THE ROLE OF GENDER INEQUALITY IN THE OBESITY EPIDEMIC: A CASE STUDY FROM INDIA

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Introduction

In the past years, obesity has become one of the major global health challenges, increasing at high rates and becoming a rising epidemic. Obesity has proven to increase risks of Non-Communicable Diseases (NCD) such as cardiovascular disease, diabetes or hypertension (Di Angelantonio et al., 2016), which led to 71% of worldwide deaths in 2016 (Bennett et al., 2018). Obesity is therefore directly associated with higher mortality, high decreases in the quality of life, and constitutes an important economic cost for countries (Cawley, 2015). Not only has the prevalence of overweight surpassed the prevalence of underweight around the world (Popkin, 2007), but there is a striking observation that obesity levels have never decreased in any country so far (Ameye & Swinnen, 2019). In fact, by 2025 it is estimated that half of the worldwide population will be overweight, and one-fifth will be obese. Alarmingly, in most countries, the prevalence of obesity is higher for women than for men (WHO, 2020; De Soysa & Lewin, 2019; Ferretti & Mariani, 2017; Garawi et al., 2014). Currently, there are 3 obese women for 2 obese men worldwide (Wells et al., 2012) and this gender gap in obesity appears to be much higher for middle-income countries (Ameye & Swinnen, 2019).

These trends are worrying considering the important gender discrepancies in health outcomes, as some of the illnesses caused by overweight (e.g. hypertension or diabetes) could be especially damaging for women's health and for their children’s, since maternal physiology can also influence children’s health outcomes (Ameye & Swinnen, 2019). The increase in female obesity is also a cause for concern because of women’s limited access to health services in developing countries. For instance, in many countries, women face structural and cultural barriers in their access to maternal health services (UNICEF 2015, Banik 2017). Socio-economic gender gaps favoring men (e.g. in income, education, health or personal autonomy) being larger in poorer countries (Dhar et al., 2019; Jayachandran, 2015), considering the gendered dimension of the obesity epidemic is all the more relevant in developing countries. Moreover, these gender differences observed in obesity outcomes suggest that gender inequality and women’s lack of empowerment could be one of the main determinants of this gap (Ferretti & Mariani, 2017). As it is fairly known, in many societies, women suffer from deprivations in basic economic and socio-political rights. These gender differences could be associated with mechanisms that increase the risk of malnutrition for women. These mechanisms are related to the socio-cultural environment and gender roles that affect women’s access to economic resources, information, education and physical activities which can also have important psychological repercussions (De Soysa & Lewin, 2019). Hence, improving women’s status in society may be a key policy avenue to address the global obesity epidemic.

As the world's second most populated country, India is an interesting middle-income economy to study in terms of gender and health inequalities. Despite high levels of economic growth in the past few decades, the country has one of the largest gender gaps in health, one of the highest rates of underweight population, accompanied by a growing overweight population and low-quality diets with major micronutrient deficiencies (Kulkarni et al., 2017). The co-occurrence of these three latter trends have been referred to as the Indian triple burden of malnutrition (Meenakshi, 2016). Besides, the country has also been experiencing alarming increases in NCDs such as type-2 diabetes (Agrawal et al., 2014), and hypertension (Gupta, 2004; Stroope, 2015). Furthermore, Indian women suffer from high levels of inequality in both opportunities and outcomes (Dhar et al., 2019), partly explained by the socially constructed and predefined gender roles with deep religious, cultural, and historical roots (Batra & Reio Jr, 2016). For example, empirical evidence shows that boys receive more childcare time than girls, in addition to being breastfed longer and to being given vitamin supplementation (Barcellos et al., 2014) showing that gender gaps already emerge during childhood and are only widened through the life course. India is also an interesting case to study given the discrepancy between overall growth and structural change and women’s economic empowerment and agency. Female labor force participation in India has been declining from 2005, dropping from 31.8% to 20.5% in 2019. This can be explained on the supply side by a household income effect (i.e. with rising male incomes, women from the household drop out of the labor market) and on the demand size by the reshaping of the sectoral structure of the Indian economy, providing less opportunities for women (Klasen & Pieters, 2015). Also, the integration of new techniques in agriculture, which employs a large part of female workforce, has had an important effect in female labor force decrease. For example, the use of deep tillage practices replaces labor typically performed by women, like transplanting, fertilizing and weeding, generating a lower demand for female labor (Basant, 1987; Carranza, 2014). For instance, according to the World Bank database, in 1991, 75.6% of the female workforce was employed in agriculture. In 2019, this number declined to 54.5%.

Given the particular context of India, affected by the triple burden of malnutrition and persistent gender inequalities, this research aims to assess how these inequalities, measured at the local level, affect women's Body Mass Index (BMI). Using longitudinal data from the India Human Development Survey from 2005 and 2011, a multilevel estimation model is employed to analyze the impact of gender inequality measured using both objective indicators of gender inequality (e.g wage and literacy gaps) and self-rated gender norms indicators (e.g permissions and decisions in the household). In addition, to identify a causal relationship, an instrumental variables approach is implemented using as instrument the preferred proportion of daughters compared to sons in a household (a proxy for child sex preferences). Indeed, we assume that, in the most unequal locality regarding gender, male births are preferred. The rest of this report presents the data and methodology used in this research, the main results and a brief discussion and conclusion.

Data and Methodology

a. Data

This study uses panel data from the nationally representative India Human Development Survey (2005 and 2011). The sample of analysis is restricted to 21,665 non-pregnant adult women (aged 18-65 in 2005). Community-level variables are computed at the Primary Sampling Unit (PSU) level (2,401 PSUs).

b. Variables

Weight indicators: We calculate the Body Mass Index dividing individual weight in kilograms by the squared height in meters. In the survey, both height and weight were measured by professional staff using a stadiometer and a weighting machine, respectively.

Indicators of PSU-level gender inequality: This study includes two types of gender inequality measurements: objective measures of inequality and indicators of gender norms. In the first category, we measure the male-female literacy gap and wage gap. The PSU-level literacy gap measures the difference in the share of literate men and women in the locality (i.e. it increases when male literacy is higher than female literacy). The PSU-level Wage Gap measures the share of the male wage premium relative to women's mean wages (i.e. it increases when men earn more than women). In the second category, we capture the extent to which it is normal for women to ask for permission to go outside of the household (i.e. to go to a health center, to visit a friend, to go grocery shopping) as well as the veiling practice. Each subjective indicator is based on dummy variables indicating whether it is normal to ask for permission. The veiling practice is also a binary indicator.

Control Variables: Our inferential analyses control for the following variables (from the 2005 wave): BMI, Age, Squared Age, Education level, Caste/Religion, Poor Household, Urban, and Region.

c. Methodology

We first use multilevel regressions to analyze the correlations between the PSU-level gender inequality variables (in 2005) and the change in BMI (ΔBMI_{ij}) between 2005 and 2011 (i.e. a weight loss or a weight gain across time), as described in Model 1. X refers to control variables measured at the individual-level *i* or at the PSU-level *j*.

Model 1: $$\Delta BMI_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 X_j + \beta_3 Gender\_Ineq_j + e_{ij} + u_j$$

To make sure we are capturing a causal relationship, unbiased by unobservable characteristics such as health service accessibility disfavoring women, or physically-intensive tasks particularly allocated to women (e.g. farming), we implement instrumental variable regressions using a control function approach as follows (see Model 2).

Model 2: $$\Delta BMI_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 X_j + \beta_3 Gender\_Ineq_j + \beta_4 \hat{\varepsilon}_j + e_{ij} + u_j$$
with $$Gender\_Ineq_j = \alpha_0 + \alpha_1 X_j + \alpha_2 Z_j + \varepsilon_j$$

We instrument objective indicators of gender inequality (i.e. literacy gap and wage gap) using the preferred proportion of daughters compared to sons in a household (capturing sex preferences for births). This instrument is considered as valid for two reasons. First, in the most gender unequal localities, male births are preferred (i.e. strong and significant correlation). Second, there is no theoretical link between female BMI and child sex preferences (i.e. exogenous instrument). Specifically, there is no direct theoretical correlation between our instrumental variable (child sex preferences) and potential omitted variables such as gender differentials in health care access. In other words, if gender inequality affects female weight across time, when transiting by child sex preferences, we can suppose that what we observe is more than a simple correlation and relies on a causal effect.

Results

Based on 2011 data, Table 1 presents basic descriptive statistics regarding gender BMI gap and gender social inequality in India, comparing rural and urban areas. As expected, gender BMI gap is higher in urban India. The gender wage gap is higher in Urban India whereas the gender literacy gap is higher in Rural India. Gender norm indicators are relatively similar in Urban and Rural areas.

Table 1. Descriptive statistics (means per PSU in 2011)

		GENDER GAP 2011	
		Rural	*Urban*
Bodyweight indicators	Gender BMI Gap in 2011 (kg/m²)	0.140	1.027
	Female weight gain b/w 2005 & 2011 (kg/m²)	1.184	1.823
Gender inequality	Gender wage gap 2011 (% of extra wage for men)	0.741	0.971
	Gender literacy Gap 2011 (extra percentage points for men)	0.214	0.107
Gender norms	Ask permission to visit health center 2011 (%)	0.487	0.522
	Ask permission to visit friends 2011 (%)	0.490	0.542
	Ask permission to go to grocery shops 2011 (%)	0.419	0.449
	Veiling practice 2011 (%)	0.478	0.549

Source: Author's Calculations from IHDS (2005-2011).

In Table 2, which presents the estimates from Model 1, we observe that **gender norms based on female permission indicators are significantly correlated to BMI changes on a 6-year long period** (between 2005 and 2011).

Table 2. Association between female permissions and BMI change across time (PSU-multilevel estimations)

Dependent Variable: BMI change b/w 2005 & 2011 (in kg/m²)	ALL WOMEN *Linear*	URBAN WOMEN *Linear*	RURAL WOMEN *Linear*
Ask permission to visit health center	**0.441*****	**0.560****	0.238
	(0.149)	**(0.239)**	(0.189)
Observations	18,137	5,566	12,571
Number of PSUs	2,389	949	1,440
Ask permission to visit friends	**0.530*****	**0.726*****	**0.323***
	(0.144)	**(0.250)**	**(0.173)**
Observations	18,137	5,566	12,571
Number of PSUs	2,389	949	1,440
Ask permission to visit grocery shops	0.083	**0.517****	-0.193
	(0.115)	**(0.201)**	(0.139)
Observations	18,137	5,566	12,571
Number of PSUs	2,389	949	1,440
Veiling practice	**-0.510*****	-0.219	**-0.542*****
	(0.117)	(0.227)	**(0.133)**
Observations	18,137	5,566	12,571
Number of PSUs	2,389	949	1,440

Source: Author's Calculations from IHDS (2005-2011).
Note: Cluster-robust standard errors in parentheses (at the PSU level). Significance levels are: *** p<0.01, ** p<0.05, * p<0.1. Control variables are (all from 2005 wave): BMI, Age, Squared Age, Education Level, Caste/Religion, Poor Household, Urban, and Region.

Considering a linear specification, we observe that **local restrictive gender norms regarding mobility lead to female weight gain in average, especially in urban areas.** Women's lack of agency regarding their mobility, illustrated by the need to ask for permission for various activities, may indeed be associated with increased sedentariness. In contrast, the results are more ambiguous among rural areas: lower permissions to visit friends slightly increases female weight, but veiling practice has clear negative association with BMI change.

Table 3 considers objective measures of gender inequality per Indian locality based on wage and literacy gaps between men and women per PSU. Considering classic multilevel estimates, we find that the local gender literacy gap is negatively associated with BMI change while the local gender wage gap is positively associated with BMI change. However, instrumental variables estimates suggest that unobserved heterogeneity biases the results from classic multilevel regressions, attributing erroneous weight changes to gender inequality because of the omission of factors jointly correlated to BMI and gender inequality, such as health service accessibility disfavoring women, or physically-intensive tasks particularly allocated to women. When potential unobserved heterogeneity is controlled for, instrumental variables regressions show consistent results regarding both indicators and emphasize rural-urban specific results. As shown in Table 3, gender **literacy gap has a positive impact on female BMI in urban areas**. Conversely, **gender literacy gap has a negative impact on female weight in rural areas**. Regarding the **gender wage gap, the sign of fitted coefficients show a negative impact in rural areas and a nonlinear effect (U-shape) in urban areas.**

Table 3. Effect of gender inequality on female BMI across time (PSU-multilevel and IV estimations)

Dependent Variable: BMI change b/w 2005 & 2011 (in kg/m^2)	ALL WOMEN				URBAN WOMEN				RURAL WOMEN			
	Multilevel		IV-Multilevel		Multilevel		IV-Multilevel		Multilevel		IV-Multilevel	
	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic
Gender literacy gap	**-1.050*****	0.042	**-4.062*****	-10.53	**-0.380**	0.549	**2.905****	-6.782	**-1.283*****	-0.652	**-6.538*****	-15.92
	(0.197)	(0.534)	**(0.0757)**	(122.5)	**(0.365)**	(0.828)	**(1.237)**	(12.75)	**(0.232)**	(0.681)	**(1.019)**	(31.65)
Square of gender literacy gap		-1.741**		13.27		-1.748		20.29		-0.939		18.84
		(0.777)		(220.7)		(1.244)		(54.54)		(0.966)		(48.83)
Observations	18,133	18,133	18,104	18,104	5,566	5,566	5,546	5,546	12,567	12,567	12,558	12,558
Number of groups	2,387	2,387	2,374	2,374	949	949	941	941	1,438	1,438	1,433	1,433
Gender wage gap	**0.074****	**0.179*****	**-0.621*****	-2.956	0.069	**0.169****	1.025	**-3.029*****	**0.052**	**0.136****	**-1.084****	-3.416
	(0.031)	**(0.048)**	**(0.0243)**	(2.789)	(0.046)	**(0.076)**	(0.730)	**(0.365)**	**(0.037)**	**(0.058)**	**(0.543)**	(38.41)
Square of gender wage gap		**-0.014*****		0.297		**-0.014****		**0.549*****		**-0.011****		0.290
		(0.004)		(0.828)		**(0.006)**		**(0.129)**		**(0.005)**		(9.825)
Observations	14,472	14,472	14,455	14,455	3,812	3,812	3,800	3,800	10,660	10,660	10,655	10,655
Number of groups	1,810	1,810	1,804	1,804	629	629	626	626	1,181	1,181	1,178	1,178

Source: Author's Calculations from IHDS (2005-2011).
Note: Cluster-robust standard errors in parentheses (at the PSU level). Significance levels are: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Control variables are (all from 2005 wave): BMI, Age, Squared Age, Education Level, Caste/Religion, Poor Household, Urban, and Region. In IV-multilevel regressions, we report bootstrapped standard errors with 100 replications. Selected instrument is (from 2005 wave): average percentage of desired daughters per PSU for gender wage gap.

Discussion and Conclusion

The results presented in this paper contribute to understanding how the challenges of malnutrition and gender inequality are connected. First, we found significant impacts of local gender inequality on women's weight, after controlling for unobserved heterogeneity and reverse causality. Second, we observe that, in middle-income countries such as India, the relationship fundamentally depends on the severity of gender inequality and the level of urbanization. While high levels of gender inequality and seclusion disfavoring women lead to significant female weight loss across time, as observed in rural areas and in localities, gender inequality occurring in urban areas leads to significant weight gain. Several mechanisms can explain how gender inequality can induce female malnutrition in developing countries, which are developing their own "obesogenic niche" different from the one in industrialized countries (Wells et al. 2012). In the context of poverty, gender gaps in wages not only contribute to lower household income resulting in less resources dedicated to food, but they also reduce women's bargaining power which have been associated to poor nutritional status (Kennedy and Peters 1992) linked to consumption of less caloric (i.e. leading to undernutrition) or caloric but cheap foods (i.e. leading to overweight and nutrient deficiency) (Taubes 2008). While our models control for household poverty, these mechanisms are likely to contribute to shaping women's overall bargaining power in household decisions at the local level, thus more generally affecting nutritional decisions. As for gender gaps in education, they imply that access to information regarding nutrition is potentially more difficult for women. Moreover, hazardous food behaviors and nutritional disorders can also arise from restrictive gender norms that increase the risk of women's mental depression due to episodes of physical or psychological violence, limitation of social interactions, or lack of ability to make simple life decisions (Case & Menendez, 2009). All of this may affect women's mobility and free access to physical activities and can contribute to women's neglect of their own bodies. Finally, our area-specific findings are not so surprising considering that the process of urbanization is concomitantly associated with the introduction of westernized lifestyles and overweight-related diets, by increasing the consumption of high-fat low-nutrient foods. Hence, in middle-income countries such as India, the combination of persistent gender inequalities and urbanization leads to an alarming rise of overweight and obesity. Our findings suggest that, **in urban areas, gender inequality might be associated to lower female mobility, sedentariness** (e.g. less outings, unemployment) **and higher socio-psychological troubles** (lower self-confidence & self-esteem) **related to weight gain**. In contrast, **in rural areas, gender inequality might be associated to food deprivations, hard labor, and lower access to health for women related to weight loss**.

To conclude, **public health policy should systematically consider gender inequality as one of the main drivers of risky nutritional behaviors when anti-obesity programs are implemented.**

Further research should consider alternative econometric models. For instance, taking advantage of the panel dimension, we plan to control for time-invariant heterogeneity using a fixed effect model. Moreover, the clinical classification based on BMI should be used to identify the direct impact of gender inequality on the risk of female overweight and obesity. In addition, investigating potential heterogeneous effects according to socioeconomic status and castes is likely to yield interesting results allowing to disentangle the heterogeneous influence of global income inequality and societal stratification from the impact of gender inequality.

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