

# Factors associated with body mass index among slum dwelling women in India: an analysis of the 2005–2006 Indian National Family Health Survey

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**Background:** Urbanization is increasing around the world, and in India, this trend has translated into an increase in the size of slum dwellings whose environments are suspected of being associated with poor health outcomes, particularly those relating to women's nutritional status. With this study, we sought to determine the factors associated with Indian women's body mass index (BMI) in slum environments, with special attention paid to women with tribal status.

**Methods:** A multiple linear regression analysis was performed on data from the Indian National Family Health Survey (2005–2006), modeling demographic and behavioral factors suspected of being associated with BMI, with additional focus on the measures of social class, specifically caste and tribal status.

**Results:** Increasing BMI is significantly and positively associated with frequency of watching television, having diabetes, age, wealth index, and residency status in the areas of New Delhi, Andhra Pradesh, or Tamil Nadu.

**Conclusion:** Although belonging to a scheduled tribe was not associated with changes in BMI, unadjusted rates suggest that tribal status may be worthy of deeper investigation. Among slum dwellers, there is a double burden of undernutrition and overnutrition. Therefore, a diverse set of interventions may be required to improve the health outcomes of these women.

**Keywords:** slums, India, BMI, women, caste, obesity, poverty

## Introduction

Life in a slum environment can have detrimental effects on residents' health status, including manifesting as diminished nutritional status. Sedentary lifestyles are common in urban centers, and unfortunately, this trend does not exclude slum dwellers.<sup>1</sup> Although undernutrition had been the main focus of interventions in slum dwellings in the past, a major global shift toward lifestyles conducive to obesity has caused overnutrition to become an issue, as well.<sup>2</sup> This phenomenon of having both undernourished and overnourished people living side-by-side is sometimes called the double burden of malnutrition, and much attention is being paid in particular to slum dwelling women's vulnerability to this phenomenon. Women are thought to be more economically and nutritionally insecure, and their physical health as mothers is a predictor of the health of offspring.

Defining population nutritional status epidemiologically is innately problematic. But body mass index (BMI) is a useful first step and is commonly collected in many government-sponsored national health surveys. The threshold of obesity has been internationally accepted as a BMI of  $\geq 30$  kg/m<sup>2</sup>.<sup>3</sup> While body adiposity index (BAI) and waist

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circumference are arguably better indices of actual adiposity,<sup>4</sup> BMI is still the most commonly used easily applied indices. Indeed, with a large population, BMI is both a noninvasive and time efficient measure.<sup>5</sup>

Several studies<sup>6–8</sup> have already attempted to determine the factors that have the greatest impact on South Asian women's BMI. Pregnant women in Assam were found to have a lower BMI if the household consisted of five or more individuals or if income was low.<sup>6</sup> According to the National Family Household Survey from 1998 to 1999 (NFHS-2), different administrative states report different average BMIs,<sup>7</sup> with more developed states, such as Punjab, having higher rates of obesity, while less developed states, such as Bihar, having higher levels of chronic energy deficiency.<sup>7</sup> As well, Yadav and Krishnan<sup>8</sup> found that urbanization itself is a risk factor for a variety of noncommunicable diseases in India, including obesity.

With the present study, we analyzed data from the 2005–2006 Indian National Family Health Survey (NFHS-3)<sup>9</sup> to determine the demographic and behavioral factors mostly associated with the BMI of Indian women living in slums. A previous attempt<sup>10</sup> to use these same data to explore BMI categorized their outcome into undernutrition, normal, and overnutrition categories, thus limiting statistical interpretations. They found no association between census slum designation and nutritional status. However, slum dwellers were ~10% more likely to be underweight. In the study described herein, we sought to conduct a more robust multivariate exploration of these same data, controlling for a wider array of putative covariates and retaining the continuous nature of the BMI outcome variable. We believe that this constitutes the first published study of BMI in modern Indian slums that features special attention to residents with tribal status.

## Methods

A multiple linear regression was applied to data from the NFHS-3, with demographic and behavioral factors modeled against the continuous outcome of BMI.

The NFHS-3 defined slums based on any of the following criteria: 1) based on the designations by the government established by any act including the Slum Act, 2) governmental recognition of the slum regardless of any previous identification, or 3) under the criterion of “a compact area of at least 300 population or ~60–70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities”, which was assessed visually by the surveyor. In this study, we used the slum definition based on the survey supervisor's assessment of slum status based on three criteria mentioned previously.

The index coding for wealth was subdivided into five categories. As well, women who indicated they were currently pregnant were excluded since they provide a skewed relationship between demographic factors and BMI. Putative covariates showing poor univariate association ( $p>0.100$ ) with BMI were omitted from inclusion in the final regression model, in order to optimize our model's robustness.

All data were analyzed using SPSS version 20 (IBM Corp., Armonk, NY, USA). Ethical approval was received from the Research Ethics Office of the University of Ottawa for this study. Written informed consent was deemed not required for this study by the Research Ethics Office of the University of Ottawa, because it used only retrospective, anonymized patient data.

## Results

A summary of covariates' significance levels and regression coefficients is presented in Table 1.

**Table 1** National Family Health Survey (NFHS-3) covariates' *p*-values and regression coefficients resulting from multiple linear regression

Covariates	<i>p</i> -value	Coefficients
Frequency of watching television	<0.001	−0.098
Poorer wealth index	<0.001	0.147
Middle wealth index	<0.001	0.175
Richer wealth index	<0.001	0.148
Lives in Tamil Nadu	<0.001	−0.166
Current age of respondent	<0.001	0.242
Lives in Andhra Pradesh	0.004	−0.091
Do you have diabetes	0.009	−0.067
Poorest wealth index	0.013	0.080
Lives in Delhi	0.030	−0.063
Tribe	0.053	0.051
Respondent does nonmanual labor	0.060	−0.054
Lives in West Bengal	0.097	−0.052
Source of drinking water	0.117	−0.048
Toilet facility	0.141	−0.045
Lives in Madhya Pradesh	0.150	0.039
Religion	0.157	0.038
Number of household members	0.180	−0.039
Respondent works at home or away	0.188	−0.036
Not part of caste/tribe	0.220	−0.032
Smokes	0.269	0.029
Household has bicycle	0.319	−0.027
Household has refrigerator	0.325	−0.032
Lifetime parity	0.369	−0.033
Household has electricity	0.570	0.018
Drinks alcohol	0.603	0.014
Household has motorcycle/scooter	0.664	0.013
Household has radio	0.717	0.010
Lives in Uttar Pradesh	0.735	−0.010
Who decides how to spend money	0.756	−0.008
Partner's education level	0.791	0.008
Highest education level	0.828	−0.007
Respondent does not work	0.966	−0.001
Don't know if part of caste or tribe	0.998	0

The regression model was determined to be significant ( $F=9.776$ ,  $p\leq 0.0001$ ), producing an  $R^2$  of 0.206.

Whether the woman was a member of a scheduled tribe was not found to be significantly associated with changing BMI, but the  $p$ -value of that adjusted association was nonetheless quite low ( $p=0.051$ ). As this is a variable of deep policy relevance, it was useful to conduct an exploratory subanalysis of tribal levels' unadjusted association with BMI. Results of that analysis showed that tribal women had significantly lower (unadjusted) average BMI than did nontribal women (20.43 vs 22.02,  $p<0.001$ ).

It was further found that those belonging to a tribe were more likely to dwell in Maharashtra or Andhra Pradesh, be in the poorest or poorer wealth index, and to perform manual labor, regardless of BMI ( $p<0.001$ ).

The rise in obesity rates in India has also seen a subsequent increase in noncommunicable diseases, including type 2 diabetes mellitus.<sup>11</sup> The naturally strong association between obesity (measured via BMI) and diabetes in the examined sample may affect the relationships of BMI with the other variables. To explore this possibility, the regression was run again without the diabetes variable included. There was no change in covariates' statistical significance, thus the diabetes variable was included in the final regression and deemed not to be an effect modifier or a confounding influence.

## Discussion

The increasing BMI of slum dwelling women is most significantly and positively associated with the following factors: frequency of watching television; having diabetes; increasing age; higher wealth index; and living in the states of New Delhi, Andhra Pradesh, and Tamil Nadu. Belonging to a tribe, while not statistically significant in the adjusted model, was an interesting variable in that it showed significant unadjusted association with living in Maharashtra or Andhra Pradesh, doing manual labor, and being in the poorer or poorest wealth index.

Our major findings are reflected in the existing literature, which confirm that among low income Indians, a sedentary lifestyle, including watching television, is a major contributor to obesity and other noncommunicable diseases.<sup>12</sup> It is important to note that the analyzed data are from 2005 to 2006. Therefore, the realities on the ground may change since that time. However, these data remain the most comprehensive set describing the entirety of the Indian slum dwelling experience and must therefore suffice for the time being.

Surprisingly, we did not find a significant adjusted association between education level and BMI (given that

education is associated with career opportunities and therefore wealth), though the unadjusted relationship was indeed significant ( $p=0.037$ ). This suggests that other factors may have been mediating the independent relationship between these two factors. This leads us to believe that having assets and adequate housing (as measured by the wealth index) is more influential than educational status alone, however attained. Both education and wealth are dimensions of socioeconomic status, which also include some measurement of social class. And in India, there is no more profound indicator of social class than caste.

Caste classification is long known as an important consideration for doing any sort of population research in India, with hereditary classification of lower ranked individuals associated with a variety of economic, and thus health, disadvantages.<sup>13</sup> Caste, defined by family lineage, defines a social hierarchy among individuals, often dictating profession, diet, and living conditions. Tribal populations are not part of the formal historic caste structure, but tribal peoples have long faced discrimination similar to that experienced by members of the lowest ranked castes.<sup>13</sup> To our knowledge, the present results represent the first attempt to model the influence of tribal status on nutritional health within modern slums.

While Tribe membership accounts for only a small fraction of the individuals in this data set, Tribe populations nonetheless constitute a largely socioeconomically disadvantaged group worthy of policy attention. The literature is barren with respect to the health status and needs of tribal peoples living in India's urban centers. Their needs represent an important future research direction, given tribal peoples' well-documented experiences with marginalization and poverty.<sup>14</sup>

Our main methodological limitation is that presented by challenges in variable coding. An example is the caste variable. Caste is a religious classification system mostly used by Hindus,<sup>13</sup> but limitedly present in some other religions, as well, including Sikhs and Buddhists. However, of the 7952 women examined, only 68.2% were Hindu, over 95% identified as belonging to a caste, despite it being an overwhelmingly Hindu designation. It is unclear whether nonHindus reported believing themselves to be part of this hierarchy or whether the question was asked of them poorly.

A further limitation was our reliance upon the formal governmental definition of slum. So-called unidentified slums, which are urban areas with slum-like conditions, which nevertheless do not have the formal designation, have similar, if not worse, conditions than identified slums.<sup>1</sup> Our sample therefore undersamples Indians living in the urban

conditions we sought to examine. It would be problematic to draw comparisons from our sample to nonslum dwellers, given that many of those may in fact experience similar slum-like conditions without the mantle of a formal slum designation.

Unidentified slums are known to have similar, if not worse, living conditions than identified slums; comparatively inferior conditions are related to the fact that unidentified slums are not eligible for publicly funded amenities due to their lack of classification. This reality serves to keep slum dwellers from unidentified slums, including those who may belong to a Tribe, in a lower wealth index compared to slum dwellers from identified slums.<sup>15</sup>

One clear message arising from these data is that slum dwellers in India are not a homogenous population. Factors such as basic housing and sanitation contribute to the wealth index calculation and are important to examine in slum dwellers because a need for infrastructure improvement is still prevalent. However, while slum dwellers have largely been characterized as profoundly impoverished, in these data, it was revealed there are slum dwellers belonging to the middle and richer wealth indexes, indicating that certain slum dwellers experience significantly greater economic standing than others. This is a critical consideration in the development of interventions or for providing resources because slum dweller needs will vary; some segments of the population may already have significant assets available to them while many others require some form of financial assistance. It will be important for future research to analyze the economic characteristics of the slum population under study before an appropriate intervention is formulated.

It is important to note that many previous studies have drawn attention to the so-called double burden of under- and overnutrition in India. Slum dwellings, which were historically associated with undernutrition, are now experiencing growing rates of obesity due presumably to the lifestyle associated with increasing urbanization.<sup>16,17</sup> Thus, slum dwellings, like Indian urban centers in general, are experiencing the double burden in lock step with the rest of the country. The extent to which “slum dwelling” may deserve a unique designation that distinguishes such neighborhoods from other urban environments – at least for population health purposes – may be overstated.

## Conclusion

While expected factors, such as age, diabetes, and a sedentary lifestyle, are associated with increasing BMI among slum

dwelling Indian women, the important insight arising from our study is that nutritional health challenges to Indian slums may not be dissimilar to challenges experienced by other urban residents, though the experiences of tribal peoples are deserving of more focused attention in future research projects.

## Disclosure

The authors report no conflicts of interest in this work.

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