Obesity prevalence in Colombian adults is increasing fastest in lower socio-economic status groups and urban residents: results from two nationally representative surveys

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Abstract

Objective: Low- and middle-income countries are experiencing rises in the prevalence of adult obesity. Whether these increases disproportionately affect vulnerable subpopulations is unclear because most previous investigations were not nationally representative, were limited to women, or relied on self-reported anthropometric data which are subject to bias. The aim of the present study was to assess changes in the prevalence of obesity from 2005 to 2010 in Colombian adults; overall and by levels of sociodemographic characteristics.
Design: Two cross-sectional, nationally representative surveys.
Setting: Colombia.
Subjects: Men and women 18–64 years old (n 31 105 in 2005; n 81 115 in 2010).
Results: The prevalence of obesity (BMI $\geq$30 kg/m^2) was 13·9% in 2005 and 16·4% in 2010 (prevalence difference = 2·7%; 95% CI 1·9, 3·4%). In multivariable analyses, obesity was positively associated with female sex, age, wealth, and living in the Pacific or National Territories regions in each year. In 2010, obesity was also associated with living in an urban area. The change in the prevalence of obesity from 2005 to 2010 varied significantly according to wealth; 5·0% (95% CI 3·3, 6·7%) among the poorest and 0·3% (95% CI −1·6, 2·2%) in the wealthiest (*P*, test for interaction = 0·007), after adjustment. Obesity rates also increased faster in older than younger people (*P*, test for interaction = 0·01), among people from urban compared with non-urban areas (*P*, test for interaction = 0·06) and in adults living in the Atlantic region compared with others.
Conclusions: Adult obesity prevalence has increased in Colombia and its burden is shifting towards the poor and urban populations.

Keywords
Obesity
Prevalence difference
Representative survey
Colombia
Adults

The global prevalence of obesity has been on the rise during the past couple of decades, especially in developing countries[1–3]. Between 1980 and 2008, mean BMI increased by 0·4 kg/m^2 per decade in men and 0·5 kg/m^2 per decade in women worldwide[4]. These increases have been steeper in Latin America, ranging from 0·6 to 1·4 kg/m^2 per decade[4]. In parallel with this shift in the BMI distribution, global obesity prevalence has doubled and by 2008 there were an estimated 502 million obese adults in the world, including 9·8% of men and 13·8% of women[4]. These changes are typically followed by rises in obesity-related chronic diseases, including type 2 diabetes and CVD, which may have devastating effects on the economies and health systems of developing countries[5–7]. Whereas the obesity epidemic in adults from the USA appears to be levelling off[8], it is uncertain whether the same is true for other regions in the Americas. In Brazil, the prevalence of obesity in adults aged 20 years or older increased from 11·1% in 2002–2003 to 14·8% in 2008–2009 according to representative anthropometric surveys[9,10]. Nevertheless, data from other countries have not been nationally representative, have focused only on women, or have relied on self-reported anthropometric data which are subject to bias.

Obesity is inversely associated with socio-economic status (SES) in developed countries, yet in poorer nations it tends to be related to wealth[11–13]. Survey data from women of childbearing age indicate that the prevalence of obesity grew more in the wealthiest than in the poorest groups of most low- and middle-income countries over the past two decades[11,13]. Nevertheless, in some lower-income countries, rates of obesity are growing faster

among adults in the lowest (compared with the highest) wealth and education groups[11,13,14]. It is hypothesized that this shift in the burden of obesity from the wealthier to the poorer may occur as countries reach a critical point in economic development[15], partly as a consequence of lowered prices of unhealthy foods, unevenness in access to a healthy diet and urbanization[2,16–21]. However, few studies have examined recent changes in adult obesity within socio-economic strata using nationwide-representative data.

We examined the trends in obesity prevalence in Colombian adults from 2005 to 2010 using data from two consecutive national nutrition surveys. We estimated changes in obesity prevalence overall and by levels of sociodemographic characteristics, including sex, age, urbanicity, food security, wealth and region.

Methods

Study population

The Colombian National Nutrition Surveys (ENSIN) were conducted in 2005 and 2010 by the Colombian Institute of Family Welfare (Instituto Colombiano de Bienestar Familiar). Details on each survey have been published elsewhere[22,23]. In brief, participants were selected to represent 99 % of the country's population using a multistage stratified sampling scheme. All municipalities from the thirty-two departments in the country were grouped into strata based on similar geographic and sociodemographic characteristics. One municipality was randomly chosen from each stratum, with probability proportional to the population size. Clusters of about ten households each were then randomly chosen from within these strata and household members were invited to participate. The 2005 survey included 17 740 households representing 1920 clusters from 209 strata. In the 2010 survey, 50 670 households were included, representing 4987 clusters from 258 strata.

Consent for participation in the surveys was obtained by the Colombian Institute of Family Welfare prior to enrolment. The Health Sciences and Behavioral Sciences Institutional Review Board at the University of Michigan determined that analyses of these anonymized data were exempt from review.

Data sources

In both surveys, trained personnel administered questionnaires to the head of the household to obtain information on demographic characteristics, measures of food insecurity and wealth. Anthropometric measurements were obtained in all household members by research personnel who had been trained and standardized on the use of anthropometric techniques, with the use of calibrated instruments. Height was measured with the use of a height board (Shorr Productions LCC, Olney, MD, USA)

in 2005 and a stadiometer (Diseños Flores S.R. Ltda, Bogota, Colombia) in 2010, to the nearest millimetre. Weight was measured on SECA Alpha model 770 scales in 2005 and on SECA 872 scales in 2010, to the nearest 100 g.

The surveys included 76 367 people in 2005 and 188 599 in 2010. For these analyses, we excluded participants <18 years of age (n 29 668 in 2005 and n 74 666 in 2010) and women who reported being pregnant or who answered 'don't know' to a question on pregnancy status (n 1707 in 2005 and n 1793 in 2010). In 2005, 4703 people aged 65 years or older were excluded. In 2010, no one aged 65 years or older was included in the survey. In addition, 9184 and 21 025 people with missing data on height or weight were excluded in 2005 and 2010, respectively. Men were more likely than women to have missing anthropometric values, especially in 2005 (online supplementary material, Supplemental Table 1). The final analytic sample comprised 31 105 adults aged 18–64 years in 2005 and 91 115 in 2010.

The outcome of interest was obesity, defined as BMI $\geq 30 \, kg/m^2$[24]. The primary correlate was year of survey (2005 or 2010). In addition, we considered socio-demographic variables as correlates of obesity within each survey, including age, sex, marital status, geographical region, urbanicity, food security and wealth. Urbanicity was categorized as living in urban settlements, in small villages or rural areas around a small town, or in rural dispersed areas distant from the nearest town. Food security status was measured using a modified version of the Community Childhood Hunger Identification Project[25], which has been previously adapted for and validated in a Colombian population[26]. There are twelve questions addressed to the head of the household regarding food insecurity experienced within the past 30 d due to lack of money for food. Only seven questions are asked to households without children. In 2010, additional questions were added to the survey; however, for comparability between years, we used only the questions and scale from 2005 to calculate food security for both survey years. Response options for each question – no, seldom, sometimes or always – were assigned codes 0, 1, 2 or 3, respectively. Codes were added through all responses and the sum was categorized into a four-level variable: food secure (sum = 0), mild food insecurity (sum = 1–7 or 1–12 in households without or with children, respectively), moderate food insecurity (sum = 8–14 or 13–24, respectively) or severe food insecurity (sum ≥15 or ≥25, respectively). Wealth was measured using an index designed for the international Demographic and Health Surveys[27]. This wealth index is constructed for each survey year from principal component analysis of a number of household assets, including type of flooring, number of bedrooms, type of toilet, mode of transportation, etc. The distribution of these variables is first standardized for the population and Z-scores for each variable are assigned to each household. Principal component analysis is then

performed using the standardized variables; the first factor identified is used to define the wealth index as a continuous variable. A higher index represents more wealth. Each person is assigned the wealth index of their household. The continuous wealth index was categorized into quintiles according to its distribution among all survey participants, accounting for the complex survey design.

Statistical analysis

All analyses were conducted with the use of the complex survey design routines of the Stata statistical software package version 12. We estimated weighted prevalences of obesity by year and within year by categories of sociodemographic predictors. Obesity prevalences were compared by levels of each correlate with the use of Rao–Scott χ^2 tests and tests for linear trend for nominal

and ordinal predictors, respectively; accounting for the complex survey design. We estimated adjusted prevalence ratios of obesity by levels of sociodemographic predictors in each year of the survey, with the use of multivariable Poisson regression models with the log-link and robust estimates of variance. In these models, adjustment variables included sex, age, marital status, food security, wealth, urbanicity and region of residence, categorized according to Table 1. Finally, we examined the change in obesity prevalence from 2005 to 2010 overall and by levels of sociodemographic variables by estimating adjusted prevalence differences (PD) and 95 % confidence intervals in multivariable Poisson regression models. To determine whether changes in obesity prevalence from 2005 to 2010 differed significantly between levels of sociodemographic predictors, we tested cross-product

Table 1 Prevalence of obesity (BMI $\geq$30 kg/m^2) in Colombian adults in the National Nutrition Surveys of 2005 and 2010

	2005				2010			
		Obese†				Obese†		
	N*	%	SE	P value‡	N*	%	SE	P value‡
Sex				<0·0001				<0·0001
Male	12 426	9·0	0·4		39 489	11·5	0·2	
Female	18 679	17·0	0·4		51 626	20·0	0·2	
Age (years)				<0·0001				<0·0001
18–24	6818	3·8	0·3		18 959	5·6	0·2	
25–34	8053	10·3	0·5		22 766	13·2	0·3	
35–44	7228	16·4	0·6		20 625	18·9	0·4	
45–54	5589	22·2	0·8		17 431	23·2	0·4	
55–64	3417	22·2	0·9		11 334	25·2	0·5	
Marital status				<0·0001				<0·0001
Married	7788	19·0	0·6		21 561	21·6	0·4	
Living together	10 512	13·9	0·5		33 625	17·5	0·3	
Never married	8059	6·6	0·4		22 358	8·4	0·2	
Separated	3738	15·6	0·8		11 113	17·7	0·4	
Widowed	998	25·6	2·1		2436	28·4	1·1	
Food security				0·04				0·001
Food secure	17 516	14·5	0·4		47 378	16·9	0·2	
Mild food insecurity	7637	14·1	0·6		27 716	16·2	0·3	
Moderate food insecurity	3455	12·0	0·8		12 640	15·7	0·5	
Severe food insecurity	1080	13·8	1·7		3381	14·2	0·8	
Wealth index quintile				<0·0001				<0·0001
1– poorest	5463	8·6	0·6		24 765	12·4	0·3	
2	8005	13·2	0·6		21 768	17·1	0·4	
3	7061	14·0	0·6		17 905	16·9	0·3	
4	5936	15·8	0·7		14 275	18·0	0·4	
5 – wealthiest	4640	16·2	0·8		12 402	17·3	0·4	
Urbanicity				<0·0001				<0·0001
Urban area	24 927	14·6	0·4		64 314	17·1	0·2	
Small rural village	3549	12·9	0·8		16 051	15·3	0·5	
Dispersed rural area	2629	10·0	0·9		10 750	13·6	0·4	
Region				0·004				<0·0001
Atlantic	7305	12·5	0·5		20 263	16·6	0·4	
Oriental	3516	14·5	0·8		13 220	17·2	0·4	
Central	6132	13·6	0·5		23 001	16·6	0·3	
Pacific	4386	15·3	0·8		13 678	17·4	0·4	
Bogotá	1510	13·2	1·0		5785	14·1	0·5	
National Territories	8256	18·3	0·8		15 168	17·8	0·5	

*N refers to the total sample frequency for each category. In 2005, fifteen people and in 2010, twenty-nine people had missing values for marital status and were excluded from the descriptive statistics of marital status. In 2005, 2063 people had missing values for food insecurity and were excluded from the descriptive statistics of food insecurity.
†Percentage of obesity and standard error are weighted to represent the Colombian population.
‡P values are from the Rao–Scott χ^2 test for sex, marital status, urban/rural and region. For age, food security and wealth index, P values represent a test for trend from unadjusted Poisson regression models with obesity as the outcome and a variable representing categories of the ordinal correlate as a continuous predictor.

(interaction) terms between year and categories of each predictor with the use of adjusted Wald tests. In supplemental analyses, we examined associations of obesity with year and sociodemographic characteristics stratified by sex.

Results

Mean BMI in 2005 and 2010 was 25·2 (SE 0·1) kg/m^2 and 25·7 (SE 0·0) kg/m^2, respectively; the difference between the years was 0·5 kg/m^2 (95% CI 0·4, 0·6 kg/m^2). There were no major changes in the shape of the BMI distribution between the survey years overall or by sex (Fig. 1). Prevalence of obesity in 2005 and 2010 was 13·9 (SE 0·3) % and 16·4 (SE 0·2) %, respectively. The PD was 2·7% (95% CI 1·9, 3·4%).

In both years, the prevalence of obesity was highest in women, participants aged 55–64 years, those without food insecurity or who were in the highest quintiles of the wealth index, and people living in urban areas or in the National Territories region (Table 1). Some of these associations differed between women (online supplementary material, Supplemental Table 2) and men (online supplementary material, Supplemental Table 3). For example, the positive associations of wealth index and food security with obesity in both survey years were stronger in men than women. Similarly, the higher prevalence of obesity in urban compared with rural areas in both survey years was apparent in men but not in women.

Next, we examined the associations of sociodemographic factors and prevalence of obesity in each survey year after adjusting for potential confounding (Table 2). In both years,
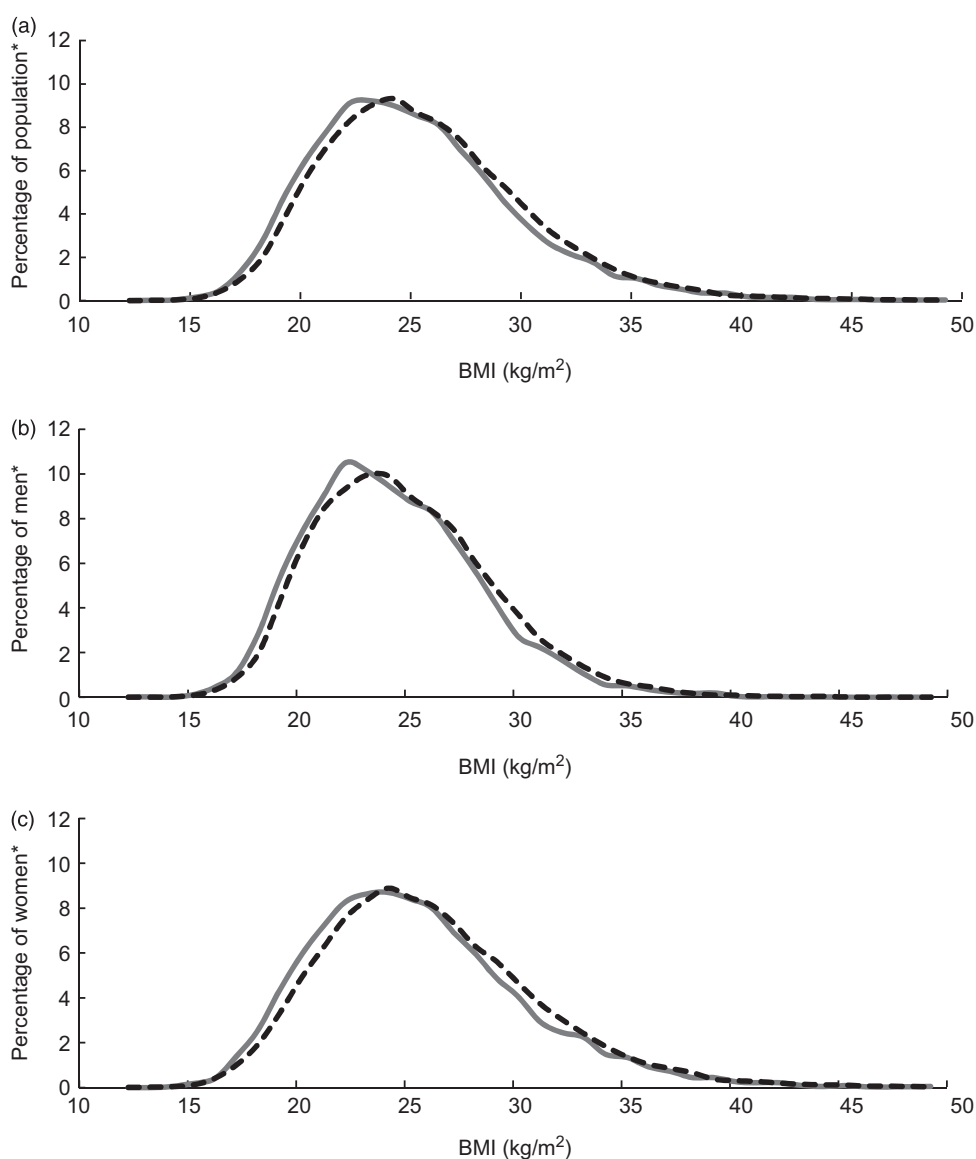

Fig. 1 BMI distribution in Colombian adults in 2005 (—) and 2010 (---): (a) total population; (b) men; (c) women. *Represents the percentage of population for a one unit change in BMI

Table 2 Adjusted prevalence ratios for obesity (BMI ≥30 kg/m²) in Colombian adults in 2005 and 2010

	2005		2010	
	PR*	95 % CI	PR	95 % CI
Sex				
Male	0·56	0·50, 0·61	0·60	0·57, 0·62
Female	1·00		1·00	
Age (years)				
18–24	0·44	0·35, 0·54	0·50	0·46, 0·54
25–34	1·00		1·00	
35–44	1·50	1·33, 1·69	1·36	1·29, 1·44
45–54	2·01	1·78, 2·27	1·67	1·59, 1·77
55–64	2·00	1·77, 2·27	1·85	1·74, 1·96
Marital status				
Married	0·99	0·90, 1·09	0·98	0·93, 1·02
Living together	1·00		1·00	
Never married	0·65	0·56, 0·74	0·66	0·62, 0·71
Separated	0·81	0·72, 0·92	0·78	0·74, 0·83
Widowed	1·02	0·85, 1·23	0·98	0·90, 1·07
Food security				
Food secure	1·00		1·00	
Mild food insecurity	1·07	0·97, 1·17	0·99	0·95, 1·03
Moderate food insecurity	1·00	0·86, 1·15	0·98	0·91, 1·04
Severe food insecurity	1·18	0·90, 1·55	0·89	0·79, 1·00
Wealth index quintile				
1 – poorest	1·00		1·00	
2	1·71	1·39, 2·10	1·33	1·24, 1·43
3	1·84	1·45, 2·35	1·31	1·21, 1·42
4	2·06	1·62, 2·62	1·38	1·27, 1·50
5 – wealthiest	2·12	1·66, 2·71	1·32	1·20, 1·44
Urbanicity				
Urban area	1·00		1·00	
Small rural village	1·11	0·96, 1·29	0·92	0·85, 1·00
Dispersed rural area	1·09	0·84, 1·41	0·86	0·79, 0·93
Region				
Atlantic	1·01	0·90, 1·14	1·06	1·00, 1·12
Oriental	1·07	0·94, 1·21	1·05	0·99, 1·11
Central	1·00		1·00	
Pacific	1·16	1·02, 1·32	1·08	1·02, 1·15
Bogotá	0·92	0·78, 1·09	0·80	0·74, 0·86
National Territories	1·42	1·26, 1·60	1·18	1·10, 1·27

*Prevalence ratios (PR) and 95 % confidence intervals are from Poisson regression with obesity as the dichotomous outcome and predictors that included indicator variables for male sex (female as reference), age (four indicators with '25–34' as reference), marital status (four indicators with 'living together' as reference), food security (three indicators with 'food secure' as reference), wealth index quintile (four indicators with '1 – poorest' as reference), urbanicity (two indicators with 'urban area' as reference) and region of residence (five indicators with 'Central' as reference). The complex sampling survey design was taken into account in the multivariable regression. One model was fitted for each year.

obesity was positively associated with female sex, age, and living in the Pacific or National Territories regions. Whereas in 2005 the association of wealth with obesity followed a dose–response gradient, in 2010 the prevalence of obesity was equally higher in wealth quintiles 2 to 5 as compared with the lowest quintile. By contrast, while living in rural areas (small rural villages or dispersed rural areas) was not related to the prevalence of obesity in 2005, it was associated with a lower prevalence compared with urban areas in 2010.

Finally, we examined the change in the prevalence of obesity from 2005 to 2010 by estimating prevalence differences in categories of each predictor, from multivariable regression models (Fig. 2). The change in the prevalence of obesity was significantly higher in persons aged 55–64 years than in younger adults (*P*, test for interaction with year = 0·01). There was also in inverse relationship between wealth and change in obesity

prevalence (*P*, test for interaction with year = 0·007). After adjustment, the prevalence difference between 2010 and 2005 in the poorest group was 5·0% (95 % CI 3·3, 6·7%) whereas there was not a significant change in the wealthiest group (PD = 0·3%; 95 % CI −1·6, 2·2%). The change in obesity prevalence was higher in people living in an urban environment (PD = 3·3%; 95 % CI 2·5, 4·1%), compared with that in people living in small rural towns (PD = 0·4%; 95 % CI −1·7, 2·6%) or in dispersed rural areas (PD = −0·3%; 95 % CI −3·4, 3·3%; *P*, test for interaction with year = 0·06). The increase in obesity prevalence also varied significantly by region (*P*, test for interaction with year = 0·02). The highest increase was observed in the Atlantic region (PD = 3·8%; 95 % CI 2·5, 5·2%), followed by the Central (PD = 3·0%; 95 % CI 1·8, 4·3%), Oriental (PD = 3·0%; 95 % CI 1·4, 4·5%), Pacific (PD = 2·2%; 95 % CI 0·5, 4·0%), Bogotá (PD = 0·8%;
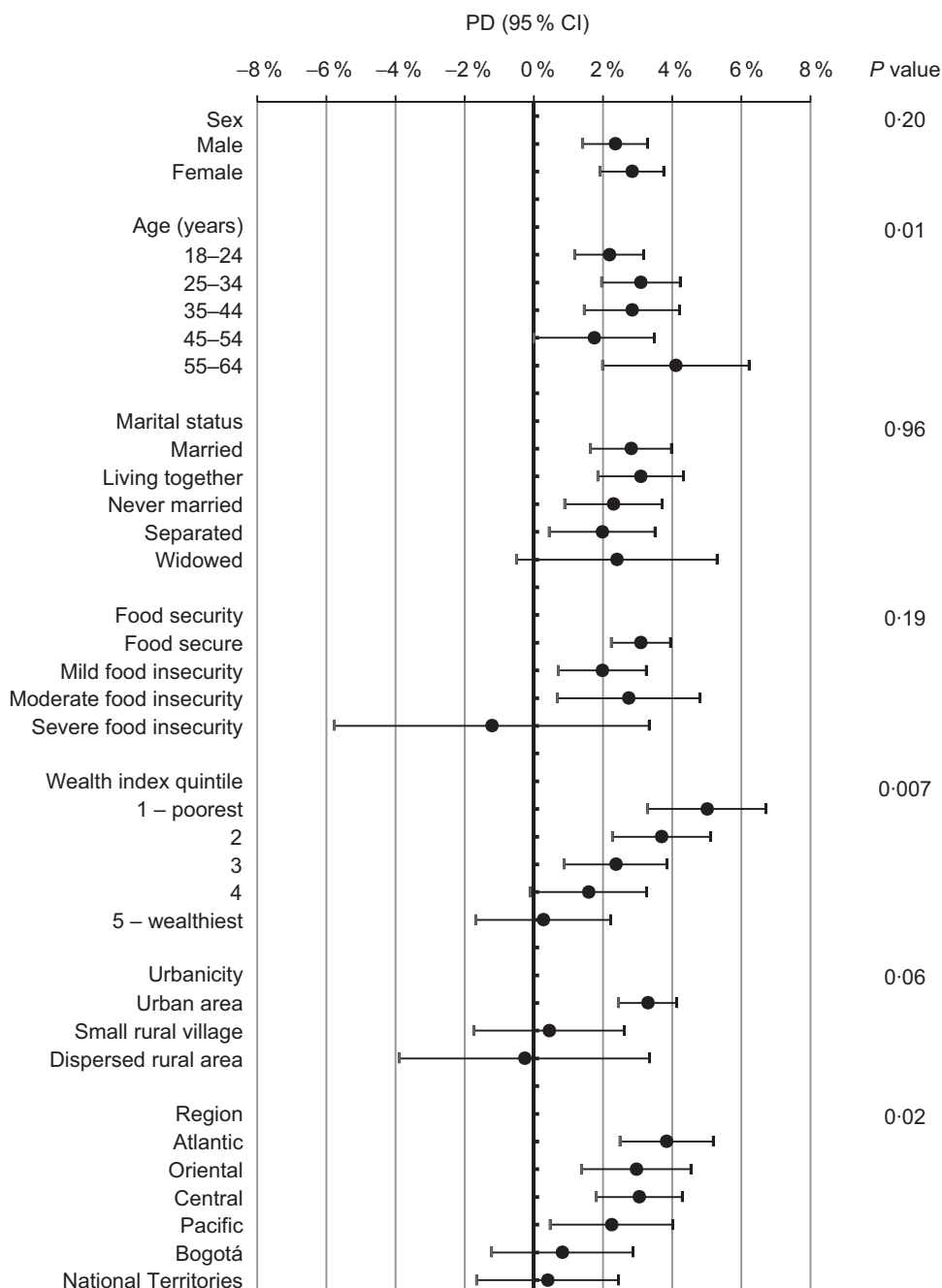
Fig. 2 Adjusted obesity prevalence differences (PD) between 2005 and 2010 among Colombian adults. Prevalence differences (●) and 95 % confidence intervals (represented by horizontal lines) are from Poisson regression models with obesity as the dichotomous outcome and predictors that included indicator variables for each sociodemographic correlate, year 2010 (2005 as reference) and cross-product (interaction) terms between year and the indicator variables of the correlate. In addition, each model was adjusted for all other sociodemographic correlates including indicator variables for male sex (female as reference), age (four indicators with '25–34' as reference), marital status (four indicators with 'living together' as reference), food security (three indicators with 'food secure' as reference), wealth index quintile (four indicators with '1 – poorest' as reference), urbanicity (two indicators with 'urban area' as reference) and region of residence (five indicators with 'Central' as reference). The complex sampling survey design was taken into account in all multivariable regression models. *P* values are from adjusted Wald tests for interaction between year and categories of each sociodemographic characteristic

95 % CI −1·2, 2·8 %) and National Territories (PD = 0·4 %; 95 % CI −1·6, 2·4 %). When the results were stratified by sex, the differential increases in obesity prevalence by age, urbanicity and region were more evident in women (online supplementary material, Supplemental Fig. 1) than men (online supplementary material, Supplemental Fig. 2). However, the greatest increase among the poorer than the wealthier remained apparent in both women and men.

Discussion

The average BMI of Colombian adults increased by $0.5\,kg/m^2$ between 2005 and 2010, equivalent to a rate of $1.0\,kg/m^2$ per decade, which is twice the mean BMI increase rate that has been noted globally, but on pace with the increase seen in the Latin American region[4]. Obesity prevalence has increased in both adult men and women; however, this rise has not been uniform. Although obesity was positively related to wealth in both years, the fastest increments have occurred in people of the lowest SES and among those living in urban areas. Whereas obesity was most prevalent in the National Territories region in both years, the rise between the surveys was lowest in that region and highest in the Atlantic, so that regional differences seen in 2005 appeared to be levelling out by 2010.

Obesity was associated with high SES in both 2005 and 2010. In settings at early stages of the nutrition transition, a positive relationship of SES with obesity might be explained by increased access to processed foods and more sedentary lifestyles among the better-off. While wealth was related to obesity in each survey year, there was a strong gradient in prevalence change between survey years by wealth index. The prevalence increased by 5 % in the poorest people but there was virtually no change in the wealthiest. This trend was more apparent in women than in men and could partly explain the lack of a clear correlation between obesity and wealth in 2010 among females. The shift in the burden of obesity from the richer to the poorer has been documented as countries move through economic development and appears to affect women before men, consistent with the results of our study. It could be due to increased availability of low-cost obesogenic foodstuffs of poor nutritional quality that are consumed by the least affluent[18]. In a review of studies from fourteen countries, Monteiro *et al.* found that the reversal of the association between obesity and SES occurs when countries have a per capita GNP (gross national product) of about $US 2500 in 2004 (approximately $US 3072 in 2013) and that this occurs at a lower GNP per capita for women than men[15]. This shift may be occurring in Colombia at a higher GNP level (from about $US 3281 in 2005 to $US 4895 in 2010, in 2013 US dollars)[28].

We found that obesity prevalence was highest in urban areas in 2005 and 2010 and that prevalence was growing faster in urban than rural areas, when controlling for sex, age, wealth, food security and other covariates. Decreased physical activity and increased consumption of high-energy foods related to urbanization have been identified as major contributors to the rise in obesity prevalence worldwide[2]. Between 2005 and 2010, imports of food products in Colombia doubled[29], potentially enhancing exposure to a more 'Western' diet which has been associated with risk of obesity[30]. An additional explanation for the greater increase in obesity among urban than rural inhabitants is that the change is mediated by improvements in SES[31]. This may not necessarily be the case in Colombia, where social and political unrest continued to displace a substantial number of people from rural to urban areas to engross the poorer groups in the cities during the period between surveys.

Of note, food security status was positively related to the prevalence of obesity in both survey years. Nevertheless, after adjustment for wealth and other potential confounders the association was attenuated and became non-statistically significant. The role of food security on obesity is controversial and possibly depends on a country's stage through the nutrition transition. In countries at more advanced stages, severe food insecurity has been related to increased prevalence of obesity[32,33] whereas in countries at earlier stages, it is related to underweight[34]. In our case, the attenuation of a positive relationship of food security with obesity after adjustment suggests that it may have been confounded by SES.

The geographical gradient of the recent changes in obesity prevalence is noteworthy. The highest increase was observed in the Atlantic region, followed by the Oriental, Central and Pacific regions, with virtually no change in Bogotá or the National Territories. The Atlantic region's prevalence was lowest in 2005; thus, regression to the mean could be an explanation for the greatest shift observed there. Nevertheless, causal explanations cannot be ruled out. These might include region-specific changes in food availability or physical activity patterns related to drifts in socio-economic or environmental conditions during this period. Future research into potential explanations for the geographic variation in changes in obesity prevalence might inform potential public health interventions to prevent further increases.

A major strength of the current study is that it assessed changes in prevalence of obesity using measured height and weight data from nationally representative samples of both adult men and women. Recent changes in the burden of obesity within socio-economic strata had not been carefully characterized in this region. The majority of prior studies of obesity trends relied on data from the Demographic and Health Surveys, which are limited to women of childbearing age; the WHO World Health Surveys, which rely on self-reported heights and weights; or small, non-representative samples[4,11,14,35]. One limitation of the study was that a sizeable group was excluded for lack of data on height or weight. If the probability of inclusion in the analyses was related to both survey year and BMI status, results could be affected by selection bias. Men were excluded more frequently in 2005 due to lack of anthropometric data, but it is uncertain whether the prevalence of obesity differed between participating and non-participating male subjects.

In sum, the prevalence of obesity among Colombian adults increased by about 3 % between 2005 and 2010. This increase has disproportionately affected the poorest

people in the country. The implications of these changes on rates of obesity-related chronic diseases require careful surveillance. Whether similar trends exist in children is a critical next step in the research agenda. Identifying both immediate and contextual causes of the recent increases in obesity rates will allow appropriate interventions and policy to be implemented to decrease their impact.

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Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980013003418

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