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Obesity and labor market in Peru

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Abstract. Obesity is a problem that affects not only developing countries but middle-income countries as well. Using anthropometric and socioeconomic information, we analyze the relationship between obesity and employment and wages in Peru. The results show that an increase in body mass index (BMI) has a negative relationship with the probability of women working (-0.3 percentage points), particularly married women. In the case of men, only those in the obese range show a negative relationship (-4.9 percentage points). With regard to monthly wages, an increase in BMI is associated with a 0.8% reduction in women's wages (US$ 2.9) and a 1.3% increase in men's wages (US$ 5.8).

Key words: body mass index; gender; labor market; Peru.

Introduction

Peru is a middle-income country that in recent decades has shown growth rates of around 4.7% (BCRP, 2018). This has been reflected both in better living conditions for its inhabitants and in higher employment levels (INEI, 2019). However, some issues that remain unresolved are the fragmented health system (Jumpa et al., 2003; Seinfeld et al., 2013), and a lack of policies that promote employee wellbeing and quality jobs (Chacaltana & Yamada, 2009; Revilla et al., 2012; Schwalb et al., 2014). Moreover, little has been studied in Peru about the possible relationship between a workforce with health problems—such as obesity—and employment and wages.

According to the World Health Organization and the Organization for Economic Cooperation and Development, obesity is one of the great ills of this age, since it is the trigger for many diseases such as diabetes mellitus and hypertension (WHO, 2018; OECD, 2019) as well as a problem that afflicts both high-income and developing countries. In the case of Peru, Álvarez-Dongo et al. (2012) and Poterico et al. (2012) show that overweight and obesity mainly affect the adult population and are associated with the socioeconomic position. Meanwhile, Huayanay-Espinoza et al. (2017) find a positive association between parity and obesity in women. According to data from Peru's National Institute of Health (Instituto Nacional de Salud), between 2007 and 2011, 11.8% of men and 19.6% of women between 15 and 65 years of age suffered from obesity—that is, they had a body mass index (BMI) above 30; 40.2% of men and 38.1% of women were overweight (BMI between 25 and 30); while 48% of men and 42.3% of women were in the normal range (BMI between 20 and 25).

With regard to employment and wages, Peru's National Institute for Statistics and Informatics (Instituto Nacional de Estadística e Informática, INEI, 2018) shows that between 2004 and 2018, the employment rate for men and women fluctuated around 80% and 60%, respectively. Of all those employed, close to 80% worked in the private sector or independently.[1] The wage gap between men and women was 25.8% in 2018; however, between 2004 and 2018, it decreased by 3.7 percentage points. In addition, only 30% of workers are in the formal sector, with the benefits of the health system that this implies (Jaramillo & Sparrow, 2014).

The relationship between obesity and the labor market can manifest itself in various ways. At the macroeconomic level, the greater the prevalence of

1 The remaining 20% was comprised of public sector workers, unpaid family workers, and domestic workers.

health problems—such as obesity– among the workforce, the higher the costs of medical care. In this regard, Cawley and Meyerhoefer (2012) show that obesity in the US is related to an increase in medical expenses equivalent to US$ 3,000, on average, per person per year. Similarly, changes in the work environment, such as the shift from manual to automated activities, can lead to a sedentary lifestyle at work and therefore to obesity problems (Philipson and Posner, 1999; Lakdawalla and Philipson, 2002; Ehmke et al., 2008).

At the microeconomic level, obesity may be associated with higher rates of absence due to illness (Bramming et al., 2019), lower productivity and, therefore, lower wages. However, this relationship is more complex than is first apparent, as there are unobservable factors that determine whether a person (or an employer) decides to provide (or hire) labor. Thus, for example, workers may or may not opt to work according to their preferences or attributes (Gortmaker et al., 1993; Loh, 1993; Mitra, 2001; DeBeaumont & Girtz, 2019), while some employers may place restrictions on hiring based on their preferences related to physical appearance (Agerström & Rooth, 2011; Caliendo & Lee, 2013; Galarza & Yamada, 2014; Arceo-Gomez & Campos-Vazquez, 2014). In any case, failure to take these variables into consideration may lead to erroneous results.

As far as the identification strategy is concerned, and as previously mentioned, the presence of unobservable variables that affect both employment and wage decisions and obesity inhibit identification of the causal effect of obesity on the labor market. Thus, this study seeks to present evidence on the relationship between obesity and employment and wages in Peru, as a middle-income country, leaving the causal issue for future research. I consider the case of Peru to be important insofar as its economic indicators have improved considerably in recent years; however, the country still faces difficulties when it comes to transferring this improvement to the wellbeing of its population.[2] I use rounds 2007–2008, 2009–2010, and 2011 of the National Household Survey (ENAHO-CENAN), which collects anthropometric and other socioeconomic information on the population. It is important to mention that, in order to avoid bias in the measurement of BMI, the survey determines the weight of the garments the respondents were wearing at the time.

The results show that, in the case of employment, an increase in one unit of BMI has a negative relationship with the probability of working for

2 Although in 2013 a law to promote healthy eating was enacted (the law against junk food), it was not until early 2020 that its regulations were approved which included the labeling of unhealthy products.

women (-0.3 percentage points, on average) and for those men in the obese range (-4.9 percentage points). In the case of monthly wages, a positive relationship is observed for men (1.3%), and a negative one for women (-0.8%). These values are similar to those found in the international literature.

The rest of this article consists of six parts: a brief review of the literature, the descriptive statistics, the identification strategy utilized, the main results, the results in subgroups, and the conclusions.

Previous literature

Most of the literature on obesity and its relationship with employment and wages centers on developed countries (Averett, 2019). One of the main potential limitations of such analyses is the possible bias resulting from the presence of unobservable variables in the model employed. In this regard, various econometric techniques seek to identify the causal effect of obesity on employment and wages. Thus, the success of the process lies in the assumptions that are being made. Nonetheless, in general the results indicate that obesity has a negative impact on the labor market.

In principle, if the model to be estimated did not depend on unobservable variables, the use of ordinary least squares (OLS) would be sufficient to identify the causal effect of obesity on employment and wages. Examples of this approach are studies by Morris (2007), Johansson et al. (2009), Asgeirsdottir (2011), and Han et al. (2009), which, for the cases of England, Finland, Iceland, and the United States, respectively, present evidence that an increase in BMI has a negative effect on the probability of women working.[3] In the case of men, the results are mixed and, for some of these countries, non-significant. The cases of the United States and England stand out, where obesity is negatively related to employment, while the opposite result is observed in Germany.[4]

The application of this technique to the case of wages and income yields a similar result, in that the negative effects are concentrated mainly on women. In the case of the United States, Averett & Korenman (1999), Cawley (2000, 2004), DeBeaumont (2009), and Mocan & Tekin (2011) find that the increase in BMI is associated with a reduction of between 0.2% and 1.8% in hourly wages. In the case of Europe, Brunello & d'Hombres (2005, 2007), Caliendo & Gehrsitz (2016), and Garcia & Quintana-Domeque (2006)

3 It is worth noting that, despite the widespread use of BMI as a measure of obesity, there are other indicators to this end; examples include fat-free mass, body fat, and waist circumference (Bozoyan & Wolbring, 2011; Ahsan & Böckerman, 2019).

4 An alternative strategy to this method is to use a semi-parametric analysis, as observed in Hildebrand and Van Kerm (2010) and Caliendo and Gehrsitz (2016).

observe a wage penalty of between 0.1% and 1%. For men, again, the results are mixed: Cawley (2004), Johar & Katayama (2012), and Pagan & Davila (1997) find negative effects among white men with obesity (between 0.2% and 1%), while Sabia and Rees (2012) note positive effects.

If the unobservable characteristics are invariant over time, an alternative strategy is to use models with fixed effects. Examples of the application of these models can be found in Lundborg et al. (2010, 2014), Pinkston (2017), Baum & Ford (2004), and Ahn et al. (2019) for Sweden, the US, the US again, and South Korea, respectively. In each case, the results show a reduction in women's income as obesity levels increase. However, the application of these techniques requires that the variable studied—BMI—present sufficient variation between periods, as well as a large sample of individuals.

Finally, it is important to note the widespread use of instrumental variables as a mechanism to recover the causal effect of obesity on the labor market. The literature considers two possible instruments: those linked to the literature on genetics and economics, and those linked toa person's environment.

Biroli (2015), Cawley et al. (2017), Brunello et al. (2019), and Böckerman et al. (2019), among others, consider obesity to have a genetic component, so having parents or family members with obesity makes children more likely to suffer from it too. In this regard, Norton & Han (2008), Lindeboom et al. (2009), von Hinke Kessler Scholder et al. (2010), and Howe et al. (2019) use the BMI of a family member or child of a working individual as an explanatory variable for obesity in that individual. Their results show negative effects mainly on women's income and wages. However, when it comes to the genetic component, it is not clear whether the obesity of a family member meets the exclusion condition of instrumental variables; that is, it does affect work decisions or not.[5] Authors like Benjamin et al. (2012), Cawley et al. (2011), and Conley (2009) have shown that the extent to which genetics can be applied in the social sciences is debatable, as currently there is not enough knowledge to determine whether the genes related to obesity are not also related to other components that are in turn related to the employment and productivity of people.

On the other hand, some instruments show that the environment in which people live and work has effects on their eating habits and customs. Morris (2006, 2007) uses the BMI of individuals who are living in the area of influence of a healthcare center in England. His results reveal negative effects on the

5 See Beauchamp et al. (2011), for the use of genetic data in economics.

employment of men and women. Along similar lines, Jay et al. (2013) study body size prevalence among residents in China's communities. Their results show that both men and women are discriminated in the labor market based on their physical appearance. However, criticism of the instrument remains, in that if people share characteristics with others in their environment (such as eating and health habits), it is to be expected that they will also share some of their work preferences , thus invalidating the instrument.

In light of the above, proposing the use of any of these techniques to identify the causal effect of obesity on employment and wages may lead to erroneous results, in that there are unobservable variables that affect both obesity and employment and wages. Thus, in the present study I try to estimate the relationship between obesity and employment and salaries in Peru, and refrain from proposing causal relationships. Although such relationships allow researchers to determine the impact of a given phenomenon, I consider our approach to the Peruvian case to be important in that it provides indications of the effects of obesity on workers, thereby facilitating the design of health policies. Likewise, I consider the Peruvian case to be of interest in that it is a middle-income country that has undergone rapid economic growth in recent decades, but one that still requires more public policies aimed at transferring these macroeconomic results to its citizens.

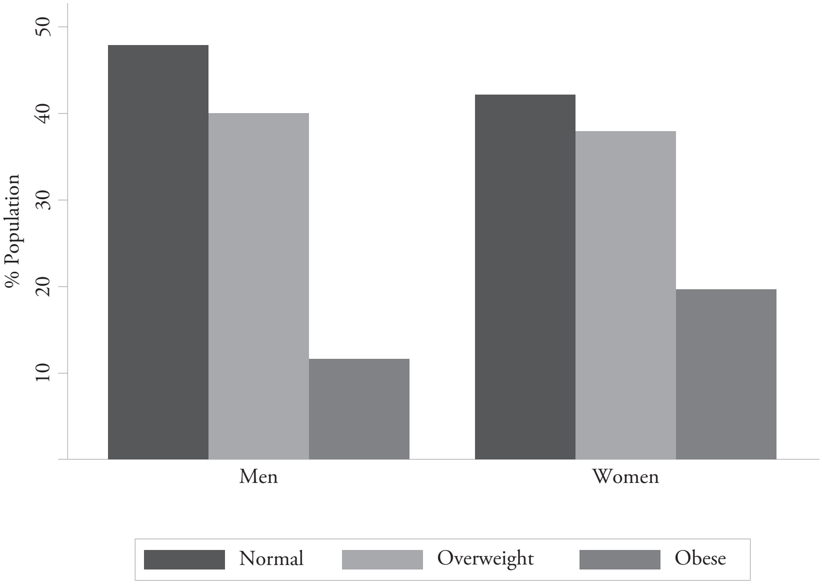
Descriptive statistics

Figure 1 shows the population between 15 and 65 years old in Peru by sex and BMI ranges. I obtained this information based on the ENAHO-CENAN survey for 2007–2011, which is representative at the national level, as well as of urban and rural areas of the country. The survey takes anthropometric measurements of all household members, as well as abdominal girth measurements and information on physical activity (members aged 14 years and older), and information on hemoglobin levels (children under the age of five and women from 12 to 49 years). This information is supplemented by socioeconomic data on household members.[6]

Overall, it can be seen that 48% of men are in the normal weight range, while 42% of women are in this category. In turn, 40% of men and 38% of women can be classed as overweight. Finally, 12% of men suffer from obesity, while the same is true of 20% of women. As BMI increases, the proportion of the population that is overweight and obese decreases, though this problem is more evident among women.

6 See INEI (2011).

Figure 1
BMI by sex

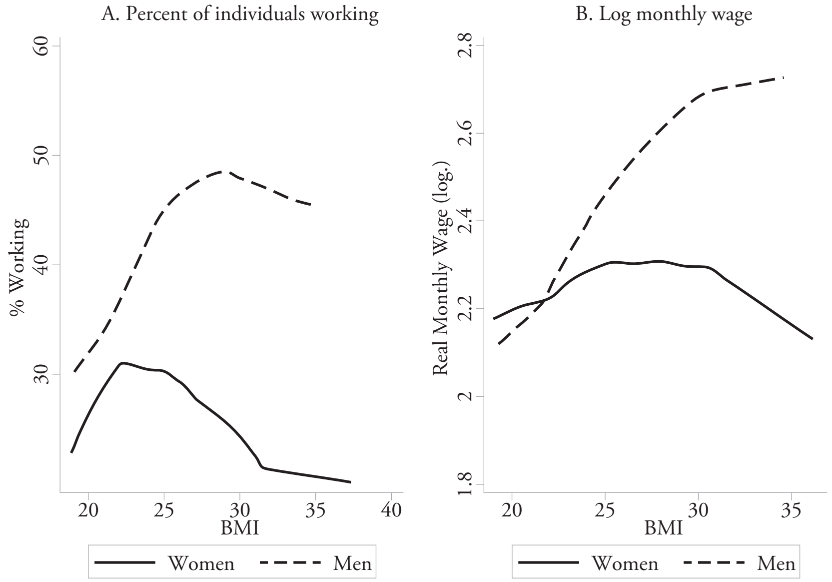


Note: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Men and women aged 15–65 years. Severely obese is included with obese. N=45, 172.

Figure 2 shows the extent of labor market participation and the wage levels of men and women at different ranges of BMI. The figure on the left shows that although the percentage of men working is higher than that of women, both behave differently as BMI increases. Among men, the percentage rises until it reaches the overweight range (BMI between 25 and 30), and then slowly declines in the obesity range (BMI > 30). Among women, labor participation increases only in the normal range (BMI between 20 and 25), then declines rapidly the greater the weight. In addition, it is notable that while the difference in labor participation between men and women is five percentage points in the normal BMI range, it is 15 percentage points in the obesity range.

With regard to wages, the figure on the right shows the evolution of monthly wages (in logarithms) at different ranges of BMI. Women's salaries are higher to begin with and then grow at a slower rate than men's, before finally peaking in the overweight range. Thus, between the normal range and the overweight range, the income of women increases by 10%, while for men the increase is 40%. Similarly, while women's wages decrease from the overweight to the obesity categories, men's wages do not. Overall, in the obesity range, men's wages are 22% higher than women's.

Figure 2
Labor market outcomes and BMI



Note: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Data restricted to individuals with valid observations aged 15–65 years and BMI from 15 to 45. In Panel A, N=45,172 (49.1% women); in Panel B, N=13,414 (35.9% women). I define 20 quantiles of BMI by sex to generate a LOWESS graph (using expansion weights in both panels).

Table 1 presents the main descriptive statistics obtained with the ENAHO-CENAN for the 2007- 2008, 2009-2010 and 2011 rounds. In general, for the period 2007-2011, I have 45,172 people between 15 and 65 years of age who can work and have information on BMI. Out of this total, those who have a valid income (29.7%) are considered as workers. In this regard, it is important to mention that the study did not consider pregnant women, as well as those with a BMI that was not between 15 and 45, in order to make the results comparable with other studies.[7] Column (1) shows that BMI is slightly higher for women (26.3), as compared to men; however, when the sample is restricted to only those who work, BMI for men and women is similar. According to obesity ranges, it is interesting to note that, in the case of those who work, the highest proportion of men are overweight (45.6%), while in the case of women the proportions are similar to those in column (1).

7 For more details about the restrictions in the sample, see Table 2. It is common practice in the literature to exclude pregnant women in literature, considering that their body composition and weight are affected by pregnancy (Cawley, 2004; Atella et al., 2008; Wada & Tekin, 2010).

I make several key observations with respect to sample characteristics such as age, marital status, area of residence, and speaking an indigenous language. The average age is 38 years, which drops to 36 when only those who work are taken into consideration. Similarly, the percentages of married people, people living in rural areas, and people speaking an indigenous language are lower for both men and women when the sample is limited to those who work. However, the percentage of health problems in the household increases when only the working sample is considered.

Finally, information on education and the labor market shows that the years of schooling for working men increase by 1.3, while for women the increase is 3.7 years. When it comes to participation in the labor market, 43.4% of men in the sample and 27.6% of women work, with the number of hours worked per week being higher for men than for women. Similarly, men earn an additional 263.4 soles per month, as compared to women (approximately, US$ 80). Among those who work full time, as well as in informal activities, these characteristics are concentrated among men.

Table 1
Descriptive statistics

	All (1)		Restricted (2)	
	Men	Women	Men	Women
No. of observations	22,983	22,189	8,596	4,818
BMI	25.5	26.3	25.9	25.9
Standard deviation	3.8	4.5	3.7	4.1
BMI ≤ 25 (%)	48.0	42.3	42.0	45.2
Overweight (%) (25 < BMI ≤ 30)	40.2	38.1	45.6	40.1
Obese and severely obese (%) (BMI > 30)	11.8	19.6	12.4	14.8
Waist circumference (cm)	88.5	86.8	89.3	85.8
Standard deviation	10.6	11.5	10.1	11.0
Age (years)	37.9	38.1	36.4	36.1
Married (%)	65.3	60.1	64.8	46.7
Rural (%)	26.7	26.7	12.6	6.2
Speaks an indigenous language (%)	19.1	22.0	13.1	8.8
Health problems (%)	53.1	53.0	55.7	57.7
Years of schooling	13.0	11.7	14.3	15.4
At least a university degree (%)	16.3	13.3	22.4	30.4
Children 6–19 years old living in household (%)	52.3	54.3	51.2	46.0
Participation in the labor force (%)	43.4	27.6	100.0	100.0

Working hours per week	47.6	42.6
Monthly wage (soles)	1,483.0	1,219.6
Full-time employment (%)	89.2	82.6
Informal employment (%)	49.5	45.4

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Column 1 presents data for all individuals with valid observations for the variables employed; Column 2 presents data only for workers with valid observations. Marriage includes cohabitation. Health problems refer to a family history of diseases. Wages given in constant soles from September 2019. Full-time refers to at least 30 hours of work during the referenced week. Informal work is defined as work without access to healthcare services. Waist circumference is observed for 77.7% of the sample in Column 1 and 78% in Column 2.

Identification strategy

In order to analyze the relationship between obesity and employment and wages, I estimated Equation (1), where Y_i is the monthly wage (in logarithms) or a dichotomous variable to indicate whether person i works or not. BMI_i is the indicator of obesity and X_i is a set of covariates that include age, age squared, years of schooling, work experience, work experience squared, number of children (if any), and dichotomous variables for: area of residence (eight

variables), rural area, survey year, indigenous language, literacy, marital status, and formality or informality of employment. Also included are variables related to the person's health conditions or lifestyle, such as: hypertension, diabetes, coronary artery disease, cancer, alcohol use, and tobacco use. This equation is estimated using OLS, where the parameter of interest (β) measures the association between BMI and the labor market. It is important to mention that the results presented in Figure 2, as well as the application of the RESET test by Ramsey (1969), indicate that the model is non-linear in BMI; therefore, BMI, as well as BMI ranges (normal and underweight: IMC ≤ 25; overweight: 25 < IMC ≤ 30; obese: > 30), are dealt with in Section 5 together with the square value. In addition, I performed the correction for selection bias proposed by Heckman (1979) in the estimation of the wage equation.[8]

$$Y_i = \alpha + \beta * BMI_i + \gamma * X_i + \mu_i \quad (1)$$

The results presented in Equation (1) show the average relationship between BMI and the dependent variable. However, it is possible that this relationship loses a lot of relevant information in the distribution of

8 Register & Williams (1990) and Colchero & Bishai (2012) used a similar strategy for the United States and the Philippines, respectively.

workers' wages. In other words, the effect of obesity on wage levels within the population may not follow the same pattern among those with low income as it does among those with high income. Thus, and following Koenker and Bassett Jr. (1978), I estimated the following equation:

$$Q_\theta(Y_i|BMI_i, X_i) = \alpha_\theta + \beta_\theta * BMI_i + \gamma_\theta * X_i \quad (2)$$

in which the expression on the left shows that the regression is performed on the θth quantile of the distribution of the dependent variable. Thus, β_θ measures the effect of BMI on wages at different points of the conditional distribution of Y_i.

Results

Table 3 shows the OLS results of the relationship between BMI and employment among men and women.[9] Panel A presents an estimate similar to Equation (1), which shows that for both sexes BMI is negatively related to the probability of being employed. However, in the case of men, this value is not significant. For women, an increase in BMI by one unit is related to a 0.3 percentage point (pp) reduction in the probability of being employed.

Given the non-linear characteristics discussed in the previous section, Panels B and C seek to capture these effects. To this end, Panel B adds the square of BMI to show the curvature in the regression. The results show that although there is evidence of a concave shape in the relationship between BMI and employment in both sexes, this is only significant in the case of men. In this regard, BMI has a positive effect on the probability of being employed at the lower end of the BMI distribution (2.9 pp increase), and then a significant negative effect in the upper end (-0.1 pp).[10] Panel C analyzes the effect of BMI for overweight and obesity ranges relative to the normal range. In the case of men, the passage from the normal weight range to overweight has no significant effect on the probability of being employed; however, moving to obesity yields a reduction of 4.9 pp in the probability of being employed in comparison with the normal range. For women, the penalty is clearer; both overweight and obesity reduce the probability of employment (-1.4 pp and -4.3 pp, respectively).

9 Since I obtain the same results when controlling for the number of children, I do not include this variable in the main regressions in order not to restrict the sample (see Table 1). Nonetheless, Tables 6 and 7 show results for different groups of people. For the detailed results, see Tables A1 to A6 in the appendix online.

10 See Figure 2.

These results show that—in the case of Peru—the relationship between obesity and probability of being employed varies according to sex. Among men, the negative effect is only observed in the obesity BMI range; while in women, the employment penalty occurs so long as the normal range of BMI is exceeded. Comparing these results to the international literature, the results for men are similar to those obtained by Johansson et al. (2009) and Campos-Vazquez and Nuñez (2019) for Finland and Mexico, insofar as the effect of obesity on employment is negative but not significant. For women, the values obtained are similar to those found by Johansson et al. (2009) for Finland, Caliendo and Gehrsitz (2016) for Germany, Greve (2008) for Denmark, Asgeirsdottir (2011) for Iceland, and Han et al. (2009) for Hispanic women in the United States.

Table 3
Results on employment

	Men	Women
	Panel A	
BMI	-0.002	-0.003***
	(0.001)	(0.001)
N	22,983	22,189
R-2 adj.	0.452	0.533
	Panel B	
BMI	0.029***	0.003
	(0.010)	(0.007)
BMI squared	-0.001***	-0.000
	(0.000)	(0.000)
N	22,983	22,189
R-2 adj.	0.453	0.533
	Panel C	
Overweight	-0.003	-0.014*
	(0.010)	(0.008)
Obese	-0.049***	-0.043***
	(0.013)	(0.010)
N	22,983	22,189
R-2 adj.	0.453	0.533

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Table 4 shows the relationship between BMI and monthly wages, expressed in logarithms.[11] Column 1 considers a model similar to that presented in Table 3, while columns 2 and 3 add a previous step by correcting for selection according to the Heckman (1979) criterion. Column 3 incorporates the average age of the children between 6 and 19 living in the household into the selection equation, so the sample is restricted to those workers meeting these characteristics.

Panel A shows that, in all cases, BMI is positively related to men's wages and negatively related to women's wages. It should be noted that all the values obtained are statistically significant. In this sense, a one-unit increase in BMI is associated with an increase in men's monthly wages by 1.3% (US$ 5.8 in September 2019), while women's monthly wages decrease by 0.8%, i.e., by US$ 2.9 less per month. In Columns 2 and 3 the Wald test (of the independence of the equations in the selection model) is rejected.

Panels B and C seek to capture non-linear effects of the relationship between obesity and wages. In the case of Panel B, the incorporation of BMI squared proves not to be significant in any of the specifications. Panel C uses dichotomous variables to analyze the effect of BMI according to ranges. In the case of men, the change from the normal BMI range to the overweight range has a positive relationship with wages (4% increase in monthly wages, or US$ 18, on average, per month). This effect is even greater in the obesity range, where salaries increase by between 12% and 13% (US$ 56.3, on average, per month). In contrast, for women, moving from the normal BMI range to overweight is associated with a wage loss of 5% (US$ 18.5), while there is a loss of about 9% (US$ 33.3, on average, per month) in the obesity range. Although signs remain in Column 3, the results are not significant, which could be explained by the restriction in the sample when incorporating an instrument into the selection equation.

Overall, the results in wages show a pattern similar to that observed in the case of employment, that is, the increase in BMI is associated with an improvement in men's wages (4.8% in standard deviations), while there is a penalty for women that increases as they move away from the normal BMI range (-3.3% in standard deviations). Among women, the wage reduction due to obesity is comparable to a loss of 0.63 years of schooling, while the result for men is comparable to 1.05 additional years of schooling. Comparison with the international literature reveals

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11 See tables A7 to A12 in the appendix online, for complete information about regressions.

that the values for men obtained are close to those observed by Lundborg et al. (2014) for men between 34 and 49 years old in the United States, and to those of Garcia and Quintana-Domeque (2009) in the case of Belgium. In particular, the magnitude of the effect is closer to that of Garcia and Quintana-Domeque (2009) (3.9% in standard deviations). In the case of women, negative effects on wages and hourly wages are found in Han et al. (2011), Han et al. (2009) Cawley et al. (2005), Sabia and Rees (2012), and Cawley (2004) for the case of the United States; Brunello and d'Hombres (2005, 2007), Garcia and Quintana-Domeque (2009), and Caliendo and Gehrsitz (2016), in the case of Europe; and Campos-Vazquez and Nuñez (2019), in the case of Mexico. The magnitude of the effect found is close to that detected by Garcia and Quintana-Domeque (2009).

Table 4
Results for monthly wages (in logs.)

	(1)		(2)		(3)	
	Men	Women	Men	Women	Men	Women
			Panel A			
BMI	0.013***	-0.008***	0.013***	-0.008***	0.013***	-0.008**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)
N	8,596	4,818	8,596	4,818	3,187	1,691
R-2 adj.	0.425	0.481				
Wald test			88.40	4.343	23.89	24.18
P-val			0.000	0.037	0.000	0.000
			Panel B			
BMI	0.027	-0.016	0.016	-0.012	0.008	-0.008
	(0.023)	(0.021)	(0.022)	(0.022)	(0.053)	(0.033)
BMI squared	-0.000	0.000	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
N	8,596	4,818	8,596	4,818	3,187	1,691
R-2 adj.	0.425	0.481				
Wald test			89.98	4.442	26.03	24.19
P-val			0.000	0.035	0.000	0.000

			Panel C			
Overweight	0.039*	-0.049*	0.040**	-0.050*	0.020	-0.028
	(0.020)	(0.026)	(0.020)	(0.026)	(0.032)	(0.047)
Obese	0.119***	-0.094***	0.133***	-0.102***	0.120**	-0.046
	(0.031)	(0.028)	(0.031)	(0.028)	(0.049)	(0.046)
N	8,596	4,818	8,596	4,818	3,187	1,691
R-2 adj.	0.423	0.481				
Wald test			87.87	4.840	23.43	22.16
P-val			0.000	0.028	0.000	0.000

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared. Column 1 does not correct for selection bias; column 2 corrects selection bias but it does not include an extra variable in the selection equation; column 3 includes the average age of children from 6 to 19 living in the household as an instrument in the selection equation.

Table 5 shows the results of the relationship between BMI and wages according to quantiles.[12] For men, panel A shows that the positive effect of BMI on monthly wages remains significant and tends to increase when going forward in the distribution of wage income. With regard to the use of BMI and BMI squared (panel B), the relationship is negative and significant in the 0.15 and 0.5 quantiles, these values being close to zero. Panel C shows that the positive effect of BMI on men's wages exhibits different behaviors according to position in the income distribution. Thus, in the lower quantile, overweight has a positive but not significant relationship with wages, while obesity (with respect to the normal range of BMI) is positively and significantly related. In the upper quantiles the relationship between BMI and wages is positive and significant, and becomes increasingly so as income levels rise. For women, Panel A shows that the negative relationship between BMI and wages is concentrated at the top of the income distribution. However, Panel C exhibits different behavior, in that overweight is negatively (and significantly) associated only in the lower part of the distribution, while obesity has negative and significant effects in the upper part.

12 The same procedure was accomplished by selection correction, as proposed by Buchinsky (2002). In all cases, values and signs were similar to those obtained in Table 5, but they were not significant.

Overall, these results again show that obesity is positively related to men's wages, and that this association grows stronger as one moves through the income quantiles. This phenomenon is not repeated among women, for whom the wage penalty is concentrated in the upper part of the income distribution and among those located in the obesity range of BMI. It is important to note that the negative effect found in women may be associated with other unobservable factors, such as appearance, discrimination, and social environment, among others (Gortmaker et al., 1993; Loh, 1993; Mitra, 2001; Campos-Vazquez & Gonzalez, 2020). Thus, although these results give an indication of different effects between men and women, a more detailed analysis of these effects on wages and their relationship with obesity is a matter for future research.

Table 5
Results for monthly wages by quantiles (in logs.)

	Men					Women				
quantile	0.150	0.250	0.500	0.750	0.850	0.150	0.250	0.500	0.750	0.850
Panel A										
BMI	0.008***	0.008***	0.015***	0.016***	0.017***	-0.003	-0.003	-0.001	-0.006**	-0.012***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
N	8,596	8,596	8,596	8,596	8,596	4,818	4,818	4,818	4,818	4,818
Panel B										
BMI	0.034***	0.032	0.042***	0.027	0.017	-0.024	0.003	0.015	0.007	-0.022
	(0.012)	(0.023)	(0.012)	(0.019)	(0.039)	(0.018)	(0.012)	(0.018)	(0.025)	(0.028)
BMI squared	-0.000**	-0.000	-0.000**	-0.000	0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	8,596	8,596	8,596	8,596	8,596	4,818	4,818	4,818	4,818	4,818
Panel C										
Overweight	0.013	0.014	0.044**	0.064***	0.089***	-0.049**	-0.038*	0.019	-0.012	-0.032
	(0.018)	(0.015)	(0.020)	(0.024)	(0.032)	(0.022)	(0.023)	(0.024)	(0.023)	(0.034)
Obese	0.060***	0.054**	0.135***	0.166***	0.205***	0.001	-0.020	-0.012	-0.091***	-0.143***
	(0.020)	(0.024)	(0.031)	(0.038)	(0.046)	(0.029)	(0.030)	(0.030)	(0.026)	(0.039)
N	8,596	8,596	8,596	8,596	8,596	4,818	4,818	4,818	4,818	4,818

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Results in subgroups

Table 6 shows the relationship between BMI and the employment status of men and women according to marital status and area of residence (rural or non-rural).[13] The second column (married) shows that BMI is negatively and significantly related to the probability of being employed for both men and women (-0.3 pp). According to BMI ranges (Panel B), the effect is concentrated within the obesity range in the case of men, while the effect is evident in both the overweight and obesity ranges in the case of women. When it comes to unmarried individuals, the effect is not significant among men, while there is only a negative and significant effect in women within the obesity BMI range BMI (-5.3 pp).

According to rural or urban area of residence (columns 4 and 5), a positive relationship with the probability of being employed is observed only for men living in rural areas (0.3 pp). In non-rural areas, the relationship is negative for both men and women, with the magnitude of the effects being very similar. Overall, these results are in line with those presented in Table 3, in which a negative relationship is observed between BMI and the probability of working, but mainly among women and particularly those who are married and live in non-rural areas.

Table 6
Results on employment by groups

	Married		Single		Rural		Non-rural	
	Men	Women	Men	Women	Men	Women	Men	Women
				Panel A				
BMI	-0.003**	-0.003***	0.000	-0.002	0.003**	0.001	-0.003**	-0.004***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
N	15,461	13,944	7,522	8,245	9,089	8,764	13,894	13,425
R-2 adj.	0.531	0.621	0.310	0.427	0.382	0.302	0.423	0.515
				Panel B				
Overweight	-0.002	-0.020**	-0.009	-0.001	0.017	0.005	-0.017	-0.023*
	(0.011)	(0.009)	(0.018)	(0.015)	(0.012)	(0.007)	(0.012)	(0.012)
Obese	-0.051***	-0.035***	-0.042	-0.053**	-0.024	0.012	-0.056***	-0.056***
	(0.015)	(0.011)	(0.029)	(0.021)	(0.020)	(0.012)	(0.015)	(0.013)

13 BMI and its square value were not included in the tables in this section since the values were not statistically significant.

N	15,461	13,944	7,522	8,245	9,089	8,764	13,894	13,425
R-2 adj.	0.532	0.621	0.310	0.428	0.382	0.302	0.424	0.516

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

A similar analysis for monthly wages is seen in Tables 7 and 8. In the case of those working in the formal sector (Column 2), BMI is related to an increase in the wages of men (1.4%) and a decrease in those of women (-1.2%). In both cases, the values are statistically significant. However, this relationship is concentrated in the obesity BMI range (Panel B). If these results are compared with those working in the informal sector (Column 3), the positive relationship between obesity and wages remains in the case of men, with very similar magnitudes. However, in the case of women, the signs found are maintained, but are not statistically significant. With respect to marital status and the area of residence (rural or urban), the results found remain, that is, positive effects in the case of men and negative effects in the case of women.

Table 7
Results on monthly wages (in logs.)

	Formal		Informal		Married		Single	
	Men	Women	Men	Women	Men	Women	Men	Women
				Panel A				
BMI	0.014***	-0.012***	0.011***	-0.005	0.012***	-0.008**	0.014***	-0.007*
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
N	4,145	2,690	4,451	2,128	5,685	2,337	2,911	2,481
R-2 adj.	0.222	0.297	0.188	0.133	0.393	0.506	0.430	0.446
				Panel B				
Overweight	0.046	-0.062	0.030	-0.043	0.031	-0.022	0.055*	-0.057
	(0.033)	(0.038)	(0.023)	(0.035)	(0.026)	(0.040)	(0.032)	(0.035)
Obese	0.120***	-0.145***	0.100***	-0.043	0.115***	-0.076*	0.114**	-0.100**
	(0.046)	(0.039)	(0.039)	(0.040)	(0.039)	(0.039)	(0.045)	(0.040)
N	4,145	2,690	4,451	2,128	5,685	2,337	2,911	2,481
R-2 adj.	0.220	0.298	0.185	0.132	0.392	0.505	0.426	0.447

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Table 8
Results on monthly wages (in logs.)

	Rural		Non-rural	
	Men	Women	Men	Women
		Panel A		
BMI	0.015***	0.003	0.013***	-0.008***
	(0.005)	(0.005)	(0.003)	(0.003)
N	1,799	583	6,797	4,235
R-2 adj.	0.418	0.526	0.396	0.472
		Panel B		
Overweight	0.038	0.010	0.037	-0.048*
	(0.030)	(0.046)	(0.023)	(0.028)
Obese	0.177***	0.036	0.110***	-0.101***
	(0.054)	(0.062)	(0.033)	(0.030)
N	1,799	583	6,797	4,235
R-2 adj.	0.417	0.525	0.394	0.472

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Figures 3 to 8 in the Appendix show the relationship between BMI and monthly wages at different points of the wage distribution. In general, the positive relationship between BMI and men's wages remains and tends to increase along with income levels. This trend holds for each of the subgroups studied. In the case of women, the negative relationship is maintained, but varies across income quantiles. In this regard, among those who work in the formal sector and are married (Figures 3 and 5), this relationship has an inverted U-shape; that is, the negative effect is greater in the lower and upper quantiles. Further studies on this relationship may help to explain whether these findings are related to discrimination against women or self-selection in the income distribution tails. On the other hand, Figures 4, 6, and 8 show that the negative effect increases along the distribution of income, as compared to those who work in the informal sector, are single, or live in non-rural areas. Finally, in the case of women in rural areas the effect is constant across many income quantiles.

Conclusions

Peru is a middle-income country that has shown remarkable economic growth in recent decades. However, problems persist in a fragmented health system (Jumpa et al., 2003; Seinfeld et al., 2013) in which only 30% of the labor force has access to the benefits of the formal system (Jaramillo and Sparrow, 2014). Given this context, this study sought to estimate the relationship between obesity and employment and wages among the labor force in Peru. Using data from the ENAHO-CENAN survey for the period 2007–2011, I found that 48% of working men are in the normal BMI range, while 42% of women are in this same category. In turn, I found that 40% of men and 38% of women are overweight, while 12% of men and 20% of women are obese.

Similarly, I observed different behaviors in the participation of men and women in the labor market the higher the BMI. Among men, the percentage increases up to the overweight range, and then slowly declines in the obesity range (Figure 2). Among women, labor participation increases only in the normal range, then declines rapidly as BMI increases. With regard to wages, women's are higher than men's in the normal range of BMI, and then grow at a slower rate than do those of men. Thus, between the normal range and the overweight range, women's income increases by 10%, while in the case of men the increase is 40%. Similarly, while women's wages decrease from the overweight to the obese range, this is not repeated for men. In general, in the obesity range, men's wages are 22% higher than women's.

Although the study only sought to find associations and not causal effects, the application of OLS and quantile regressions show that an increase of one unit in BMI has a negative relationship with the probability of women working (-0.3 pp., on average), particularly among married women and those living in urban areas. In the case of men, only those in the obese range show a negative relationship (-4.9 pp.). On the other hand, an increase of one unit in BMI is associated with a reduction of 0.8% in women's monthly wages (US$ 2.9, on average). Thus, moving from the normal BMI range to overweight is associated with a wage loss of 5% (US$ 18.5), while there is a loss of about 9% (US$ 33.3) in the obesity range. In the case of men, the effect is positive and significant (an additional US$ 5.8) in most of the subgroups analyzed. I observed that the change from the normal BMI range to the overweight range has a positive relationship with wages (4% increase in monthly wages, or US$ 18). This effect is even greater in the obesity range, where salaries increase between 12% and 13% (US$ 56.3).

These results are close to those found in other countries, both in magnitudes and in terms of the persistent negative effect on women. Further studies should not only focus on analyzing the possible causality of the findings found, but also seek to determine whether the wage penalty observed among women could be related to discriminatory effects on their appearance or self-selection in the labor market. In addition, little is known about this relationship in the informal sector. Given that this sector accounts for such a large proportion of the Peruvian economy, field experiments could shed light on this topic and analyze how behavioral responses change vis-a-vis variations in physical appearance and health.

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Appendix

Table 2
Sample restriction

Initial sample	146,037
Working people aged 15-65	65,614
Height and weight both valid	49,091
Not pregnant	48,474
15 <= BMI <= 45	48,400
Monthly wages > = 250	45,172

Notes: Author's own calculations, using data from the ENAHO-CENAN 2007–2011. Only individuals with height between one and 2.2 meters and weight between 20 and 220 kg were included. Wages given in constant solesfrom September 2019.

Figure 3
Monthly wages in the formal sector

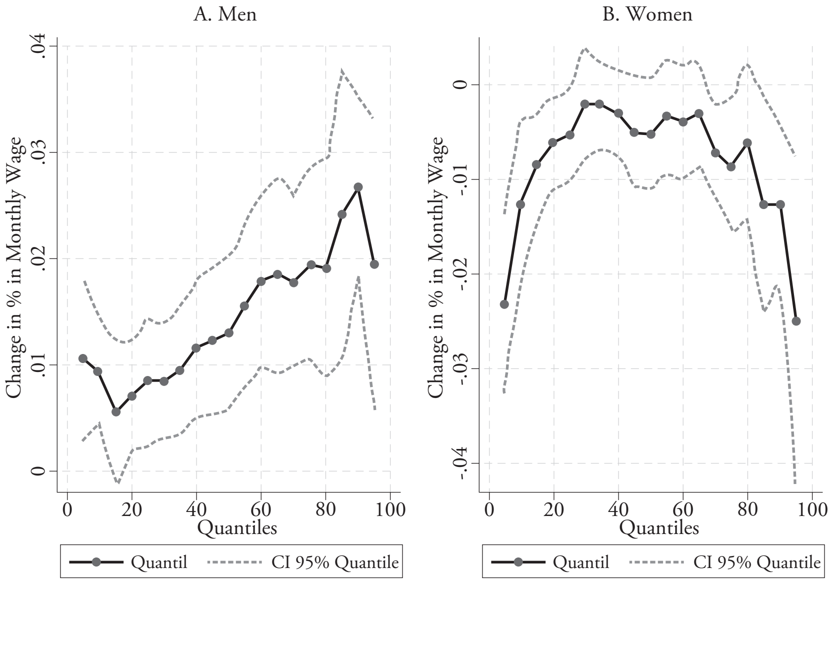
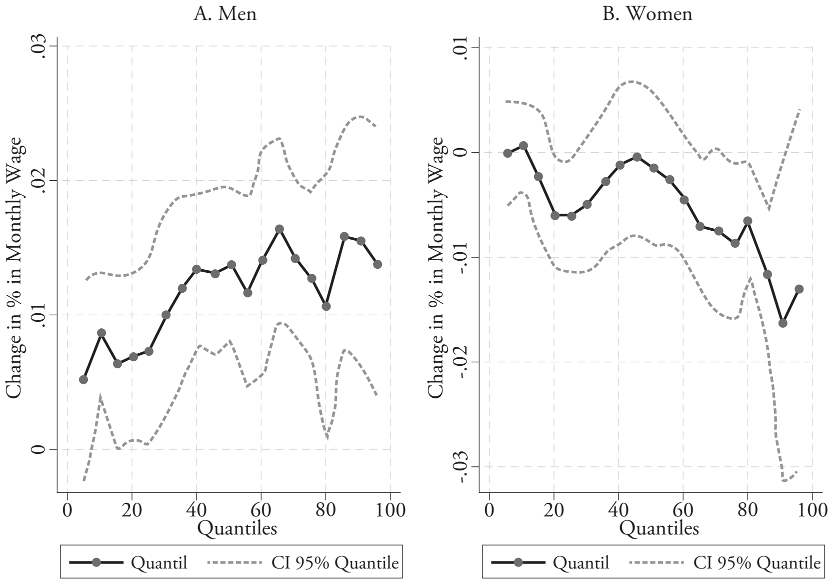


Figure 4
Monthly wages in the informal sector



Notes: Author's own calculations, using data from the ENAHO-CENAN 2007– 2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Figure 5
Monthly wages in married people

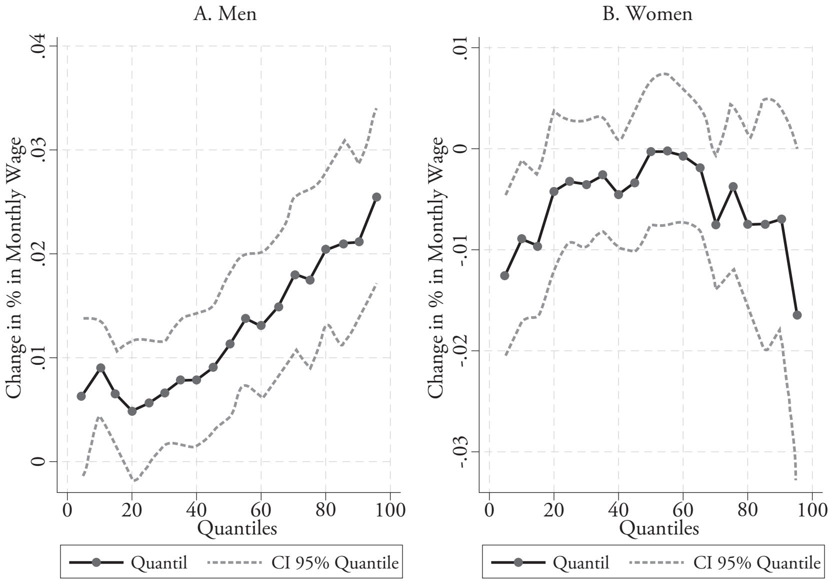
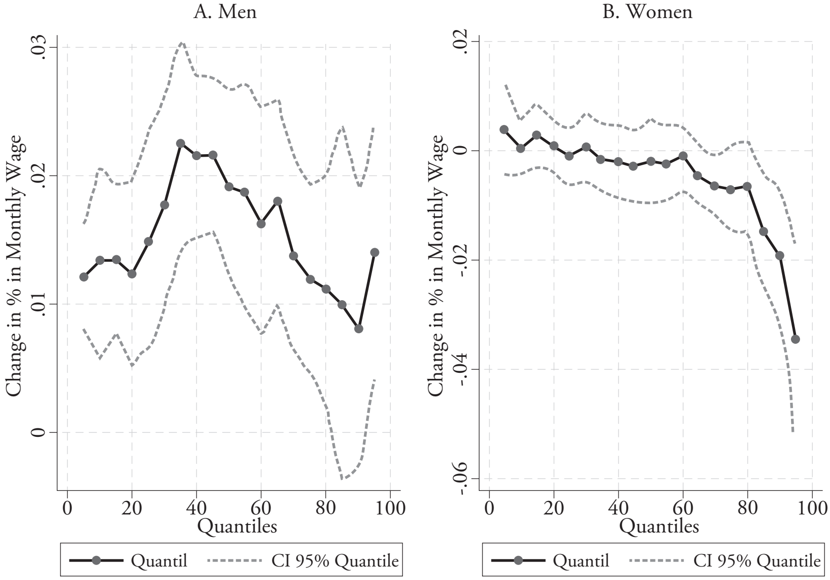


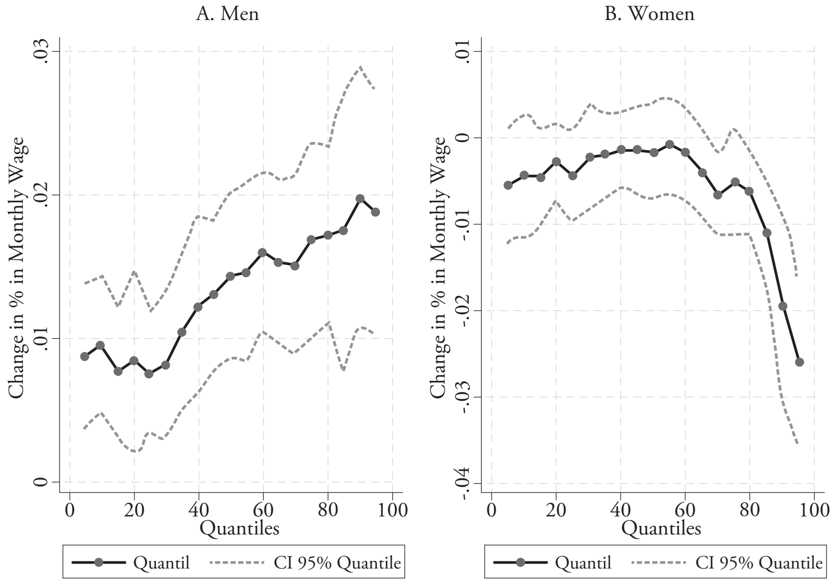
Figure 6
Monthly wages in single people



Notes: Author's own calculations, using data from the ENAHO-CENAN 2007– 2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.

Figure 7
Monthly wages in rural areas

Figure 8
Monthly wages in non-rural areas



Notes: Author's own calculations, using data from the ENAHO-CENAN 2007– 2011. Robust standard errors in parentheses. Wages given in Peruvian soles from September 2019. ***p<0.01, **p<0.05, *p<0.1. Both regressions include the following variables: age, age squared, dummies of rural area, geographic area, survey year, speaks an indigenous language, literacy, married, formal labor, attends private or public school, variables of health problems, experience, and experience squared.