Original Article

Double burden of underweight and overweight among children (10–19 years of age) of employees working in Indian industrial units

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ABSTRACT

Background. Along with the existing problem of underweight, overweight in children is increasing in the developing world. However, there is little information on its magnitude and pattern in the Indian context. We aimed to study the pattern and correlates of overweight in Indian children and adolescents.

Methods. A total of 3750 children in the age group of 10–19 years, who were family members of randomly selected employees from 10 different industrial sites in India, were surveyed using an interviewer-administered questionnaire.

Results. The prevalence of underweight was highest in peri-urban areas (30.2% and 53.2% according to Indian and international criteria, respectively). In urban and highly urban areas, the prevalence of underweight was 14.1% and 9.8%, respectively, according to the Indian criteria, and 27.1% and 19.2%, respectively, according to international criteria. The proportion of overweight children was highest in the highly urban category (19.1% and 13.4% according to Indian and international criteria, respectively). The level of urbanization (OR 3.1 and 4.7 for overweight in urban and highly urban areas, respectively, compared with peri-urban areas, $p < 0.001$), physical activity (OR 0.4, $p < 0.001$, in children with physical activity score $\geq$75th percentile compared with a score $<$ 75th percentile) and frequency of meals outside the home (OR 12, $p < 0.001$, if $>$ 25% weekly meals taken outside the home compared with $<$ 25% of weekly meals outside home) were significant predictors of overweight.

Conclusion. There is a double burden of underweight and overweight among Indian children and adolescents.

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INTRODUCTION

While underweight and undernutrition remain problems that cause more than half of all child deaths, the WHO projection for 2015 estimates that over 1.5 billion people will be overweight, of which children are expected to constitute about 10%.[1,2] The problem of obesity in children is global and has been increasing in the developing world.[3] In Thailand, the prevalence of obesity in 5–12-year-old children rose from 12.2% to 15.6% in just 2 years.[4] Although the complications of obesity commonly manifest during adult life, its seeds are sown and nourished during childhood.[5,6] Childhood obesity is directly linked to abnormalities in blood pressure, serum cholesterol, insulin resistance and diabetes in adults.[6,7] Extrapolation from current US data suggest that adolescent overweight will increase the prevalence of obesity among 35-year-olds in 2020 to 30%–44%, resulting in an increase in prevalence of 5%–16% of coronary heart disease (CHD) among future young and middle-aged adults by 2035.[8]

A recent review summarizing nutrition-related data of Indian children in the age group of 6–18 years suggests a 'double burden' of both undernutrition and overweight.[9] Undernutrition is a major public health problem in India, and the cost of lost productivity, illness and death due to malnutrition amounts to US$ 10–28 billion or 3%–9% of the gross domestic product (GDP).[10] However, overweight and related nutritional status among Indian children in the age group of 10–19 years has not been studied adequately. The reported studies on overweight or obesity in this age group were done in some specific areas of the country and only in school-going children.[11–13] The prevalence rate estimated from these studies suggests that 13%–20% of children in the age group of

10–18 years are overweight (using international cut-offs for body mass index [BMI]).

To gain insights into the determinants of overweight, we analysed data of children 10–19 years of age from a study that was initiated as part of a cardiovascular disease (CVD) risk factors surveillance programme at 10 different industrial sites in India.[14]

METHODS

Ten medium-to-large industries (defined as those employing 1500–5000 persons) in the organized sector were selected from different sites spread across India. Industries selected were from both the public and private sectors, based on their willingness to participate in the study. The detailed methodology of selection of the study subjects for the main study has been published elsewhere.[14] Briefly, at each participating centre, 800 employees in the age group of 20–69 years were selected by age- and sex-stratified random sampling. For the current study, the children (age group 10–19 years) of these employees were included. We expected a total of 400 children in this age group from each centre.

The study involved collection of data related to the demographic profile, individual characteristics related to major risk factors for CVD and anthropometric profile. To ensure the accuracy, completeness and comparability of anthropometric measurements, and of interviewee responses across the 10 study sites, several quality control measures were included in the study protocol. The study followed a common study protocol and a manual of operation. Common measurement techniques by trained study staff using structured pre-tested proformas were used at all the participating centres. Periodic calibration of measuring instruments and random cross-checking of the anthropometric measurements were done.

Questionnaire administration and measurement techniques

Written informed consent was obtained from the parents (employee) of every study participant. The scope of the survey was explained to all participating children before administration of the questionnaire, and all physical measurements were taken after obtaining the verbal consent of the participating child. A standard stadiometer was used to measure height and an electronic weighing machine was used to measure weight. A standard tape measure was used for measuring waist circumference (WC) while subjects were lightly clothed. WC was measured in centimetres (cm) to the nearest 0.1 cm at a level midway between the lower rib margin and the iliac crest. Weight was measured (to the nearest 0.1 kg) without shoes or any heavy outer garments, with the subject standing still on the weighing scale and the weight equally distributed on each leg. Height was measured (to the nearest 0.1 cm) in conjunction with the weight, without shoes and with the subject in an erect position against a vertical surface, and the head positioned so that the top of the external auditory meatus was at the same level as the inferior margin of the bony orbit. Physical activity was assessed using close-ended questions probing self-perceived, self-reported (domestic, leisure time and transport related) and intensity of physical activity. Differential scores based on intensity and time spent were allotted to each activity and the scores were added together to assess the overall physical activity. The proportion of food consumed outside the home on an average in a week was assessed using a close-ended question and classified into 4 groups (<25%, 25%–50%, 50%–75%, >75% of weekly meals).

Definitions

Classification of participating sites. Based on the location of the industry and level of urbanization, the sites were classified into 3 different categories—highly urban (sites located within the city limits of metropolitan cities), urban (sites located within the city limits of other major cities) and peri-urban (sites located outside the city limits).[15]

Underweight and overweight. For our analysis, we used age-specific international cut-offs for underweight and overweight using BMI criteria and similar cut-offs from a national reference population.[16,17]

Statistical analysis

The data were analysed using the SAS 9.1 software. Descriptive and analytical statistics were used in the analysis of data. For categorical variables, percentages were used to describe the data and, for continuous variables, mean/median were used. Two-sided $p<0.05$ was considered to be statistically significant. Initially, in bivariate analysis, odds ratios (OR) were calculated for individual predictor variables for overweight. Subsequently, variables that were significant ($p<0.05$) were entered into a multiple logistic regression model to generate ORs and 95% confidence interval (CI) of OR for overweight.

RESULTS

General characteristics of the study population

Based on the sampling scheme, we approached 4214 children in the age group of 10–19 years. A total of 3750 children responded to the questionnaire survey (response rate 89%). The proportion of boys and girls in the study was equal (1851 boys and 1853 girls) and their mean (SD) age was 14.6 (2.7) years (Table I). Of the study participants, one-third (33.8%) were from highly urban areas. The proportion of children not currently studying was 16.5% but only 2.4% were in regular employment. Eighteen per cent of children had a family history (one of their parents) of diabetes, and other CVD including hypertension.

Anthropometric measurements

The mean BMI and WC among both boys and girls across all age categories are given in Table II. The mean BMI levels increased

TABLE I. General characteristics of the study population

Characteristic	Total (*n*=3704)	Boys (*n*=1851)	Girls (*n*=1853)
Mean (SD) age (years)	14.6 (2.7)	14.5 (2.7)	14.6 (2.7)
Location of industry (%)			
Peri-urban	39.8	40.7	38.8
Urban	26.4	25.7	27.1
Highly urban	33.8	33.5	34.1
Currently studying (%)			
Yes	83.5	86.7	80.4
No	16.5	13.3	19.6
Currently employed (%)			
Yes	2.4	2.6	2.1
No	97.7	97.4	97.9
Education of mother (%)			
Up to primary level	20.2	22.0	18.4
Above primary level and up to secondary school	12.5	15.0	10.1
Above secondary school and up to graduation	35.1	35.2	35.1
Graduates plus	32.1	27.8	36.4
Family history of diabetes/cardiovascular disease (%)			
Yes	18.1	16.4	19.9
No	81.9	83.6	80.1

linearly with age in both boys and girls (Table II). Similarly, a linear relationship between WC and age was also observed in both boys and girls (Table II). Children in the highly urban group had the highest BMI (19.1 [3.9] in boys and 19.5 [3.8] in girls) and WC (68.2 [10.2] cm in boys and 68.1 [9.6] in girls) with progressively lower values in children from the urban and peri-urban groups (Table III).

Prevalence of underweight and overweight

The prevalence of underweight was highest in the peri-urban area (30.2% and 53.2% as per Indian and international criteria, respectively), while in the urban and highly urban areas it was 14.1% and 9.8%, respectively, according to Indian criteria and 27.1% and 19.2%, respectively, according to international criteria (Fig. 1). The proportion of overweight children was highest in the highly urban category (19.1% and 13.4% as per Indian and international criteria, respectively). Overall, 9.9% of boys and 7.9% of girls were overweight by either criteria.

Correlates of overweight

The OR of overweight in boys compared with girls was 1.2 (0.9–1.3). The proportion of overweight in children currently studying was 10.4% compared with 1.5% in non-school-going children (Table IV). However, the difference was not statistically significant after adjusting for all other variables. The prevalence of overweight was 9% among those who were currently not employed. The adjusted ORs for overweight in urban residents and highly urban residents compared with peri-urban residents were 3.1 (95% CI 1.3–6.8, p<0.001) and 4.7 (95% CI 2.3–9.8, p<0.001), respectively. Children with a physical activity score of >12 (>75th percentile of physical activity score) had an adjusted OR of 0.4 (95% CI 0.2–0.6, p<0.001) for overweight compared with those who had a physical activity score <12. Similarly, those who were eating ≥25% of their weekly meals outside their home had a 12 times

TABLE II. Mean body mass index (BMI) and waist circumference (WC) levels in various age categories

Age (years)	Boys (*n*)	Girls (*n*)	Mean (SD) BMI		Mean (SD) WC	
			Boys (*n*=1851)	Girls (*n*=1853)	Boys (*n*=1851)	Girls (*n*=1853)
10	129	102	16.6 (3.4)	15.7 (3.5)	60.4 (8.4)	59.2 (8.9)
11	195	189	17.0 (3.4)	16.4 (3.3)	60.6 (8.4)	60.5 (7.9)
12	224	207	16.7 (3.0)	17.1 (3.4)	61.8 (9.0)	62.9 (8.6)
13	196	194	17.4 (3.1)	17.9 (3.2)	63.3 (7.5)	63.8 (7.7)
14	205	215	17.7 (3.5)	18.5 (3.2)	66.0 (8.7)	65.7 (8.0)
15	197	204	18.3 (4.4)	18.8 (3.9)	67.1 (8.6)	66.8 (9.2)
16	192	181	18.6 (3.2)	18.8 (3.0)	69.4 (8.6)	66.8 (7.8)
17	202	194	19.6 (3.3)	19.8 (3.5)	71.3 (9.0)	69.4 (9.5)
18	169	205	19.6 (3.4)	19.8 (3.3)	71.9 (8.4)	68.8 (8.6)
19	142	162	20.3 (3.8)	19.9 (3.4)	73.1 (8.6)	69.9 (9.6)

TABLE III. Mean levels of body mass index (BMI) and waist circumference (WC) stratified by place of residence

Place	Boys (*n*)	Girls (*n*)	Mean (SD) BMI		Mean (SD) WC	
			Boys	Girls	Boys	Girls
Peri-urban	754	719	16.0 (2.3)	16.4 (2.5)	63.7 (7.4)	63.0 (9.2)
Urban	476	502	18.4 (3.5)	18.2 (3.3)	65.6 (9.9)	63.3 (6.6)
Highly urban	621	632	19.2 (3.9)	19.5 (3.8)	68.2 (10.2)	68.1 (9.6)
Total	1851	1853	18.1 (3.7)	18.4 (3.6)	66.4 (9.6)	65.6 (9.1)

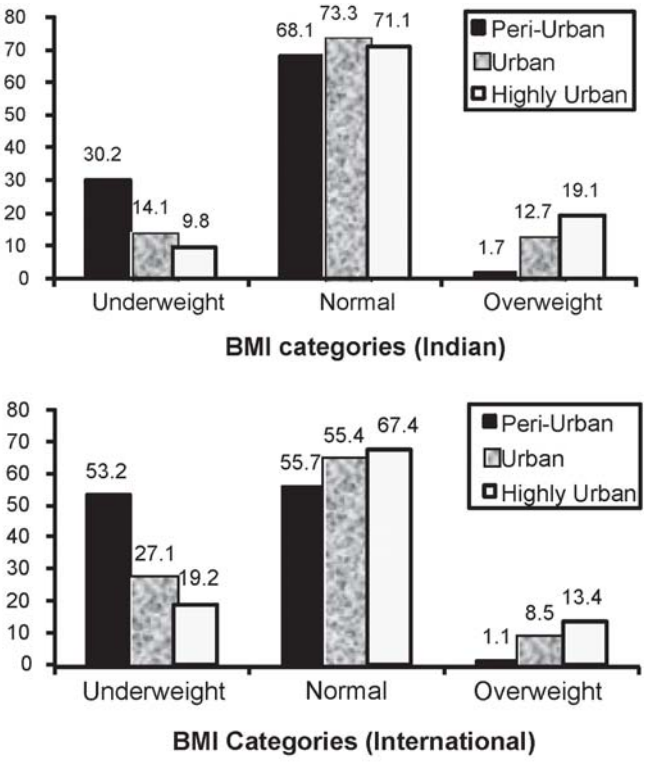

FIG 1. Proportion of underweight and overweight children in the age group of 10–19 years BMI body mass index

TABLE IV. Variables significantly associated with overweight (bivariate and multivariate analysis)

Variable	Overweight (%)	Bivariate OR (95% CI)	Multivariate OR* (95% CI)
Gender†			
Girls	7.93	1	
Boys	9.89	1.2 (0.9–1.3)	
Currently studying			
No	1.48	1	1
Yes	10.37	2.8 (1.8–4.3)	1.08 (0.2–4.4)
Currently employed†			
No	9.01	1	
Yes	4.60	0.84 (0.8–1.2)	
Education of mother†			
Up to primary level	7.0	1	
Above primary level up to secondary school	8.3	1.1 (0.7–1.6)	
Above secondary school and up to graduation	8.1	1.1 (0.7–1.5)	
Graduates plus	9.9	1.2 (0.75–1.6)	
Location of industry			
Peri-urban	1.11	1	1
Urban	8.52	8.3 (4.4–15.7)	3.1 (1.3–6.8)
Highly urban	13.36	13.7 (7.5–25.3)	4.7 (2.3–9.8)
Physical activity score			
<12 (<75th percentile)	10.1	1	1
>12	3.8	0.35 (0.2–0.6)	0.4 (0.2–0.6)
Eating outside			
<25% of weekly meals	7.0	1	1
>25% of weekly meals	51.9	14.3 (10.1–20.1)	12.0 (7.7–18.7)
Family history of diabetes/cardiovascular disease†			
No	8.58	1	
Yes	10.42	1.2 (0.9–1.6)	

* Adjusted for age † Not considered in the multilogistic regression model

higher risk of being overweight compared with those who were eating <25% of their weekly meals outside their home after adjusting for all other risk factors (OR 12, 95% CI 7.7–18.7, p<0.001). Educational status of the mother or family history of diabetes or CHD did not make a significant difference to the child being overweight.

DISCUSSION

This study conducted in 10 different industrial sites has generated estimates of the prevalence of underweight and overweight at the national level, in children of individuals in an industrial workplace, in the age group of 10–19 years. The estimated prevalence was based on international as well as national criteria. Therefore, cross-country comparisons as well as within-country comparisons are possible. The findings suggest a double burden of both underweight and overweight in Indian children with a wide heterogeneity in prevalence across geographical locations stratified by the level of urbanization.

The prevalence of underweight was relatively high in the study population, especially in the peri-urban localities. To the best of our knowledge, no study from India has reported on the proportion of underweight in children in this age group. The overall prevalence of overweight in our study was relatively low compared with other studies reported from different parts of India.[11–13] The multicentric nature of our study and the inclusion of peri-urban areas partly explains the reason for this difference. Further, our study was done at the community level and both school-going children as well as those who were not attending school were part of the study.

Our study establishes the existence of a double burden of underweight and overweight in Indian children, even in settings where the socioeconomic status is considerably higher than that in the general population. The stage of epidemiological transition influences the burden of overweight as is evident from the considerable heterogeneity in the prevalence of overweight and underweight children when stratified by the level of urbanization. The follow up data of these children may be of immense help in devising strategies to control chronic diseases in the future.

Among children in developing countries, underweight is still a bigger problem than overweight. However, many countries (such as Morocco, Guatemala and the Dominican Republic) have seen a rising trend in the prevalence of overweight children. In Morocco, for example, the percentage of overweight children more than tripled between 1987 and 2004, from 2.7% to 9.2%. In a shorter time period (from 1991 to 2002), the percentage of overweight children in the Dominican Republic more than doubled from 2.8% to 6.5%.[18,19] Highly urbanized locations in India appear to be following a similar pattern. Industries located in highly urban and urban regions had a high prevalence of overweight children compared with those in peri-urban areas. Urbanization leads to several lifestyle changes, resulting in an increased consumption of energy-rich foods, a decrease in energy expenditure (through less physical activity) and loss of the social support that is available in rural societies. All these factors lead to higher rates of obesity and other risk factors for chronic diseases.[20] Given that Indians have a high propensity to develop metabolic abnormalities with lower levels of body weight and BMI, the higher burden of overweight in urban areas is a cause for concern, and urgent and concerted prevention policies are needed to reduce this burden.

We further explored the reasons for overweight among these children and two major reasons emerged: (i) lower physical activity levels and (ii) frequently eating outside home. Epidemiological studies have consistently shown a negative relationship between measures of physical activity and indices of obesity (usually BMI) in adults.[21] The relationship appears to be similar in men and women, and across all ages.[22–28] This inverse relationship between physical activity and BMI has been seen using both self-reports of amount of physical activity and actual measurements made using doubly labelled water.[26–28] A recent study from India suggests that almost three-quarters of urban adolescents have a sedentary lifestyle.[29] This finding has serious implications for the future burden of obesity among urban Indian children.

Eating food outside the home was a significant variable associated with overweight in our study. Increased intake of energy-dense food has been shown to be an established risk factor for obesity among children and adults.[30] The mean BMI for men and women aged ≥15 years has increased in India from 2002 to 2005 and projections for 2010 show a further increase.[31] This increase in BMI levels in Indian children matches the nutritional transition in India, i.e. replacement of traditional Indian diets by diets high in total energy, fats, salt and sugars, which is linked to the consumption of refined foods and foods of animal origin with an increased fat content.[32] The transition in dietary pattern among children is driven partly by demand (increased income and reduced time to prepare food) and partly by supply-side factors (increased production, promotion and marketing of processed foods and foods high in fat, salt and sugar). A major proportion of global marketing is now targeted at children and is possibly the cause of their unhealthy behaviour. The dietary changes, when coupled with low physical activity levels, especially in a highly urbanized environment, will lead to a major epidemic of overweight and obesity.

Conclusion and policy implications

Our study highlights the double burden of both underweight and overweight in Indian children. However, the prevalence of underweight and overweight children is heterogeneous across centres based on the level of urbanization. Therefore, due consideration should be given to the geographical difference in the burden of underweight and overweight while formulating nutritional policies for children in India.

Since overweight in childhood and the development of obesity in adolescence are strongly related to other CVD risk factors in adulthood, weight control coupled with prevention of overweight and encouragement of a physically active lifestyle are important, beginning in childhood. It has been shown that brief interventions at both the individual and community level can reduce the burden of obesity in children.[33] Similar intervention studies are required in Indian settings to demonstrate the impact of different intervention strategies on preventing overweight and related morbidities.

Limitations

Our study has all the limitations inherent in a cross-sectional design. The participants were children of randomly selected employees from the organized industrial sector. Therefore, the results may not be generalizable to the entire population. Considering the workforce in India in both the organized and unorganized sectors (approximately 320 million in 1998), the study findings are valid for a major proportion of the total population. The diverse nature of the industries selected for the study, ranging from tea gardens to the airlines industry, with a judicious mix of private and public sector units, increased the generalizabilty of our results. Although we have presented the prevalence of underweight based on BMI, we did not measure important factors associated with underweight such as birth weight, and mother's age and height at birth.

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