NEW EVIDENCE OF THE EFFECT OF BODY WEIGHT ON LABOR MARKET OUTCOMES IN A DEVELOPING COUNTRY[1]

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This paper provides new evidence of the effect of body weight on labor market outcomes in Brazil. The methodology uses the sibling's body mass index as an instrumental variable to deal with endogeneity issues. We found that body weight has a positive effect on wages and formal employment. Furthermore, we also find heterogeneous effects by sex, race, and residence area. The evidence also suggests that education is an important mechanism through which body weight affects labor market outcomes.

Keywords: body weight; labor market outcomes; informal employment; human capital.

NOVA EVIDÊNCIA DO EFEITO DO PESO CORPORAL NO SUCESSO NO MERCADO DE TRABALHO EM UM PAÍS EM DESENVOLVIMENTO

Este artigo fornece novas evidências do efeito do peso corporal sobre os sucessos no mercado de trabalho no Brasil. A metodologia usa o peso corporal de algum irmão como uma variável instrumental e mitiga potenciais fontes de viés. Os resultados mostraram que o peso corporal tem um efeito positivo sobre os salários e a probabilidade de emprego formal. Além disso, evidenciaram-se impactos heterogêneos por sexo, raça e área de residência. A evidência sugere também que a educação é um importante mecanismo por meio do qual o peso corporal afeta os sucessos no mercado de trabalho.

Palavras-chave: peso corporal; sucessos no mercado de trabalho; emprego informal; capital humano.

JEL: I10; J46; J24; J30.

1 INTRODUCTION

This paper provides new evidence of the effect of body weight on labor market outcomes in a developing country context. In addition to estimating the effects on wage, we also examine informal employment, one dimension of labor market that is prevalent in developing countries and has not previously been examined by literature. The literature has long discussed the relationship between body size, measured by body mass index (BMI), and labor market outcomes (Baum; Ford, 2004; Cawley, Han and Norton, 2009; Cawley, 2004). It has been argued that obesity increases

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the risk of various diseases such as cancer, diabetes, depression and arthritis (Abbott *et al.*, 1994; Pi-Sunyer, 2002), adversely affecting labor productivity. This has been one of the main arguments in the literature to expect a negative relationship between BMI and wages, and much of the evidence, which has focused on the developed countries, is consistent with this view. However, such relationship may be different in a developing country context. To the extent that the insufficient intake of nutrients is much more prevalent in developing countries, weight gains may reflect better health and nutrition, which could result in higher labor productivity. There is evidence consistent with this. Indeed, while increases in BMI is associated with reduced wages among obese individuals, an opposite relationship has been found among non-obese individuals (Shimokawa, 2008; Wada and Tekin, 2010). Thus, one could expect plausibly that increases in BMI, on average, is associated with better labor market outcomes if poor nutrition is pervasive in poor countries.

Understanding the effects of body size on labor market outcomes is important for a number of reasons. First, an estimation of this relationship may provide relevant information on the determinants of poverty persistence since success in the labor market is directly related to family income and individual welfare. Second, understanding the effects of variations in health and nutrition on labor productivity might contribute to formulation of employment benefit policies such as health insurance, health promotion programs and disease management interventions.

Establishing causation between body weight and labor market outcomes is extremely difficult. An Ordinary Least Squared (OLS) regression cannot provide causality because body weight is likely endogenous. A source of endogeneity is simultaneity or reverse causality, as individuals with higher earnings may differently invest in their health relative to individuals with lower incomes. Moreover, if relevant variables, such as individual background, that are correlated with both labor productivity and BMI are omitted, the regressions will be subject to omitted variables bias, or the second source of endogeneity. Finally, BMI is likely to be subject to measurement error and it may introduce an attenuation bias. An alternative to deal with these issues is the use of an instrumental variable (IV) approach.

Previous studies have proposed a variety of instrumental variables to correct these potential endogeneity issues. For developing countries, much of the existing studies have used disease environment, health infrastructure and health input prices as instrument variables for BMI. In the Brazilian case, Thomas and Strauss (1997) use the relative prices of food as instrumental variables for BMI and find that higher BMI leads to higher wages. As emphasized by Cawley (2004), instruments of this sort are unlikely to meet the exclusion restriction condition, at least in cross-sectional settings. For example, food prices could be correlated with other unobserved factors that may affect also labor market outcomes, such as input prices and labor demand.

We explore the instrumental variable proposed by Cawley (2004), who uses genetic variation in the US context. Specifically, this author proposes to use the BMI of a relative as an instrumental variable for BMI, arguing that any differences in BMI among siblings are strongly correlated because they share much of the same genes. The crucial assumption of this strategy is that the BMI of a sibling is not correlated with unobserved determinants of labor market outcomes. The plausibility of this assumption is supported by evidence suggesting that the correlation between BMI across siblings is not explained by home environment (Comuzzie and Allison, 1998; Vogler *et al.*, 1995). Thus, our main contribution to the Brazilian literature is to use this empirical strategy and to provide estimates of the effect of body weight on labor market outcomes.

Our second contribution is to extend the analysis to informal employment. The literature has emphasized the potential detrimental effects of informality on well-being due to inferior working conditions. If the BMI affects labor productivity, then differences in BMI could explain variations in the employment conditions. For example, less productive individuals may see the informal sector as a mechanism for receiving higher income than that they would receive in the formal sector.

To preview, we found that increases in BMI is associated with better labor market outcomes. Specifically, we found that BMI has a positive effect on wages and reduces the likelihood of informal employment (measured as lack of social security). We also find heterogeneous effects by sex, race and urban/rural status. Indeed, we find larger effects among women, non-white people and individuals living in urban areas.

We also provide suggestive evidence that education is an important mechanism by which BMI affects labor market outcomes. In particular, we find that the effect of BMI on wages is reduced by about 80% when the years of schooling is included as a control variable. Education might be a plausible mechanism in view of the evidence from studies showing that poor health, particularly during early stages of life, affects adversely human capital accumulation (Currie and Moretti, 2007; Currie, 2009). Thus, one possible interpretation of our findings is that lower BMI means poorer health in childhood, implying less acquisition of human capital and worse labor market outcomes in adulthood. In our IV setting, this mechanism is plausible because the variation we are exploiting is likely related to genetic factors. Put differently, our IV strategy exploits long-term variations in body weight, which means that differences in body weight in childhood can persist into adulthood. One caveat, however, with our analysis is that education is endogenous and therefore we may be exaggerating its role. Moreover, we cannot completely rule out the possibility that the reduction of the effect of BMI when controlling for education is due to collinearity problems. We therefore see this empirical analysis as an exploratory exercise and should be interpreted with caution.

The rest of the paper is organized as follows. The following section presents a review of the literature. Section 3 presents a description of the data. Section 4 presents a description of the methodology used and discusses the plausibility of using the strategy proposed by Cawley (2004) in the Brazilian context. Section 5, we present the results of the estimates from OLS and Instrumental Variables (IV). Finally, section 6 concludes.

2 LITERATURE REVIEW

2.1 Body Mass Index

The majority of studies uses BMI to represent individuals' body mass. However, it should be noted that such a measurement might not be the most accurate since it does not distinguish, for example, between fat, muscles and bones.[6] Some studies take into account different measurements of body mass such as waist circumference, fat-free mass and body fat separately, and even individuals' height (Bozoyan and Wolbring, 2011; Johansson *et al.*, 2009). The biggest concern about using BMI is the weight-wage relationship for men because muscle can be classified as fat and it may bias the analysis involving fatness and obesity in the male population (Bozoyan and Wolbring, 2011). Although BMI presents some limitations, it is the most convenient measure available and broadly accepted in the literature (Rashad, Grossman and Chou, 2006). This is mainly due to the lack of information of individual's body composition other than weight and height in national surveys. BMI can be easily obtained by dividing weight (kilograms) divided by the square of height (meters) and, even though has been pointed out as a flawed measure, has systematically presented the direction in which body mass may reflect in better or worse labor market performance across countries.

2.2 Background on BMI and labor market outcomes

Any empirical exercise that attempt to ascertain the importance of body weight in labor market outcomes must take into consideration the endogeneity of BMI. The literature has largely recognized that the relationship between wages (or other labor market outcomes) and body weight may occur in both directions and most of the studies have used the IV method to account for the endogeneity problem. Sargent and Blanchflower (1994), Averett and Korenman (1996) and Wada and Tekin (2010) treat the endogeneity problem by using a lagged value of BMI. This strategy has to satisfy the hypothesis of independence of lagged BMI and the wage equation's residuals. However, as points out Atella, Pace, and Vuri (2008), this may not hold due to the unobserved individual effects which may affect both lagged BMI and wages.

6. For a better discussion on this matter, see Bozoyan and Wolbring (2011).

Baum and Ford (2004), Conley and Glauber (2006) and Wada and Tekin (2007) used fixed effect estimators to control for the unobserved individual characteristics. This strategy, while controlling for the unobservable effects, does not solve the reverse causality problem (Atella, Pace and Vuri, 2008). Moreover, we should note that the fixed effect estimator assumes that the unobservables are time invariant, which should be considered a plausible assumption. Other set of studies has used some indicators related to health problems such as self-esteem and poverty as instrument (Morris, 2006; Pagan and Dávila, 1997). However, Cawley (2004) argues that these variables are likely to affect directly labor market outcomes and therefore are not valid instruments. Other instruments use average BMI within household, presence of individuals with diseases caused by overweight in the household (Lundborg *et al.*, 2007).

Cawley (2000, 2004) uses the BMI of family members such as parents', siblings' and children's. (Cawley, Grabkal, and Lillard (2005) use the BMI of a child or a parent assuming that the BMI of a biological family member is not directly correlated with the individuals' wage. In general, these studies provide several pieces of evidence in favor of the exclusion restriction. A comprehensive review and discussion by Cawley (2004) suggests that home environment is not correlated with sibling differences in BMI. Lindeboom, Portrait and Van-Den-Berg (2010) also aimed at validating the body size of a biological relative as instrument. They find that the correlation in intergenerational obesity is mainly due to genetic factors. Thus, this instrument has been the most widely accepted in literature.

Using the BMI of a family member as instrument, Cawley (2004) studies find that higher BMI is negatively associated with wages in the US. This finding has been also found in other developed countries, including Australia, Germany, UK, and Denmark (Cawley, Grabkal and Lillard, 2005; Greve, 2008; Kortt and Leigh, 2010). These studies also find gender differences in the effects of body weight. For example, Greve (2008) find negative and positive effects for women and men, respectively. In a study for England, Scotland and Wales, Sargent and Blanchflower (1994) found no effects for men and negative effects for women. While for England, Morris (2006, 2007) finds BMI positively related for men's and negatively related for women's wages and employment. Baum and Ford (2004) found both genders suffering from a persistent wage penalty during a great part of their working years. Brunello and D'hombres (2007) found negative effects for both genders. Lundborg *et al.* (2007) found negative effects on employment independently of gender but negative for women's wages.

For developing countries, the relationship between BMI and labor market outcomes tend to be positive. In this view, Schultz (2003) investigates the effects of human capital inputs on wages and finds positively related responses from height, BMI, education and migration for Ivory Coast and Ghana. He found that a unit increase in BMI is associated with a 9% raise in wages for women in the Ivory Coast. His results for men suggested that an additional unit of BMI increases men's wages by 15% in the Ivory Coast and by 7% in Ghana. Using data from of Indian coalmine workers, Dinda *et al*. (2006) found a positive effect of BMI on wage earnings. For Brazil, (Thomas, and Strauss (1997) examined the link between body weight and wages among a sample that gathered detailed information of 53,000 households. Using relative prices of food as instrumental variables for BMI, these authors provided evidence that BMI is associated with higher wages for males after controlling for height and nutrient intakes, and these impacts are generally largest among the less educated. As is possible to note, the literature for Brazil is limited. Our results are closely related with the findings by Curi e Manezes-Filho (2008), who found that taller people earn, on average, a higher salary.

In general, previous studies about the relation between BMI and labor market outcomes argue that improvements in health conditions is a plausible mechanism by which higher BMI (from underweight to normal) is positively associated with wage and employment. For instance, better health conditions may result in higher labor productivity and lower prevalence of work-absenteeism. Another possible explanation for the positive sign is attributed to the fact that jobs are more exhausting in developing countries and thus have higher body mass requirements (Glick and Sahn, 1998).

However, the results from these studies for developing countries are difficult to be interpreted. Indeed, much of existing studies do not address the endogeneity problem or use instrumental variables that are unlikely to meet the exclusion restriction. For example, previous studies have used food prices or health infrastructure as instruments. As we mentioned in the introduction of this paper, these variables could be directly related to labor demand or other determinants of wages and employment. Therefore, our main contribution is provide new evidence of the effect of body weight on labor market outcomes using the empirical strategy proposed by Cawley (2004).

3 DATA

This study uses data from the last Consumer Expenditure Survey – POF (*Pesquisa de Orçamentos Familiares*) 2008-2009 which was conducted by the Brazilian Census Bureau – IBGE (*Instituto Brasileiro de Geografia e Estatística*) between May 2008 and May 2009 through interviews in a sample of Brazilian households. Each household was interviewed for a 7-day period through questionnaires regarding the household and its members. The survey aimed to provide information on the household budget composition and on population's life conditions as to measure the structures of consumption, expenditures and income sources. The sampling of POF is part of the group of complex surveys which involves the use of three types of probability samples (simple random sampling, stratified sampling and cluster sampling). Firstly, census sectors, which are geographical areas defined in the Brazilian 2000 Demographic Census, were selected to form a chief sample used by IBGE in all household surveys of the bureau. These sectors were then divided in strata by a geographical and statistical stratification method.[7] Secondly, census sectors were sampled from each stratum and formed a subsample used to select the 55,970 households of POF final sample. All the information is available in the form of microdata disposed in different records.

The definition of family differs from the one used by the POF. One household is composed by individuals who live under the same roof and share food and living expenses while families are blood-related individuals or individuals connected by domestic dependence or living rules. This implies that one household can have more than one family. Particularly, this condition was observed in only 5.34% of the 55.970 sampled households.

In Brazil, country-representative household budget surveys have been conducted since the seventies' decade and more recently information on anthropometric measures was collected from each member in the household during the period of the interview. These measures contain information such as body weight and height which made possible to calculate the BMI. This index was then estimated for each individual by dividing weight (kilos) by the square of height (meters).

Only Registers 02 and 14 were used in this study. The first one is related to the people living in the household and the second one has information on labor, income and income deductions. The sample of this study includes family members in the household from 18 to 60 years old and was restricted to individuals that were registered as children in POF. This restriction was imposed due to the estimation method chosen to test the relationship between BMI and labor market outcomes. More precisely, the estimation requires information on the individual's siblings. Since older individuals are less likely to co-reside with their parents, young individuals mainly compose our sample. We do not exclude older individuals co-residing with their parents in order to maximize the precision of the estimates. However, excluding individuals who are 35 years old or more do not affect our results and conclusions.[8]

7. For more details on POF stratification method see the publication "*Despesas, rendimentos e condições de vida*" of IBGE.
8. Results available upon author request.

In order to assess the relationship between BMI and labor market outcomes, the variables considered were people's hourly wages and a proxy created to measure informality in the labor market. The hourly wage variable is simply the division of the individual's monthly labor income by the number of monthly hours worked. We only considered in the analysis the main job declared by the respondent and jobs of only four groups: private sector, public sector, domestic and temporary (rural areas). In addition, we only considered monthly wages above 100.00 Brazilian *Reais* to generate the hourly wage variable. To create the proxy for informality, we used one of the indexes presented Henley; Arabsheibani, and Carneiro (2009) These authors define informality as the number of people in the labor market that do not contribute to any form of social security. We created a binary variable as a measure of the informal labor market; this variable is equal to 1 if the individual did not contribute to a public social security system, and 0, otherwise. The other variables included were the individual's social and demographic characteristics such as age, sex, race, education years, area of residence and region. These are considered control variables that could also affect labor market outcomes (see table 1 for a description of the variables used).

TABLE 1
Main labor market outcomes equation variables

Labor Market Outcomes:
Hourly wage = monthly wage divided by the total of monthly worked hours.
Informal employment = 1, if the individual does not contribute for social security, 0; otherwise.
Socioeconomic and Demographic Characteristics:
Body Mass Index (BMI) = body weight (kilograms) divided by the square of height (meters)
Age (in years) = individual's age
Male = 1, if individual is male, 0; otherwise.
White = 1, if individual declared him/herself as white, 0; otherwise.
Education years = individual's schooling years
Area of residence:
Rural = 1, if individual's household is located in rural areas, 0; otherwise.
Metropolitan City = 1, if individual's household is located in a metropolitan city, 0; otherwise.
Region:
North = north region household, 0; otherwise.
Northeast = northeast region household, 0; otherwise.
Southeast = southeast region household, 0; otherwise.
South = south region household, 0; otherwise.
Midwestern = mid-western region household, 0; otherwise.

Elaborated by authors.

Table 2 presents the summary statistics for all the variables discussed. It is interesting to notice the high participation of informal labor market at 42%. The maximum hourly wage observed was 116.79 Brazilian *Reais*. The level of BMI is on average 23.67, which is considered normal weight according to World Health Organization classification[9] (Who, 1995). The age is on average 26 years and the years of education is on average 10 years. About 58% of the individuals are male and 52% declared themselves as whites. Only 9% of the individuals live in rural areas while 41% belong to cities in the metropolitan area. Most of the individuals live in the Southeast of Brazil (53%) followed by Northeast (21%) and South (14%).

TABLE 2
Summary Statistics

	N	Mean	Standard Deviation	Min	Max
Labor Market Outcomes:					
Hourly wage	8,831	4.83	5.60	0.47	116.79
Informal employment	8,461	0.42	0.49	0	1
Socioeconomic and Demographic Characteristics					
Body Mass Index (BMI)	8,831	23.67	4.32	13.80	150
Sibling's BMI	8,831	21.01	5.26	8.87	150
Age (in years)	8,831	26.06	7.57	18	60
Male	8,831	0.58	0.49	0	1
White	8,831	0.52	0.50	0	1
Education years	8,770	10.48	3.14	0	15
Area residence :					
Rural	8,831	0.09	0.28	0	1
Metropolitan City	8,831	0.41	0.49	0	1
Region:					
North	8,831	0.05	0.21	0	1
Northeast	8,831	0.21	0.41	0	1
Southeast	8,831	0.53	0.50	0	1
South	8,831	0.14	0.35	0	1
Midwestern	8,831	0.07	0.25	0	1

Source: Research results.
Notes: All statistics were obtained using sample weights.

9. The WHO classification of body weight is: underweight if BMI < 18.5 kg/m², normal if 18.5 kg/m² ≥ BMI < 25 kg/m², overweight if 25 kg/m² ≤ BMI < 30 kg/m² and obese if BMI ≥ 30 kg/m².

4 EMPIRICAL STRATEGY

We use the technique of instrumental variables to estimate the effect of BMI on labor market outcomes as follows:

First stage:

$$BMI_i = \theta \, BMI_i^{sibling} + X'\beta + \xi_i. \quad (1)$$

Second stage:

$$y_i = \delta \widehat{BMI}_i + X'\pi + \eta_i. \quad (2)$$

BMI is the body mass index of the individual *i* and $BMI_i^{sibling}$ is the body mass index sibling. *y* represents different measures of labor market outcomes. The *X* vector includes a set of specific individual characteristics such as sex, race, and civil status. The terms ξ and η are idiosyncratic errors. The standard errors are clustered at States level.

The final coefficient of interest is δ, which represents the effect of BMI on a given labor market outcome measure. The model essentially follows the same identification strategy of Cawley (2004). The assumptions behind the identification strategy are: *i*) the sibling BMI has a significant correlation with the BMI; and *ii*) the sibling BMI is properly excluded from the equation (2), or equivalently is uncorrelated with η. The validity of the first assumption is expected due to the sibling of same parents share half of their genes. This would ensure a strong correlation between BMI and sibling BMI.

The second assumption is more challenging since we cannot test directly its validity. It could be argued that non-genetic variation in BMI could be correlated with the error term in the second-stage. In particular, a possibility is that learning habits at home are correlated with BMI and wages. Nevertheless, there is no evidence finding a significant effect of common environment within the home on BMI (Comuzzie and Allison, 1998; Vogler *et al.*, 1995). In addition, there is evidence showing that the BMI between adopted siblings are not significantly correlated. This suggests that most of the BMI correlation between siblings is mainly explained by genetic factors. However, we recognize that there are threats to this empirical strategy that we cannot rule out. First, we are not able completely to rule out that the correlation between the BMI and background familiar characteristics is zero in the Brazilian case.

Second, since young individuals compose mainly our sample, a selection bias could arise. In this case, our results may be not representative of the entire population. However, we estimate OLS regressions using the complete sample and find quite similar results to that of our restricted sample.[10] This suggests that our IV estimates might have still external validity to the entire population.

10. Results available upon author request.

5 RESULTS

5.1 OLS estimates

The first procedure to analyze the relationship between BMI and labor market outcomes was to estimate OLS regressions (see table 3).Panel A shows the results for wage while panel B shows the results for informal employment. Column (1) is based on a specification that includes State and Cohort fixed effects (dummies controlling for the individual's birth year) and a dummy for male individuals as control variables. The other columns correspond to different specifications that include additional groups of controls. At the bottom of the table, the number of observations presented.

TABLE 3
OLS estimates of the relationship between BMI and labor market outcomes

	(1)	(2)	(3)	(4)
	Panel A: Log of hourly wage			
Body mass index	0.00356 [0.00192]*	0.00268 [0.00184]	0.00240 [0.00196]	0.00110 [0.00175]
Number of observations	8,815	8,815	8,815	8,754
	Panel B: Informal employment			
Body mass index	0.000635 [0.00179]	0.000880 [0.00174]	0.00112 [0.00175]	0.00149 [0.00183]
Number of observations	8,446	8,446	8,446	8,386
State fixed effects	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes
Male dummy	Yes	Yes	Yes	Yes
Residence area	No	Yes	Yes	Yes
Other demographic characteristics	No	No	Yes	Yes
Household head characteristics	No	No	No	Yes

Source: Research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. State fixed effects include dummies of State of residence. Cohort fixed effects include birth year dummies. Residence area includes dummies indicating metropolitan city and rural residence status. Other demographic characteristics contain dummies indicating birth month and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. * p<0.1.

The BMI parameter varies from a significant effect on the logarithm of hourly wages in the first specification to insignificant estimates in the remaining ones. In terms of magnitude, the parameter of interest suffered a substantial decrease when more control variables were included. When the controls related to the area of residence are added the coefficient of interest is reduced by 32%, and now is not significant. Indeed, when all the control variables are added (column 4), the coefficient of interest is reduced by 223%.

On the other hand, the relationship between BMI and informal employment is never statistically significant. As more groups of controls are included, the parameter became larger. It is also important to note that the sign of the coefficients is positive, which suggests that higher BMI increases the likelihood of informal employment.

In general, there is little evidence of a systematic association between BMI and labor market outcomes. In addition, the results are very sensitive to control variables included in the regressions. This suggests that the measurement error in BMI and omitted variable bias could play an important role.

5.2 IV estimates

The second approach to estimate the relationship between BMI and labor market outcomes in Brazil was to use an instrumental variable strategy. Two-Stage Least Squares Estimation were used. We opted to use as instrument the BMI of the individual's sibling. Table 4 presents evidence that the sibling's BMI is strongly correlated with BMI. Specifically, the estimates shown are for the equation that relates the individual's BMI to his/her sibling's BMI. The sign of the coefficient is positive and statistically significant in all regressions, as expected. In addition, the F-statistics for instrument exclusion above 10 indicates that the sibling's BMI has sufficient predictive power on BMI. Importantly, the parameter of interest does not change significantly, as different controls were included in the regression. For example, the coefficient of interest changes from 0.17 to 0.168. This can be interpreted as favorable evidence to the fundamental assumption of the identification strategy.

TABLE 4
First stage results: relationship between BMI and sibling BMI

	Dependent variableis BMI			
	(1)	(2)	(3)	(4)
Sibling Body Mass Index	0.17 [0.0240]***	0.17 [0.0243]***	0.169 [0.0244]***	0.168 [0.0249]***
Exc. instruments F-stat.	50.11	48.84	48.18	45.5
Kleibergen and Paap test (p-value)	0.00	0.00	0.00	0.00
Number of observations	8,781	8,781	8,781	8,725
Basic controls	Yes	Yes	Yes	Yes
Residence area	No	Yes	Yes	Yes
Other demographic characteristics	No	No	Yes	Yes
Household head characteristics	No	No	No	Yes

Source: Research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. Basic controls include State and cohort fixed effects, sex and dummies for sibling's birth year and sex. Residence area contains dummies indicating metropolitan city and rural residence status. Other demographic characteristics contain dummies for birth month and white race, and sibling's month birth and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. *** $p<0.01$.

Table 5 presents instrumental variables estimates of the association between BMI and labor market outcomes. In this regression the individual's own BMI was instrumented by his/her sibling's BMI and the same controls included in the previous regressions were used as shown in columns from (1) to (4). In contrast to OLS estimates, the instrumental variables results are all significant. The addition of more sets of controls caused a decrease in the parameters magnitude in both the hourly wage and the informal employment equations. However, it seems to stay more stable in comparison to OLS estimates. The results indicate that increases in BMI are associated with increases in wages. An important difference with the OLS results is that now the effect on informal employment BMI is negative and statistically significant, suggesting that increases in BMI reduces the likelihood of informal employment. These changes in the coefficients are consistent with the presence of a severe measurement error attenuating the OLS estimates. Pu differently, measurement error in BMI seems an important source of bias, as bias from omitted variables would imply that the OLS likely overcome the true effects of BMI.

TABLE 5
Instrumental variables estimates of the relationship between BMI and labor market outcomes

	(1)	(2)	(3)	(4)
	Panel A: Log of Hourly Wage			
Body mass index	0.0342 [0.0141]**	0.0318 [0.0132]**	0.0264 [0.0130]**	0.0248 [0.0116]**
Number of observations	8,781	8,781	8,781	8,725
	Panel B: Informal Employment			
Body mass index	-0.0180 [0.00943]*	-0.0165 [0.00947]*	-0.0161 [0.00908]*	-0.0161 [0.00912]*
Number of observations	8,413	8,413	8,413	8,359
Basic controls	Yes	Yes	Yes	Yes
Residence area	No	Yes	Yes	Yes
Other demographic characteristics	No	No	Yes	Yes
Household head characteristics	No	No	No	Yes

Source: Research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. Basic controls include State and cohort fixed effects, sex and dummies for sibling's birth year and sex. Residence area contain dummies indicating metropolitan city and rural residence status. Other demographic characteristics contain dummies for birth month and white race, and sibling's month birth and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. *, ** e *** = p<0.1, p<0.05 e p<0.01.

5.3 Comparison with previous studies

We now compare our results to those derived from previous studies. Schultz (2003) finds that that one unit increase in BMI is associated with a 9-15 percent raise in in the Ivory Coast and with a 7 percent raise in Ghana. Our results are much smaller than these estimates, which could due to differences between Brazil and these countries, or its estimates could be larger in magnitude because the instruments he used are less likely to isolate the causal effect of body weight from unobserved factors. He used community health infrastructure, water and sanitation conditions as instruments for BMI. These instruments may be correlated with other unobserved factors affecting labor market conditions. Regions with less supply of health services are poor and likely have a lower number of firms in general, which could affect labor demand and in turn individual wages.

For Brazil, Thomas and Strauss (1997) find that 1 percent increase in BMI is associated with 2.2 percent increase in wages. Our estimate point is only 0.5 percent increase in earnings. We believe that these differences are explained by the ability of the instruments used in their work and ours in identifying the causal effect of body weight. As such, we believe that the use of food price as instrument may introduce larger bias than the use of sibling's BMI as the source of variation.

5.4 Subgroup analysis

The BMI effect on labor market outcome was also evaluated in different subsamples to capture the heterogeneity of this effect among different groups of the society. Table 6 illustrates how BMI may affect hourly wages and informal employment according to the individuals' sex, race and residence area. It was used instrumental variables estimation considering all the group of controls. Interestingly, the positive impact on wages and the negative impact on informal employment were also observed in all subsamples. Nevertheless, BMI may not affect labor market outcomes of some groups separately.

The parameters were significant only for female individuals, non-white individuals and for people living in urban areas in the hourly wages equation. On the informal employment equation, the significant parameters were also for female individuals and in contrast to the hourly wage equation, informal employment seems to be affected by BMI only for people in rural areas. These results indicate that BMI is positively related to women's hourly wages and it has no influence on male individuals' labor market outcome.

The significant relationship between BMI effect and hourly wages of non-white individuals indicates that race is a relevant aspect on this subject as a higher body weight or a better sign of nutritional condition may enhance higher wages in this specific group. It makes sense that only individuals in urban areas may present a positive response on hourly wages by an increase on BMI. Labor markets in urban areas tend to be more competitive and individuals with a higher body mass may more productive and therefore better compensated.

TABLE 6
Instrumental variables estimates of the relationship between BMI and labor market outcomes by sex, race and residence area

	Male	Female	White	Non-white	Urban	Rural
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: log of hourly wage					
Body mass index	0.0159 [0.0145]	0.0326 [0.0178]*	0.0182 [0.0202]	0.0381 [0.0179]**	0.0262 [0.0125]**	0.00384 [0.0275]
Number of observations	5,133	3,592	3,779	4,946	7,485	1,240
	Panel B: informal employment					
Body mass index	-0.000759 [0.0120]	-0.0434 [0.0157]***	-0.0168 [0.0137]	-0.0179 [0.0141]	-0.0123 [0.00930]	-0.0459 [0.0212]**
Number of observations	4,901	3,458	3,619	4,740	7,151	1,208
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Residence area	Yes	Yes	Yes	Yes	Yes	Yes
Other demographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Household head characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. Basic controls include State and cohort fixed effects, sex and dummies for sibling's birth year and sex (columns 1 and 2 do not include sex, while columns 3 and 4 do not include white dummy). Residence area contain dummies indicating metropolitan city and rural residence status (columns 5 and 6 do not include rural dummy). Other demographic characteristics contain dummies for birth month and white race, and sibling's month birth and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. * p<0.1, ** p<0.05, *** p<0.01.

5.5 Does Education Matter?

Our final effort is to present evidence on a potential channel through which BMI may affect labor market outcomes. In particular, we investigate if education plays a role. In order to address this issue directly, table 7 present an exercise where we run the benchmark specification controlling for years of education (column 2). The education could be a mechanism give that human capital accumulation is directly affected by individual's health conditions, as suggested by the literature (Currie and Moretti, 2007; Currie, 2009). For comparison purposes, the column (1) of table 7 presents the results of the column (4) of Table 4. The results in panel A in the table show that the effect of BMI on wages are reduced and no longer statistically significant when education years is included as a control variable. In fact, the effect of BMI on hourly wages is reduced by about 80%. Panel B results indicate that the effect of BMI on informal employment is also reduced (in absolute value) and no longer statistically significant.

These results suggest that education may be an important mechanism by which BMI affects labor market outcomes. Some evidence for the developed world suggests that there is, in fact, a relationship between body weight and education attainment. The study by Kaestner and Grossman (2009) is an example of the relationship between body weight and educational attainment among children. They aim to point out the effects of obesity in terms of discrimination and expect negative effects on school performance. Though they found no difference in achievement between obese/overweight children and average weight children, the authors emphasize that body weight can exert some influence on school performance as children age and previous evidence has shown that body weight does have implications on human capital formation. Han, Norton and Powell (2011) investigate the direct and indirect effects of body weight/obesity on wages operated through education and occupation choice. They focus on the long term effects of body weight on wages and found that higher levels of BMI during teenage years are related to lower levels of accumulated education in the early thirties, which negatively affects wages at this age. Therefore, they found that education is a mechanism in the weight-wage relationship.

TABLE 7
Instrumental variables estimates of the relationship between BMI and labor market outcomes (controlling by education years)

	Baseline	Contolling by Education years
	(1)	(2)
	Panel A: Log of Hourly Wage	
Body mass index	0.0248 [0.0116]**	0.0137 [0.0106]
Education years	- -	0.0798 [0.00361]***
Number of observations	8725	8668
	Panel B: Informal Employment	
Body mass index	-0.0161 [0.00912]*	-0.0121 [0.00877]
Education years	- -	-0.0318 [0.00286]***
Number of observations	8359	8302
Basic controls	Yes	Yes
Residence area	Yes	Yes
Other demographic characteristics	Yes	Yes
Household head characteristics	Yes	Yes

Source: research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. Basic controls include State and cohort fixed effects, sex and dummies for sibling's birth year and sex. Residence area contain dummies indicating metropolitan city and rural residence status. Other demographic characteristics contain dummies for birth month and white race, and sibling's month birth and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. *, ** e *** = p<0.1, p<0.05 e p<0.01.

Our result indicates that education is, as opposed to Han, Norton and Powell (2011), a mechanism through which BMI positively affects wages, reflecting better health and ability to accumulate human capital. However, we emphasize that our exercise should be considered as suggestive and requires further investigation. Other mechanisms also should be explored in future research. Furthermore, the literature for the developing world is still scarce and our results are a first and important step on this agenda.

5.6 Robustness of Findings

Our strategy to test the validity of the results was to analyze the changes on BMI parameters by performing two different specifications. One consisted in the exclusion of outliers in BMI and the other in the inclusion of extreme low values in wages. Table 8 presents the results of the alternative specifications in comparison to the baseline model in column 1. Overall, our results in the table show that the estimates are not sensible to outliers both in BMI and wage.

TABLE 8
Instrumental variables estimates of the relationship between BMI and labor market outcomes (robustness of findings)

	Baseline	Excluding Outliers in BMI	Including extreme low wages
	(1)	(2)	(3)
		Panel A: Log of Hourly Wage	
Body mass index	0.0248 [0.0116]**	0.0359 [0.0151]**	0.0298 [0.0119]**
Number of observations	8,725	8,565	9,072
		Panel B: Informal Employment	
Body mass index	-0.0161 [0.00912]*	-0.0219 [0.0118]*	-0.0177 [0.00915]*
Number of observations	8,359	8,208	8,727
Basic controls	Yes	Yes	Yes
Residence area	Yes	Yes	Yes
Other demographic characteristics	Yes	Yes	Yes
Household Head Characteristics	Yes	Yes	Yes

Source: Research results.
Notes: 1. Standard errors (in brackets) are robust to heteroskedasticity. Column 2 eliminates potential outliers by restricting our sample to include only individuals with a BMI above 15 and lower than 35. Column 3 includes individuals with a wage lower than 100.00BrazilianReais in our sample. Basic controls include State and cohort fixed effects, sex and dummies for sibling's birth year and sex. Residence area contain dummies indicating metropolitan city and rural residence status. Other demographic characteristics contain dummies for birth month and white race, and sibling's month birth and white race. Household head characteristics are education years, age, and sex. All estimations use sample weights.
2. *, ** e *** = p<0.1, p<0.05 e p<0.01.

6 FINAL REMARKS

Analyzing the relationship between Body weight and labor market outcomes has been the main subject of this study. To deal with the potential endogeneity of body weight, we use instrumental variable technique. Our findings suggest that higher BMI is associated with higher wages and reductions in the probability of informal employment. In addition, we found that the effects are greater in women, the nonwhite people and individuals living in urban areas. These results contrast with those of developed countries where a negative relationship is found between BMI and labor market outcomes. One potential explanation is that increments in BMI mean improvements in the health and nutrition due to that of nutrient intake is lower in developing countries.

Our results also suggest that education may be an important mechanism through which the BMI affects the results of the labor market. This is plausible in view of studies showing that early nutrition is an important determinant for formation of human capital. Therefore, our results could represent the long-term relationship between BMI and labor market outcomes. Nonetheless, evidence of this study is essentially suggestive and requires further research.

We are aware that there are several limitations. The use sibling's BMI as an instrument implies that our sample is based on individuals who have at least one sibling. Therefore, our results may not be generalized to the entire population. Furthermore, the use of that instrument necessarily implies a reduction in the number of observations which could affect the precision of estimates. Setting aside the issue of generalizability, the fact that the performance in the labor market is directly related to poverty and individual welfare, estimating the causal effect of malleable variables in terms of policy as the BMI is an important question *per se*.

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