Title: Within country differences of the association between parity and overnutrition in Peruvian women.

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Abstract

Background: Evidence denotes a direct association between parity and overnutrition in developing societies. This work aims to assess the relationship between them in Peruvian women, and to investigate whether this association varies by place of residence and socioeconomic status.

Methods: We used secondary data from the National Health and Demographic Survey 2011 of Peru (ENDES 2011). Parity was the independent variable, defined as the number of children ever born to a woman. The outcome variable was the body mass index (BMI), with cut-off points of 25-30 kg/m^2 and ≥ 30 kg/m^2, for overweight and obesity; respectively. We included other variables due to their potential confounding or modification effect, such as: age, place of residence, wealth index, education, and frequency of watching television. We used a significance level of 5%.

Results: We analyzed information of 18262 women. The mean BMI was 25.9 Kg/m^2 (SD±4.6). The overall prevalence of obesity and overweight was of 17.2% and 35.0%, respectively. Rural and urban women reported having had 2.5 (95%CI: 2.4-2.6) and 1.5 (95%CI: 1.4-1.5) ever born children, respectively. We found a positive association between parity and overnutrition, and identified the effect modification of place of residence and wealth. The relationship between parity with overweight or obesity was stronger in urban than in rural areas. Women in the bottom and top groups of wealth index showed stronger associations than the other categories of socioeconomic status.

Conclusion: Our findings suggest that the more childbirths a woman has, the more likely she is of being overweight or obese. This relationship varies by socioeconomic status and area of residence. Identification of increased BMI in women, especially after the first

childbirth, should be evaluated in primary care to establish adequate public health policies to tackle obesity in Peruvian women.

Introduction

Obesity has become a harmful condition in societies undergoing nutrition transition [1,2]. Parity has been extensively reported to increase the risk of overweight and obesity in developed countries [3-9]. Furthermore, this relationship seems to vary by place of residence, race, socioeconomic status, and other factors. For instance, African-American women in the United States, living in a rural area and being domestic worker, with lower income and lower education presented higher parity-associated overweight [10].

One study assessing the relationship between parity and overweight using secondary national datasets from twenty eight countries found a positive but weak association between parity and overweight, suggesting that this relationship may differ across countries, depending on the country's development and household wealth [8]. This study reported that there was an association between parity and overweight in all women of the highest socioeconomic group regardless of the country's development indicator. Conversely, this association was found among women in the lowest and middle socioeconomic groups only in the most developed countries, meaning that the burden of parity-related overweight starts including women from all socioeconomic status as development increases [8].

To our knowledge, the association between parity and obesity in Latin America has been roughly assessed only in Brazil [11] and Chile [7]. However, it has not been reported in other Latin American societies whether this association differs by place of residence and socioeconomic status. The ongoing nutrition transition that developing countries are facing [2] leads to a more obesogenic environment, and it could be helpful to identify and characterize the possible relationship between parity and overnutrition.

We consider important to explore whether parity could affect the likelihood of a women to be obese, and if it changes within country. For this reason, we aimed: 1) to assess the association between parity and overnutrition; and 2) to evaluate how this association could change by place of residence and socioeconomic status in Peru.

Methods

In the last decades, Peru has faced rapid social and economic changes with subsequent alterations of socio-economic indicators. By year 2007, the literacy rate was about 90% in women 15 years or older. In 2010, 95% of Peruvian women received prenatal care; total fertility rate by 2010 was 2.5 births per women, and this rate had been slightly decreasing during the previous decade [12]. Along with these health and socio-demographic indicators, the Peruvian economy has also improved, and according to the World Bank, Peru is now an upper-middle income country [13].

We used data from the National Health and Demographic Survey 2011 (Spanish: ENDES 2011) to assess the association of interest. This survey was conducted by the National Institute of Statistics and Informatics of Peru (Spanish: INEI), and it was used to collect demographic and health information from women aged 15 to 49 years old, and from their under-five children. The master sample frame for this survey was the 2007 Peruvian Census. The ENDES 2011 had two samples units, being the primary unit sample the cluster of households, and the second unit the household in both, rural and urban areas. A total of 1132 clusters, and 27709 households were part of this survey with a response rate of 99.1%. Further information can be found elsewhere [14].

We found a total of 22517 observations in the original dataset, but we excluded 272 due missing values of body mass index (BMI), 815 and 3168 because the respondent was either pregnant, or breastfeeding at the time of the survey, respectively. Independent variable was parity, defined as the number of children ever born to a woman, as it has been used in previous studies [8,15]. For statistical purposes we decided to classify this variable in four groups, taking women who had never had a child as the reference group. BMI was the main outcome, and it was defined as the woman's weight in kilograms

98 divided by her height in meters squared (Kg/m^2). Weight was measured to the nearest 0.1
99 kg with participants wearing light clothing and no shoes; height was measured to the
100 nearest 0.1 cm. We used international standards [16] to define normal, overweight and
101 obesity according to woman's BMI: 18.5–24.9 kg/m^2; ≥25.0 - <30.0 kg/m^2; and ≥30.0
102 kg/m^2, respectively. In addition, we defined excess of weight as ≥25.0 kg/m^2; and
103 underweight as <18.5 kg/m^2. Covariates were wealth index and education, both in
104 quartiles as used in a previous examination of a similar Peruvian survey [17], age in
105 groups of 5 years, place of residence, and frequency of watching television as a proxy of
106 inactivity.

107 For our analyses, we used Stata version 11.0 (StataCorp. 2011. College Station, TX:
108 StataCorp LP). Linear regression was performed when BMI was a continuous variable.
109 We used *Poisson* regression to find prevalence ratio estimates due to high obesity or
110 overweight prevalence, taking normal BMI as reference. All analyses were conducted
111 applying the *svy* command, taking into account the survey's design. We tested effect
112 modification using the Wald's test, with a $p<0.05$ determining a significant statistical
113 interaction.

114 The present study was approved by the Institutional Review Board of the Scientific
115 Research Office, at the Universidad Peruana Cayetano Heredia (SIDISI code 61753).

116

Results

A total of 18262 women were included into analysis. The mean age of the participants was 31.0 years (SD±10.5), having the overall mean BMI of25.9 Kg/m^2 (SD±4.6). The overall prevalence of obesity and overweight was of 17.2% (95% IC: 16.3 – 18.0) and 35.0% (95% IC: 34.0 – 36.0), respectively. Regarding parity, 38.3% reported no having had any ever born child, 15.7% have had one child, 18.0% two children, and 28.0% had three or more childbirths in their life. Rural and urban women reported having had 2.5 (95%CI: 2.4-2.6) and 1.5 (95%CI: 1.4-1.5) ever born children, respectively. Table 1 shows demographic characteristics according to nutritional status in Peruvian women.

The linear association between parity and BMI can be observed in Table 2. It depicts a positive relationship, which is maintained after adjusting for covariates. Additional analysis showed that age had the most important confounding effect among all covariates. Hence, non-nulliparous women gained more BMI units as the childbirth number increased, compared to women who have never had children. For instance, for women who have had three or more childbirths, their mean BMI was 2.5 kg/m^2 [95% IC: 2.2-2.9 kg/m^2] greater than those of nulliparous women, adjusting for age group, education quartiles, wealth index, television viewing and type of place of residence.

Prevalence ratios are presented in Table 3. The association between parity and the three types of overnutrition was strong in the crude model; but as in linear regression model, the magnitude of this relationship experienced attenuation by all adjusted covariates, more prominent with age. On the other hand, we found that women with ≥3 childbirths in their life compared to nulliparous had a likelihood of being overweight, obese or to develop excess of 1.8 [95%CI 1.6-2.0], 2.9 [95%CI 2.4-3.5], and 1.7 [95%CI 1.6-1.9], respectively. The greatest measures of association were found in the obesity-column.

When we assessed interaction, we found that only estimates performed by survey complex design methods (*svy* command) showed significant p values, highlighting the effect of ENDES sample design in our results. Further analysis showed that place of residence ($p<0.05$) and wealth index ($p<0.01$) modified the association between parity and obesity in adjusted model—there was only a significant effect modification in crude estimates for wealth index ($p<0.05$).

In case of the association between parity and overweight and excess of weight, only place of residence had a strong effect modification ($p<0.0001$) for both crude and adjusted models. Even evaluating interaction, obesity columns maintained strongest measures of association.

Wealth index also reflected effect modification on the parity-excess of weight association only in adjusted model ($p<0.05$). As seen in previous analyses, the obesity column had the greatest values of overnutrition, depicting that poorest and richest women had a likelihood of more than 100% of being obesity compared to nulliparous. These results by stratification according to place of residence and wealth groups are shown in Tables 4 and 5, respectively.

Summarizing our findings, we found a positive association between parity and overnutrition in both stratified analysis, and these estimates showed stronger magnitudes in the obese and excess of weight groups than in the overweight group. Regarding the association by place of residence, there is stronger association in urban than in rural areas, both in the crude and adjusted model. In stratified models by wealth index, the higher magnitudes of association were found in the top and bottom groups; these findings were similar for overweight and excess of weight.

Discussion

We found that 17.2% Peruvian women of reproductive age were obese, implying an increase of 83% since 1996 (9.4%) [18]. Our results point out to a positive relationship between parity and overweight, obesity and excess of weight; and we observed the strongest magnitudes of association with obesity as the outcome variable. This pattern--greatest size effects with obesity and lowest for overweight as outcomes--continued in stratified analyses by place of residence and wealth index groups, being stronger in urban than in rural areas, and in the top and bottom quartiles of wealth index.

Findings of the present study confirm results from previous reports on the association between parity and overweight and obesity in developed [9,10,19-25] and developing countries [7,11,26-28]; and adds to the literature the knowledge of an effect modification not only of socioeconomic status, but also of the place of residence on this relationship. Similar reports were also found when using waist circumference as outcome [29].

Cross-sectional analyses have shown a positive association between parity an overweight, varying by country's development and across their socioeconomic groups [8,15]. A similar study in Chilean population found that parity modestly influenced BMI after adjusting for socioeconomic indicators like ours [7]. In our study, we found a stronger association in the top and the bottom quartiles of wealth index, in comparison to the other groups. Therefore, our findings slightly differ from what Kim et al [8] had previously reported, where the higher a country's development and wealth index are, the greater the magnitude of the association between parity and overweight in women. Hence, we tested the effect modification of place of residence on the relation of interest and it suggests that the relationship between parity and overnutrition depends on where the woman lives—suggesting an environmental effect [2].

Differences between our findings and those from Kim et al. could be due to the nutrition transition in Peru [30], where they reported that obesity was associated with wealthier status but less educational level and in urban settings [17]. However, different stages of the nutritional transition have been reported in other Latin American countries [1,31], and this denotes diverse obesity burden in socioeconomic groups as a country increases its economic development [32,33]. Thus, we can hypothesize that the relationship between parity and overnutrition could have changed across years between and within countries in developing nations.

Understanding why women who have had more childbirths might have more risk to develop overweight has been suggested to be part of—as we previously mentioned—environmental factors and not to only pregnancy itself [34]. These assumptions could be explained by different factors occurring from months after the end of pregnancy–such as increasing physical inactivity and less healthy dietary patterns [35-37]—and through life [38,39]. All these factors raise in the context of lifestyles changes, where sedentary lifestyles are increasing and unhealthy diets have dramatically changed in transitioning societies like Peru [2,38].

Excess of weight would be centrally distributed, increasing abdominal obesity [40], which represents a significant risk factor for chronic diseases progression [41]. Moreover, weight gain after pregnancy could be higher in women with high pre-pregnancy BMI, and the effect of lactation could help women to control their weight [11,20]; but we could not assess the effect of lactation in our dataset given its transversal nature. Previous studies have suggested that excess of weight during pregnancy would be associated with overweight and obesity in future life [20,42], as well as risk of postpartum diabetes [43]; likewise, becoming a mother at younger ages could affect a women's health, because it could lead to overnutrition progression [44]. Furthermore, women's BMI, weight gain

during pregnancy and parity could also affect their offspring's health, predisposing children to being overweight or obese in young adulthood [45].

Strengths and Limitations

We have used a national representative data set from the Peruvian Demographic Health Survey, and even after exclusion of observations we had a large sample size. The cross-sectional design of this study prevents us from inferring causality. Another common limitation in cross-sectional studies when trying to assess this relationship, represents the inability to measure BMI before and after pregnancy, and for subsequent pregnancies [46].

In this study, we have no information about nutritional habits and physical activity. It has been reported that the consumption of trans fats and low physical activity during the postpartum increase the likelihood of overweight and obesity [35,40]. It has also been reported effectiveness of contraceptives is lower in women with a BMI greater than 25 kg/m^2 compared to women with normal weight [47]. Given the cross-sectional nature of the survey, we have not evaluated this effect but we believe they can play an important role in the relationship between parity and overweight. Despite these limitations, our findings pointed out that Peruvian women could have more risk to develop overweight or obesity as parity increases. Furthermore, our results are consistent with other studies evaluating the association between parity and overnutrition. This assumption should be confirmed by additional—population based and prospective--epidemiological studies in other similar settings.

Conclusion

Our findings show a positive association between parity and overnutrition. This relationship varies by socioeconomic status and area of residence. Identification of excess

of weight in women visiting prenatal care, especially after the first childbirth, needs to be evaluated in primary care; and could constitute another angle for tackling obesity in Peru and other Latin American countries.

Acknowledgements

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Competing Interests

J. Jaime Miranda is an Academic Editor for PeerJ.

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379 **Table 1:** Participants' demographic characteristics by BMI (Kg/m^2). ENDES Peru
380 2011[a, b].

Variable		Underweight	Normal	Overweight	Obesity	p[†]
	N	%	%	%	%	
	18 262	N= 364	N= 8 368	N= 6 395	N= 3 135	
Total Children Ever Born						
None	6 473	4.0	68.2	22.1	5.7	<0.001
1 Child	2 734	0.9	43.0	39.3	16.8	
2 Children	3 187	0.6	30.9	46.7	21.8	
≥ 3 Children	5 868	0.4	26.8	42.7	30.1	
Quartiles of Education						
1st Bottom	5 280	1.7	38.2	36.8	23.4	<0.001
2nd	5 880	1.9	46.4	35.2	16.5	
3rd	4 099	2.4	52.6	31.9	13.1	
4th Top	3 003	1.5	48.3	36.1	14.1	
Quartiles of wealth index						
1st Bottom	4 566	1.7	48.7	34.3	15.3	<0.001
2nd	4 566	2.1	45.3	35.1	17.5	
3rd	4 568	2.2	43.6	34.7	19.4	
4th Top	4 562	1.6	46.4	35.6	16.4	
Age Group (years)						
15-19	3 663	5.5	73.9	17.5	3.1	<0.001
20-24	2 399	2.5	61.5	28.3	7.8	
25-29	2 310	1.5	50.4	36.0	12.1	
30-34	2 351	0.7	37.6	42.8	18.9	
35-39	2 577	0.6	29.9	43.2	26.3	
40-44	2 572	0.2	27.8	43.0	29.0	
45-49	2 390	0.6	27.2	42.6	29.6	
Type of place of residence						
Urban	12 122	1.9	44.1	35.1	18.9	<0.001
Rural	6 140	1.8	51.7	34.7	11.8	

Television viewing						
None at all	1 058	2.0	52.8	34.7	10.6	
Less/At least once a week	5 495	2.2	50.9	33.1	13.8	<0.001
Almost every day	11 709	1.8	43.4	35.8	19.1	

a. Data does not include participants currently pregnant or breastfeeding at the moment of the survey.

b. The results were calculated through analysis for complex samples, percentages may not sum up 100%.

†Differences were determined using x^2 Test.

387 **Table 2:** Linear regression, crude (main effect) and adjusted for covariates, ENDES
388 Peru 2011.

	Body Mass Index					
	N=18 262			N=18 262		
	Crude			Adjusted [a]		
	β	95% CI		β	95% CI	
Children ever born						
No Child	Ref			Ref		
1 Child	2.6	2.4	2.9	1.4	1.1	1.7
2 Children	3.7	3.4	3.9	1.9	1.6	2.2
≥ 3 Children	4.4	4.2	4.7	2.5	2.2	2.9
Quartiles of Education						
Education Quartile 2	-0.2	-0.5	0.0	-0.3	-0.6	-0.1
Education Quartile 3	-0.2	-0.5	0.1	-0.5	-0.8	-0.3
Education Quartile 4	-0.1	-0.3	0.3	-0.7	-1.0	-0.3
Quartiles of wealth index						
Wealth Quartile 2	0.5	0.3	0.7	0.4	0.1	0.6
Wealth Quartile 3	1.0	0.7	1.2	0.7	0.5	1.0
Wealth Quartile 4	1.0	0.7	1.2	0.5	0.2	0.8
Age Group						
20-24 Age Group	1.1	0.8	1.3	1.1	0.8	1.4
25-29 Age Group	1.6	1.3	2.0	1.7	1.3	2.0
30-34 Age Group	2.4	2.1	2.8	2.3	1.9	2.7
35-39 Age Group	3.0	2.7	3.4	2.9	2.5	3.3
40-44 Age Group	3.4	3.0	3.7	3.2	2.8	3.6
45-49 Age Group	3.3	2.9	3.7	3.1	2.7	3.5
Type of place of residence						
Residence Rural	-1.6	-1.8	-1.4	-1.0	-1.2	-0.8
Television viewing (week)						
Television Less/At least once	1.1	0.7	1.4	0.6	0.2	0.9
Television Almost everyday	2.0	1.6	2.3	1.1	0.8	1.4
Intercept	23.6			22.0		

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390 [a] Adjusted for age group, education quartiles, wealth index, television viewing and type
391 of place of residence.

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394 Table 3. Association between parity and overweight, obesity and excess of weight, crude and adjusted. Poisson regression. ENDES Peru 2011.

	Overweight						Obesity						Excess of Weight (BMI ≥ 25 Kg/m^2)					
	N= 14 763			N= 14 763			N= 11 503			N= 11 503			N= 17 898			N= 17 898		
	Crude			Adjusted†			Crude			Adjusted†			Crude			Adjusted†		
	PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI	
Children ever born																		
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	2.0	1.8	2.1	1.5	1.4	1.7	3.7	3.1	4.3	1.9	1.6	2.4	2.0	1.8	2.1	1.5	1.4	1.6
2 Children	2.5	2.3	2.7	1.7	1.6	1.9	5.4	4.6	6.3	2.3	1.9	2.8	2.4	2.2	2.5	1.6	1.5	1.8
≥3 Children	2.5	2.3	2.7	1.8	1.6	2.0	6.9	6.0	7.9	2.9	2.4	3.5	2.5	2.4	2.7	1.7	1.6	1.9

395 † Adjusted for age group, education quartiles, wealth index, television viewing, and type of place of residence.

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397 Table 4. Association between parity and overweight, obesity, and excess of weight, by type of place of residence. ENDES Peru 2011.

	Overweight						Obesity						Excess of Weight (BMI ≥ 25 Kg/m^2)					
	Crude			Adjusted†			Crude			Adjusted†			Crude			Adjusted†		
	PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI	
Urban			N= 9 496						N= 7 569						N= 11 876			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	1.9	1.7	2.1	1.5	1.3	1.6	3.7	3.1	4.4	2.0	1.6	2.4	1.9	1.8	2.1	1.4	1.3	1.6
2 Children	2.4	2.2	2.7	1.7	1.5	1.9	5.3	4.5	6.2	2.3	1.9	2.9	2.3	2.2	2.5	1.6	1.5	1.7
≥3 Children	2.7	2.5	2.9	1.8	1.6	2.0	7.5	6.4	8.7	2.8	2.3	3.5	2.6	2.5	2.8	1.7	1.6	1.9
Rural			N= 5 267						N= 3 934						N= 6 022			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	2.2	1.9	2.6	1.5	1.3	1.8	3.4	2.2	5.2	1.4	0.9	2.2	2.2	1.9	2.5	1.4	1.2	1.7
2 Children	2.7	2.3	3.1	1.7	1.4	2.0	6.6	4.3	10.1	1.9	1.2	3.0	2.7	2.4	3.0	1.6	1.4	1.9
≥3 Children	2.6	2.3	2.9	1.6	1.4	2.0	9.3	6.3	13.8	2.6	1.6	4.0	2.7	2.4	3.1	1.6	1.4	1.9

398 † Adjusted for age group, education quartiles, wealth index, television viewing.

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400 Table 5. Association between parity and overweight, obesity, and excess of weight, by wealth index. ENDES Peru 2011.

	Overweight						Obesity						Excess of Weight (BMI ≥ 25 Kg/m^2)					
	Crude			Adjusted†			Crude			Adjusted†			Crude			Adjusted†		
	PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI		PR	95% CI	
First (Lower)			N= 3 830						N= 2 921						N= 4 482			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	2.0	1.7	2.4	1.4	1.1	1.8	3.8	2.5	5.8	2.2	1.2	3.8	2.0	1.8	2.4	1.4	1.2	1.8
2 Children	2.6	2.2	3.1	1.7	1.4	2.2	6.1	4.0	9.3	2.8	1.5	4.9	2.6	2.2	3.0	1.7	1.4	2.1
≥3 Children	2.7	2.3	3.1	1.8	1.5	2.2	8.1	5.6	11.6	3.4	2.0	5.8	2.8	2.5	3.1	1.8	1.5	2.2
Second			N= 3 708						N= 2 884						N= 4 466			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	1.9	1.6	2.2	1.2	1.0	1.6	3.4	2.4	4.8	1.4	0.9	2.2	1.9	1.6	2.2	1.2	1.0	1.5
2 Children	2.6	2.3	3.1	1.6	1.3	2.0	6.2	4.5	8.4	1.9	1.3	2.8	2.6	2.3	2.9	1.5	1.3	1.8
≥3 Children	2.5	2.2	2.9	1.4	1.2	1.8	6.4	4.8	8.7	1.7	1.1	2.5	2.5	2.2	2.8	1.4	1.2	1.6
Third			N= 3 592						N= 2 863						N= 4 460			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	

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1 Child	2.0	1.7	2.4	1.6	1.3	2.0	3.4	2.5	4.8	1.5	1.0	2.2	2.0	1.7	2.3	1.5	1.3	1.7
2 Children	2.4	2.1	2.7	1.8	1.5	2.1	5.1	3.8	6.8	1.8	1.2	2.5	2.3	2.1	2.6	1.6	1.4	1.8
≥3 Children	2.5	2.2	2.8	1.8	1.4	2.1	6.9	5.3	9.0	2.0	1.4	2.9	2.5	2.3	2.8	1.6	1.4	1.9
Fourth			N= 3 633						N= 2 835						N= 4 490			
No Child	1	-		1	-		1	-		1	-		1	-		1	-	
1 Child	2.0	1.7	2.3	1.5	1.3	1.7	4.1	3.0	5.4	2.4	1.7	3.3	2.0	1.8	2.2	1.5	1.3	1.7
2 Children	2.4	2.1	2.7	1.6	1.4	1.9	4.9	3.8	6.4	2.5	1.8	3.4	2.3	2.0	2.5	1.6	1.4	1.8
≥3 Children	2.7	2.4	3.0	1.8	1.5	2.1	7.6	6.0	9.7	3.3	2.4	4.4	2.6	2.4	2.9	1.7	1.5	1.9

† Adjusted for age group, education quartiles, television viewing, and type of place of residence.

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