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Transitioning to an obese India: Demographic and structural determinants of the rapid rise in overweight incidence

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ABSTRACT

India, which has long suffered from undernutrition, has seen a rapid rise in overweight incidence in the last decade and a half. These changes are characterized by significant within-country differences in overweight incidence that vary by gender and regional development levels. In this paper, we provide an integrative framework, linking the income-gradient hypothesis of obesity with biological, obesogenic, and environmental factors to provide an explanation on the emergence of within-country differences in overweight patterns. We utilize *measured* body mass index (BMI), along with individual- and household-level data of over 800,000 men and women surveyed in the National Family Health Surveys of 2005–06 and 2015–16 to identify correlates of within-country differences in overweight incidence. A decomposition analysis reveals that among women, in addition to increasing access to obesogenic technologies, biological factors are associated with overweight incidence. Among men, obesogenic factors related to technology use and health behaviors are associated with the rise in overweight incidence, but biological factors are not. At lower levels of regional development, overweight incidence is associated with greater access to obesogenic technology such as motorized transport, which reduces physical activity among men at higher rates than women. At higher levels of economic development, obesogenic behaviors, such as watching more television and reducing smoking, are associated with overweight incidence. Our results corroborate the call by public health experts for group-specific policies to stem the rise of overweight incidence in developing countries.

1. Introduction

In 2014, there were 2 billion overweight individuals globally, and the direct health care costs of obesity were around US$2 trillion (Dobbs et al., 2014). These costs, less than US$1billion in 2005, increased tenfold in slightly over a decade (Kelly et al., 2008). Of the global overweight population, around 14 percent live in India. In this same time period, between 2005 and 2015, overweight incidence doubled in the country (ICMR, 2017; Pingali et al., 2019a; Aiyar et al., 2021). An analysis of the distribution of overweight incidence revealed that there were significant intracountry differences (Meenakshi, 2016; Pingali et al., 2019a). Rural areas, which have been traditionally food insecure, saw the largest increase in overweight incidence. Overweight prevalence among women continued to be higher than men, but the rapidly rising male overweight incidence drove the decadal increase. Building on the Swinburn et al. (2019) intracountry differences model of nutrition transition (Popkin, 1999), we identify three stressors—biological, obesogenic, and environmental (health)—which are correlated with the emergence of within-country and gender differences in overweight incidence in this context.

To empirically model rising overweight incidence and these intracountry differences, we use the third (2005–06) and fourth (2015–16) rounds of the National Family Health Surveys (NFHS) of India. The NFHS is a nationally representative, multi-year, cross-sectional data set with information on height and weight measurements of over 800,000 women and men between the ages of 18 and 49. These two data sets

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capture health, demographic, obesogenic, socioeconomic status (SES) information, as well as on geographic indicators for both genders, and are most comparable in terms of data collected.[1] Using the Oaxaca–Blinder (OB) decomposition method, we identify the most important correlates of these emerging intracountry differences in nutrition transition (NT) in India.

We see that the positive correlation of overweight incidence across the distribution of SES has increased in rural areas. In urban areas, which are at later stages in the NT, *lower* SES shows a greater (positive) correlation with overweight incidence. This finding supports the propositon made by Popkin (1997, 1999) that economic development increases overall income per capita and changes the principal malnutrition risk faced by the poor from undernutrition to overnutrition. We show that biological differences, intrahousehold differences in access to obesogenic technologies and, obesogenic behaviors provide insight about within-country differences in overweight incidence in this context, affirming and building on the proposition of Swinburn et al. (2019) that an "obesogenic environment" accounts for within-country differences of overweight incidence during the NT. Within groups, we find that biological risks, such as age and lowering of reproductive stress, are correlated with higher overweight rates among women (Adair, 2004; Wen et al., 2009; Averett et al., 2014) but not as much for men. Among men, changes in access to obesogenic technologies are associated with overweight incidence. The type of biological and obesogenic factors that are correlated with overweight incidence also vary by the level of economic development. At early stages of the NT (such as rural areas), when the level of economic development is low, the lowering of reproductive stress is associated with higher overweight incidence among women. At later stages of the NT (urban areas), when the level of economic development is high, age becomes strongly associated with overweight incidence. For men, at early stages of the NT, access to motorized vehicles is strongly (positively) correlated with overweight incidence. This type of obesogenic technology is correlated with growing economic opportunities for the household and is available for men's use (Masamha et al., 2018). We hypothesize that its relationship with overweight incidence comes from the reduction in physical activity, which the technology enables for this group. At later stages of the NT, obesogenic behaviors, such as the reduction in smoking incidence and an increase in hours of watching television, are also correlated with overweight incidence among men. As expected, women's overweight incidence is also correlated with an increase in hours spent watching television. We propose that these results can be explained by intrahousehold differences in access to obesogenic technologies. Technologies that are nonexcludable within the household (such as television) affect overweight incidence among both men and women. Obesogenic technologies, which are excludable or associated with gendered access (motorized vehicles), affect men more. Thus, we assert that intrahousehold differences moderate the gendered experience of the NT. Surprisingly, we see that dietary diversity reduces risks for overweight incidence among rural women but does not for any other group. The quality of the health environment, within which individuals live, is also a major factor that explains rising overweight incidence (Popkin et al., 1995; Dunton et al., 2009; Roberto et al., 2015). This rise can be explained by cluster-level factors, such as urbanization and increases in sedentary lifestyles due to the transitioning from labor-intensive agricultural occupations (Popkin, 1997; Jeffery and French, 1998). Correlations between these factors and obesity have been found in other papers from India (Dang et al., 2019; Siddiqui and Donato, 2020; Aiyar et al., 2021).

Our paper contributes to the literature in the following ways: first, at the individual level, we find that the type of biological factor that is correlated with overweight incidence varies by the level of economic development. Literature from developed countries has highlighted the influence of factors such as age, reproductive stress, and genetics (James et al., 2001; Adair, 2004; Wen et al., 2009; Averett et al., 2014). We show that the type of biological factor (reproductive stress or age) associated with overweight incidence depends on the level of development (lower or higher). Second, intrahousehold differences in access to obesogenic technologies influence the within-household obesogenic environment. This creates the medium through which gender differences in overweight incidence emerge. Third, we show that beyond individual- and household-level factors, which are correlated with obesity, one should also take into account the influence of meso- and macro-environmental conditions while assessing the correlates of overweight incidence. Here, we show that changes in access to obesogenic technologies in rural areas and changes in obesogenic behaviors in urban areas are correlated with overweight incidence. All these factors create the conditions from which within-country and within-gender differences in overweight incidence emerge. Thus, in conclusion, we propose that nutrition policies focused on prescribing diet and physical activity changes should take into consideration gender, age, and the influence of the obesogenic environment. We also submit that similar correlational expositions may be important to inform research seeking causal explanations on rising obesity risks at low levels of food security.

The rest of the paper is structured as follows: in Section 2, we provide a conceptual model that adds new dimensions of gender and level of economic development to explain within-country differences in rising overweight incidence in the NT. In Section 3, we present details on data and variables used. We also present literature in support of the variables used in the analysis. In Section 4, we describe the methods and the respective empirical strategies. In Section 5, we summarize the results. Section 6 provides a discussion on policy implications, and Section 7 concludes.

2. Conceptual framework

Our conceptual model extends the nutrition transition theory to include an explanation on how within-country differences in overweight prevalence rates emerge over time. Popkin (1997, 1999) suggests that during a country's NT, obesity risks decline among the richer populations and increase among the poorer populations. The transition from labor-intensive agricultural work to nonagricultural employment during economic growth reduces the energy expenditure of the work effort (Popkin, 1997; Jeffery and French, 1998). At the same time, rising wages and the growth in female labor force participation increase the opportunity cost of women's time for home production. Combined with access to (relatively) cheaper processed foods, intake of energy-dense foods increases. Thus, calorie expenditures of individuals decrease. These two factors reinforce risks for overweight incidence. The rich are able to ameliorate these effects by improving dietary diversity and increasing physical activity due to greater leisure. Hence, during economic development, there is a shift of the socioeconomic (SES)-gradient to lower economic classes (Popkin et al., 1995; Popkin, 1997, 1999; Bell et al., 2002; Kosulwat, 2002; Case and Menendez, 2009; Jones-Smith and Popkin, 2010; Dake et al., 2011; Averett et al., 2014; Tafreschi, 2015). Swinburn et al. (2019) develop the NT model further and propose that an "obesogenic environment," consisting of biological factors (genetics, health) and other factors (socioeconomic, cultural, and transportation), account for within-country growth of overweight incidence.

We propose that, in addition to these factors identified by Popkin et al. (1995), Popkin (1997) and Swinburn et al. (2019), within-country differences may arise due to biological differences and intrahousehold differences in obesogenic technologies or obesogenic behaviors that also vary by regional development. Adding to Swinburn et al. (2019), biological risks in our model arise from both changes in the level of reproductive stress and age when economic development increases. Obesogenic risks for overweight incidence are subdivided into two categories - an obesogenic technology effect and an obesogenic behavior

[1] Round 1 (1992–93) and Round 2 (1998–99) did not collect information from men, whose experiences of obesity are an important part of our model. Hence, we did not use these earlier survey years.

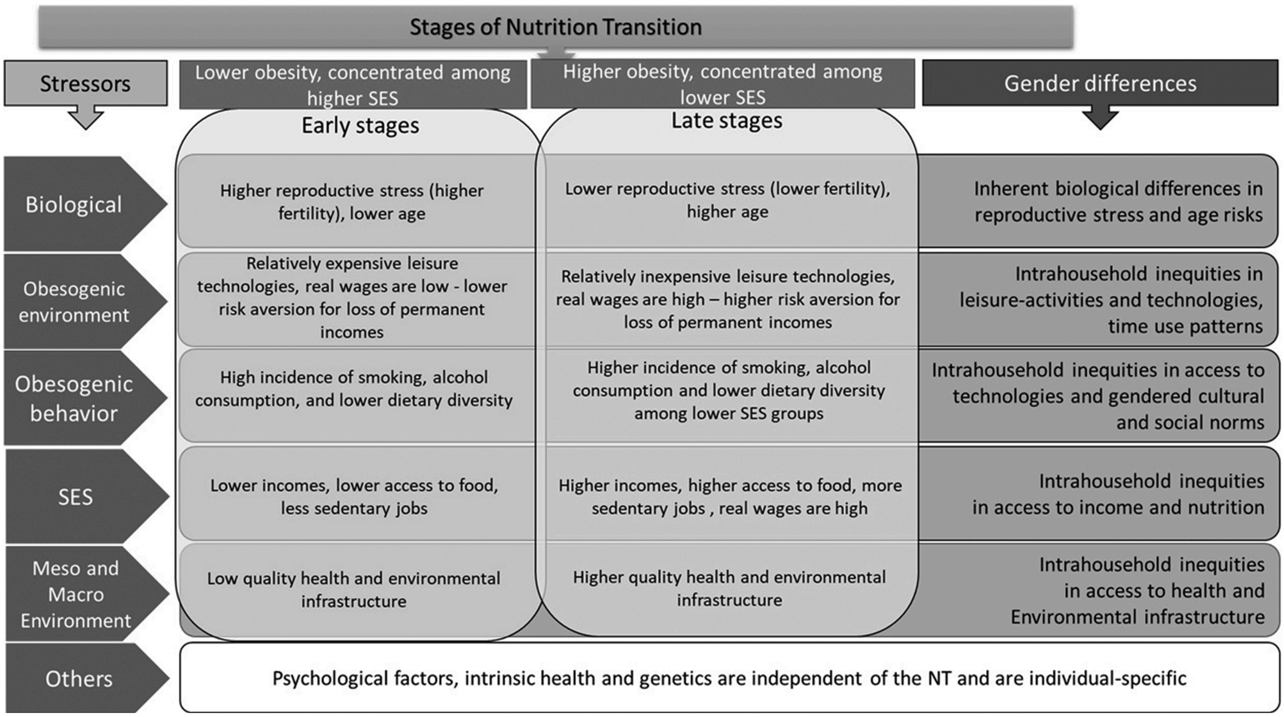

Fig. 1. Factors that contribute to within-country differences in overweight prevalence during the nutrition transition.

effect. The former refers to the effects of, access to, leisure-enhancing technologies found within the household that increase propensity for obesity. The latter refers to individual behaviors that are associated with sedentary lifestyles. These influence obesity and their effects vary by gender and level of economic development. Adding to the NT, we propose that the health environment within which an individual is situated is an important input for increasing overweight incidence. At the meso-level, cluster-wise impacts of development influence overweight incidence of the individual. At the macro-level, the state-of-residence, which is correlated with the development trajectory of the individual, also plays a role. Other factors identified such as intrinsic health, psychological factors, and genetics are assumed to be specific to the individual and uncorrelated with economic development. In Fig. 1, we summarize mechanisms that create within-country and gendered differences in overweight prevalence.

2.1. Biological stressors

The literature on fertility shows a relationship between diminishing fertility and increases in BMI (Adair, 2004). When women's fertility is incomplete or they have shorter lengths of birth spacing (between children), they experience higher reproductive stress (Dhingra and Pingali, 2021). This stress is also associated with a decrease in maternal BMI. Age may also contribute to overweight incidence. In developed countries, women tend to be more vulnerable to the negative effects of age-related increases in BMI (Kolodinsky and Goldstein, 2011). Mortality risks among obese, middle-aged (40–60 years) individuals are higher than in a comparably aged, healthy cohort (Bender et al., 1999; Elia, 2001).

At early stages of NT, when development and the demographic transition is at a nascent stage, fertility is high, and the population share is skewed toward a younger age group. In these populations, there are higher rates of reproductive stress, and hence, lower overweight incidence. At later stages of NT, when the demographic transition is complete, fertility declines first, thus increasing risks for obesity. When the NT is complete, fertility in the population is low and the demographic dividend has waned. This increases the demographic-related risks for overweight incidence among older populations (Bar and Leukhina, 2010).

For men, given their different physiology, we hypothesize that reproductive stressors are not significant factors in overweight risks. Age, on the other hand, may impact male overweight incidence through its relationship with nutritional intake and physical activity.

2.2. Obesogenic stressors

2.2.1. Influence of the obesogenic technology

A stressor emphasized in the literature is obesogenic technology. In our model, we conceptualize the consumption of obesogenic technology as an outcome of a leisure–labor trade-off that varies with the level of NT. In the initial stages of NT, when development is low and wages are on the rise, the opportunity costs of leisure activities are high. Individuals choose to consume technologies or goods and services that enhance their ability to rest (since leisure is at a premium at this time). This includes the purchase of motorized vehicles or construction of piped water supplies within the household. Increases in access to such technologies facilitate increases in overweight incidence through the reduction of work-related physical activity. At later stages of NT, when real wages have converged across sectors, leisure is no longer at a premium. Hence, individuals may redirect time toward activities or technologies, such as exercise machines, which can increase their health (Lakdawalla and Philipson, 2009).

If there are intrahousehold differences in accessing leisure technologies, these would contribute to differences in overweight rates by gender. For example, time-saving home technologies, such as piped drinking water, washing machines, and vacuum cleaners reduce the caloric expenditure of individuals (Popkin, 1997). Since women are largely relegated to these tasks, their calorie use may decrease faster than men during the NT, thus increasing their risks for getting overweight. Intrahousehold disparities in access to income-generating assets leads to men using motorized vehicles more than women (Masamha et al., 2018). These intrahousehold disparities in access to goods and services are known to impact nutritional outcomes of women more adversely (Sengupta et al., 2015; Meenakshi, 2016; Pingali and Rao, 2017; Pingali et al., 2019a).

2.2.2. Influence of obesogenic behaviors

Other obesogenic factors include behaviors such as watching television, smoking, consuming alcohol, and consuming fatty foods. These factors showcase that individuals exhibit present bias, and thus, engage in unhealthy behaviors that increase overweight incidence. At early stages of development, when the NT is just beginning, individuals may have high discount rates and may prefer time spent watching television or consuming more addictive goods (rather than time spent exercising). At later stages of the NT, these same individuals may prefer to invest more time on health production (Jeffery and French, 1998). These factors may change their risks for overweight incidence regardless of gender.

At lower SES, individuals are more likely to smoke more, less likely to binge drink, and less likely to consume fatty foods. These factors are negatively correlated with overweight incidence. For example, smoking has been found to reduce overweight incidence; for those who stop smoking, however, overweight incidence risk factors greatly increase, compared to nonsmoking groups (Popkin et al., 1995; Rosmond and Björntorp, 1999; Thorpe and Ferraro, 2004; Gallus et al., 2015). Access to tobacco and alcohol in India varies by gender and level of economic development (Neufeld et al., 2005). These differences may explain intrahousehold and intra-country differences in overweight incidence. Consumption of television, on the other hand, may be nonexcludable by gender. Hence, such technologies may increase time spent on leisure for both genders, thus increasing risks for overweight for both groups.

Increase in demand for dietary diversity is an outcome of NT. Economists have proposed that the greater influence of globalization increases demand for more Western diets (Pingali, 2007). These diets, which are characterized by greater consumption of energy dense foods, such as sugary beverages and fried foods, are also risk factors for overweight incidence. It has been found that Indians are much more susceptible to diet-related diseases when they consume the same amount of food as comparable white-counterparts in the same weight, gender, height, and age class (Gulati et al., 2013; Arora et al., 2014). Women in India are also known to have lower dietary diversity within the same household. However, these factors have not yet been linked to overweight incidence in India.

2.2.3. Socioeconomic status-related stressors

During early stages of the NT, overweight incidence is associated with higher SES of individuals (Popkin et al., 1995; Adair, 2004; Victora et al., 2008; Wang et al., 2009; Wen et al., 2009; Custodio et al., 2010; Black et al., 2013; Averett et al., 2014). At later stages of NT, markets and food safety nets increase access to food. Opportunity cost of wage loss from leisure is higher among those of lower SES than high SES. If food markets are perversely structured, this could discourage consumption of healthy foods in favor of processed foods. These factors may increase risks for overweight incidence among lower SES groups. Among higher SES groups, loss of permanent income from being unhealthy outweighs short-term costs involved in investing in health. Thus, the rich and higher SES groups utilize their higher incomes to buy better quality food and utilize leisure on health-building activities. These actions reduce overweight incidence among higher SES groups, flipping the SES–overweight incidence gradient at higher levels of development (Cawley, 2010, 2015; Hajizadeh et al., 2014; Gallus et al., 2015).

The caste and religion variables are similar to the race variable in developed countries. They capture structural differences that can lead to socioeconomic disparities in health outcomes commonly seen in developed country contexts (Cossrow and Falkner, 2004; Dinsa et al., 2012; Hajizadeh et al., 2014; Paeratakul et al., 2002; Wilcox et al., 2011). In India, caste and religion captures cultural differences and differences in dietary habits and nutritional behaviors (Kulkarni, and Gaiha, 2017). Groups that are in lower SES groups also have lower access to food and greater food insecurity. Therefore, they are likely to have lower overweight incidence. Hence, we include these variables in the measure of the SES gradient for overweight incidence (Chitnis, 1997; Kulkarni and Gaiha, 2017).

Differences in intrahousehold access to income by gender may influence the SES–overweight gradient. At lower levels of incomes, women face higher constraints in access to food (Pingali and Rao, 2017). When economic constraints ease, they may likely see an increase in overweight incidence. For richer women, lower intrahousehold inequality may protect them against the SES gradient. Better access to information and options to partake in their own health investments may protect them against overweight incidence risks that arise from higher SES (Cawley, 2015).

2.3. Health environment stressors

2.3.1. Influence of within-community (meso) health environment

Another important determinant of overweight incidence is the role of the meso-level development. The availability of public infrastructure to engage in exercise can help reduce overweight rates (Popkin et al., 1995; Dunton et al., 2009; Roberto et al., 2015). However, at early stages of the NT, the lack of access to safe and affordable public spaces to engage in physical activity may further exacerbate inactivity (Popkin et al., 1995; Dunton et al., 2009; Roberto et al. 2015). Gender differences in occupations and access to health and environmental infrastructure may impact risks for women thus creating gender differences in overweight patterns.

Overweight incidence levels within a local area have been found to be strongly correlated with development indicators in emerging economies (Popkin et al., 1995; Jones-Smith and Popkin, 2010; Aiyar et al., 2021). In addition to its relationship with local level development, cluster-level overweight incidence may also be attributed to cultural norms that are pervasive in local areas. In many less developed countries, being overweight is considered to be a physically attractive trait (Misra et al., 2011; Ranjani et al., 2016), while in developed countries, it is considered to be a negative trait (Ulijaszek, 2007; Cawley, 2015). Thus, a community-level overweight incidence indicator might be a key predictor for changes in overweight rates among individuals during the NT as well.

2.3.2. Influence of the macro- (state-of-residence) environment

Siddiqui and Donato (2020) identified overweight incidence in India as dependent on the economic growth within a particular region (state). They found that the SES gradient is downward sloping for urban women living in more developed states in India. More developed states experience obesity at higher rates in the population even among their poor (Griffiths and Bentley, 2001; Meenakshi, 2016). Building on Swinburn et al. (2019), we propose that the NT stage matters in explaining India's within-country differences. In low agricultural productivity states (LAP)/lagging states, lower economic growth and lower access to proper nutrition imply the states are in the early stages of the NT. These Indian states have development outcomes similar to poor countries in sub-Saharan Africa (Pingali and Aiyar, 2018). High agricultural productivity (HAP) states are in the middle of their transformation. Though incomes are increasing, the main value-addition in HAP states comes from the agricultural sector. Rapidly transforming states (RTS) are highly urbanized states and are on the way to completing their NT. These states are characterized by more developed food markets as well as more opportunities for economic growth. The latter group is comparable to emerging economies from Asia and Latin America (Pingali and Aiyar, 2018; Pingali et al., 2019b). Thus, we create a classification that characterizes changing risks during the early, middle, and late stages of NT at the macro-level.

2.4. Other factors

Among other individual-level factors that impact overweight incidence are intrinsic health, mental health, and genetics. Intrinsic health

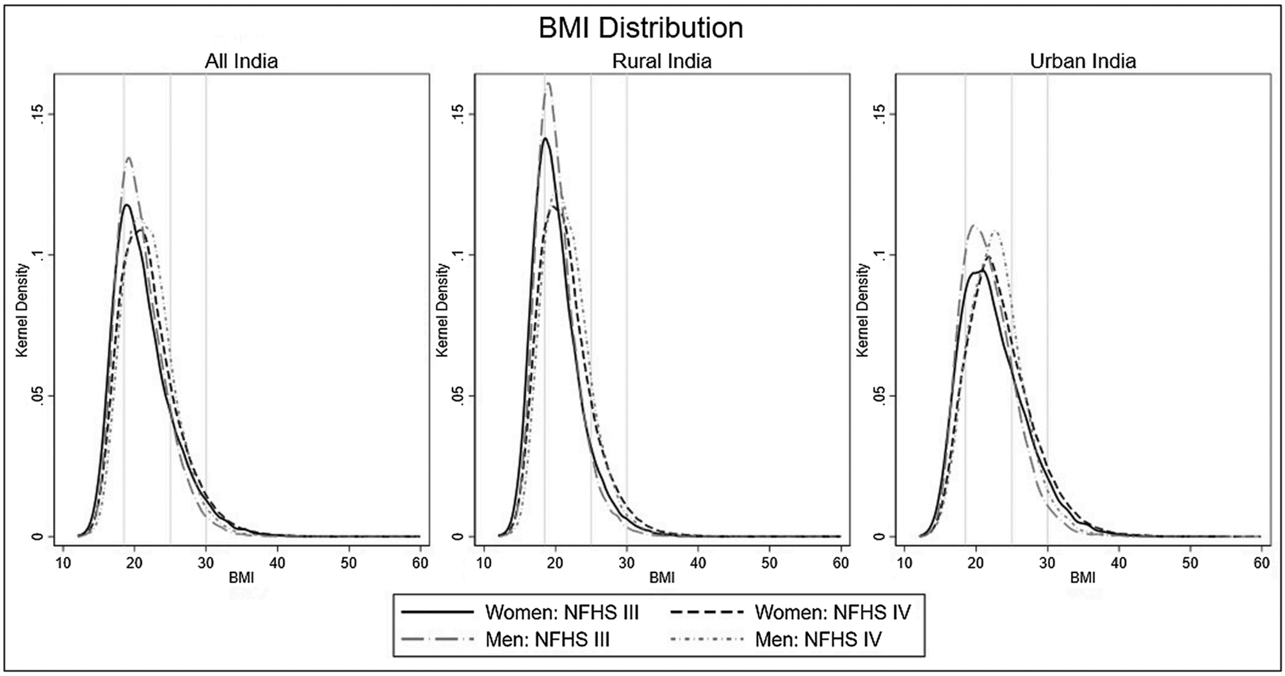

Fig. 2. Changes in distribution of BMI between NFHS III and NFHS IV.
Fig. 2 shows the distribution of BMI by each group—All India (left), Rural (middle) and Urban (right). In each graph, the vertical lines represent the cutoffs for underweight (left: BMI < 18.5), overweight (middle: BMI ≥ 25), and obese (right: BMI ≥ 30). The solid black curve represents the distribution of women's BMI in 2005–06, and the black curve with dashed lines represents the distribution of women's BMI in 2015–16. The gray curve with dashed lines represents the distribution of men's BMI in 2005–06, and the gray dotted curve represents the distribution of men's BMI in 2015–16

Table 1
Sample proportions of outcomes, by place of residence, gender, and the National Family Health Survey round.

	All India		Rural				Urban			
			Women		Men		Women		Men	
	NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV
Underweight (BMI < 18.5)	0.29	0.19	0.35	0.23	0.30	0.18	0.20	0.13	0.20	0.12
Normal (18.5 ≤ BMI < 25)	0.58	0.60	0.56	0.61	0.63	0.67	0.54	0.56	0.62	0.61
Overweight (BMI ≥ 25)	0.13	0.21	0.09	0.14	0.07	0.15	0.26	0.31	0.18	0.27
Percent change in overweight incidence (base 2005)		57		75		117		25		53

Source: Authors' calculation using sample, aged 18–49 with non-missing BMI and main explanatory variables, extracted from National Family Health Surveys (NFHS) Round III (2005–06) and IV (2015–16); excludes Union Territories.
Notes: BMI: Body Mass Index.

conditions can slow down metabolism and reduce energy to do physical activity, and hence, increase risks for overweight incidence. Risks also vary by physiology. Women, for example, are not able to convert excess calories into lean muscle as efficiently as men (James et al., 2001), making women more susceptible to gaining weight. Studies have also shown that overweight incidence is correlated with lower self-esteem and greater propensity for depression (Rosmond and Björntorp, 1999; Falkner et al., 2001; Roberto et al., 2015). These factors negatively influence the daily commitment of people to self-development and the incentive to exercise, which can lead to greater overweight incidence. According to Sniderman et al. (2007), Asian populations have lower adipose storage compartments than their white counterparts. These genetically related factors have been thought to explain the higher rates of growth in abdominal overweight incidence among Asians and higher risks for vascular diseases at lower BMI (Sniderman et al., 2007).

3. Data and methodology

3.1. Data

Our data come from the National Family Health Survey (NFHS) of India, a nationally representative, multi-stage, cross-sectional survey. The data set is also known as the Demographic Health Surveys (DHS) of India. In this paper, we use data from NFHS III (2005–06) and NFHS IV (2015–16), since the previous rounds of NFHS do not collect survey information from men. The NFHS III and IV contain information from more than 800,000 women and men, between the ages of 15–49, living in more than 700,000 households. In both NFHS III and IV, the focus is on collecting information on women's and children's health. Hence, samples for these groups tend to be large, compared to men's samples. In this analysis, we use information from adult men and women. The adult

Table 2
Sample means/proportions, by round and place of residence.

Covariates		All India		Rural India		Urban India	
		NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV
Age cohorts	Age: 18–19[b]	0.09	0.08	0.09	0.08	0.09	0.07
	Age: 20–24	0.20	0.18	0.19	0.18	0.20	0.18
	Age: 25–29	0.18	0.18	0.18	0.18	0.18	0.18
	Age: 30–34	0.16	0.16	0.16	0.16	**0.16**	**0.16**
	Age: 35–39	**0.15**	**0.15**	0.15	0.15	0.15	0.15
	Age: 40–44	0.13	0.13	0.13	0.13	0.13	0.13
	Age: 45–49	0.10	0.12	0.10	0.12	0.10	0.12
Reproductive stress	Unmarried	0.23	0.19	0.18	0.17	0.28	0.23
	Children born (no.)	2.16 (2.03)	2.10 (1.81)	2.46 (2.15)	2.23 (1.86)	1.82 (1.82)	1.79 (1.63)
	Fertility not completed	0.43	0.40	0.40	0.39	0.46	0.43
Obesogenic factors	Diet diversity: High	0.21	0.23	0.27	0.26	0.15	0.17
	Smoke	0.30	0.16	0.33	0.16	0.27	0.14
	Alcohol	0.16	0.07	0.16	0.07	0.16	0.06
	Leisure: TV not daily	0.47	0.44	0.64	0.53	0.27	0.22
	Exercise: Time to fetch water (minutes)	4.63 (12.43)	4.47 (10.77)	6.28 (13.93)	5.49 (11.69)	2.79 (10.21)	2.01 (7.57)
	Transport: Car	0.07	0.10	0.05	0.09	0.08	0.13
	Transport: Motorbike	0.24	0.39	0.15	0.34	0.34	0.53
Socioeconomic status (SES)	Harmonized Wealth Index (HWI)	–0.15 (1.05)	0.08 (0.92)	–0.70 (0.92)	–0.20 (0.86)	0.47 (0.81)	0.75 (0.66)
	Education: No education[b]	0.27	0.29	0.37	0.34	0.16	0.17
	Education: Primary	0.15	0.13	0.18	0.15	0.12	0.11
	Education: Secondary	0.44	0.44	0.39	0.42	0.50	0.49
	Education: Higher	0.13	0.13	0.06	0.09	0.22	0.24
	Religion: Hindu[b]	0.73	0.74	0.75	0.76	0.71	0.69
	Religion: Muslim	0.13	0.13	0.10	0.11	0.16	0.18
	Religion: Christian	0.09	0.07	0.10	0.07	0.08	0.08
	Religion: Other religions	0.05	0.05	0.06	0.05	**0.05**	**0.05**
	Caste: Missing	0.04	0.05	0.05	0.05	0.04	0.05
	Caste: SC	0.17	0.18	0.17	0.19	0.16	0.16
	Caste: ST	0.13	0.18	0.17	0.21	0.08	0.11
	Caste: OBC	0.33	0.38	0.35	0.37	0.32	0.41
	Caste: None of the above[b]	0.33	0.21	0.26	0.18	0.40	0.27
Meso-environment	Adults overweight: Community	0.14 (0.13)	0.18 (0.14)	0.08 (0.09)	0.14 (0.12)	0.21 (0.13)	0.28 (0.15)
State of residence	LAP[b]	0.34	0.50	0.36	0.52	0.32	0.44
	HAP	0.14	0.10	0.14	0.10	0.14	0.11
	RTS	0.32	0.22	0.28	0.18	0.37	0.29
	Hilly	0.20	0.18	0.22	0.19	0.17	0.16
	Observations	156,374	659,592	82,255	465,914	74,119	193.678

Source: Authors' calculation using sample aged 18–49 with non-missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
Notes: Standard deviations for continuous variables are in parentheses.
Figures in bold represent differences that are not statistically significant between rounds. All other changes between NFHS III and NFH IV show that means are statistically different at the 5% level.
BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states.
[b]This is the omitted category.

samples are designed to be representative at the regional (state) level. Only in NFHS IV is the women's survey designed to be representative at the district (county) level. Information on the socioeconomic variables (except incomes and expenditures), demographic information, fertility-related choices, and preferences and location of the households are also collected from those surveyed.

3.1.1. *Outcome variable*

In the NFHS, the height and weight of individuals were measured during the survey. In our paper, we calculate the BMI by dividing the weight of the individual in kilograms with the squared height (meters squared) of an individual. This is the standard formula of the World Health Organization (WHO) for measuring BMI. Wen et al. (2009) showed that Asian-adults are at high risks for overweight incidence-related noncommunicable diseases (NCDs) and mortality at a lower BMI of 23. However, to maintain consistency with the commonly used global standards for identifying overweight adults, we use the BMI cutoff of 25.[2]

We drop individuals between the ages of 15–18, since their BMIs are more amenable to changes in immediate health. Also, WHO defines overweight incidence differently for these age groups, making comparisons more complicated (Dunton et al., 2009). We also drop women who report being pregnant during the surveys, as their BMI measurements do not represent their steady-state BMI. Additionally, to increase comparability across years, we restrict our samples to individuals who live in states that were surveyed in both years. This excludes adults living in six union territories of India. After the exclusion criteria, we are left with information from 840,226 individuals. Of these individuals, we exclude

[2] A robustness analysis does not reveal sensitivity of our results to the choice of this cutoff for overweight incidence.

Table 3
Linear probability model results for covariate on overweight incidence by survey round.

Stressors	Variables	Rural women		Rural men		Urban women		Urban men	
		NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV	NFHS III	NFHS IV
Age cohorts	Age: 20–24	0.00 (0.00)	0.01*** (0.00)	0.00 (0.00)	0.02*** (0.00)	0.01* (0.01)	0.02*** (0.00)	0.01* (0.01)	0.07*** (0.01)
	Age: 25–29	0.03*** (0.00)	0.05*** (0.00)	0.02** (0.00)	0.05*** (0.01)	0.07*** (0.01)	0.10*** (0.01)	0.05*** (0.01)	0.11*** (0.01)
	Age: 30–34	0.06*** (0.00)	0.11*** (0.00)	0.04*** (0.01)	0.08*** (0.01)	0.15*** (0.01)	0.18*** (0.01)	0.08*** (0.01)	0.15*** (0.01)
	Age: 35–39	0.09*** (0.01)	0.14*** (0.00)	0.05*** (0.01)	0.11*** (0.01)	0.22*** (0.01)	0.23*** (0.01)	0.12*** (0.01)	0.17*** (0.01)
	Age: 40–44	0.11*** (0.01)	0.16*** (0.00)	0.06*** (0.01)	0.12*** (0.01)	0.27*** (0.01)	0.29*** (0.01)	0.13*** (0.01)	0.19*** (0.02)
	Age: 45–49	0.13*** (0.01)	0.18*** (0.00)	0.07*** (0.01)	0.12*** (0.01)	0.28*** (0.01)	0.30*** (0.01)	0.14*** (0.01)	0.21*** (0.02)
Reproductive stress	Unmarried	–0.04*** (0.00)	–0.06*** (0.00)	–0.04*** (0.00)	–0.05*** (0.00)	–0.07*** (0.01)	–0.07*** (0.00)	–0.07*** (0.01)	–0.05*** (0.01)
	Children born (no.)	–0.00*** (0.00)	–0.00*** (0.00)	–0.00* (0.00)	–0.00*** (0.00)	–0.00 (0.00)	0.00** (0.00)	–0.00 (0.00)	0.01* (0.00)
	Fertility not completed	–0.01** (0.00)	–0.01*** (0.00)	–0.00 (0.00)	0.00 (0.00)	–0.01 (0.01)	–0.01** (0.00)	–0.02* (0.01)	–0.02 (0.01)
Obesogenic factors	Diet Diversity: High	–0.01** (0.00)	–0.00 (0.00)	–0.00 (0.00)	–0.01* (0.00)	–0.00 (0.01)	–0.00 (0.00)	–0.01 (0.01)	–0.00 (0.01)
	Smoke	–0.02*** (0.00)	–0.03*** (0.00)	–0.01*** (0.00)	–0.02*** (0.00)	–0.02*** (0.01)	–0.03*** (0.00)	–0.03*** (0.01)	–0.03*** (0.01)
	Alcohol	0.01 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.01 (0.02)	0.01 (0.01)	–0.00 (0.01)	–0.01 (0.01)
	Leisure: TV not daily	–0.01*** (0.00)	–0.01*** (0.00)	–0.01* (0.00)	–0.01** (0.00)	–0.03*** (0.01)	–0.01*** (0.00)	–0.02*** (0.01)	–0.01 (0.01)
	Exercise: Time to fetch water (minutes)	–0.00 (0.00)	–0.00*** (0.00)	0.00 (0.00)	–0.00 (0.00)	–0.00 (0.00)	–0.00 (0.00)	0.00 (0.00)	–0.00 (0.00)
	Transport: Car	0.03*** (0.01)	0.02*** (0.00)	0.02* (0.01)	0.03*** (0.01)	0.03** (0.01)	0.02*** (0.00)	0.03* (0.01)	0.01 (0.01)
	Transport: Motorbike	0.02*** (0.00)	0.02*** (0.00)	0.06*** (0.01)	0.03*** (0.00)	0.04*** (0.01)	0.02*** (0.00)	0.06*** (0.01)	0.04*** (0.01)
Socioeconomic status (SES)	Harmonized Wealth Index	0.03*** (0.00)	0.03*** (0.00)	0.02*** (0.00)	0.02*** (0.00)	0.04*** (0.00)	0.05*** (0.00)	0.03*** (0.00)	0.02*** (0.01)
	Education: Primary	0.01*** (0.00)	0.02*** (0.00)	0.01** (0.00)	0.02*** (0.00)	0.02** (0.01)	0.03*** (0.01)	0.02 (0.01)	0.03* (0.01)
	Education: Secondary	0.02*** (0.00)	0.04*** (0.00)	0.02*** (0.00)	0.03*** (0.00)	0.04*** (0.01)	0.04*** (0.00)	0.04*** (0.01)	0.05*** (0.01)
	Education: Higher	–0.01 (0.01)	0.02*** (0.00)	0.03*** (0.01)	0.06*** (0.01)	0.02 (0.01)	0.02*** (0.01)	0.05*** (0.01)	0.07*** (0.01)
	Religion: Muslim	0.03*** (0.00)	0.03*** (0.00)	0.01 (0.01)	0.01** (0.00)	0.06*** (0.01)	0.05*** (0.00)	0.02** (0.01)	0.03*** (0.01)
	Religion: Christian	0.01** (0.00)	0.01** (0.00)	0.01* (0.01)	–0.00 (0.01)	0.02 (0.01)	0.02** (0.01)	0.02 (0.01)	0.02 (0.01)
	Religion: Other religions	0.02** (0.01)	0.01*** (0.00)	0.00 (0.01)	–0.00 (0.01)	0.03** (0.01)	0.01* (0.01)	0.03* (0.01)	0.03 (0.02)
	Caste: Missing	–0.01 (0.01)	–0.01*** (0.00)	–0.01 (0.01)	–0.02** (0.01)	–0.01 (0.01)	–0.02*** (0.01)	–0.01 (0.01)	–0.03 (0.01)
	Caste: SC	–0.01* (0.00)	–0.02*** (0.00)	–0.01* (0.00)	–0.02*** (0.01)	0.01 (0.01)	–0.01 (0.00)	0.01 (0.01)	0.00 (0.01)
	Caste: ST	–0.00 (0.00)	–0.01*** (0.00)	–0.00 (0.00)	–0.00 (0.00)	–0.02* (0.01)	–0.02** (0.01)	–0.01 (0.01)	–0.00 (0.01)
	Caste: OBC	–0.00 (0.00)	–0.02*** (0.00)	–0.01** (0.00)	–0.00 (0.00)	0.01* (0.01)	–0.01* (0.00)	0.00 (0.01)	0.00 (0.01)
Meso-environment	Adults overweight: Community	0.88*** (0.01)	0.92*** (0.00)	0.88*** (0.01)	0.96*** (0.01)	0.82*** (0.01)	0.92*** (0.01)	0.83*** (0.02)	0.94*** (0.01)
State of residence	HAP	–0.03*** (0.00)	–0.05*** (0.00)	–0.02*** (0.00)	–0.03*** (0.00)	0.00 (0.00)	–0.03*** (0.00)	0.00 (0.01)	–0.02*** (0.01)
	RTS	–0.03*** (0.00)	–0.04*** (0.00)	–0.02*** (0.00)	–0.03*** (0.00)	–0.02*** (0.00)	–0.02*** (0.00)	–0.01 (0.00)	–0.02*** (0.00)
	Hilly	–0.01*** (0.00)	–0.02*** (0.00)	–0.01*** (0.00)	–0.01** (0.00)	0.02*** (0.00)	0.00 (0.00)	0.02** (0.01)	0.01 (0.01)
	Constant	0.02** (0.01)	–0.03*** (0.00)	0.02* (0.01)	–0.05*** (0.01)	–0.11*** (0.01)	–0.17*** (0.01)	–0.04* (0.02)	–0.16*** (0.02)
	Observations	53,914	405,610	28,341	60,304	45,189	166,584	28,930	27,094
	R-squared	0.160	0.167	0.161	0.202	0.199	0.196	0.169	0.226

*p < 0.1, **p < 0.05, ***p < 0.01.

Source: Authors' calculation using sample aged 18–49 with non-missing BMI and main explanatory variables, extracted from the Indian National Family Health. Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.

Notes:

This table utilizes Eq. 1.

Standard errors are in parentheses and are clustered at the village/urban block level. Regressions are weighted by survey weights.

The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25. Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste categories for caste; LAP for state of residence.

BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.

Table 4
Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III.

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.208*** (0.001)	0.159*** (0.001)	0.148*** (0.002)	0.318*** (0.002)	0.272*** (0.005)
Overweight in NFHS III	0.132*** (0.002)	0.091*** (0.002)	0.068*** (0.002)	0.254*** (0.005)	0.178*** (0.004)
Total change[b]	0.075*** (0.003)	0.068*** (0.003)	0.080*** (0.003)	0.064*** (0.005)	0.094*** (0.007)
Explained contribution	0.094*** (0.003)	0.087*** (0.003)	0.103*** (0.003)	0.089*** (0.005)	0.116*** (0.006)
Unexplained contribution	–0.019*** (0.001)	–0.019*** (0.001)	–0.023*** (0.002)	–0.025*** (0.002)	–0.022*** (0.003)
B. Percent explained[c]: *Percent contribution of each risk factor to total change in overweight incidence over time*					
Age	4.12***	4.40***	0.66**	11.83***	3.84***
Reproductive stress	3.29***	0.94*	–0.08	–0.66	0.66
Obesogenic factors	20.35***	12.19***	22.80***	17.65***	20.50***
Socioeconomic status	16.77***	22.76***	16.58***	27.58***	15.76***
Meso-environment	77.99***	82.91***	85.77***	80.93***	82.97***
State of residence	3.55***	6.04***	3.58***	2.83**	0.85

***Source*:** Authors' calculation using sample aged 18–49 with non-missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
Notes: Panel A is calculated from OB decompositions run by using Eq. 4.
Each category in Panel B is the sum of percent contributions of individual variables that represent these categories. Detailed information on the contribution of each variable is in Table 5 below.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI $\geq$ 25.
[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III] BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.
Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.
[c] Percent explained refers to the % of Total change and is calculated as [(Explained estimate/Total change)* 100].
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
Age is the summation of the effects of belonging to each age cohort (20–24, 25–29, 30–34, 35–39, 40–44, 45–49 years); Reproductive stress sums the effects of whether the individual is unmarried, has not completed fertility, and the number of children born; Obesogenic factors are the sum of individual's food consumption behavior (high diet diversity, alcohol, and smoking consumption), Leisure (frequency of watching television), Exercise (time spent in fetching water), and Household's access to automatic vehicle; Socioeconomic status refers to the sum of the effects of individual's education, household wealth, caste, and religion on probability of the individual being overweight; Meso-environment refers to the overweight incidence environment captured by the proportion of overweight adults in the village or urban block; and State of residence refers to the summation of the effects of whether the individual belongs to HAP, RTS, or Hilly States.

an additional 2.64 percent of the sample, as their BMI was missing due to the lack of information on height, weight, or both. Comparing the sample for those with and without BMI information, we find that there are no statistical differences across covariates. Among the 818,065 individuals with valid BMI information, less than 1 percent have some covariates missing. T-tests of BMI reveal that there are no differences between groups with missing covariates, and hence, we drop them from the final sample. Our final sample consists of 815,966 individuals between the ages of 18 and 49.

In Fig. 2, we see that distribution of BMI has been shifting to the right over time, and there is greater mass from the increase in the prevalence of overweight or obesity incidence. This has come from both a reduction in undernutrition, as well as an increase in overnutrition within the country. In Table 1, we can see the mean overweight or obesity rates across the country between NFHS III and IV. The prevalence of overweight (and obese) individuals has almost doubled in a decade, increasing from 16 percent to 26 percent. Women in urban areas have the highest overweight rates, and the rate has increased from 31 percent to 41 percent. Rural women have seen an increase in overweight incidence from 11 percent to 19 percent while rural men have seen their overweight prevalence increase from 8 percent to 17 percent. Urban men's overweight incidence has increased from 21 percent to 32 percent. In the last row in Table 1, we can see that the changes in overweight incidence in the country have been driven by rural overweight rates and changes in overweight incidence among men.

3.1.2. Variable(s) of interest

NFHS samples are collected separately for men and women. Based on data available in the NFHS, we identify covariates to capture the conceptual categories discussed in Section 2. More detailed information on how each covariate was constructed from the data set is available in Appendix A.

3.1.3. Biological variables

Gender, age, and reproductive factors are observed in the NFHS. Age is collected as reported age, in years, during the survey year. Birth year information is not consistently available among all respondents. We find that there is recall bias in age that leads to spikes in the age-distribution at multiples of five. Hence, we create categories of age cohorts that we identify as similar to those used in the literature.[3]

We capture reproductive stress in three ways in this paper: we utilize information from the NFHS on marital status, the number of children born, and preference for stopping fertility. Greater reproductive stress is correlated with being married, having more children, and a lower preference for ending fertility (Adair, 2004; Wen et al., 2009; Averett et al., 2014). The literature does not document the role of ending fertility or the number of children for determining overweight incidence among men. We assume that this is an outcome of (maybe an obvious reason) male physiology. We include these same variables for the analysis in men as a data check.

A data-related caveat here is that we recognize that other factors, such as mental health, intrinsic health, and genetics are also biological inputs into overweight incidence that may be specific to the individual.

[3] We also find our results are robust to including the variable as age in years. We maintain groupwise classification for ease of interpretation and for comparability with the literature.

Table 5
Detailed Oaxaca–Blinder decomposition of the explained part of the overweight prevalence gap[a].

Stressors	Variables	All India (1) %[b]	Rural women (2) %[b]	Rural men (3) %[b]	Urban women (4) %[b]	Urban men (5) %[b]
Age cohort	Age: 20–24	–0.07*	–0.01	–0.01	–0.26	–0.46
	Age: 25–29	–0.17*	–0.23**	–0.09	–0.30	–0.02
	Age: 30–34	–0.52***	–0.94***	–0.04	–0.96	0.53
	Age: 35–39	–0.23	–0.28	–0.19	–0.80	0.75
	Age: 40–44	0.50*	0.43	–0.04	2.57**	0.88
	Age: 45–49	4.60***	5.43***	1.03***	11.60***	2.14***
Reproductive stress	Unmarried	1.74***	–1.09***	–1.02***	–0.98*	0.94*
	Children born (no.)	1.26***	2.45***	0.99*	0.92	0.13
	Fertility not completed	0.26***	–0.38**	–0.05	–0.55	–0.40
Obesogenic factors	Diet diversity: High	0.06	0.20*	0.12	0.05	–0.35
	Smoke	5.16***	1.67***	3.14***	0.50*	3.16***
	Alcohol	–0.17	–0.24	–0.12	0.04	0.08
	Leisure: TV not daily	1.74***	2.32***	1.25*	2.54***	1.26**
	Exercise: Time to fetch water (minutes)	0.10	0.26	–0.05	0.83	–0.27
	Transport: Automatic vehicle	13.36***	8.13***	18.59***	13.53***	16.57***
Socioeconomic status (SES)	Harmonized Wealth Index	15.38***	24.08***	16.20***	23.02***	13.06***
	Education: Primary	–0.51***	–0.48***	–0.64*	–0.60*	–0.48
	Education: Secondary	0.58***	1.71***	1.50***	0.30	–0.17
	Education: Higher	0.55**	–0.45	1.84***	1.46	2.51***
	Religion: Muslim	0.85***	0.47	0.28	3.41**	0.87*
	Religion: Christian	–0.39**	–0.50*	–0.71*	–0.30	–0.17
	Religion: Other religions	–0.03	–0.15	0.02	–0.11	0.11
	Caste: Missing	–0.08	–0.02	–0.21	–0.14	–0.50
	Caste: SC	–0.07	–0.29*	–0.32*	0.07	–0.11
	Caste: ST	0.02	–0.01	–0.01	–0.80	–0.39
	Caste: OBC	–0.01	–0.17	–0.13	1.41*	0.01
Meso-environment	Adults overweight: Community	76.91***	80.74***	83.95***	79.74***	82.13***
State of residence	HAP	0.83***	2.13***	0.98**	–0.06	–0.02
	RTS	3.23***	3.09***	2.58***	2.89***	1.11
	Hilly	0.12	0.67**	0.25	0.01	0.36

Source: Authors' calculation using sample aged 18–49 with non-missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
Table Notes: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
Each cell in columns 1–5 is the percent contributions of variable as calculated in Eq. 5.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25.
[a]The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b]Percent refers to the percent explained of the total change and is calculated as [(Explained estimate/Total change)* 100]; Total Change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].
BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India. Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

We cannot model these factors due to lack of data. Even in cases where the factor is measured (diabetes incidence, for example), there is no consistency on how the variable is measured over time. Hence, we choose not to include those variables in this analysis.

3.1.4. Obesogenic variables

Drawing from literature that identifies obesogenic factors, we utilize covariates from NFHS, which capture changes in obesogenic technologies and obesogenic behaviors. For the former, we use two measures of access to obesogenic technologies. Time spent fetching water from outside the home reflects individuals' physical activity. In rural areas and among lower SES groups, individuals have to walk to and from outdoor water sources. For men, however, this variable cannot provide insight, since most water collection activities are undertaken by women. On the other hand, for men, the presence of a motorized transport vehicle within the household can be used as a measure of physical activity. Motorized vehicles include the use of a car (more common in urban areas) or a motorbike (common in both rural and urban areas), and they are mostly used by men in the household. Hence, we use this as a proxy of physical activity in men.

For obesogenic behaviors, we utilize variables recommended in the literature, such as hours spent watching television, alcohol consumption, smoking, and dietary diversity. A higher frequency of hours spent watching television indicates individuals' preferences for "relaxing" over engaging in exercise. Alcohol and tobacco consumption are coded as dummy variables that take a value 1 if the individual reports this activity. To capture diversity in diets, we construct a crude score using Arimond et al's 2010 definition of Dietary Diversity. A higher frequency of consuming non-staples in the diet, as listed in the NFHS (see Appendix A, Table A1 for details), increases our score of diet diversity. A caveat of our measure is that we cannot capture actual calorie consumption, the frequency of consumption of energy dense foods, or information on eating out, as these variables are not collected in either survey.

3.1.5. Socioeconomic variables

For socioeconomic variables that affect overweight incidence, we use a wealth index, education, caste, and religion. To account for intertemporal variation in data collection, we construct a harmonized wealth index (HWI), using a pooled-generation approach of common assets and

Table 6
Oaxaca–Blinder decomposition of changes in mean overweight prevalence between NFHS IV and NFHS III by wealth quintile (WQ)[a].

	All India	Rural India		Urban India	
A. Poorest (WQ = 1)	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.062*** (0.001)	0.054*** (0.001)	0.054*** (0.003)	0.185*** (0.003)	0.150*** (0.007)
Overweight in NFHS III	0.030*** (0.001)	0.026*** (0.001)	0.018*** (0.001)	0.131*** (0.004)	0.087*** (0.004)
Total change[b]	**0.032*** (0.001)**	**0.027*** (0.002)**	**0.036*** (0.004)**	**0.054*** (0.005)**	**0.063*** (0.008)**
Explained contribution	0.030*** (0.002)	0.025*** (0.002)	0.027*** (0.003)	0.051*** (0.005)	0.050*** (0.006)
Unexplained contribution	0.002 (0.002)	0.002 (0.003)	0.009* (0.005)	0.003 (0.006)	0.013 (0.008)
	All India	Rural India		Urban India	
B. Poor (WQ = 2)	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.110*** (0.001)	0.085*** (0.001)	0.072*** (0.003)	0.274*** (0.004)	0.210*** (0.008)
Overweight in NFHS III	0.073*** (0.002)	0.055*** (0.002)	0.038*** (0.003)	0.237*** (0.007)	0.165*** (0.007)
Total Change[b]	**0.037*** (0.002)**	**0.030*** (0.003)**	**0.034*** (0.004)**	**0.037*** (0.008)**	**0.045*** (0.010)**
Explained contribution	0.035*** (0.002)	0.037*** (0.003)	0.043*** (0.005)	0.061*** (0.007)	0.067*** (0.009)
Unexplained contribution	0.002 (0.003)	–0.007 (0.004)	–0.009 (0.006)	–0.023** (0.007)	–0.022* (0.011)
	All India	Rural India		Urban India	
C. Middle (WQ = 3)	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.178*** (0.001)	0.126*** (0.001)	0.112*** (0.003)	0.330*** (0.004)	0.294*** (0.010)
Overweight in NFHS III	0.140*** (0.003)	0.097*** (0.003)	0.070*** (0.004)	0.299*** (0.007)	0.223*** (0.008)
Total Change[b]	**0.039*** (0.003)**	**0.029*** (0.004)**	**0.042*** (0.005)**	**0.030*** (0.008)**	**0.071*** (0.013)**
Explained contribution	0.046*** (0.003)	0.042*** (0.004)	0.050*** (0.006)	0.056*** (0.007)	0.088*** (0.011)
Unexplained contribution	–0.007* (0.003)	–0.013** (0.005)	–0.008 (0.007)	–0.025*** (0.008)	–0.017 (0.013)
	All India	Rural India		Urban India	
D. Richer (WQ = 4)	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.271*** (0.002)	0.182*** (0.002)	0.167*** (0.004)	0.373*** (0.004)	0.342*** (0.010)
Overweight in NFHS III	0.232*** (0.004)	0.155*** (0.005)	0.124*** (0.006)	0.369*** (0.009)	0.299*** (0.011)
Total Change[b]	**0.039*** (0.004)**	**0.027*** (0.005)**	**0.044*** (0.007)**	**0.004 (0.010)**	**0.043** (0.015)**
Explained contribution	0.063*** (0.004)	0.046*** (0.005)	0.070*** (0.008)	0.040*** (0.008)	0.087*** (0.014)
Unexplained contribution	–0.024*** (0.004)	–0.019*** (0.006)	–0.026** (0.009)	–0.036*** (0.009)	–0.044** (0.015)
	All India	Rural India		Urban India	
E. Richest (WQ = 5)	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.364*** (0.002)	0.295*** (0.002)	0.268*** (0.005)	0.399*** (0.005)	0.352*** (0.010)
Overweight in NFHS III	0.345*** (0.005)	0.267*** (0.007)	0.234*** (0.010)	0.411*** (0.009)	0.338*** (0.012)
Total Change[b]	**0.019*** (0.006)**	**0.028*** (0.007)**	**0.034** (0.011)**	**−0.012 (0.010)**	**0.014 (0.016)**
Explained contribution	0.054*** (0.005)	0.068*** (0.008)	0.093*** (0.012)	0.032*** (0.009)	0.064*** (0.014)
Unexplained contribution	−0.035*** (0.004)	−0.040*** (0.007)	−0.059*** (0.013)	−0.044*** (0.009)	−0.050*** (0.013)

Notes: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
All panels are calculated from OB-decompositions run by using Eq. 4 on a wealth quintile sub-sample. The wealth quintile is calculated from the harmonized wealth index (HWI). Please see Appendix A, Table A1 for more details on the same.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BM I ≥ 25.
[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].

services available. This construction follows the methodology proposed by Staveteig and Mallick (2014).[4] A higher value of the wealth index implies that the household has a higher economic status. The second variable is education. Literature shows that those in the highest education classes have lower overweight incidence. We group individuals into those with no education, primary education, secondary education, and higher education.[5] By examining the changes in shares of each group over time and the correlation with overweight incidence, we provide evidence of the group risks for growth in overweight incidence by education levels. Third, for the caste variable, we use information on whether an individual belongs to the scheduled caste (SC), scheduled tribe (ST), or other groups. The religion variable, added to capture cultural differences in groups, accounts for whether individuals report themselves as Hindu, Muslim, Christian, or others.

3.1.6. *Meso-environment variables*

The literature recognizes a clustering of economic development, food availability (and preferences), and overweight incidence. As seen in Aiyar et al. (2021), cluster-level overweight incidence is highly correlated with access to urban markets with more economic opportunities and greater access to food. This strong relationship has also been attributed to cultural norms; in many less developed areas, being overweight is considered a physically attractive trait (Misra et al., 2011; Ranjani et al., 2016). To serve as proxy for this effect, we use the percent of individuals within a sample cluster who are overweight.[6] A sample cluster in NFHS data is a village in rural areas and a block in urban areas.

[4] The construction of HWI gives us the flexibility of using the assets of our choice. The variables that went into constructing HWI for India included: type of wall, roof, and floor material; number of usual residents per sleeping room; ownership of assets like land for agriculture (rural only), radio, mobile, refrigerator, watch, electric fan, table, chair, water pump, sewing machine, television; having a bank account; access to electricity, clean fuel for cooking; owning of farm animals; whether food is cooked in a separate room (kitchen) and cooking arrangement (chullah or stove). The codes for each of the variables were harmonized across the surveys. Then using the harmonized variables common to urban and rural areas, the HWI was computed using principal component analysis. Overall, we find that the HWI is highly correlated with the existing NFHS reported Wealth Index. Also, the process of harmonizing the coding across the two rounds does not compress the index, as the codes are very similar across the two rounds.

[5] We find results are robust to including the variable as education in years as well. We maintain groupwise classification for ease of interpretation.

[6] Percent overweight in the community = (Total number of sample adults overweight in the community excluding the respondent)/(Total number of sample adults in the community -1) * 100

3.1.7. State of residence variables

In order to capture the association of the macro-institutional environment on overweight incidence, we build on the framework of Indian development proposed by Pingali et al. (2019b), in which states are classified as lagging, highly productive agricultural, and highly urbanized states, based upon their level of structural transformation. More details on the states assigned to each group can be found in Appendix A.

3.2. Empirical strategy

3.2.1. Linear probability model

In the first stage, we use a linear probability regression model (LPM) to model the relationship between overweight and its correlates. Since our sample size is large, our estimates are no different than nonlinear estimations using logit or probit models.[7] The LPM model provides us with an overview of the cross-sectional contribution of each of the independent variables in each sample. The coefficients in the LPM model between the NFHS III and NFHS IV offers first stage results on the effect of each predictor on overweight incidence. We use the following model

$$Y_{is} = \beta_0 + \sum_{k=1}^{K} \beta_k * X_{is}^k + \sum_{c=1}^{C} \beta_c * X_{is}^c + \alpha_s + \varepsilon_{is} \quad (1)$$

Here, Y_{is} is the measure of overweight incidence for individual i in state of residence s. It is equal to 1 if BMI $\geq$ 25 and 0 otherwise. X_{is}^k are the k individual covariates that have been identified as determinants of overweight incidence. These include predictors of age, reproductive stress, the obesogenic environment, and SES at the household level. X_{is}^c refers to the local health environment factors of the individuals at the cluster level that influence overweight incidence. State of residence fixed effects, α_s, account for macro-level factors. The regressions are clustered at the primary sampling units, and the estimates are weighted to be nationally representative.

3.2.2. Oaxaca–Blinder (OB) decomposition

We utilize the Oaxaca–Blinder (OB) decomposition (Oaxaca, 1973; Blinder, 1973), to model which determinants explain the increase in overweight incidence in India between 2005–06 and 2015–16. OB decompositions can be divided into two parts: one, the portion that explains the differences in outcomes that arise from changes in the distribution of the predictors; and two, the changes in relative contributions of each predictor to the total change. Since we expect there are, most likely, differences related to how women and those at lower levels of economic development experience risks for overweight incidence, we model the OB decomposition to account for rural–urban differences between women and men separately.

The OB decompositions are derived as follows: consider that OW_{iw} denotes a dummy equal to 1 if the BMI for the ith individual measure in survey wave w, ($w = 3$ for NFHS III and $w = 4$ for NFHS IV) is greater than or equal to 25. Let $X_{iw}^{'}$ denote the set of predictors associated with the incidence of overweight rates among adults. Then, the probability of being overweight in a given year can be written as:

$$OW_{iw} = X_{iw}^{'}\beta_w + \varepsilon_{iw} \quad (2)$$

In a fully determined system, the change in means over each survey wave (between the NFHS III and NFHS IV) can be represented as:

$$\overline{OW}_4 - \overline{OW}_3 = \overline{X}_4^{'}\widehat{\beta}_4 - \overline{X}_3^{'}\widehat{\beta}_3 \quad (3)$$

where the left-hand side of the equation represents the total percent change in the overweight level over time.[8]

This change can be decomposed into the following:

$$= (\overline{X}_4 - \overline{X}_3)^{'}\ \widehat{\beta}_3 + \overline{X}_4^{'}(\widehat{\beta}_4 - \widehat{\beta}_3) \quad (4)$$

$$= \textit{Covariate Effect} + \textit{Coefficient Effect}$$

$$= \textit{Explained Effect} + \textit{Unexplained Effect}$$

The covariate (explained) effect is interpreted as effect of the change in the distribution of predictors on overweight incidence. That is, it captures how the changes in the distribution of factors related to age, reproductive stress, obesogenic factors, SES, and the health environment (meso- and state-of-residence factors) are correlated with the changes in the mean overweight incidence rates over the last decade. The covariate effect is weighted by the risk posed by each predictor and this is derived from the regression coefficients from NFHS III survey.[9] The coefficient (unexplained) effect, on the other hand, measures the change in the "relative contributions" of these predictors on overweight incidence. It captures the differential strength of relationships between adult health and the overweight incidence-related endowments over the survey time frame. The unexplained components are weighted by the average of the distribution of the predictors in the NFHS IV survey.[10] For this paper, we derive separate OB decompositions for urban females, rural females, urban males, and rural males.

To aid in interpretation, we also calculate the contribution of each of the predictors to the increase in overweight prevalence within a group. The estimate for the explained and unexplained effect for each predictor, in each group, is converted to percent share of the total change using the following equations:

$$\textit{Percent explained by a predictor} = \left[\left(\frac{\textit{Explained estimate}}{\textit{Total change}}\right)*100\right] \quad (5)$$

$$\textit{Percent unexplained by a predictor} = \left[\left(\frac{\textit{Unexplained estimate}}{\textit{Total change}}\right)*100\right] \quad (6)$$

The contribution of the factor (biological, obesogenic, SES, environmental factors, etc.) to total change is calculated by summing up the share of the covariates that make up the specific factor. This is done separately for the explained and unexplained estimates.[11]

4. Results

4.1. Summary statistics

In Table 2, we present sample and t-test results from changes in the means between NFHS III and IV. Overall, we see that, between 2005–06 and 2015–16, the mean age has increased. Total fertility rates in India are now close to replacement rates, and more individuals report having completed their fertility. The wealth index has been growing, while there has been little or no change in distribution of education. In terms of

[7] Results can be provided on request.

[8] This is similar in magnitude to the value obtained by subtracting the percentage of overweight individuals in NFHS III from the percentage of individuals overweight in NFHS IV.

[9] An alternative specification would be to use the regression coefficients from NFHS IV survey. Our results don't change with this alternative specification. See Appendix E, Table E3 for details.

[10] An alternative specification would be to use the by the average of the distribution of the predictors in the NFHS III surveys. Our results don't change with this alternative specification. See Appendix E, Table E3 for details.

[11] For each table presented, including those in the Appendix, we provide a reference to the equation used to estimate the results in the table footnotes.

obesogenic behaviors, the consumption of alcohol and tobacco has decreased. Additionally, the amount of time spent in physical activity such as walking, as proxied for by time taken to collect water, has decreased while the frequency of watching television has increased between the rounds. There are greater reports of car and motorbike ownership across the rounds. Overall, the percent of people consuming a diet with greater diversity has increased..

4.2. Linear probability model

Table 3 displays results from LPM run on the NFHS III and NFHS IV for rural women, rural men, urban women, and urban men. The models utilize all information described from Eq. 1. The direction of the association of most covariates with being overweight is as expected across the four models. Across all groups, age is positively correlated with overweight incidence, and this correlation has increased over time. This is in line with Dake et al. (2011) and Riera-Crichton and Tefft (2014), who found similar results in Ghana and China, respectively. With regard to reproductive stress, a lower stress, as indicated by falling fertility and a greater preference for fertility stopping, is associated with greater overweight incidence among women. This is supported by the literature from Ulijaszek (2007), who recognized the relationship of the demographic transition on overweight rates. Among men, being unmarried and having less children is correlated with overweight incidence. Among obesogenic behaviors, higher dietary diversity is weakly and negatively correlated with overweight incidence in rural areas, but this is not the case for urban areas. Reductions in smoking, increase in television watching, and access to motorized technology are correlated with higher overweight incidence. These results are in line with literature that links obesogenic factors to the overweight incidence (Bell et al., 2002; Huffman and Rizov, 2007; Goryakin and Suhrcke, 2014). Having some education increases the correlation with overweight incidence, but more education has higher correlations with overweight incidence in rural areas. This relationship weakens a bit in urban areas. Women from religious minorities have higher correlations and those among the Scheduled Caste and Scheduled Tribe groups have lower risks for overweight incidence, compared to the majority and other castes. Clustering of overweight incidence at the local level, which encompasses the effect of local development, access to markets, and cultural preferences for overweight incidence, is strongly and positively associated with individual-level overweight rates (Jones-Smith and Popkin, 2010). Macro-level factors indicate that the risk for overweight incidence is lower among more developed states as compared to less developed states.

4.3. Oaxaca-Blinder (OB) decomposition

Using Eq. 4, we run an OB decomposition separately for each group—all India, rural women (RW), rural men (RM), urban women (UW), and urban men (UM). Overall, we see that the covariates chosen in the empirical model explain a large portion of the increase in adult overweight incidence, and in many cases, the entire change.

Table 4 presents the main results from the OB decomposition. In Panel A in the table, we see that overweight prevalence has increased by 7.5 percentage points (pp) between the two rounds (Standard error [SE], 0.003). For rural women, it has increased by 6.8 pp (SE 0.003) and for urban women by 6.4 pp (SE 0.005). Rural men have seen a 8.0 pp increase (SE 0.003), and urban men, a 9.4 pp increase (SE 0.007). From the aggregate decomposition, we find that the explained contribution, that is, the changes in the distributions of the covariates explains the majority of the change across all groups (RW, 0.087, SE 0.003; UW, 0.089, SE 0.005; RM, 0.103, SE 0.003; UM, 0.116, SE 0.006). The unexplained changes, that is, the changes in the relative contributions of each factor, do not play as important a role (RW, –0.019 SE 0.001; UW, –0.025, SE 0.002; RM, –0.023 SE 0.002; UM, –0.022 SE 0.003).

In Panel B of Table 4, we calculated the total contribution of the stressors—age, reproductive stress, obesogenic factors, SES, meso-environment and the state of residence—to the increase in overweight incidence for each group (using Eq. 5). Here, we find that biological factors that matter for women do not matter for men as much. Five percent and 12 percent of the change in overweight incidence among rural and urban women, respectively, come from the lowering of reproductive stress and increases in age due to the demographic transition. In Table 4, Panel B, we also see that obesogenic factors contribute more to overweight incidence than do SES factors in India now. Obesogenic factors contributed 20 percent of the explained change in overweight incidence, and SES, 17 percent. In these contributions, there are gender differences. SES explains greater change in overweight incidence than obesogenic factors for women, contributing to 23 percent of the change among rural women and 28 percent for urban women. The percent contribution of obesogenic factors stands at 12 percent and 18 percent, for rural and urban women, respectively. This is consistent with studies that show that SES status is positively correlated with overweight incidence in developing countries, with women being at higher risk (Case and Menendez, 2009; Hruschka and Brewis, 2013; Tafreschi, 2015). For rural men, 23 percent of the explained change in overweight incidence came from obesogenic factors, with 17 percent from SES. For urban men, 21 percent of the change was contributed by obesogenic factors and 16 percent from SES. Thus, men seem to be more affected by the changes in obesogenic environment in India over the last decade. One of the major contributions to overweight incidence comes from the meso-environment, as seen in Table 4. The community prevalence of overweight incidence is the largest contributor, accounting for almost the entire explained effect of increase in overweight incidence (see Table 5). This fact is true regardless of gender and speaks to the concern that local-level development greatly influences the within-country experiences of the NT in a developing country.[12]

In Table 5, we take a more in-depth examination of the drivers of the changes in the explained effect. Among women, overweight incidence among those living in rural areas is associated with both age and reduction in reproductive stress. Among urban women, age is the only factor among the biological factor that determines overweight incidence changes. There are also differences in how biology is associated with overweight incidence across age groups. In Table 5, we see that women above 45 are most susceptible to overweight incidence, since the percent contribution from their age has increased. In India, differences in development patterns between rural and urban areas have led to lower fertility in the former and aging populations in the latter. Urban women have reached replacement fertility rates long before their rural counterparts, whose fertility rates have been decreasing but more slowly. This change is reflected in the growth in overweight incidence across the country as well. Going forward, it remains to be seen if further reduction in the reproductive stress below the replacement fertility level and aging continue to account for the increase in overweight incidence among women in India. We can see that increases in television watching and ownership of motorized vehicles over the survey periods are highly correlated with the explained changes in overweight incidence. In transitioning countries, the increase in usage of leisure-enhancing technologies have been identified as major contributors to changes in overweight incidence (Lakdawalla and Philipson, 2009; Goryakin and Suhrcke, 2014). There are other gender differences. Among women, the increase in frequency of watching television is positively associated with increasing overweight incidence. For men, increased access to

[12] In an online appendix, we show that these variables track closely to community level development indicators. Changing the variable to these development indicators does not change the import of the main analysis but the strength of the relationship slightly weakens in favor of a greater correlation with SES status. This, we propose, supports our argument that SES factors at the local level, proxied for by community variable is an important contributor to overweight incidence.

motorized transport explains changes in overweight incidence levels.[13] Among obesogenic behaviors, besides television watching, reduction in smoking incidence is positively associated with increasing overweight incidence. This outcome is associated with a larger portion to rural overweight rates than urban overweight incidence. Consuming a diet with higher diversity reduces overweight rates among rural women but has no alleviating effect on any other groups.[14]

In Appendix B, Table B1, we present the percent contributions of the coefficient (unexplained) effect. Overall, we find that although the aggregated unexplained effect is small, it consists of a mix of positive and negative coefficients that cancel each other out. The intercept term captures the bulk of the effect. This term is hard to interpret, as it is a residual category. We propose that this might be picking up a change in the returns to factors, which have not been identified in the model, such as intrinsic health and the role of genetics. Graphs comparing the percent contributions of each category to explained and unexplained changes can be found in Figs. B1 and B2 in Appendix B. To rule out concerns that it is only changes in the left tails of the BMI distributions that are driving our effects, we run a Machado-Mata decomposition as well. We find that that covariate effects from Eq. 4 dominate the total change effect across the entire distribution (see Appendix C).

Table 6 provides a disaggregated view of which wealth quintiles account for the increase in overweight incidence. Here, we see that among those in rural areas, there is an equi-proportionate increase in overweight incidence across all income classes among both men and women. This ranges from around 3–4 pp for each gender across all wealth quintiles. Among urban areas, overweight incidence has increased by 5 pp for women (SE 0.005) and 6 pp for men (SE 0.008) among the poorest. As wealth quintile increases, this change becomes smaller, with effect turning to a statistical 0 at the highest levels of wealth quintiles (WQ 5). These results provide evidence for the changing SES-gradient of overweight incidence with greater NT.

4.4. Robustness checks

We ran multiple robustness checks on Eq. 4 to determine if the model is sensitive to specification choice or sample inclusion criteria. The results are reported in Appendix E. In Appendix E, Table E1, we estimate the OB decomposition using nonlinear specifications for the dependent variable. We find that the results described are not sensitive to implementing this check. In Table E2, we find that if we change BMI cutoffs for overweight to BMI ≥ 23, our results hold. This is done to maintain parity with other health literature that proposes that a BMI of 23 should be the standard overweight definition among Asians, due to their increased risks (Wen et al., 2009). Another concern is the choice of weights used in constructing the counterfactual distribution in the decomposition. In the main analysis, we present the OB decompositions, using the coefficients from the LPM of NFHS III survey as the weights. Hence, we rerun the analysis using the coefficients from the LPM of NFHS IV as the weights for the OB decomposition. In Table E3, we find that our results do not change. We also rerun the entire analysis by including all missing cases in the model. We replace the values of the missing covariates with the average value of each group within a gender, state or cluster. Table E4 shows that the main results from the OB decomposition do not change.

5. Conclusion

In India, in the last decade, an additional 280 million people in India have become at risk for obesity, and consequently, obesity-related NCDs. Increases in overweight incidence between 2005–06 and 2015–16 have emerged from rural areas, which are food insecure. The rates of overweight incidence have remained higher for women, but recent increases in overweight incidence in India have come from men. In this paper, we provide a discussion on the drivers of these within-country changes.

Similar to the prediction of the NT theory, we find that overweight incidence has begun to emerge among lower SES groups in India. Rural overweight incidence has increased across the income gradient, and urban overweight incidence has rapidly increased among those with lower SES. Furthermore, we see that differences in biological factors and obesogenic factors explain gender and within-country differences in overweight incidence. At the individual level, biological factors, such as age and reproductive stress, are associated with women's overweight incidence, but not so for men. We also see that intrahousehold differences in access to obesogenic technologies explain gender differences. Male overweight prevalence is more closely related to access to motorized vehicles. These vehicles enable greater income generation and are more likely to be used by men. When technologies are relatively nonexcludable within a household—such as a television—then women's overweight rates are impacted as much as men. At later stages of economic development (urban areas), obesogenic behaviors related to smoking and watching television explain the rise in overweight incidence.

In summary, our results suggest that reducing overweight incidence in developing countries like India requires group-based and community-based approaches. For example, nutrition education programs will be useful in stemming the overweight incidence pandemic only if they include age- and gender-appropriate counseling services and account for differences in intrahousehold access to food and obesogenic technologies. In the short term, health and nutrition counseling, focused on overweight incidence reduction, needs to be delivered to rural women during reproductive health check-ups. Women who have completed their fertility and women who are in their middle ages need to be specifically targeted for such programs in urban areas. Among men, nutrition education needs to include a focus on increasing physical activity and daily exercise. Proactive campaigns that create awareness of obesogenic behaviors may forestall further growth of overweight incidence in rural economies, while in urban economies, counseling services to change behaviors are required. In the long term, food and agricultural policies should subsidize the production and consumption of healthy foods. To counter the reduction in physical activity associated with the NT, these same policies should include investments in environmental resources that encourage people to exercise or engage in recreational physical activity.

Given that many developing countries are beginning to see similar changes in their NT, we believe that lessons learned from our study may be useful for supporting policymakers working to reduce overweight incidence in similar contexts. For example, we feel that lessons learned from rural areas in India may be relevant to policymakers working on reduction of overweight incidence in poorer developing countries. Lessons learned from urban areas in India, on the other hand, may be relevant to stemming the rapid increase in obesity among other emerging economies. Our use of open-source data from the DHS allows the model proposed here to be replicated across these contexts. However, we also recognize that we cannot provide causal insight into which factors matter the most. We join the call for more impact evaluations to identify cost-effective strategies in the global fight against the obesity epidemic.

[13] In Appendix D, Table D1, we show another dimension of physical activity: participation in the labor force. We see that the reduction of labor force participation is positively correlated with the rise in obesity. This effect is greater for women, as compared to men, with no differences across rural and urban areas. Among men, the effect is driven by an increase in jobs requiring low physical intensity and a reduction in overall labor force participation. This allows us to conclude that the role of the obesogenic environment has been a key factor behind the increase in obesity, especially among men.

[14] Our dietary diversity measures cannot separate consumption of energy dense foods in diets, eating out, and eating processed foods from calories consumed from eating healthy foods. These factors are important in assessing the role of diets on obesity (Asghari et al., 2017).

CRediT authorship contribution statement

Anaka Aiyar: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing, Visualization. **Sunaina Dhingra:** Conceptualization, Methodology, Formal Analysis, Data Curation, Writing, Visualization. **Prabhu Pingali:** Conceptualization, Resources, Writing.

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Appendix A. Variables constructed

Table A1
Description of variables used in the analysis.

Categories	Variable	Description
	Overweight	1 if BMI $\geq$ 25, 0 otherwise
Age cohort	Age: 18–19[a]	1 if individual is between 18–19 years, 0 otherwise
	Age: 20–24	1 if individual is between 20–24 years, 0 otherwise
	Age: 25–29	1 if individual is between 25–29 years, 0 otherwise
	Age: 30–34	1 if individual is between 30–34 years, 0 otherwise
	Age: 35–39	1 if individual is between 35–39 years, 0 otherwise
	Age: 40–44	1 if individual is between 40–44 years, 0 otherwise
	Age: 45–49	1 if individual is between 45–49 years, 0 otherwise
Reproductive stress	Unmarried	0 if individual is married, 1 otherwise
	Children born (no.)	Number of children born to the individual
	Fertility not completed	0 if individual cannot have/doesn't want any more children, 1 otherwise
Obesogenic factors	Diet diversity	We construct a measure similar to the one proposed by Arimond et al. (2010). Since we do not have quantity measures, we assign 1 to individuals who say they eat any of the following categories at least weekly (or more)—eggs, fish, meat, fruits, vegetables, pulses, dairy. We then sum across the categories and divide the distribution into quartiles. Individuals in the lowest quartile are those with low diet diversity and individuals in the highest quartile have high diet diversity.
	Smoke	0 if individual doesn't smoke, 1 otherwise
	Alcohol	0 if individual doesn't consume alcohol, 1 otherwise
	Leisure: TV not daily	0 if individual watches TV daily, 1 otherwise
	Exercise: Time to fetch water (minutes)	Total time spent (in minutes) in fetching water, if any.
	Transport: Car	1 if household owns a car, 0 otherwise
	Transport: Motorbike	1 if household owns a motorbike, 0 otherwise
Socioeconomic status (SES)	Harmonized Wealth Index (HWI)	HWI is constructed using a pooled generation approach of common assets and services across surveys within a country to compare economic status of households across time (Staveteig and Mallick, 2014). A higher value of the wealth index implies that the household has a higher economic status.
	Education: No education[a]	1 if individual has no education, 0 otherwise
	Education: Primary	1 if individual has primary education, 0 otherwise
	Education: Secondary	1 if individual has secondary education, 0 otherwise
	Education: Higher	1 if individual has higher education, 0 otherwise
	Religion: Hindu[a]	1 if household head follows Hindu religion, 0 otherwise
	Religion: Muslim	1 if household head follows Islam, 0 otherwise
	Religion: Christian	1 if household head follows Christianity, 0 otherwise
	Religion: Other Religions	1 if household head follows religion other than listed above, 0 otherwise
	Caste: Missing	1 if the caste of the household is not reported, 0 otherwise
	Caste: Scheduled caste (SC)	1 if household head belongs to Schedule caste category, 0 otherwise
	Caste: Scheduled tribe (ST)	1 if household head belongs to Schedule tribe, 0 otherwise
	Caste: Other backward caste (OBC)	1 if household head belongs to other backward caste category, 0 otherwise
	Caste: None of the above[a]	1 if household head belongs to none of the caste categories listed above, 0 otherwise
Meso-environment	Adults overweight: Community	Proportion of overweight adults in the village/urban block where the individual resides
State of Residence	Low agricultural productivity (LAP)[a]	1 if individual resides in either Bihar, Madhya Pradesh, Uttar Pradesh, Odhisa, Jharkhand, Chhattisgarh, West Bengal, Rajasthan 0 otherwise
	High agricultural productivity (HAP)	1 if individual resides in either Punjab, Haryana, Andhra Pradesh, Himachal Pradesh 0 otherwise
	Rapidly transforming states (RTS)	1 if individual resides in Karnataka, Goa, Maharashtra, Tamil Nadu, Gujarat, Kerala, Uttarakhand, Delhi 0 otherwise
	Hilly	1 if individual resides in Jammu and Kashmir, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura,=

***Source*:** Authors' calculation using sample aged 18–49 with non-missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
***Table Notes*:** BMI: Body Mass Index; NFHS: National Family Health Survey;
[a]This is the omitted category.

Appendix B. Percentage contributions of unexplained component of the OB decomposition

Table B1
Detailed Oaxaca–Blinder decomposition of the unexplained component of the overweight prevalence gap[a].

Stressors	Variables	All India (1) %[b]	Rural women (2) %[b]	Rural men (3) %[b]	Urban women (4) %[b]	Urban men (5) %[b]
Age cohort	Age: 20–24	2.16**	1.68	5.03***	2.73	9.88***
	Age: 25–29	6.11***	6.20***	8.68***	7.27*	10.80***
	Age: 30–34	9.21***	10.02***	9.26***	7.91**	12.20***
	Age: 35–39	8.64***	9.76***	11.31***	3.48	8.56**
	Age: 40–44	8.92***	9.38***	10.07***	2.74	8.95**
	Age: 45–49	8.67***	8.55***	8.45***	3.65	8.93**
Reproductive stress	Unmarried	–2.73***	–3.94***	–3.58	0.14	7.47
	Children born (no.)	7.16***	5.42	–3.94	18.71**	11.67*
	Fertility not completed	–0.42	–0.21	2.68	–0.78	2.21
Obesogenic factors	Diet diversity: High	0.89	1.81	–1.15	0.86	1.16
	Smoke	–0.85	–1.07	–1.68	–0.35	–2.47
	Alcohol	–0.43	–0.39	–0.71	0.19	–3.48
	Leisure: TV not daily	0.86	–0.51	–0.37	3.72	2.16
	Exercise: Time to fetch water (minutes)	–0.57	–1.39*	–0.20	0.30	–0.39
	Transport: Automatic vehicle	–11.25***	–2.77	–12.55***	–14.66**	–11.81
Socioeconomic status (SES)	Harmonized Wealth Index	0.33	−0.88	–0.25	2.28	–4.72
	Education: Primary	2.36***	1.94*	2.26*	1.63	1.44
	Education: Secondary	9.59***	12.10***	7.06	–0.58	6.74
	Education: Higher	1.09	2.97**	4.60**	0.34	6.26
	Religion: Muslim	0.74	0.81	0.89	–4.27*	0.64
	Religion: Christian	–0.46	–0.51	–1.08	0.35	–0.13
	Religion: Other Religions	–0.41	–0.19	–0.36	–1.21	–0.08
	Caste: Missing	–0.78*	–0.33	–0.67	–1.72	–0.94
	Caste: SC	–3.45***	–4.56***	–1.99	–4.21*	–1.17
	Caste: ST	–1.63*	–2.09	0.39	0.48	0.97
	Caste: OBC	–5.64***	–8.45***	2.82	–11.33**	–0.14
Meso-environment	Adults overweight: Community	17.38***	7.74**	14.12***	46.52***	30.91***
State of residence	HAP	–2.52***	–2.48***	–1.87**	–5.41***	–2.96**
	RTS	–2.53***	–3.04***	–2.31**	–3.75*	–2.99
	Hilly	–1.27*	–1.88*	0.67	–3.05	–1.95
	Constant	–74.22***	–72.25***	–84.62***	–91.02***	–120.95***

***Source*:** Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.

***Table Notes*:**

*p < 0.1, **p < 0.05, ***p < 0.01.

Each cell in columns 1–5 is the percent contributions of variable as calculated in Eq. 6.

The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI $\geq$ 25.

[a]The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.

[b]Percent refers to the percent explained of the total change and is calculated as [(Explained estimate/Total change)* 100]; Total Change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].

BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and North-east of India.

Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; None of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

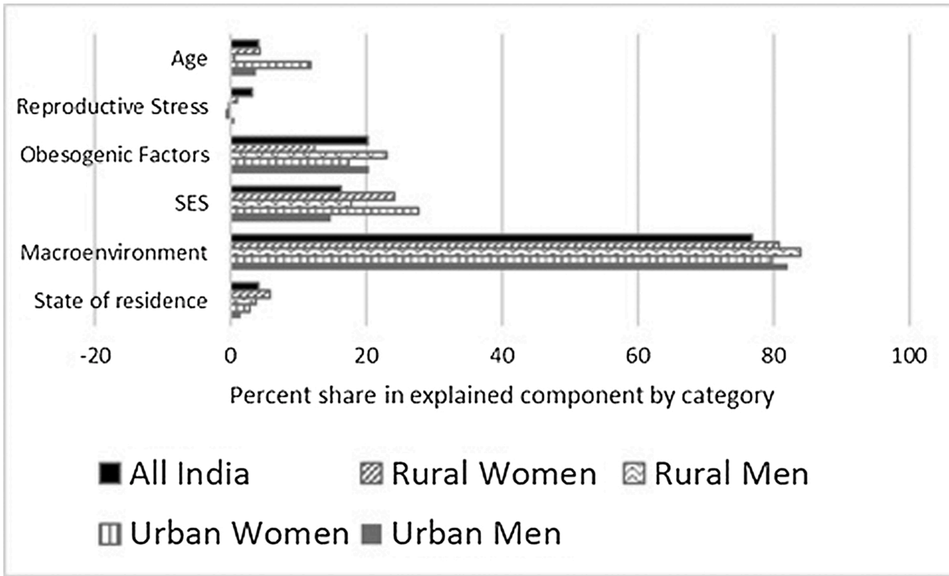

Fig. B1. Contributions of stressors to explained (covariate) changes in overweight incidence.

The percent contribution of each coefficient in the category is first calculated using Eq. 5. The total share for each category, as presented in this graph, is the sum of the share of each variable's contribution in that specific category. You can see Table A1 for more details on which variables represent which categories.

The percent contribution of each coefficient in the category is first calculated using Eq. 6. The total share for each category, as presented in this graph, is the sum of the share of each variable's contribution in a specific category. You can see Table A1 for more details on which variables represent which categories.

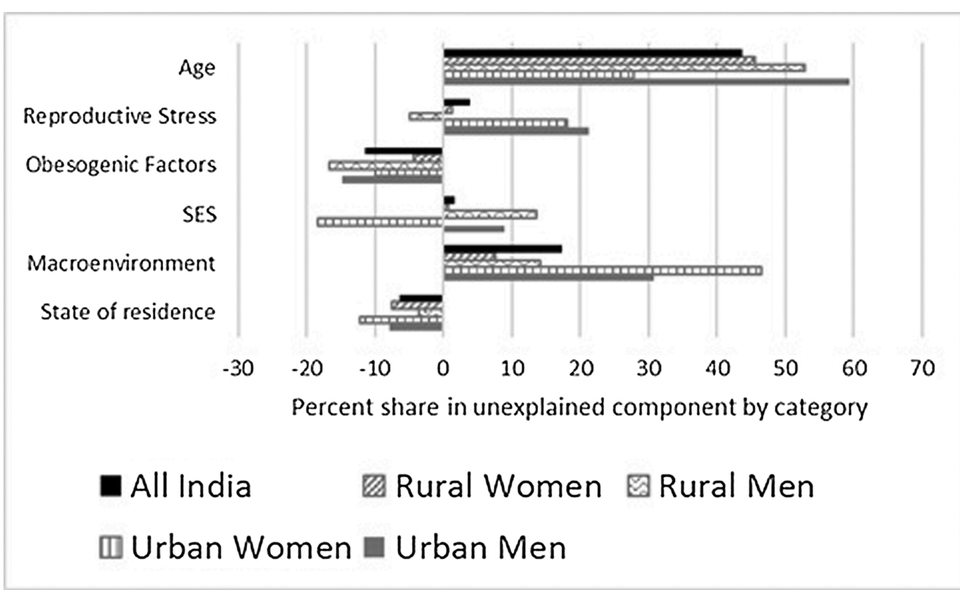

Fig. B2. Contributions of stressors to unexplained (coefficient) changes in overweight incidence.

Appendix C. Quantile decomposition of the change in the BMI distribution, by gender and place of residence

We run a counterfactual-based decomposition of the entire BMI distribution using the methodology developed by Machado and Mata (2005) (MM decomposition), for each subgroup. The MM decomposition constructs a counterfactual distribution using the quantile estimates of the returns to various covariates obtained from quantile regressions at different quantiles of the BMI distribution (Fig. C1).

The figure plots the combined results of the OB and the MM decomposition of the change in BMI distribution for four subgroups: Rural (Men and Women) and Urban (Men and Women), over nine deciles using the 2005–06 coefficients as weights to construct the counterfactual distribution. The solid black curves represent the total change in BMI; the dashed curve represents the estimate of covariate effect, and the dotted curve depicts the coefficient effect across the BMI distribution. The corresponding horizontal line represents the mean estimates obtained using OB decomposition of BMI.

The curves for total change in BMI lie above 0 across all subgroups, which means that the BMI has improved over time for undernourished as well as over nourished in rural as well as urban areas for men and women. However, there are visible regional differences which are symmetrical among men and women within a region. The graphs for urban areas are flatter, suggesting that the change has been similar across the distribution. The curves for rural areas are upward sloping and steeper, meaning that the change in BMI is higher in right tail of the distribution. Similar to the decomposition analysis presented in the main paper, we find that the covariate effect dominates the total change effect in all our samples. We also find that the confidence intervals of the distributions of the coefficient and covariate effect overlap with the mean effects. The latter indicate that the mean decomposition, presented as the main specification in the paper, is a fair representation of the decomposition effects across the distirbution of BMI.

Appendix D. Role of physical activity from employment in contributions to overweight incidence

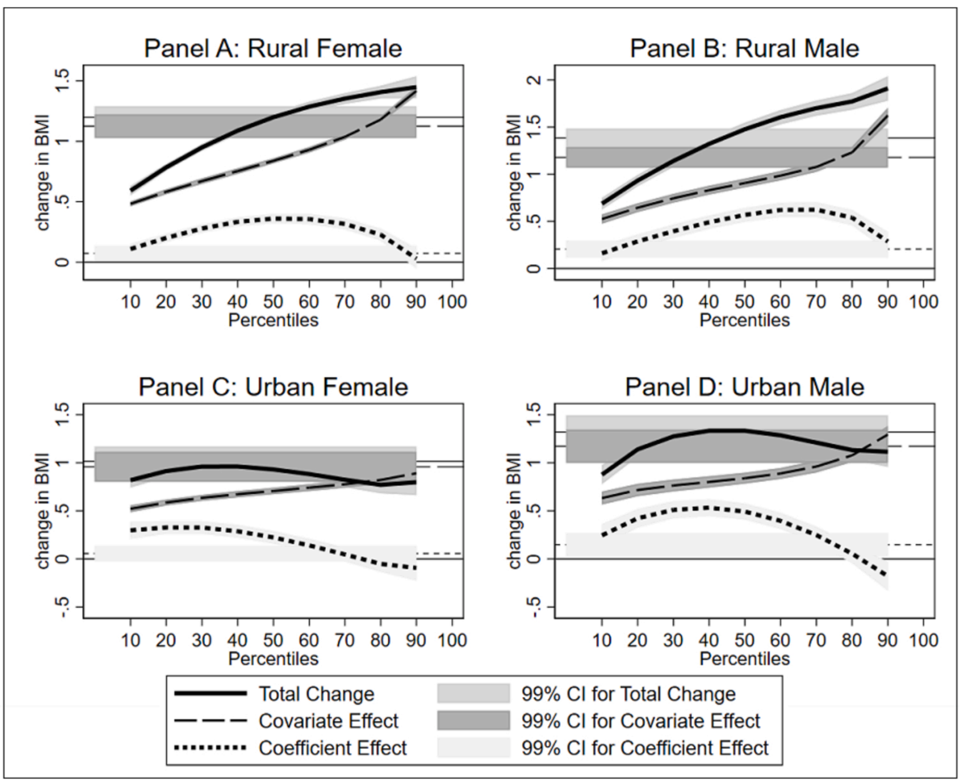

Fig. C1. MM decomposition of the change in the BMI distribution, by gender and place of residence.
Source: Authors' calculation using sample aged 18–49, extracted from National Family Health Survey (Round III and IV); excludes Union Territories. ***Notes***: BMI: Body mass index; the 99 percent confidence bands are obtained using the bootstrap technique (100 replications).

Table D1
Including employment intensity as an additional factor: Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III [a].

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.207*** (0.002)	0.169*** (0.002)	0.147*** (0.002)	0.328*** (0.005)	0.271*** (0.005)
Overweight in NFHS III	0.132*** (0.002)	0.091*** (0.002)	0.068*** (0.002)	0.254*** (0.005)	0.178*** (0.004)
Total Change[b]	0.075*** (0.003)	0.078*** (0.003)	0.079*** (0.003)	0.074*** (0.007)	0.092*** (0.007)
Explained contribution	0.092*** (0.003)	0.096*** (0.003)	0.098*** (0.003)	0.096*** (0.006)	0.111*** (0.007)
Unexplained contribution	–0.017*** (0.001)	–0.018*** (0.002)	–0.019*** (0.002)	–0.022*** (0.003)	–0.018*** (0.004)
B. Percent explained[c]: *Percent contribution of each risk factor to total change in overweight incidence over time*					
Age	4.24***	4.01***	0.58*	10.06***	3.48***
Reproductive stress	–0.01	0.73	–0.27	–0.66	0.19

(*continued on next page*)

Table D1 (*continued*)

Obesogenic factors	18.58***	11.28***	22.93***	15.02***	21.79***
Employment intensity	1.75***	3.50***	–2.05**	3.51***	–2.60***
Socioeconomic status	17.48***	22.14***	14.86***	22.49***	13.14***
Meso-environment	78.36***	78.61***	84.47***	77.10***	82.72***
State of residence	2.90***	3.32***	3.67***	1.61*	1.19

Source: Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.

***Table Notes*:**

*p < 0.1, **p < 0.05, ***p < 0.01.

Panel A is calculated from OB-decompositions run by using Eq. 4.

Each category in Panel B is the sum of percent contributions of individual variables that represent these categories.

The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25.

[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.

[b] Total Change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III]. BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India. Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; None of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

[c]Percent explained refers to the % of Total change and is calculated as [(Explained estimate/Total change)* 100]. *p < 0.1, **p < 0.05, ***p < 0.01.

Age is the summation of the effects of belonging to each age cohort (20–24, 25–29, 30–34, 35–39, 40–44, 45–49 years); Reproductive stress sums the effects of whether the individual is unmarried, has not completed fertility, and the number of children ever born; Obesogenic factors is the sum of individual's food consumption behavior (high diet diversity, alcohol and smoking consumption), Leisure (frequency of watching television), exercise (time spent in fetching water) and Household's access to automatic vehicle; Socioeconomic status refers to the sum of the effects of individual's education, household wealth, caste and religion on probability of the individual being overweight; Meso-environment refers to the overweight incidence environment captured by the proportion of overweight adults in the village or urban block; and State of residence refers to the summation of the effects of whether the individual belongs to HAP, RTS or Hilly States.

Employment Intensity refers to the summation of the effects of whether the individual is involved in a low, moderate, or vigorous intensity job if is involved in any occupation. This classification is taken from Dang et al. (2019).

Appendix E. Robustness checks

Table E1

Nonlinear (logit) specifications of Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III.[a]

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.208*** (0.000)	0.159*** (0.000)	0.148*** (0.001)	0.318*** (0.001)	0.272*** (0.002)
Overweight in NFHS III	0.132*** (0.001)	0.091*** (0.001)	0.068*** (0.001)	0.254*** (0.001)	0.178*** (0.002)
Total Change[b]	0.075*** (0.001)	0.068*** (0.001)	0.080*** (0.001)	0.064*** (0.002)	0.094*** (0.003)
Explained contribution	0.088*** (0.001)	0.085*** (0.002)	0.114*** (0.005)	0.091*** (0.002)	0.129*** (0.004)
Unexplained contribution	–0.012*** (0.002)	–0.017*** (0.003)	—0.034*** (0.005)	–0.027*** (0.003)	–0.035*** (0.005)

***Source*:** Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.

***Table Notes*:**

*p < 0.1, **p < 0.05, ***p < 0.01.

Panel A is calculated from OB-decompositions run by using Eq. 4.

The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25.

[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.

[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].

BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.

Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

Table E2
Using BMI cutoff for 23 for overweight: Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III[a].

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.350*** (0.001)	0.284*** (0.001)	0.302*** (0.003)	0.481*** (0.003)	0.475*** (0.006)
Overweight in NFHS III	0.237*** (0.003)	0.177*** (0.003)	0.155*** (0.003)	0.386*** (0.005)	0.326*** (0.006)
Total Change[b]	0.113*** (0.003)	0.107*** (0.003)	0.148*** (0.004)	0.094*** (0.006)	0.149*** (0.008)
Explained contribution	0.113*** (0.003)	0.113*** (0.004)	0.137*** (0.005)	0.095*** (0.006)	0.132*** (0.008)
Unexplained contribution	–0.000 (0.002)	–0.006* (0.002)	0.010* (0.004)	–0.001 (0.003)	0.016** (0.006)

Source: Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
Table Notes:
*p < 0.1, **p < 0.05, ***p < 0.01.
Panel A is calculated from OB decompositions run by using Eq. 4.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 23.
[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].
BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.
Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

Table E3
Alternative specification of counterfactual (NFHS IV coefficients): Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III [a].

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.208*** (0.001)	0.159*** (0.001)	0.148*** (0.002)	0.318*** (0.002)	0.272*** (0.005)
Overweight in NFHS III	0.132*** (0.002)	0.091*** (0.002)	0.068*** (0.002)	0.254*** (0.005)	0.178*** (0.004)
Total Change[b]	0.075*** (0.003)	0.068*** (0.003)	0.080*** (0.003)	0.064*** (0.005)	0.094*** (0.007)
Explained contribution	0.099*** (0.003)	0.094*** (0.003)	0.109*** (0.003)	0.089*** (0.005)	0.121*** (0.007)
Unexplained contribution	–0.023*** (0.001)	–0.026*** (0.001)	–0.029*** (0.002)	–0.025*** (0.002)	–0.027*** (0.003)

Source: Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005–06) and IV (2015–16); excludes Union Territories.
Table Notes:
*p < 0.1, **p < 0.05, ***p < 0.01.
Panel A is calculated from OB-decompositions run by using Eq. 4.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25.
[a] The decomposition is carried out using NFHS IV coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].
BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.
Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

Table E4
Including all flagged covariates: Oaxaca–Blinder decomposition of changes in overweight prevalence between NFHS IV and NFHS III[a].

A. Changes in mean prevalence	All India	Rural India		Urban India	
	Aggregate	Women	Men	Women	Men
Overweight in NFHS IV	0.208*** (0.001)	0.159*** (0.001)	0.148*** (0.002)	0.318*** (0.002)	0.273*** (0.005)
Overweight in NFHS III	0.132*** (0.002)	0.091*** (0.002)	0.068*** (0.002)	0.254*** (0.005)	0.178*** (0.004)
Total Change[b]	0.075*** (0.003)	0.068*** (0.003)	0.080*** (0.003)	0.064*** (0.005)	0.094*** (0.007)
Explained contribution	0.095*** (0.003)	0.088*** (0.003)	0.103*** (0.003)	0.089*** (0.005)	0.116*** (0.006)
Unexplained contribution	−0.019*** (0.001)	−0.020*** (0.001)	−0.024*** (0.002)	−0.025*** (0.002)	−0.022*** (0.003)

Source: Authors' calculation using sample aged 18–49 with non–missing BMI and main explanatory variables, extracted from National Family Health Survey Round III (2005/06) and IV (2015/16); excludes Union Territories.
Table Notes:
*p < 0.1, **p < 0.05, ***p < 0.01.
Panel A is calculated from OB-decompositions run by using Eq. 4.
The dependent variable is a dummy equal to 1 if individual is overweight or obese, i.e., BMI ≥ 25.
[a] The decomposition is carried out using NFHS III coefficients to construct counterfactual. Decompositions are clustered at the village/urban block level and weighted by NFHS survey weights.
[b] Total change over time is calculated as [% overweight in NFHS IV – % overweight in NFHS III].
BMI: Body Mass Index; NFHS: National Family Health Survey; SC: Scheduled Caste; ST: Scheduled Tribe; OBC: Other Backwards Caste; LAP: Low Agricultural Productivity states; HAP: High Agricultural Productivity states; RTS: Rapidly Transforming states, Hilly: States in the North and Northeast of India.
Benchmark category is age group 18–19 years for individual's age; no education for level of education; Hindu for religion; none of the listed caste for caste; LAP for state of residence. The summation is possible because the effects of these variables are expressed in the same unit, i.e., change in overweight prevalence.

Appendix F. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ehb.2021.101041.

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