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RESEARCH REPORT

Descriptive epidemiology of body mass index of an urban adult population in western India

H C Shukla, P C Gupta, H C Mehta, J R Hebert

Study objective: To describe height, weight, and body mass index (BMI) of the adult urban population in Mumbai, western India and to estimate the prevalence and severity of thinness and overweight in this population. To describe the association of BMI with education, age, and tobacco habits in an urban Indian population.

Design: Cross sectional representative survey of 99,598 adults (40,071 men and 59,527 women).

Setting: The survey was carried out in the city of Mumbai (formerly known as Bombay) in western India.

Participants: Men and women aged ≥35 years who were residents of the main city of Mumbai.

Main results: The mean height, weight, and BMI were 161.0 (SD 6.7) cm, 56.7 (SD 11.0) kg, and 21.8 (SD 3.8) kg/m² for men and 148.0 (SD 6.2) cm, 49.8 (SD 11.2) kg, and 22.7 (SD 4.7) kg/m² for women, respectively. Some 19% of men and women were thin (BMI<18.5 kg/m²), while 19% of men and 30% of women were overweight (BMI≥25 kg/m²). Multivariable logistic regression analyses showed that age, level of education, and tobacco use were independently associated with BMI. The odds ratio (OR) and 95% confidence intervals (CI) for thinness (BMI<18.5 kg/m²) were OR 6.52, 95%CI 5.38 to 7.89 for men and OR 4.83, 95%CI 3.71 to 6.28 for women, respectively, (p<0.001) for the lowest level of education (illiterate group). The OR and 95%CI for overweight were 2.25, 2.20 to 2.58 for college educated men and 1.90, 1.64 to 2.20 for college educated women, respectively, (p=0.001). Both smoking (2.33, 2.09 to 2.59; 2.89, 1.77 to 4.72 for men and women, respectively, p<0.001) and smokeless tobacco use (1.65, 1.52 to 1.80; 2.26, 2.14 to 2.38 for men and women, respectively p<0.0001) were significantly associated with low BMI.

Conclusions: Sequelae of thinness and overweight represent major public health problems. The results of this study, indicating an equal prevalence of thinness and overweight in an urban area and their association with age, level of education, and tobacco use raise concerns of an emerging public health crisis in urban India.
and included in the sample if their residence status was confirmed by their having a “ration card”. These cards, issued by the Bombay Municipal Corporation, act as a proxy for residence cards and permit access to all city and state government services (including receiving certain food items at subsidised prices). Such people comprised about 5% of the sample. Less than 1% of people approached did not agree to be interviewed and provide anthropometric measurements. A total of 99,958 adults, consisting of 40,071 men and 59,527

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>N</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35–44</td>
<td>15421</td>
<td>162.1 (6.7)</td>
<td>57.8 (11.0)</td>
<td>22.0 (3.7)</td>
</tr>
<tr>
<td>45–54</td>
<td>10636</td>
<td>161.1 (6.6)</td>
<td>57.3 (11.1)</td>
<td>22.1 (3.8)</td>
</tr>
<tr>
<td>55–64</td>
<td>8272</td>
<td>160.1 (6.6)</td>
<td>56.1 (10.7)</td>
<td>21.8 (3.7)</td>
</tr>
<tr>
<td>65–74</td>
<td>4439</td>
<td>159.6 (6.4)</td>
<td>54.4 (10.6)</td>
<td>21.3 (3.8)</td>
</tr>
<tr>
<td>75–84</td>
<td>1091</td>
<td>158.8 (6.9)</td>
<td>52.1 (10.1)</td>
<td>20.6 (3.6)</td>
</tr>
<tr>
<td>85+</td>
<td>212</td>
<td>156.3 (7.0)</td>
<td>48.3 (8.9)</td>
<td>19.8 (3.3)</td>
</tr>
<tr>
<td>Total</td>
<td>40071</td>
<td>161.0 (6.7)</td>
<td>56.7 (11.0)</td>
<td>21.8 (3.8)</td>
</tr>
</tbody>
</table>

Total 95.2% of respondents had received education past secondary level. Descriptive statistics (mean, standard deviations, centiles, and proportions within categories) were calculated for the total survey population and by age, educational background, and tobacco use.

Multivariable analysis was performed using logistic regression. The response variable, BMI, was converted into a dichotomous variable by using two cut off points: 18.5 and 25.0 kg/m² for analysis of thinness and 18.5–25 and 25–30 kg/m² were used for analysis for predictors of overweight. Three possible models corresponding to these two cut off points were fit. Age (in five year age groups), education, and tobacco use were fit as independent variables in the final model.

RESULTS

Table 3 shows the adjusted odds ratio (OR) for thinness by level of education and tobacco use.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational status</td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>4.83 (3.71 to 6.28)</td>
</tr>
<tr>
<td>Primary</td>
<td>2.25 (1.73 to 2.93)</td>
</tr>
<tr>
<td>Middle</td>
<td>2.33 (1.78 to 3.05)</td>
</tr>
<tr>
<td>Secondary</td>
<td>2.10 (1.73 to 2.55)</td>
</tr>
<tr>
<td>College</td>
<td>1.00</td>
</tr>
<tr>
<td>Tobacco use</td>
<td></td>
</tr>
<tr>
<td>No tobacco use</td>
<td>1.00</td>
</tr>
<tr>
<td>Smoker</td>
<td>2.26 (2.14 to 2.38)</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>2.23 (2.09 to 2.59)</td>
</tr>
<tr>
<td>Mixed</td>
<td>3.12 (1.80 to 5.41)</td>
</tr>
</tbody>
</table>

†Results are controlled for age and either tobacco use (for the educational status results) or educational status (for the tobacco use results). †All ORs were significant at p<0.0001.
compared with women, but the relative weight of women (expressed as BMI) was higher. Younger cohorts tended to be taller and heavier. Men, 35–44 years old were, on average, 5.8 cm taller, 9.5 kg heavier, and had BMI 2.2 kg/m² higher compared with the most elderly (85+ years). The youngest women were, on average, 8.1 cm taller, 11.8 kg heavier, and had a BMI 3.2 kg/m² higher compared with the eldest women.

In men, prevalence of thinness and overweight were similar (19.5% and 19.2% respectively) (table 2). By contrast, in women, there was a significantly higher prevalence of overweight (29.7%) compared with thinness (19.1%).

The prevalence of severe thinness (BMI < 16 kg/m²) was similar in both men and women (4.8% and 5.7%, respectively). More women were obese (BMI > 30 kg/m²) compared with men (6.8% vs. 2.2%) and 0.2% of women had a BMI > 40 kg/m². In both men and women, the older cohorts (75+ years) had higher prevalence of thinness while obesity was highest in the 45–54 years old cohort. Table 3 and 4 give the odds ratio for thinness and obesity associated with levels of education (adjusted for age and tobacco use) and for tobacco use (adjusted for age and level of education).

### DISCUSSION

The Mumbai population was on average, 12 cm shorter, 24 kg lighter, and had a BMI 4 kg/m² lower than the UK population and the USA population. The BMI profile presented in this paper is from the largest urban survey done on adults in India to date. Besides being one of the largest cities in India, Mumbai is the country’s financial centre and is host to people from all states of India. The age distribution of the study sample was similar to that of urban India. Literacy in the study sample was 87.6% and 54.7% compared with 81.3% and 62.5% for urban India for men and women, respectively (15–59 age group). We excluded affluent housing residents and adults aged 20–34 years of age. While this might be seen as a limitation, it can be argued that middle to low income strata form a substantial segment of the population and are the groups in whom the epidemiological transition will have the most impact. The findings presented in this paper provide evidence that both overweight and thinness are equally prevalent in the urban population of Mumbai.

Emerging problems related to overweight against a background of chronic underweight in large segments of the population raises important questions about policies aimed at health promotion. For example, in a country with a preponderance of overweight a recommendation can be targeted at lowering BMI values without much concern for thinness (except among people with eating disorders). On the other hand, in a country with a preponderance of thinness, a recommendation can be targeted at increasing body weight without much concern for inducing obesity or overweight related illness. In this study, we have found that it will be necessary to attend to both overweight and overweight portions of the distribution in identifying vulnerable targeting interventions. Because age, education, and tobacco use are independently associated with BMI, such targeting will need to take these factors into account.

### Age and BMI

Age seems to be an independent risk factor for thinness. In interpreting this association, it must be noted that in cross-sectional surveys the observed associations between age and BMI most probably reflect both the secular and the longitudinal changes in the physical status. Despite this, a high prevalence of thinness among the aged is of concern. This is in contrast with observations in elderly populations in affluent countries such as the UK, where 5% of men and 6% of women aged 75+ years are thin, and 64% men and 57% women are overweight. There may be many reasons for higher prevalence of thinness among elderly Indians. Because of “cohort” effects, older people may have been thinner throughout their life span. Also, in the older age groups, mortality and morbidity may influence the anthropometric profile with thinness being associated with longevity. To some extent, thinness can be seen as an adaptation consonant with long term survival. On the other hand, loss of income and independence may have caused a drop in the BMI in the elderly group. It is most likely that a combination of all these factors influences BMI in the urban slum population, which reported that 36.7% were underweight and 11.6% were overweight.

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### Key points

- **Urban India faces the public health burden associated with both the extremes of malnutrition—that is, thinness and overweight.**
- **The “at risk” groups for thinness are illiterate/less educated and elderly while the college educated middle age groups are “at risk” of overweight.**
- **Tobacco use including oral use (a common practice in India) is an independent risk for thinness in this population.**
- **There is a need to integrate education and health policy for interventions to alleviate thinness and curb overweight.**

### Table 4

<table>
<thead>
<tr>
<th>Educational status</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Primary</td>
<td>1.35</td>
<td>1.44</td>
</tr>
<tr>
<td>Middle</td>
<td>1.57</td>
<td>1.47</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.59</td>
<td>1.47</td>
</tr>
<tr>
<td>College</td>
<td>2.25</td>
<td>1.90</td>
</tr>
<tr>
<td>Tobacco use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No tobacco use</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Smokers</td>
<td>0.79</td>
<td>0.72</td>
</tr>
<tr>
<td>Non-smokers</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Results are controlled for age and either tobacco use (for the educational status results) or educational status (for the tobacco use results). All ORs were significant at p<0.001 except the one marked NS.

"The BMI profile presented in this paper is from the largest urban survey done on adults in India to date. Besides being one of the largest cities in India, Mumbai is the country's financial centre and is host to people from all states of India. The age distribution of the study sample was similar to that of urban India. Literacy in the study sample was 87.6% and 54.7% compared with 81.3% and 62.5% for urban India for men and women, respectively (15–59 age group). We excluded affluent housing residents and adults aged 20–34 years of age. While this might be seen as a limitation, it can be argued that middle to low income strata form a substantial segment of the population and are the groups in whom the epidemiological transition will have the most impact. The findings presented in this paper provide evidence that both overweight and thinness are equally prevalent in the urban population of Mumbai.

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In our study all forms of tobacco use were independently associated with lower BMI. Lower BMI in smokers compared with non-smokers has been reported in many studies. The smoking-BMI association has been attributed to the effect of smoking on physiological processes that lead to changes in appetite, food preferences, and basal metabolic rate. There have been no previous reports on smokeless tobacco use and, as far as we are aware, this is the first to show smokeless tobacco use as an independent risk for low BMI. This merits further investigation as tobacco use in India takes a variety of smokeless and smoking forms, of which cigarettes are only a minor part.

Conclusions

This study showed that both chronic underweight and overweight are equally present in an urban population of India, with important public health implications for the burden of diseases associated with both extremes of physical status. Moreover, findings relating age, education, and tobacco use to BMI provide information for further study and formulation of health policy. High prevalence of thinness in the less educated urban populations coupled with a high prevalence of overweight among the more educated is a matter of great concern. The World Bank estimates that malnutrition costs India at least US$10 billion annually in terms of lost productivity, illness, and death. If the present trend of rural to urban migration continues, less educated agricultural male labourers are the most likely to migrate because industrialisation and the diminishing contribution of agriculture to GDP may force them to seek alternative sources of income in urban areas. The size of the less educated urban population is a key determinant of the prevalence of thinness. Therefore, the burden of diseases associated with thinness will most probably continue to be a major public health challenge in urban India. As migration continues, the transition from low to higher education occurs in the middle class and those aspiring to middle class status. Thus, the burden of overweight associated diseases also will continue to increase. To meet this double burden of public health challenges, policy makers may need to consider the formulation of an integrated health and education policy that aims to improve educational status and alleviate illiteracy related thinness yet curb the increase of obesity in urban India.

The other vulnerable group at risk of thinness is the elderly. This segment of the population is growing worldwide and concern for the nutritional status of the elderly has been expressed in many countries. The BMI distribution observed in the elderly in this urban survey provides evidence that provisions for the care of this group need to be considered carefully by health care policy makers.

Further studies on other determinants of adult BMI and on the distribution of BMI in children and young adults in urban India are urgently required to obtain a fuller picture of high risk populations for both extremes of BMI.

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Conflicts of interest: none
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