Overweight/Obesity Transition and its Determinants in India, 2005-06 to 2015-16

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Abstract

In India, 135 million people suffer from overweight/obesity. The prevalence of obesity varies by age, gender, location, and socioeconomic factors in India. The existing healthcare services are causing a growing public health concern. This study used the National Family Health Survey data from 2005-06 to 2015-16 to measure the prevalence and obesity transition among different sub-populations of India. The study used unit-level data for NFHS-3 & 4 (2005-06 and 2015-16). Bivariate analysis was used to study the prevalence of overweight/obesity, and geospatial maps were used to portray the overweight/obesity transition across sub-populations, space and time. Multivariate analyses were used to determine the likelihood of overweight/obesity among different variables. The results showed that the prevalence of overweight/obesity in most of the developed states is still high among different sub-groups of the population, with a few EAG states experiencing positive incremental change. Overweight/obesity has substantially increased in all EAG states with varying degrees of convergence across the population cohorts. The study found that the likelihood of overweight/obesity is higher among females compared to males. It was concluded that India's health delivery system needs reorganisation to consider the evolving disease patterns. Health system funding must be rearranged to account for rising NCD costs and the poor's disproportionate share of those costs.

Keywords: obesity, nutritional transition, low HDI, socioeconomic status, poor, BMI

Introduction

The rise in overweight and obesity has become a global phenomenon, with a significant increase over the last two to three decades. While obesity has been a problem in developed nations, it has now become more prevalent in low and

middle-income countries (WHO, 2010). The increase in overweight and obesity in these countries is linked to changes in food habits due to urbanisation, as well as reduced physical activity resulting from demographic and epidemiological transitions (Popkin *et al.*, 2012; Griffiths & Bentley, 2001; Law *et al.*, 2020; Meenakshi, 2016; Misra *et al.*, 2011; Shamsi *et al.*, 2018; Shetty, 2002).

Global dietary trends are shifting towards energy-dense foods high in fats and sugars. At the same time, reduced physical activity due to technological advancements, urbanisation and economic progress have led to a significant increase in overweight and obesity, posing a serious public health crisis. As a result, there has been a shift in the disease burden from infectious and communicable diseases to non-communicable diseases (NCDs), such as obesity, diabetes, and cardiovascular disease, causing major morbidity and mortality (Arokiasamy, 2018; ISDBIC, 2017; Zakaria & Donato, 2020).

The rise in overweight and obesity is no longer confined to wealthy industrialised societies but is also occurring rapidly in developing nations. India, for example, has experienced high economic growth, leading to social and economic changes. In addition to undernourishment among young children, India is now facing the additional burden of overweight and obesity among young adults, which may have significant social,

physiological, and psychological impacts (Khan & Mohanty, 2018; Ansary & Rath, 2020; Shetty, 2002). However, there is a lack of comprehensive research into the macroeconomic causes of the rise in overweight or obesity in India.

According to the World Health Organization, as of 2021, 1.9 billion people worldwide are overweight, with 650 million of them classified as obese. WHO's 2017 report on global disease burden revealed that over 4 million people die annually due to complications related to being overweight or obese. In India, approximately 135 million people are suffering from overweight or obesity (Ahirwar & Mondal, 2019). The prevalence of obesity in India varies across age, gender, location, and socioeconomic status. India, as a developing nation, is undergoing a transition from issues of malnutrition to obesity due to industrialisation and rapid urbanisation. The incidence of obesity differs between states, rural and urban areas, and genders. Although socioeconomically underdeveloped states (Empowered Action Groups including Madhya Pradesh, Chhattisgarh, Bihar, and Jharkhand) have lower obesity rates compared to more developed states such as Punjab, Andhra Pradesh, and Chandigarh, the former recorded significant increases between 2005-06 and 2015-16. In a study by Mishra *et al.* (2018), it was revealed that urban residents are more likely to be obese than rural residents.

On the other hand, a study showed that indigenous populations

are at a higher risk of obesity (Oliveira *et al.*, 2015). The study also indicated a clear link between obesity and excessive calorie intake, less physical activity, consumption of junk food, and a sedentary lifestyle among Indian students (Shaik *et al.*, 2016; Ningombam *et al.*, 2018). Siddiqui and Donato (2016) highlighted that the obesogenic environment in India has led to the prevalence of overweight or obesity not only among males and females but also across different social groups and regions. Both Muslim females and Sikh females have high rates of overweight or obesity due to sociocultural influences (Garg *et al.*, 2010). Consequently, poor eating habits, sedentary lifestyles, and limited healthcare services are contributing to the increasing public health concerns related to overweight and obesity in India (Ahirwar & Mondal, 2019). Given these circumstances, this study aims to comprehensively assess the overweight and obesity epidemic among adult men and women in India using unit-level data from the nationally representative National Family Health Survey.

Objectives

The main goal of this study is to explore the transition towards overweight and obesity across various sub-groups of the population in India and its states. The study also aims to analyse the influence of individual factors, local neighbourhood factors, and state-level factors on obesity and overweight among different sub-populations in India.

Data Sources and Methodology

This study utilises data from two National Family Health Survey (NFHS) rounds. The unit level data of NFHS-3 (2005-06) and NFHS-4 (2015-16) were obtained from the Demographic Health Survey website. These surveys gather maternal and child health information, including body measurements for females aged 15-49 and males aged 15-54. NFHS-3 had 124,384 female and 74,369 male participants, whereas NFHS-4 included 699,686 females and 112,122 males. Body mass index (BMI) is used to classify overweight and obesity among adults, with a BMI ≥25 indicating overweight or obesity. The study includes bivariate analysis using socioeconomic and demographic variables such as place of residence, religion, caste, education level, wealth index, age group, and working status. Additionally, geospatial mapping is used to analyse regional variations over time. Furthermore, logit regression analysis examines the socioeconomic and demographic predictors of overweight and obesity prevalence after accounting for other factors. It aims to find the best-fitting model to describe the relationship between the dichotomous characteristic of interest (dependent variable = response or outcome variable overweight/obese coded '1' and not overweight coded '0') and a set of independent (predictor or explanatory) variables.

The logit equation is expressed as:

Logit (p) = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots \ldots \beta_n X_n + E$

p = Dependent variable (different measures of undernutrition coded as 1 and nourished coded as 0). ß0 = Constant; ß1 = Coefficient of variable X1; E = Error Term

Analysis and Discussion

Overweight/Obesity Transition Among Different Sub-groups of Population in India

Over the past decade, the number of overweight or obese men and women in India has more than doubled. From 2005-06 to 2015-16, there was a significant increase in overweight and obesity across all Indian states, in both rural and urban areas. Some states saw a rise in overweight/obesity levels to a critical point, particularly in areas where it was not previously a severe issue. In 2015-16, there was a wider gap in overweight and obesity prevalence between rural and urban areas compared to 2005-2006, impacting both men and women. Surprisingly, it was found that eating habits did not seem to have a clear impact on the prevalence of overweight and obesity. The prevalence of obesity varied significantly between different populations, with obesity increasing with age and peaking between ages 44-49 for women and 50-54 for men (Figure 1). Furthermore, a significant percentage of adults in India were found to be overweight or obese, with women having a higher average prevalence of obesity than men.

In all rounds of the NFHS, both males and females in rural and urban areas are more likely to be overweight or obese as they age, from 15 to 19 to 45 to 49. According to Figure 1, which shows the mean prevalence of overweight/obesity for each age group, the 45-49 age group among rural males has the highest percentage of mean prevalence of overweight/obesity. Along with diverse and inconsistent dietary practices among the states, balanced diets are another factor. We found that states with higher levels of socioeconomic development had a greater risk of overnutrition at the individual level. However, in recent years, states with lower levels of socioeconomic development have also seen significant increases in the incidence of overweight and obesity.

Analysis of the household level wealth index across sub-populations based on gender, rurality, and NFHS rounds found that the mean prevalence of overweight/obesity has increased dramatically in India over the past ten years. In rural India, the mean prevalence of overweight/obesity among men in the poorest quintile was only 1.5 per cent in 2005-2006, but it rose to 7.4 per cent in 2015-16, a fivefold increase. The figure doubled simultaneously within the same reference group, going from 13.3 per cent to 24.7 per cent. Table 1 further reveals that rural men in the richest quintile are more obese than those in the poorest quintile.

Figure 1

Mean Prevalence of Overweight/Obesity and Age Groups by Sectors and Gender
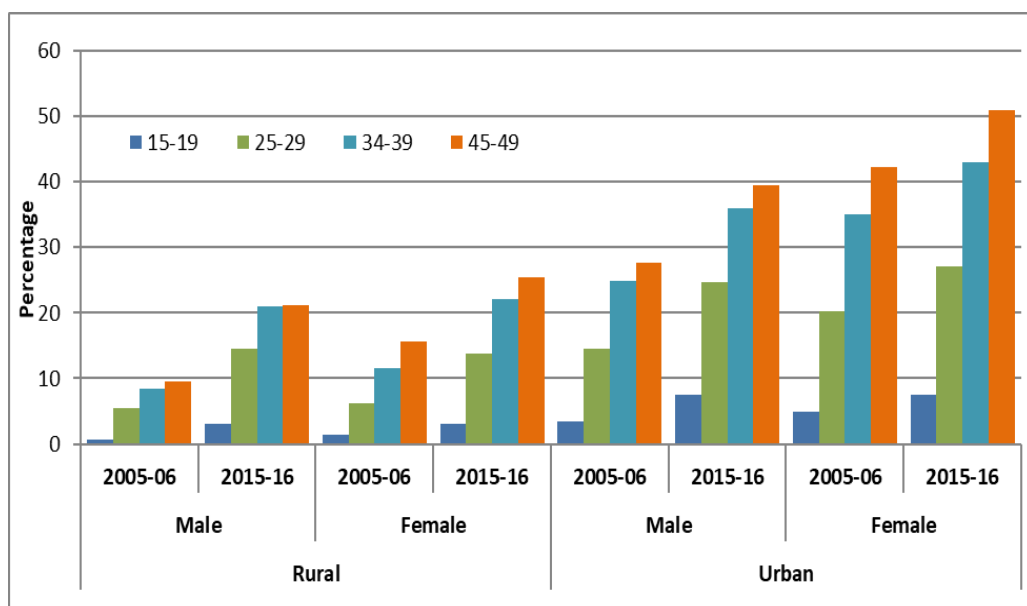
Source: National Family Health Survey-2005-06 & 2015-16

Table 1

Mean Prevalence of Overweight/Obesity and Wealth Quintiles by Sectors and Sex in India.

	Proportion of population with overweight/obesity							
Wealth Quantile	Rural				Urban			
	Male		Female		Male		Female	
	2005-06	2015-16	2005-06	2015-16	2005-06	2015-16	2005-06	2015-16
(1) Poorest 20%	1.5	7.4	2.5	7.4	5.9	14.6	9.0	19.0
Q-2	2.3	9.7	3.9	10.2	9.1	21.7	14.3	27.4
Q-3	3.6	12.8	5.0	12.9	14.0	29.4	21.7	32.0
Q-4	5.6	16.1	7.4	17.0	22.8	31.7	30.3	36.7
(5) Richest 20%	13.3	24.7	14.7	25.3	30.6	38.1	37.7	39.8
Total	5.9	14.7	7.3	14.9	16.7	27.3	23.2	31.1
	34,559	74,683	65,560	4,88,060	34,650	34,017	53,174	1,99,096

Source: National Family Health Survey-2005-06 & 2015-16

Women in both the poorest and richest quintiles are in a similar predicament. It is interesting to note that the prevalence of overweight/ obesity is higher among women in rural areas than among men in both the richest and poorest quintiles. In urban areas, the mean prevalence of obesity among men in the lowest quintile was greater in 2005-2006 (6 per cent vs 1.5 per cent in rural areas). The result shows some

concerning trends related to overweight and obesity in different demographic groups. In urban areas, the prevalence of overweight and obesity is significantly higher among males in the wealthiest quintile compared to males in both the poorest and richest rural quintiles. Urban females also have a higher prevalence of overweight and obesity compared to males, regardless of income. Over the years, there has been a notable increase in overweight and obesity among females in the poorest quintile.

Furthermore, the data also reveals that in 2005-06, 21.9% of Sikh men in rural areas were overweight or obese, with Christian males following closely at 11% (Table 2). In the same period, 28% of rural Sikh women were overweight or obese, compared to only around 4% of Christian-ST women. These patterns have persisted, with approximately one-third of Sikh men in rural areas being overweight or obese in 2015-16, while the prevalence of overweight and obesity among rural Christian-ST women remained significantly lower.

The prevalence of overweight /obesity is higher among Hindu women as a whole (over 20%) compared to Muslim women (16.4%). This difference is particularly noticeable in urban areas. While the prevalence among Sikh men remains high, there has been a declining trend from 2005-06 to 2015-16. In urban areas, over 37% of Sikh men were obese in 2005-2006, which

decreased to about 34% in 2015-16. On the other hand, the mean prevalence of overweight/obesity showed an increasing trend across all other socio-religious categories. Among the Christian general category, 22% of males were overweight in 2005-06, increasing to 32% in 2015-16.

The increase in obesity in India is attributed to low levels of physical activity and shifts in dietary habits toward more animal products, saturated fats, and sweets. Research has demonstrated a strong link between food choices and physical exercise and the risk of obesity, hypertension, diabetes, and stroke. Additionally, studies on occupational physical activity have concluded that occupation is a categorical variable influencing obesity. Regarding women with a higher physical activity related to employment, Table 3 shows that the risk of manual labour workers being overweight is lower than those not employed. In contrast, white-collar men and women in rural areas are more likely to be overweight than non-working individuals. For example, white-collar male workers were 25.6 % overweight or obese in rural areas during this decade compared to those who were not working, which was 8.8%.

Further, the findings indicate no statistically significant differences between male manual workers and unskilled labourers in urban and rural areas. In the 2005-2006 period, around 14% of people categorised as not in the workforce reported being

obese or overweight; this number increased to 20% in 2015-16, while the average incidence of obesity among white-collar jobs increased to 32% from 20% over the same period. The mean prevalence of obesity among manual labour workers has tripled over the same period, reaching 18% in 2015-16. According to Table 3, the population in white-collar jobs in India is more likely to be obese or overweight, regardless of their gender, place of residence, or surroundings, although with varying degrees. Data analysis indicates that the mean prevalence of overweight/obesity among white-collar rural males doubled over the past ten years, from 12.2% to 25.6%. At the same time, the mean

prevalence of overweight/obesity increased for those not in the workforce and manual labour from 2.3% and 5% to 8.8% and 14.7%, respectively.

The mean prevalence of obesity among female manual workers increased threefold from 4.2% to 13.3% (Table 3). Still, the mean prevalence of overweight/obesity is higher among white-collar female employees (25.5%). While urban females in the same category reported 35.4%, urban males in white-collar jobs reported a higher prevalence of overweight/obesity with roughly 37%. It is interesting to note that in 2015-16, the prevalence of overweight/ obesity was higher among urban females

Table 2

India: Mean Prevalence of Overweight/Obesity among Social Religious Groups by Sectors and Sex

	Proportion of population with overweight/obesity							
Correlates	Rural				Urban			
	Male		Female		Male		Female	
	2005-6	2015-16	2005-06	2015-16	2005-06	2015-16	2005-06	2015-16
Hindu-caste	4.4	13.2	5.3	12.8	13.8	24.9	19.3	28.7
Hindu-general	9.6	18.6	10.9	20.3	21.1	32.0	28.6	35.4
Muslim	5.6	14.7	8.2	16.4	14.0	26.0	22.7	31.4
Christian-ST	3.5	9.5	4.2	10.0	10.6	22.2	9.8	21.7
Christian-general	11.3	26.0	17.2	29.5	22.4	32.4	29.1	38.1
Sikh	21.9	29.3	27.7	29.6	37.4	34.1	41.7	36.1
Other Groups	2.9	12.8	4.4	12.4	22.7	30.2	20.9	29.2
Total	5.9	14.7	7.3	14.9	16.7	27.3	23.2	31.1
	34,559	74,683	65,560	488,060	34,650	34,017	53,174	199,096

Source: National Family Health Survey-2005-06 & 2015-16

Table 3

India: Mean Prevalence of Overweight/Obesity and Nature of Occupation by Sectors and Gender

Proportion of population with overweight/obesity							
Correlates	Rural				Urban		
	Male		Female		Male		Female	
	2005-06	2015-16	2005-06	2015-16	2005-06	2015-16	2005-06	2015-16
Not in workforce	2.3	8.8	9.2	14.9	7.1	17.0	24.4	31.1
White collar	12.2	25.6	16.1	25.5	24.1	36.7	25.4	35.4
Manual labour	5.0	14.7	4.2	13.3	13.0	26.8	14.9	29.3
Total	5.9	14.7	7.3	14.9	16.7	27.3	23.2	31.1
	34,559	74,683	65,560	4,88,060	34,650	34,017	53,174	1,99,096

Source: National Family Health Survey-2005-06 & 2015-16

who were not employed than among males. In the non-working group of urban males in 2015-16, 17% were reported to be obese, compared to 31% of urban females. Similarly, among manual labour in 2015-16, 26.8% of urban males reported being overweight or obese, compared to more than 29% of urban females (Table 3).

Overweight/Obesity Transition Across the States and Sectors in India

The following section illustrates the prevalence of overweight and obesity at a sub-national level. The average overweight and obesity prevalence in the country increased by 8.8 percentage points between 2005-06 and 2015-16. Andhra Pradesh reported the highest increase (15 percentage points), more than double the national average. Following Andhra Pradesh, Goa (15 percentage

points), Himachal Pradesh (14.8 percentage points), Jammu & Kashmir (14.4 percentage points), and Sikkim (14.2 percentage points) also showed significant increases. It is interesting to note that more than 50 per cent of Indian states experienced an increase in overweight and obesity prevalence. Punjab had the lowest increase at 3.7 per cent. Further analysis shows that

the northern, northeastern, and southern states had the greatest changes in prevalence. Central and northeast Indian states acted as a boundary between those in the north and south in 2005-06 and 2015-16 (Maps 1&2). In 2005-06, Punjab (27.1 per cent) and Kerala (25.1 per cent) reported the highest prevalence, while the remaining northern and southern states had medium rates. Meanwhile, central and north Indian states had low rates. Jharkhand had the lowest

prevalence at 5 per cent, followed by Bihar, Chhattisgarh, Madhya Pradesh, and Rajasthan (Maps 1&2). It is worth noting that states with the lowest rates of overweight and obesity are also known as India's "hunger bowl," where a high percentage of children are underweight and have stunted growth. BIMARU/EAG states also showed a lower prevalence of overweight and obesity.

Based on map 2, it is clear that over the past ten years, overweight and obesity rates have increased in central India, while the northern and southern states have consistently high prevalence rates of overweight/ obesity. In 2015-16, states like Himachal Pradesh, Uttarakhand, J&K, Haryana, Delhi, and Punjab reported a mean prevalence of overweight/obesity greater than 20 per cent, along with Gujarat, Maharashtra, Andhra Pradesh, Karnataka, Goa, and Kerala in the southern states. In these states, one-third of the population reported being overweight or obese, with Jharkhand having the lowest rate at 10 per cent.

India is experiencing unprecedented changes in the prevalence rate of overweight/ obesity, especially as more than two-thirds of the population lives in rural areas. Rural India's obesity rate has doubled in the past decade, increasing from 7 per cent to 15 per

cent, while urban areas have a prevalence rate of 30.5 per cent. Although the prevalence rate is higher in urban areas, the occurrence rate decreases. The impact of nearby urban areas on rural surroundings has led to changes in lifestyle, eating patterns and access to manufactured foods, led to changes in lifestyle, eating patterns and access to manufactured foods, contributing to the rising obesity rate in rural areas.

In the last ten years, most Indian states have reported a high prevalence of urban obesity, with Andhra Pradesh having the highest percentage of overweight/obese urban residents in 2015-16 at 41.9 per cent. Punjab and Haryana have shown a drop in overweight/obesity rates from 2005-06 to 2015-16, while Odisha recorded a doubling of the mean prevalence of overweight/ obesity.

Determinants of Overweight/ Obesity Transitions in India

The analysis was conducted separately for rural men and women and urban males and females in both the NFHS-3 and NFHS-4 rounds, with the results presented in Appendix 1 and 2. The study's model suggests that in younger adult ages, men had a higher probability of being overweight or obese than women, even after adjusting for age, sex, and other socioeconomic and demographic factors. The study also demonstrates that overweight/

Maps (1, 2, 3, & 4)
State-wise Prevalence of Overweight/Obesity in Different Scenarios
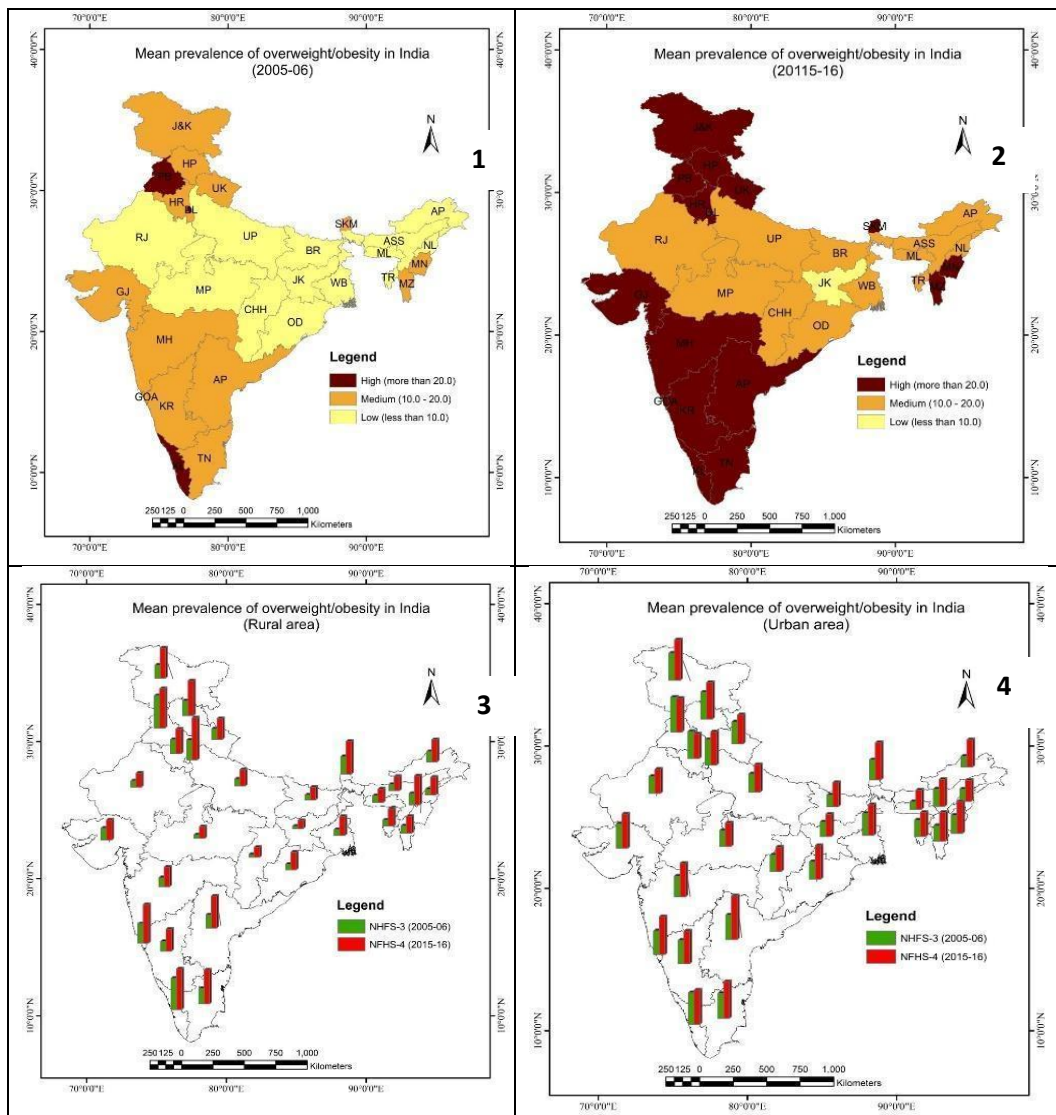
obesity currently affects a higher percentage of women and is still a serious public health concern. Due to the complex and diversified food consumption patterns in the Indian states, the effect of eating habits does not reflect a long-term pattern of overweight/obesity risk in men and women. This might be because NFHS-3 and NFHS-4 data are too limited to analyse several lifestyle aspects thoroughly. The rise in prevalence rates and the favourable wealth gradient that exists across the four subpopulations in both the NFHS rounds are included in the

obesity transition concept. According to our model's findings for urban and rural females, education first positively correlates with the risk of being overweight or obese in 2005-06 and 2015-16. This study also found that the gender gap widened with quintiles between 2005-06 and 2015-16. Across all subgroups, the population in the richest quintile is more likely to be overweight or obese than in the poorest quintile. Compared to the other cohorts in the reference group without schooling, rural males with a number of years of schooling between 13 and 15 indicated an increased likelihood of being overweight or obese. The study found that the probability of overweight and obesity among men under the age of adulthood has been rising quickly.

Compared to the reference age range of 25-29, urban females aged 45-49 reported having higher odds of being overweight or obese (Appendix-1&2). Watching TV daily positively impacts the chance of becoming overweight or obese, and the influence is more pronounced among rural women than urban women. In both rural and urban male cohorts, the likelihood of being overweight or obese is higher among Sikhs than among Hindus in general, followed by Muslims and then Christians (Appendix-1 & 2).

In this socio-religious group of rural female cohorts, Muslim rural females are more likely to be overweight/obese than Hindu-General (Ref category). In contrast, Sikh community urban females are more likely to be overweight/obese than Hindu-general (Ref category). In both the 2005-06 and 2015-16 NFHS cycles, the SC and ST populations had lower odds of being overweight or obese than the Hindu-general population. Additionally, the study indicated that using motorised vehicles and clean cooking fuels increased the likelihood of being overweight or obese in all subpopulations compared to not utilising (Appendix-1 & 2). Males who live in rural areas are more likely than the rest of the subpopulation to be overweight or obese. Gender inequalities were found to be greater among Muslims than among Hindus and other groups.

Finally, it can be claimed that gender variations exist in the risk of being overweight or obese in India. Regarding the male-female subpopulation in rural and urban areas and types of economic activities, the likelihood of overweight/obesity is higher among the subpopulation in white-collar jobs than among the subpopulation engaged in manual work in 2005-06 and 2015-16; the result is also statistically significant (sig. 0.000) (Appendix-1&2).

Conclusion

The global prevalence of overweight and obesity has significantly

increased over the past few decades. Studies show that there are over one billion overweight individuals and nearly half a billion obese adults worldwide. What was once primarily a problem in well-developed nations has become a serious epidemic, even in middle-income countries. Factors such as urbanisation, changes in eating habits, lack of physical activity, demographic changes, and sedentary lifestyles all contribute to the obesity epidemic and other non-communicable diseases.

India is currently undergoing a dietary and epidemiological shift, and this transition is closely linked to the rising obesity rates. The country faces significant income and health disparities, which have led to varying levels of obesity among men and women across different states. The prevalence of overweight and obesity has increased significantly over the past decade, showing differences across population groups, states, genders, and wealth quintiles. While some states have seen decreases in overweight and obesity rates, others, particularly less developed and more populated states, have experienced significant increases, surpassing wealthier states.

This situation indicates an impending health crisis in states with lower Human Development Index (HDI) scores, with individuals from lower socioeconomic backgrounds being disproportionately affected. India's economic transition, sedentary lifestyles, changing eating habits, and globalisation have contributed to the rise in obesity.

As these factors permeate populations with previously lower obesity rates, the prevalence of overweight and obesity is expected to continue rising. However, the regional impact of this obesity shift, particularly in states with lower HDI scores, remains uncertain. Understanding sociocultural influences, gender and education dynamics, and the interplay between individual and state-level economic and human development is crucial for addressing the geographic disparities contributing to the obesogenic environment.

Policymakers face the challenge of identifying regionally specific factors influencing high body mass index (BMI) rates and developing targeted policy solutions while avoiding a broad, macro-level approach. India's health system must adapt to the changing disease patterns and allocate resources to address the increasing costs associated with non-communicable diseases.

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Appendix 1

Multivariate Logistic Regression Analysis of Overweight and Obesity by Selected Background Characteristics, India National Family Health Survey (2005-06)

Parameters	Rural male N=33,159		Urban male N=33,594		Rural female N=65,502		Urban female N=53,131	
	OR	CI (95%)	OR	CI (95%)	OR	CI (95%)	OR	CI (95%)
Poorest quintile (Ref)								
Q_2	1.66**	1.27-2.18	1.36**	1.17-1.59	1.18*	1.02-1.35	1.39**	1.26-1.54
Q_3	2.16**	1.67-2.79	1.87**	1.60-2.18	1.40**	1.22-1.60	1.88**	1.69-2.08
Q_4	2.59**	2.02-3.33	2.48**	2.10-2.94	1.58**	1.39-1.80	2.47**	2.21-2.76
Richest quintile	3.26**	2.51-4.23	3.26**	2.72-3.90	1.96**	1.71-2.24	3.31**	2.94-3.73
No education (Ref)								
1-5 Years	1.24*	1.03-1.49	1.11	0.94-1.31	1.33**	1.21-1.45	1.18**	1.08-1.28
6-8 Years	1.21*	1.00-1.46	1.34**	1.15-1.57	1.59**	1.44-1.75	1.33**	1.23-1.44
9-10 Years	1.49**	1.24-1.78	1.39**	1.19-1.61	1.55**	1.40-1.71	1.32**	1.22-1.43
11-12 years	1.55**	1.26-1.91	1.31*	1.12-1.55	1.52**	1.33-1.74	1.28**	1.17-1.41
13-15 Years	1.71**	1.37-2.12	1.41**	1.20-1.66	1.41**	1.20-1.65	1.15*	1.04-1.26
>=16 years	1.31*	0.98-1.75	1.49**	1.24-1.78	1.50**	1.17-1.91	1.20*	1.06-1.34
Age groups 25-29 (Ref)								
15-19	0.15**	0.11-0.21	0.25**	0.21-0.30	0.19**	0.16-0.22	0.21**	0.19-0.23
20-24	0.47**	0.38-0.58	0.51**	0.45-0.30	0.49**	0.43-0.55	0.45**	0.41-0.49
30-34	1.62**	1.37-1.93	1.52**	1.36-1.70	1.70**	1.53-1.88	1.68**	1.56-1.81
35-39	2.16**	1.82-2.55	2.17**	1.94-2.42	2.56**	2.31-2.84	2.39**	2.22-2.58
40-44	2.19**	1.84-2.61	2.21**	1.97-2.47	2.98**	2.68-3.31	3.07**	2.83-3.32
45-49	2.61**	2.18-3.12	2.47**	2.20-2.78	3.49**	3.12-3.91	3.15**	2.89-3.43
50-54	2.43**	2.00-2.96	2.20**	1.93-2.51	NA	NA	NA	NA
Not watching TV (Ref)								
Less than once a week	1.16	0.96-1.40	0.89	0.72-1.10	1.50**	1.34-1.68	1.14*	1.00-1.30
At least once a week	1.29*	1.07-1.57	1.00	0.83-1.22	1.78**	1.60-1.98	1.29**	1.15-1.45
Almost everyday	1.79**	1.51-2.13	1.22	1.02-1.46	2.20**	2.01-2.40	1.49**	1.35-1.65
No tobacco use (Ref)								
Uses tobacco	0.79**	0.71-0.89	0.73**	0.67-0.80	0.63**	0.55-0.72	0.76**	0.68-0.85
No alcohol (Ref)								
Alcohol	1.09	0.98-1.20	1.05	0.98-1.12	0.97	0.80-1.17	0.95	0.78-1.15
Hindu-general (Ref)								
Hindu caste	0.86**	0.77-0.96	0.85**	0.79-0.92	0.87**	0.81-0.94	0.86**	0.81-0.90
Muslim	1.05	0.85-1.30	1.16*	1.04-1.28	1.67**	1.51-1.86	1.35**	1.26-1.45
Christian-ST	0.68**	0.55-0.84	0.52**	0.44-0.63	0.63**	0.54-0.73	0.42**	0.37-0.48
Christian-general	1.51**	1.14-1.99	1.10	0.93-1.31	1.56**	1.33-1.82	1.15*	1.02-1.30
Sikh	3.09**	2.43-3.92	1.97**	1.52-2.55	3.13**	2.75-3.56	1.85**	1.57-2.18
Others	1.14	0.83-1.56	0.87	0.73-1.04	1.09	0.90-1.32	0.77**	0.67-0.87
Not using a motorised vehicle (Ref)								
Using motorised vehicle	1.89	1.69-2.12	1.35**	1.25-1.46	1.21**	1.12-1.31	1.04	0.98-1.10
Not using clean fuel (Ref)								
Clean cooking fuel	1.78	1.58-2.01	1.21**	1.09-1.33	1.58**	1.46-1.71	1.30**	1.22-1.39
Manual work (Ref)								
Not in workforce	0.97	0.75-1.25	0.88*	0.76-1.01	1.59**	1.48-1.71	1.41**	1.30-1.52
White collar	1.36**	1.22-1.53	1.21**	1.13-1.31	1.62**	1.44-1.82	1.24**	1.13-1.36
_cons	0.01**	0.01-0.01	0.04**	0.03-0.05	0.01**	0.01-0.02	0.05**	0.04-0.05

Note: Asterisks denote the level of statistical significance: ** $P < 0.001$; * $P < 0.05$.
OR denotes Odd Ratio, and CI denotes confidence interval.

Appendix 2
Multivariate Logistic Regression Analysis of Overweight and Obesity by Selected Background Characteristics, India National Family Health Survey (2015-16)

Parameters	Rural male N= 74,683		Urban male N= 34,017		Rural female N= 488,060		Urban female N= 199,096	
	OR	CI (95%)	OR	CI (95%)	OR	CI (95%)	OR	CI (95%)
Poorest quintile (Ref)								
Q_2	1.07	0.98-1.17	1.14*	1.04-1.26	1.19**	1.15-1.23	1.36**	1.31-1.41
Q_3	1.18**	1.08-1.28	1.43**	1.28-1.58	1.34**	1.30-1.39	1.59**	1.53-1.66
Q_4	1.30**	1.19-1.42	1.44**	1.28-1.61	1.53**	1.47-1.58	1.80**	1.72-1.89
Richest quintile	1.53**	1.39-1.69	1.71**	1.52-1.94	1.86**	1.79-1.93	2.04**	1.94-2.14
No education (Ref)								
1-5 Years	1.30**	1.19-1.42	1.13*	0.99-1.30	1.26**	1.23-1.30	1.24**	1.19-1.29
6-8 Years	1.32**	1.21-1.44	1.23**	1.09-1.40	1.44**	1.40-1.48	1.33**	1.28-1.38
9-10 Years	1.52**	1.40-1.65	1.36**	1.20-1.53	1.57**	1.52-1.61	1.37**	1.31-1.42
11-12 years	1.51**	1.38-1.66	1.34**	1.17-1.52	1.54**	1.49-1.60	1.27**	1.22-1.33
13-15 Years	1.61**	1.45-1.78	1.37**	1.20-1.56	1.42**	1.36-1.48	1.15**	1.10-1.20
>=16 years	1.59**	1.39-1.80	1.29**	1.11-1.49	1.51**	1.42-1.60	1.18**	1.12-1.24
Age groups 25-29(Ref)								
15-19	0.20**	0.17-0.22	0.23**	0.20-0.27	0.18**	0.17-0.19	0.21**	0.20-0.22
20-24	0.52**	0.47-0.57	0.55**	0.49-0.61	0.49**	0.48-0.51	0.48**	0.46-0.50
30-34	1.48**	1.37-1.60	1.46**	1.33-1.61	1.68**	1.64-1.73	1.69**	1.63-1.75
35-39	1.85**	1.70-2.00	1.80**	1.64-1.98	2.17**	2.10-2.23	2.19**	2.12-2.28
40-44	1.95**	1.80-2.12	2.05**	1.86-2.26	2.57**	2.49-2.65	2.72**	2.62-2.82
45-49	2.01**	1.85-2.19	2.07**	1.87-2.28	2.91**	2.82-3.00	3.00**	2.88-3.12
50-54	2.07**	1.89-2.27	2.04**	1.83-2.27	NA	NA	NA	NA
Not watching TV (Ref)								
Less than once a week	1.07	0.97-1.18	0.88	0.74-1.03	1.21**	1.16-1.25	1.06**	0.99-1.13
At least once a week	1.32**	1.22-1.44	0.93	0.81-1.06	1.37**	1.32-1.41	1.14**	1.08-1.21
Almost everyday	1.62**	1.51-1.75	1.02	0.91-1.16	1.73**	1.69-1.77	1.29**	1.24-1.35
No tobacco use (Ref)								
Uses tobacco	0.72**	0.68-0.75	0.71**	0.67-0.76	0.73**	0.71-0.75	0.82**	0.79-0.85
No alcohol (Ref)								
Alcohol	1.15**	1.10-1.21	1.05*	0.99-1.12	0.95*	0.90-1.00	1.01	0.92-1.10
Hindu-general (Ref)								
Hindu caste	0.84**	0.79-0.89	0.85*	0.79-0.91	0.78**	0.76-0.79	0.88**	0.85-0.90
Muslim	1.10*	1.01-1.20	1.00	0.92-1.09	1.43**	1.39-1.48	1.33**	1.29-1.38
Christian-ST	0.86*	0.77-0.96	0.83*	0.72-0.95	0.80**	0.76-0.83	0.67**	0.64-0.71
Christian-general	1.39**	1.17-1.65	1.09	0.90-1.31	1.33**	1.23-1.42	1.28**	1.18-1.39
Sikh	1.65**	1.46-1.88	1.23	1.03-1.47	1.58**	1.51-1.66	1.06	0.98-1.14
Other religion	1.31**	1.16-1.48	1.14	0.96-1.35	1.09*	1.03-1.15	0.91*	0.85-0.98
Not using a motorised vehicle (Ref)								
Using motorised vehicle	1.38**	1.31-1.45	1.34**	1.25-1.43	1.14**	1.12-1.16	1.04*	1.02-1.07
Not using clean fuel (Ref)								
Clean cooking fuel	1.55**	1.47-1.63	1.48**	1.36-1.61	1.56**	1.53-1.60	1.32**	1.28-1.36
Manual work (Ref)								
Not in workforce	1.08*	1.00-1.16	1.02	0.94-1.11	1.13**	1.09-1.18	1.13**	1.06-1.20
White collar	1.24**	1.16-1.32	1.10*	1.03-1.17	1.23**	1.11-1.36	1.10*	0.99-1.22
_cons	0.05**	0.05-0.06	0.13**	0.11-0.15	0.04**	0.04-0.05	0.10*	0.09-0.11

Note: Asterisks denote the level of statistical significance: ** $P < 0.001$; * $P < 0.05$ OR denotes Odd Ratio, and CI denotes confidence interval