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Original Research Article

Nutritional and blood pressure screening in school children in rural South India: a cross-sectional study

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ABSTRACT

Background: Screening for diseases is not very popular in Indian populace in general, and receive little attention from heath care policy makers, administrators or even health care providers, who concentrate on curative services. Health and nutritional screening of school children and adolescents, remains virtually a neglected field. So we conceived this study to look at the feasibility of large scale health screening of adolescents at school by a simple and inexpensive way by looking into the nutritional status (survey of anthropometry) and blood pressure readings among adolescents.

Methods: Students from 5 rural school in South India from age group of 10 to 18 years (fifth to twelfth standard) were assessed for their height, weight, BMI and blood pressure. Data was entered in WHO Epidata™ (version 3.0) and transferred to SPSS 12.0 version for analytical studies.

Results: In current study of 2201 students, wasting (35.5%), stunting (24.5%), high BMI (7.6%) were found. Prevalence of wasting is 1.63 times higher in males ($p<0.001$). There is significant relationship with high BMI and severe stunting ($p<0.001$, OR 2.54; 1.58%, 4.1%; 95% CI). Prevalence of pre-hypertension is 14.1% and hypertension is 9.5%. There is a linear trend in the prevalence of hypertension and BMI ($p<0.001$). As the BMI increases, blood pressure also increases.

Conclusions: Even with all advances in health care, undernutrition is highly prevalent. Obesity is on a rise in rural population and high proportions of overweight children are stunted also. High BMI is a risk factor for hypertension.

Keywords: Anthropometry, Blood pressure, Obesity, Stunting, BMI

INTRODUCTION

Health screening and secondary prevention are concepts which are unfamiliar to the Indian populace in general and these receive little attention from heath care policy makers, administrators or even health care providers who concentrate on curative services.[1] Though some master health check-up plans for adults are available and there is increasing awareness on nutritional and developmental surveillance of young children during the past few years, health and nutritional screening of school children and adolescents (whose hospital visits are much less frequent compared to infants toddlers and adults), remains virtually a neglected field, except for issues related to puberty and sexuality. [2]

So, we conceived a study to look at the feasibility of large scale health screening of adolescents at school by simple and inexpensive methods which could be performed with minimal expertise and supervision and the utility of data thus collected on addressing the issue of at least one major chronic disease. Nutritional survey with cardiovascular health screening was an obvious choice but the degree of expertise required for clinical screening of CVS makes it difficult, so we thought of screening for blood pressure along with the nutritional survey.[3]

Thus, we decided to do this survey of body mass index (BMI) and blood pressure (BP) among children 10-18 years of age.[4] Despite limitations of time, we hoped to glean information that could guide us on deciding on utility of larger screening programs and in designing such a screening program more efficiently by focusing on vulnerable subgroups, if any such subset could be defined.

METHODS

The study was done in 2201 students from 5 Government higher secondary schools and 2 middle schools, situated in villages, the rural area of Tamil Nadu, South India during the period of Aug 2013 to March 2014. All Students from 10 to 18 years of age, (fifth to twelfth standard) were included. Consent was taken initially from the heads of those schools (principals) and dates were fixed for school visits. Informed consent forms for inclusion in the study were distributed to the students on the day before the planned school visit through the health workers and signatures were obtained from parents who were willing to permit their children to be examined. The consent form also included a questionnaire with relevant past and present medical history details of each student which were to be filled at home with input from their parents. All the students who had brought the completed consent forms and willing personally were examined during the school visit.

Sample design and study population

Current study was a cross sectional study that included all consenting children who were present on the date of examination, in the selected schools.

Sample size

From available reports of South India, the prevalence of hypertension was 10.58% and obesity was 14.3%. Sample sizes were calculated by the formula;

$$4\text{pq}/d^2$$

For a precision of 20%, the sample size for blood pressure was 845 ($4pq/d^2=4x10.58x89.42/(2.116)^2= 845$) and obesity was 554 ($4pq/d^2=4x15.3x84.7/(3.06)^2= 554$). A total 2201 children were included, much larger than the calculated sample size, to cover for the likelihood of missing data which can occur in large scale single visit screening procedures.

Exclusion criteria

An exclusion criterion for current study was children who are known to have cardiac or renal or any chronic illnesses or are on medications.

Data collection procedure

Height and weight of each student class wise were measured and documented. Height was measured with a wall mounted stadiometer to the nearest centimetre. The student was positioned; making the student stand straight (upright), with back touching the wall and head at Frankfurt plane, facing forward and looking straight ahead, heels placed together, buttocks and shoulder in contact with the wall. The movable headboard of the stadiometer was then gently lowered until it touches the top of the head and the measurement noted to the nearest centimetre. Weight was measured on a bathroom scale by making the student stand on it after removing the footwear, wearing standard school uniform and standing straight). The weighing scales were regularly calibrated with known weights and adjusted, to ensure accuracy. BMI was calculated using the formula weight (kg)/height $(m)^{2.}$

The blood pressure was measured with appropriate sized cuff in the right arm after making them sit relaxing with an electronic BP apparatus (Omron company) which was calibrated (If the right arm could not be used due to injury or other reasons, the left arm was used). Those found to have BP values above 90th centile on initial examination were rechecked at the end of the session. No revisits were done.

Data analysis

Data was entered in WHO Epidata™ (version 3.0) and transferred to SPSS 12.0 version for analytical studies (anthropometry was classified using WHO Anthroplus software and Z-scores were calculated). Blood pressure was classified with 4th report by of the National heart lung and blood institute, US. Descriptive statistics are provided for weight, height, BMI, blood pressure. Mean, median, standard deviations, p value, relative risks odds ratio 95th% CI, were calculated using SPSS. Graphs, bar diagrams, scatter plots were derived using Microsoft excel and SPSS, $p<0.05$ was considered as significant.

RESULTS

Students from class 5 to class 12 were included in current study. Normally, the age of children in these classes would be 10 to 17 and hence the number of 18 year olds was very less (0.8). Maximum students were from 14 and 15 years, 18.3% and 17.1% respectively. When BMI and height were compared, there was a significant relationship between obesity and severe stunting ($p<0.001$, OR 2.54 (95% CI 1.58%, 4.1%). Males have a significantly higher BMI compared to females ($p<0.027$), Odds ratio (95% CI; 1.45; 1.04, 2.2). There was no significant correlation between wasting and stunting in observations of current study, ($p=0.056$), Odds ratio 0.91 (95% CI; 0.67, 1.00). Wasting was seen more among male as compared to female (1.63 times higher) ($p<0.001$), Odds ratio 1.63 (95% CI; 1.36, 1.95).

Table 1: Summary of current study findings.

Parameters	Observations
Age (10-18 years)	Grades 5-12
Gender: male-female ratio	1.225:1 (M: 55%, F: 45%)
Height (cm)	
Mean	150.24 (SD 12.27)
Male	152.18 (SD 13.448)
Females	147.90 (SD 10.204)
Mean difference	4.277 (p<0.001)
Severe stunting (z-score <-3)	6.7% (143)
Stunting (z-score <-2 to -3)	17.8% (379)
Weight (kg)	
Mean	38.5 (SD 9.96)
Male	39.18 (SD 10.691)
Females	37.69 (SD 8.934)
Mean difference	1.484 (p<0.001)
BMI for age N (%)	
Severe wasting (z-score <-3)	322 (15.2)
Wasting (z-score -3 to <-2)	429 (20.3)
Risk of obesity (z-score >1 to 2)	132 (6.3)
Overweight (z-score >2 to 3)	28 (1.3)
Obese (z-score >3)	1 (0.0)
Low (Z score <-2) wasting/severe wasting	751 (35.5)
High (Z score 1 and above) risk of obesity and obesity	161 (7.6)
Mean blood pressure (mmHg)	
Systolic	108.96 (SD 13.29
Diastolic	63.46 (SD 10.986)

Blood pressure

Study participants BPs were classified based on the fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents, (NIH, US) as having normal BP (systolic and diastolic BP <90th percentile for age, gender and height for age), pre-hypertension (BP >90th percentile but <95th percentile) and stage 1; hypertension (BP >95th percentile, but <99th percentile+5 mmHg) and stage 2; hypertension (systolic or diastolic BP >99th percentile for age, gender and height for age+5 mmHg).

Prehypertension was noted as 14.7%, hypertension was 10.3% (stage 1; 9.8%, stage 2; 0.5%). Out of the total 2053 adolescents, 1538 (74.9%) had normal blood pressure.

The mean systolic blood pressure was 108.96 mmHg and mean diastolic blood pressure 63.46 mmHg. There was a linear trend in BP with increase in age. As the age increases, the BP levels are also increasing. There was a linear trend in the prevalence of hypertension (p<0.001) and BMI. As the BMI increased, blood pressure also increased.

Association between obesity with severe stunting and hypertension

Among the 23 adolescents with the 'risk of obesity/overweight/obesity along with severe stunting, 39.1% had pre-hypertension/hypertension whereas among those with normal or below normal BMI for age, 24.8% had pre-hypertension and hypertension. This difference is not statistically significant, (p<0.144), Odds ratio 1.57 (95% CI; 0.94, 2.63).

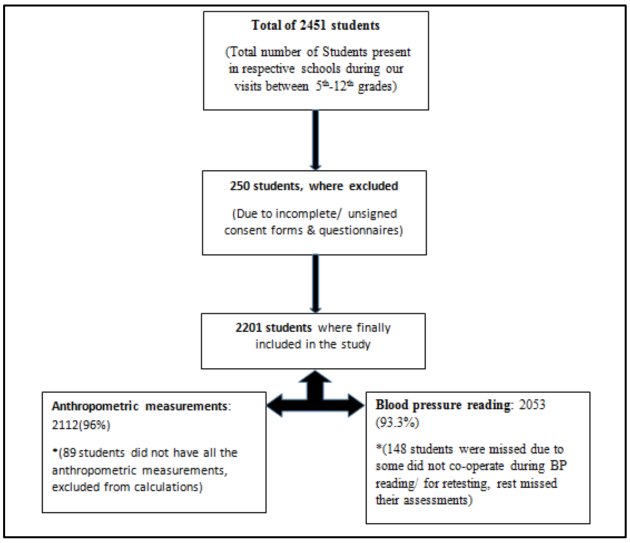

Figure 1: Schematic diagram of including students in current study.

*A few students left the school premises before completion of all phases of the various measurements and tests and hence some of these student's data were incomplete.

DISCUSSION

Under nutrition

The reported prevalence of malnutrition varies across states, with Madhya Pradesh recording the highest rate (55%) and Kerala among the lowest (27%).[5] India has the highest underweight prevalence among adolescent girls among the countries with available data (DHS survey 2002-06), at 47%.[6] In current study the overall 35.5% had wasting (severe wasting and wasting) and 7.6% had higher than normal BMIs (risk of obesity, overweight and obesity). This is comparable with Mukhopadhyay et al study from Kolkata, North India found prevalence of 36.49% (i.e. one third of the population), which is comparable with our study.[7] Considering sex variation, the rate of undernutrition among adolescent boys in Ashish et al study was 41.08% is distinctively lower than the other two Indian studies: one of urban boys of Kolkata (50.50%) studied by de Onis et al and another among rural boys of nine provinces of India (67%) reported by Venkaiah et al.[8] In current study 40.6% of wasting was observed in boys, which was comparable to Ashish et al data from an urban area. The rate of undernutrition among adolescent girls in our study was

29.5% which also was comparable with Ashish et al 30.61%. This was significantly higher compared to Bangladeshi girls (16%) studied by Ahmed et al.[9] But lower than Kenyan refugee girls (55%) and rural Indian girls (40%) reported by IRC (1997) and Venkaiah et al was 39.5%.[10] In the study by Ghalib et al comparing the same ethnic group of people living in different environment (South Indian children living in South India and UAE) having difference in their nutrition. Ghalib observed in 2005 that South Indian children living in south India (Kerala and Tamil Nadu) seemed to have much higher percentage (57.5%) of wasting than children of the same ethnic group living in Dubai, UAE (7.7%).[11]

Based on our data, which found much lower rates (29.5%), we feel that there was good progress in South India in the field of adolescent girls' nutrition in recent past. Undernutrition still remains a more significant health challenge to adolescents in rural areas, even in a rapidly developing state like Tamil Nadu (with wasting in 35% and stunting in 25% of our subjects), despite good economic progress and great strides made in the field of health care by our nation in recent years and the many recent reports predominantly from urban areas on the increasing prevalence of overweight and obesity in adolescents.

Table 2: Relationship between BMI for age and blood pressure.

Nutritional status based on BMI for age	Blood pressure, frequency (%)			Total
	Normal (N=1520)	Pre-hypertensive (N=301)	Hypertensive (N=211)	
Severe wasting (<-3)	256 (82.8)	29 (9.4)	24 (7.8)	309
Wasting (-2.99 to <-2)	331 (79.2)	61 (14.6)	26 (6.2)	418
Normal (-2 to 1)	843 (73.4)	175 (15.2)	130 (11.3)	1148
Risk of obesity (>1 to 2)	72 (56.3)	32 (25)	24 (18.8)	128
Overweight (>2 to 3)	17 (60.7)	4 (14.3)	7 (25)	28
Obesity (>3)	1 (100)	0 (0)	0 (0)	1

Table 3: Association between obesity and hypertension.

BMI for age	Blood pressure, frequency (%)			P value	Odds ratio (95% CI)
	Normal (N=1520)	Pre-hypertensive (N=301)	Hypertensive (N=211)		
Z-score >1 (risk of obesity/overweight/obese)	90 (57.3)	36 (22.9)	31 (19.7)	<0.001	1.8 (1.47- 2.2)
Upto Z-score 1	1430 (76.3)	265 (14.1)	180 (9.5)		

Stunting

The mean height of males and females in our study was 152.18 and 147.9 respectively. Nitish Mondal et al observed the overall prevalence of stunting among adolescents to be 46.6%.[12] This was much higher than our study results in which 24.5% (17.8% had stunting and 6.7% were severely stunted). Stunting was found to be 32.2% (95% CI: 31.6, 32.9) in boys and 34.4% (95% CI: 34.2, 34.7) in girls in NFHS-4.[13] This was again higher than the prevalence in current study. Bisai et al study in North India found that the overall rates of underweight and stunting were 28.3% and 27.8%, respectively, that can be comparable with our study having stunting of 24.5% and underweight was higher than that being 35.5%.[14] However, their study used National centre for health statistics (NCHS) z-scores to evaluate levels of underweight and stunting and we used WHO 2008 standards for stratification.

We need to know the parental heights also to categorize pathological stunting, which couldn't be done as the study was done in school setting.

Overweight and stunting

In current study observations overweight was 1.3% and those stratified as at risk of obesity was 6.3%, so altogether those with BMI above normal was 7.6%. Adolescents with risk of obesity and overweight were found to be more among the severely stunted group (16.1%) as compared to the participants whose height for weight is >-3 Z-score (7%) and this difference is statistically significant. Hoffman et al who did a study in Brazil to know why nutritionally stunted children are at risk of Obesity also found this apparent paradox of obesity in nutritionally stunted children.[15] They postulated that nutritional stunting is associated with impaired fat oxidation, a risk factor that predates obesity. It is also possible that since height is squared in the denominator in calculating BMI, small deviations in height can affect BMI much more than small deviations of weight.

Hypertension

Prevalence of hypertension; Raj et al study conducted in Kerala (urban population) showed prevalence of hypertension to be 10.58%. They had 24842 students of ages 5-16 years.[16] Current study prevalence of hypertension corresponds to this and their setting was in urban population. In a study done in Brazil among1878 subjects of age group 14-20 years using office BP on a single measurement, the prevalence of hypertension was 17.3%. This was comparable to current study in sample size and prevalence, yet gives a higher prevalence of hypertension. This could be attributed to study technique variation (more likelihood of white coat effect when BP is checked in hospital than in school). In another Indian study conducted in Wardha by Patil and Garg among 958 school children of age 6-16 years, prevalence of hypertension was found to be 3%, of which 2.8% were males and 3.2% females. Mean SBP was 97.2 and DBP was 62.1. In current study mean SBP was 108.98 and DBP was 63.46. In the above mentioned study, 3 visits were done with initial visit showing 6.5% which subsequently decreased to 3.6% and 3% in the next second and third visits. Since current study was focused on a higher age group and included only one reading, our higher prevalence could be partly attributed to these factors.

Correlation of hypertension and BMI

We could demonstrate a linear correlation between BMI and hypertension (Figure 2-3). Monyeki et al from South Africa, comparing the relation between fat pattern, physical fitness and blood pressure, observed that waist girth adjusted for age and gender significantly contributed to inter individual variability of systolic BP.[17]

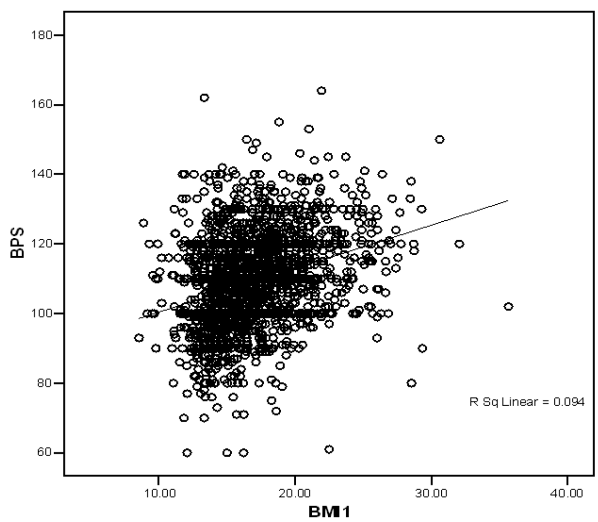

Figure 2: Systolic BP compared with BMI.

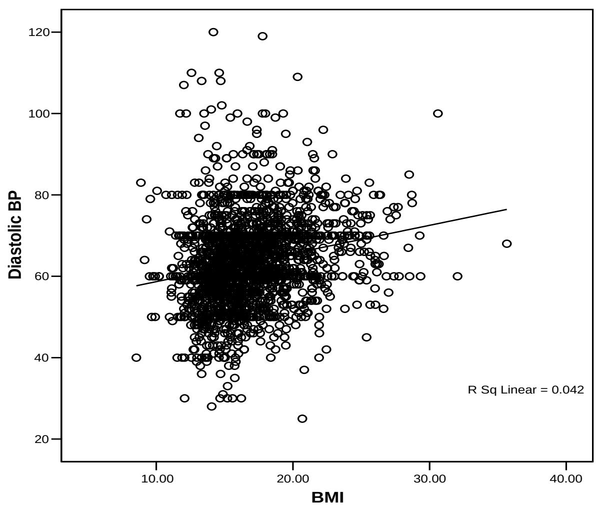

Figure 3: Diastolic BP compared with BMI.

A study by Anand et al found the prevalence of hypertension in children with obesity to be 15 times the normal.[18] But the study by Raj et al in Kerala found that BP correlated better with height and weight when taken as separate variables, than with BMI. In current study, BMI was taken in all the children from age group 10-18 years and its overall correlation as a single entity with hypertension was studied. Out of 211 who were found to be hypertensive and had both anthropometric measurements, 24 (18.8%) had risk of obesity and 7 (25%) were overweight, and the lone obese subject was hypertensive. Statistically there was a linear trend of correlation between BMI and BP for both SBP and DBP. Among those with normal or below normal BMI for age, prevalence of hypertension was found to be 9.5%. We could find no statistically significant correlation between BP and stunting (p=0.144).

Limitations

Limitations for current study were; repeat BP measurements (on another day/different settings) according to recommended guidelines for labelling a person hypertensive and treating them leads to limited accuracy of prevalence data.[19] Paucity of time and personal made repeat school visits impossible. If data on birth weights of underweight children and parental height and weight were collected, it would have given better insights into causes of under nutrition, whether dietary deficiency or poor intrauterine endowment.

CONCLUSION

It can be concluded that BP checking universally to adolescent health screening is not useful or cost-effective in societies with poor health consciousness without the backing of a robust system for follow-up. However, we could define 2 groups based on nutritional status assessment, those with BMI Z Scores <-2 or >1 who may potentially benefit from selective screening of BP.

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