pandemic, leading to sedentary lifestyle and stress, might have attributed to this high prevalence of elevated blood pressure among the study subjects. However, the observed prevalence is close to the magnitude of hypertension shown by Maiti and Bandyopadhyay among urban adolescents of West Bengal (12) and Kumar and co-workers in Patna in the age group≥15 years (5). The magnitude of elevated blood pressure (11.6%) in the present study was congruent to similar studies conducted in rural setting by Kumar and colleagues in Patna (5), Ravi and Vineetha in Kerala (27) and Kumar and colleagues in Wardha, India (28). Furthermore, the prevalence of adolescent hypertension in the present study (10.7%) was much higher compared to that of other studies conducted in rural India and West Bengal. The different classifications used for assessing blood pressure status and hypertension among adolescents might have contributed to the varying magnitude.

The mean of Systolic Blood Pressure and Diastolic Blood Pressure noted in this study were 115.02+10.853 and 71.52+8.484 mm of Hg, respectively, higher than those observed in rural Wardha, located in Maharashtra, India, (27) among school-going children aged 5-15 years and 11-17 years, respectively. The present study was undertaken among late adolescents only while the aforementioned papers considered lower age groups. The study also revealed that the Systolic and Diastolic Blood Pressure increased from 15 to 19 years. Nag and colleagues (14), in their study among urban adolescents aged 13 to 17 years, also reported a rise in blood pressure from 13 to 17 years among boys, but not among girls. The difference in study settings, study population, and methods of measurement used might have accounted for this difference in the magnitude and mean blood pressure.

High blood pressure in childhood and adolescence is positively correlated with elevated blood pressure in adulthood. It is a known fact that hypertension enhances the risk of cardiovascular diseases (CVD), renal diseases, and cerebrovascular accidents. Primary hypertension during early years of life is associated with the major risk factors for CVD, like dyslipidaemia, hyperglycaemia, and insulin resistance. These risk factors are triggered by a number of lifestyle factors, such as physical inactivity, raised BMI, unhealthy dietary pattern, and addiction to tobacco. They become vulnerable to end organ damage from hypertension, which can culminate into significant morbidity and premature mortality (30).

In our study, the prevalence of elevated blood pressure was higher in older age groups of 18-19 years compared to their younger (15-17) counterparts and also among males as compared to females The positive correlation of hypertension with age was also reported by Anand and co-workers (22), and RoyChoudhury and colleagues (29).The male preponderance among adolescents is in consonance with the findings of several studies and is attributed to the rising levels of male hormones during the pubertal spurt (5, 23, 25, 29). The current study also revealed the significant association of elevated blood pressure among adolescents with occurrence of hypertension among first-degree relatives, as reported by several studies (28, 29). This is in parlance with common knowledge of genetic predisposition of hypertension. These nonmodifiable risk factors of elevated blood pressure limit the role of primordial and primary prevention, and thus underscore the importance of screening for hypertension among adolescents.

The current study found that the prevalence of elevated blood pressure and hypertension varied significantly with higher levels of paternal education compared to their lower levels. Scant literature is available pertaining to this association in India. Higher paternal education might relate to higher income, with an influence on lifestyle resulting elevation of blood pressure. The prevalence was significantly greater among subjects who belonged to higher socioeconomic strata compared to those from lower and middle classes, which was in line with the findings of RoyChoudhury and colleagues (29). Mohan and co-workers reported that the risk of obesity was 36 times greater among those belonging to higher socioeconomic strata, indicating the latter as an important predisposition for hypertension (24). However, MadhavikuttyAmma and colleagues in rural Kerala (31) and Kaczmarek and co-workers among Polish adolescents (32) reported an inverse relationship with socioeconomic conditions and high blood pressure. Inadequate income is linked to lower levels of education leading to poor health literacy, for which adoption of unhealthy lifestyle might be a possible explanation. This also indicates that the epidemic of non- communicable diseases is pervasive across all socioeconomic strata.

The present study revealed a higher prevalence of elevated blood pressure among those with inadequate physical activity; sedentary lifestyle predisposes to obesity and hypertension. Studies conducted in India and the world have consistently reported a very strong link between blood pressure and obesity. Obese adolescents run thrice the risk of development of hypertension than their nonobese counterparts (21, 24, 29, 33). In our study, the prevalence was nearly five times higher among overweight and obese subjects than that in subjects with normal or low Body Mass Index. Of note, 36% and 87.5% of the study participants who had Stage 1 hypertension and Stage 2 hypertension, respectively, were either overweight or obese. The obtained findings herein are in accordance with those reported in both urban and rural India (5, 21, 24, 27, 29, 32). Moreover, it is well known that unhealthy dietary patterns with high intake of energy dense food, including processed drinks and aerated beverages, intake of saturated fat and trans-fat in conjunction with low intake of fruits and vegetables, are risk factors for raised blood pressure since they are very likely to lead to obesity. The prevalence of elevated blood pressure was higher among non-consumers of fruit and those who reported frequent intake of calorie-dense food, which were however not significantly higher compared to their normal counterparts. In our study, nearly two thirds of the participants reported intake of fruit the previous day whereas Kumar and colleagues noted that 35% of their study adolescents did not consume fruit in the previous week (5). Such contradiction might be attributed to easy availability and accessibility to affordable fruits in rural Murshidabad. Our study reported that frequent intake of junk food could be due to availability of locally prepared low-cost deep-fried food, which was also available near the school premises. In rural schools of Burdwan, high blood pressure was significantly influenced by intake of junk food more than once a week (29). The current study did not take into account salt intake among adolescents because of difficulty in estimation of the amount of salt. Meanwhile, the high intake of junk food among study participants (92%) indirectly points towards extra salt intake among the study subjects.

Smartphone overuse among adolescents is a matter of concern. A study conducted in rural North India reported that 30.3% of adolescents were smart phone-dependent (34). The current study revealed that the prevalence of elevated blood pressure was significantly higher among smart phone users compared to non-users (31.8% vs. 16.8%). A study among Chinese adolescents found a much higher value (35); nonetheless, the findings might not be comparable due to different study settings and different methods of assessment. Lack of sleep or poor sleep quality enhances the risk of hypertension not only among adults, but also among adolescents by enhancing stress. Inadequate sleep may be associated with smart phone overuse as well. In the present study, the prevalence of elevated blood pressure and hypertension was not significantly associated with hours of sleep, similar to a Chinese study (36). Scant literature is available regarding the correlation of sleeping pattern and smart phone use with adolescent hypertension in India. A study among Lithuanian adolescents found short sleep duration (<7 hours) as a risk factor for hypertension (37). Herein, only 2.7% of the study subjects had some form of addiction in the form of tobacco use, all of whom were male. The association of addiction with blood pressure status could not be observed due to low figures obtained in this work.

4.1. Limitations

This research was conducted after the schools reopened following the lockdown in the Coronavirus pandemic, which might have brought forth this picture of adolescent hypertension. Moreover, the small sample size limits the generalizability of the study findings. Further research is required in the district in order to explore the relationship between blood pressure and sleeping pattern and smart phone use among late adolescents.

5. Conclusions

The study revealed a high burden of elevated blood pressure among late adolescents. The prevalence was significantly influenced by higher socioeconomic status, family history of hypertension among first degree relatives, high Body Mass Index for age, and smart phone use. Overweight or obesity was found to be a major correlate influencing high blood pressure status.

This underscores the importance of annual screening of adolescents for elevated blood pressure through school setting. Measurement of blood pressure as a part of school health programme may be undertaken by training school teachers. Primary care physicians can play a pivotal role in unmasking the submerged part of the iceberg. In addition, promoting physical activity in school and health promotion among adolescents by imparting education on healthy food habits, restricting sale of unhealthy food near the school campus, and restricted use of smart phones might be conducive in mitigating this problem.

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We are deeply indebted to our school authorities, parents and students for their kind cooperation.

Ethical Approval

The proposal was authorized by Institutional Ethics Committee (IEC MSD/MCH/PR/204/2020 dt 5.2.2020). Informed consent (assent) was sought from the study participants prior to the study. Written consent was also obtained from the parents of adolescents below 18 years.

Conflict of Interest

The authors of this manuscript declare no relationships with any company whose products or services may be related to the subject matter of the article. Sarmila Mallik is a member of the editorial board.

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