DISPARITIES IN REGIONAL OBESITY RATES IN ARGENTINA BY SOCIOECONOMIC STATUS

FRANCINE RÍOS-FETCHKO[1], ALICIA FERNÁNDEZ[1, 2], RAÚL MEJÍA[2, 3], M. VICTORIA SALGADO[2, 4]

[1]University of California, San Francisco, San Francisco, CA, USA, [2]Centro de Estudios de Estado y Sociedad, Buenos Aires, Argentina, [3]Hospital de Clínicas José de San Martín, Buenos Aires, Argentina, [4]Unidad de Conocimiento Traslacional Hospitalaria Patagónica, Hospital SAMIC El Calafate, Santa Cruz, Argentina

Abstract

Background: Obesity rates in Latin America are increasing overall and among people with low socio-economic status (SES). Obesity and SES disparities can vary by region-a valuable indicator of local drivers. The objective of this study was to examine regional and SES differences in obesity in Argentina.

Methods: We used data from Argentina's 4th National Risk Factors Survey (n = 29226) 2018 and defined obesity as BMI ≥ 30. Low SES was defined as not finished high school or having a household income in the lowest two quintiles. Descriptive analysis stratified by sex compared obesity rates by SES, province, and region. Age-adjusted logistic regression models explored the association between obesity, socioeconomic status, and region.

Results: Obesity rates varied more by SES among women (39% for low SES vs. 26% for middle/high SES; p < 0.001) than among men (33% low SES vs. 29% middle/high SES; p = 0.027). The Patagonian region had the highest obesity prevalence for both men (36%) and women (37%). A gender-stratified age-adjusted analysis with region and SES showed that low SES (OR 1.72, 95% CI 1.45, 2.03) and the Patagonian region (OR 1.29, 95% CI 1.02, 1.62) were the only significant predictors for women.

Conclusions: SES associated disparities in obesity in Argentina were pronounced for women but not men. Disparities were particularly high in Patagonia. Further research is needed to understand the drivers behind these SES, regional, and gender disparities.

Key words: obesity, disparities, socioeconomic status, geographic location, Argentina

Resumen

Disparidades en prevalencia de obesidad por región y estatus socioeconómico en Argentina

Introducción: Las tasas de obesidad en América Latina están aumentando, tanto en la población general como entre las personas con bajo nivel socioeconómico (NSE). Las disparidades en obesidad y NSE pueden variar ampliamente según la región, un indicador potencialmente valioso de fenómenos causales locales. El objetivo de este estudio fue examinar las diferencias en la prevalencia de obesidad a nivel regional y según el NSE en Argentina.

Métodos: Utilizamos datos de la 4ª Encuesta Nacional de Factores de Riesgo realizada en Argentina en 2018 (n = 29226). Definimos obesidad como índice de masa corporal ≥ 30, y bajo NSE como no haber terminado la escuela secundaria o tener un ingreso familiar en los dos quintiles más bajos. El análisis descriptivo estratificado por sexo comparó la prevalencia de obesidad por NSE, provincia y región. Además, utilizamos modelos de regresión logística ajustados por edad para explorar la asociación entre obesidad, nivel socioeconómico y región, tanto globalmente como estratificando por sexo.

Resultados: Las tasas de obesidad variaron más por NSE entre las mujeres (39% NSE bajo vs. 26% NSE medio/alto; p < 0.001) que entre los hombres (33% NSE bajo vs. 29% NSE medio/alto; p = 0.027). La región patagónica tuvo la mayor prevalencia de obesidad tanto para hombres (36%) como para mujeres (37%). Un análisis estratificado por género, con región y NSE como covariables, mostró que el bajo NSE (OR 1.72, IC 95% 1.45, 2.03) y la región patagónica (OR 1.29, IC 95% 1.02, 1.62) fueron los únicos predictores significativos para las mujeres; ninguno se asoció significativamente con un mayor riesgo de obesidad para los hombres.

Conclusiones: Las disparidades asociadas al NSE en la obesidad en Argentina fueron pronunciadas entre mujeres, pero no entre hombres. Las disparidades fueron particularmente altas en la Patagonia. Se necesita más estudios para comprender los factores detrás de estas disparidades de NSE, regionales y de género.

Palabras clave: obesidad, disparidades, nivel socioeconómico, región, Argentina

---

KEY POINTS

- Obesity disparities by region and socioeconomic status can provide insight into local drivers of obesity rates and inform public health policy.
- This study found that regional differences in obesity prevalence were relatively small but that disparities by SES status were large.
- This study also found that disparities in obesity by socioeconomic status were more pronounced for women (than for men) and that the Patagonian region had the highest obesity prevalence for both men (36%) and women (37%).

Obesity prevalence and incidence rates continue to rise across most countries, especially in low- and middle-income nations[1]. With multiple drivers and an often-complex epidemiology, obesity proves to be a challenge for governments and public health officials trying to create a structured approach to prevention and treatment. In Latin America –notably, the most unequal region of the world[2] –obesity rates are not only rising across the board but are also becoming increasingly associated with lower socioeconomic status[3]. However, while increasing socioeconomic health disparities have been noted in many countries, this trend is not uniform across the region, furthering the difficulties of one-size-fits-all public health measures[3].

Shaped by distinct histories and economic development patterns, drivers of obesity may vary by country, region, population group, and local customs, resulting in geographic variance in obesity prevalence. In the United States, for example, regional differences in obesity are very large, in the order of 6 absolute percentage points, with the poorer, southeastern and midwestern parts of the country having a prevalence of obesity of 34%[4]. Disparities between individual states are even larger, reaching as high as 15 percentage points[4]. In both England and Spain, significant health disparities across an array of metrics have been recorded between the Northern and Southern regions[5, 6].

In Argentina, obesity has increased for both men and women in the last decades[3, 7]. In addition, the gap in obesity rates between the lowest and highest income groups has increased from 7.6 percentage points to 10.2 for women from 2005 to 2013[3]. Overall increases in national socioeconomic disparities in obesity rates may obscure important regional differences in this county, which is characterized by a Northern region with an strong indigenous culture; a central region that includes the most populated cities and richest agricultural territories; and a Southern region that was colonized less than 200 years ago and remains the least densely populated area of the country[8].

We leveraged data from the latest Argentine National Survey of Risk Factors to examine the relationships between socio-economic status, gender, regions and provinces, and obesity rates in Argentina.

Materials and methods
National Risk Factor Survey

This study used data from Argentina's 4th National Survey of Risk Factors, conducted in 2018 (ENFR 2018), which was designed and administered by the Argentinian National Institute of Statistics and Census and the Ministry of Health and Social Development of the Nation[7]. The ENFR is a nationally representative survey study that

samples from all adults living in localities with 5000 or more inhabitants[7]. The ENFR gathers participant reported demographic and health data including tobacco use, diet, and alcohol consumption, and measures blood pressure and cholesterol levels in a sub sample. Body mass index (BMI) is calculated using height and weight recorded by trained staff at the time of survey administration. See Table 1 for sample size breakdown by region and gender. More information on the methodology of ENFR data collection can be found in official reports[7]. In this study, we defined obesity as BMI greater than or equal to 30 for both men and women.

Socioeconomic status definition

There is no broadly accepted way to measure socioeconomic status (SES) in middle-income countries such as Argentina[9]. Many studies use either education or income alone, or some combination of these and other factors[10-13]. We chose a combined approach, considering both education and household income –the two most common measures– to create a dichotomous SES categorization (low SES, or middle/high SES).

According to data from the ENFR 2018, more than 88% of 18-64 year old Argentine adults finished elementary school (this number increases to more than 90% among adults younger than 55), while only 42.8% finished secondary school (equivalent to 12 years of education)[7]. Thus, secondary education completion was chosen as the cutoff point in this study to best capture educational disparities.

We followed the protocol on measuring poverty by income described in 2018 by the Economic Commission for Latin America. Their report established 'not low income' as the first quintile whose percentage of households with unsatisfied basic needs does not exceed 10%[14] . In Argentina, this happens from the third quintile onwards. Given this, we categorized people in the lowest two quintiles as low SES.

Therefore, participants in this study were categorized as having low SES if they did not finish high school and/or reported a household income in quintiles 1 or 2. This combined dichotomization allows us to capture both a life-standing proxy of SES –education level– while also capturing potential recent changes in SES status due to income.

We performed a sensitivity analysis comparing our primary combined income and education definition of SES and an alternative definition including only education (Appendix). We looked at significance and direction of the relationship between SES and obesity prevalence

across regions and provinces with each of the two definitions of SES for both men and women.

Geographic variation

We defined the Metropolitan area as consisting of Buenos Aires City and the surrounding metropolitan area that belongs to the province of Buenos Aires; Pampeana as the rest of the province of Buenos Aires, and the provinces of Cordoba, Entre Rios, La Pampa and Santa Fe; Northwest (NOA) as provinces Catamarca, Jujuy, La Rioja, Salta, Santiago, and Tucumán; Northeast (NEA) as Corrientes, Chaco, Formosa, and Misiones; Patagonia as Chubut, Neuquén, Rio Negro, Santa Cruz, and Tierra del Fuego; and Cuyo as Mendoza, San Juan, and San Luis (Fig. 1).

Data analysis

Data analysis was conducted using STATA software version 13 (STATA Corp LP; College Station, Texas, EE. UU.). Mean and standard deviation are reported for continuous variables. For categorical variables, we report n and corresponding percentages. Statistical significance was

Figure 1 | Regions of Argentina

Northwest
Northeast
Pampeana
Cuyo
Patagonia
Metropolitana

defined with a two-sided alpha of 0.05 (p-values < 0.05). Descriptive analysis stratified the sample by sex and compared obesity rates by socioeconomic status, province and region using Chi-square test for categorical variables. Logistic regression models adjusted for age and SES (model 1) and age, SES and region (model 2) explored the association between obesity, socioeconomic status, and region – both overall and stratified by sex.

Results

Table 1 shows the population distribution by gender and region evaluated in the 4th National Risk Factors Survey. The total sample population used was n = 29,226-52% female, 48% male, with an average age of 43.9 years (SD 17.8) overall – 44.1 (SD: 18.7) for women and 43.8 (SD: 16.7) for men. In 2018, Argentina had an overall adult obesity rate of 32.4%: 31.4% for men and 33.4% for women (Fig. 2).

Table 2 presents results of obesity prevalence by gender, SES status, region and province. Average BMI for the population was 28 (SD: 5.8) overall and 28 for both women (SD: 6.6) and men (SD: 4.9). Analysis by region showed that, for men, regional obesity rates were lowest in NEA (27.8%), followed by Pampeana (29.5%), NOA (32.0%), Metropolitana (32.3%), and Cuyo (33.7%); the highest obesity rate for men was in Patagonia (Southern region) (35.9%) (Fig. 2). Rates for women were higher than for men in all regions but followed similar spatial trends. Rates for women by increasing prevalence were as follows: NEA (30.3%), Metropolitana (32.3%), Pampeana (34.2%), NOA (34.8%), Cuyo (34.8%) and Patagonia (36.9%) (Fig. 2).

Bivariate analysis showed that country-wide differences in obesity rates between individuals of low SES compared to middle/high SES were significant for both men and women. Among

Table 1 | Study population by gender and region

Region	Men (n, %)	Women (n, %)	Total (n, %)
Total Argentina	13 915	15 311	29 226
Metropolitana	5407 (38.9%)	5944 (38.8%)	11 351 (38.9%)
Pampeana	4261 (30.6%)	4758 (31.1%)	9019 (30.9%)
NOA	1496 (10.8%)	1631 (10.7%)	3127 (10.7%)
NEA	1064 (7.6%)	1175 (7.8%)	2239 (7.7%)
Cuyo	908 (6.5%)	994 (6.5%)	1902 (6.5%)
Patagonia	779 (5.6%)	809 (5.3%)	1588 (5.4%)

NOA: Northwest Argentina; NEA: Northeast Argentina

Figure 2 | Obesity prevalence by gender, region and SES status in Argentina, 2018. A: Women. B: Men
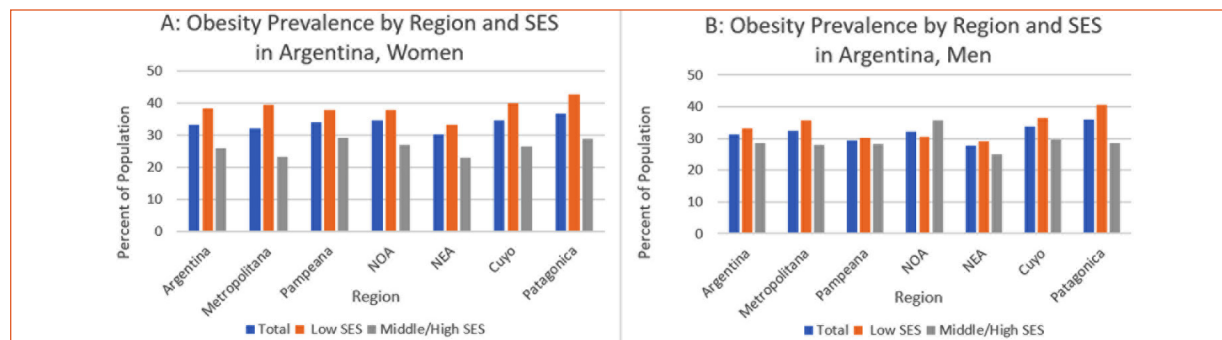
SES: socioeconomic status; NOA: Northwest Argentina; NEA: Northeast Argentina

men, the national obesity rate for those with low SES was 33.2% versus 28.6% for those with middle/high SES (p = 0.0274); national rates for women were 38.5% for low SES and 26.0% for middle/high SES (p < 0.001). The prevalence of obesity was highest among women of low SES in all regions. The biggest SES disparities in women were seen in the regions of Metropolitana (39.6% prevalence of obesity in low SES vs. 23.1% in middle/high SES; p < 0.001), Patagonia (42.9% in low SES vs. 29.0% in middle/high SES; p = < 0.001) and Cuyo (40.1% in low SES vs. 26.4% in middle/high SES; p = 0.0092). Three areas: NOA (38.1% in low SES vs. 27.2% in middle/high SES; p < 0.001), NEA (33.4% in low SES vs. 23.0% in middle/high SES; p = 0.004) and Pampeana (38.0% in low SES vs. 29.2% in middle/high SES; p = 0.004) had smaller disparities. Among men, by contrast, obesity disparities by SES were only significant in Patagonia, where the obesity rate was 11.9 percentage points higher for men of low SES compared to men of middle/high SES (p = 0.004) (Table 2). Provincial level results are also shown in Table 2.

Table 2 | Obesity prevalence by region, province, gender and SES status, Argentina, 2018

	Men			Women		
	Low SES	Middle/High SES	p-value	Low SES	Middle/High SES	p-value
Argentina	33.2	28.6	0.027*	38.5	26.0	<0.001*
Metropolitana y	**35.8**	**28.0**	**0.066**	**39.6**	**23.1**	**<0.001***
Pampeana	**30.3**	**28.3**	**0.537**	**38.0**	**29.2**	**0.004***
Ciudad de BA	31.2	23.6	0.241	26.5	18.1	0.109
Buenos Aires	35.7	29.1	0.110	40.4	27.8	<0.001*
Córdoba	28.7	22.1	0.249	35.1	26.4	0.127
Entre Ros	26.7	28.6	0.738	32.6	32.6	0.999
La Pampa	48.1	17.4	<0.001*	37.3	25.7	0.109
Santa Fe	26.7	39.1	0.060	42.2	28.1	0.025*
Northwest	**30.6**	**35.7**	**0.179**	**38.1**	**27.2**	**<0.001***
Catamarca	28.3	25.9	0.767	36.3	38.2	0.797
Jujuy	31.7	39.9	0.324	37.1	30.1	0.346
La Rioja	39.3	43.4	0.685	35.2	29.6	0.482
Salta	30.3	28.7	0.826	35.0	26.8	0.198
Santiago	29.7	40.0	0.321	35.6	40.8	0.550
Tucuman	29.4	38.3	0.291	43.6	17.2	<0.001*
Northeast	**29.2**	**25.0**	**0.337**	**33.4**	**23.0**	**0.004***
Corrientes	21.9	32.5	0.217	37.4	28.0	0.210
Chaco	26.3	14.3	0.125	30.9	14.9	0.019*
Formosa	31.5	36.8	0.481	29.4	21.9	0.216
Misiones	36.9	22.9	0.042*	34.3	25.5	0.176
Cuyo	**36.4**	**29.7**	**0.283**	**40.1**	**26.4**	**0.009***
Mendoza	39.8	29.6	0.278	37.1	24.6	0.114
San Juan	35.3	36.7	0.887	46.2	31.0	0.079
San Luis	26.3	19.8	0.361	41.8	27.0	0.035*
Patagonia	**40.4**	**28.5**	**0.004***	**42.9**	**29.0**	**<0.001***
Chubut	40.5	18.3	0.002*	42.6	34.3	0.254
Neuquén	30.4	31.0	0.947	50.1	22.6	0.001*
Rio Negro	44.8	33.0	0.097	37.2	31.2	0.288
Santa Cruz	44.7	36.2	0.446	45.0	29.3	0.053
Tierra del Fuego	48.9	27.6	0.100	36.1	26.7	0.389

SES: socioeconomic status, BA: Buenos Aires
* Significant to 95%

Age adjusted logistic regression analyses with only SES as a co-variate showed that low SES was associated with increased likelihood of obesity in the country as whole (OR 1.43, 95% CI 1.26, 1.62). Sex stratification revealed that only disparities among women (OR 1.71, 95% CI 1.45, 2.02) by SES, and not those among men (OR 1.17, 95% CI 0.97, 1.42), were significant on a national scale (Table 3).

The addition of region as a co-variate in the model found that the Patagonian region was significantly associated with an increased risk of obesity for the population overall in age-adjusted analyses (OR 1.25, 95% CI 1.05, 1.49), as was SES (OR 1.43, 95% CI 1.26, 1.63). A gender-stratified analysis with region and SES showed that SES (OR 1.72, 95% CI 1.45, 2.03) and the Patagonian region (OR 1.29, 95% CI 1.02, 1.62) were the only significant predictors for women; among men, neither region nor SES were significantly associated with increased risk of obesity (Table 3).

A one-year increase in age was associated with a statistically significant marginal increase in risk of obesity in all regression analyses (OR 1.02, 95% CI 1.01, 1.03) (Table 3).

Sensitivity analysis results were robust for univariate regional analyses, showing no difference in significance or directionality between single or combined definitions of SES in any region. Significance differed in 6 provinces and directionality differed in 3 provinces for both men and women. In multivariate analyses, significance only varied marginally in the Patagonian region for women. All other multivariate analyses were robust in significance and directionality between single and combined definitions of SES (Appendix).

Discussion

In this analysis of regional obesity rates by socioeconomic status and gender, we found that regional differences were evident though not very pronounced. By contrast, differences by socioeconomic status were large –particularly for women– and were robust to distinct definitions of SES.

Overall, we found that women of low socioeconomic status consistently have the highest rates of obesity in Argentina in both regional and provincial analyses. This is in accordance with prior literature focused only on provincial analyses [15]. Disparities in disease burden for women by SES were found in all regions and six provinces. While our study did not investigate drivers of gender-based disparities, other authors have hypothesized that the stronger effects of SES on women's BMI compared to men may be due to occupational differences stemming from higher prevalence of manual labor in men of low SES, or to sociocultural pressures to fit aesthetic standards faced in particular by women of middle/high SES[15, 16]. Child bearing, a driver of obesity in women, may also differ by SES[17].

Table 3 | Obesity association with age, SES, and region, overall and stratified by sex; Argentina, 2018

Covariates	Overall	Male	Female
Model 1: Adjusted for age and SES			
Age	OR: 1.02 (1.01, 1.03)*	OR: 1.02 (1.02, 1.03)*	OR: 1.02 (1.02, 1.03)*
SES	OR: 1.43 (1.26, 1.62)*	OR: 1.17 (0.97, 1.42)	OR: 1.71 (1.45, 2.02)*
Model 2: Adjusted for age, SES, and region			
Age	OR: 1.02 (1.02, 1.03)*	OR: 1.02 (1.02,1.03)*	OR: 1.02 (1.02, 1.03)*
SES	OR: 1.43 (1.26, 1.63)*	OR: 1.17 (0.96, 1.43)	OR: 1.72 (1.45, 2.03)*
Pampeana	OR: 0.97 (0.82, 1.14)	OR: 0.88 (0.69, 1.13)	OR: 1.05 (0.85, 1.30)
NOA	OR: 1.06 (0.89, 1.25)	OR: 1.03 (0.79, 1.33)	OR: 1.09 (0.88, 1.36)
NEA	OR: 0.86 (0.72, 1.03)	OR: 0.85 (0.64, 1.12)	OR: 0.87 (0.69, 1.11)
Cuyo	OR: 1.09 (0.87, 1.35)	OR: 1.06 (0.76, 1.48)	OR: 1.12 (0.83, 1.48)
Patagonia	OR: 1.25 (1.05, 1.49)*	OR: 1.23 (0.94, 1.60)	OR: 1.29 (1.02, 1.62)*

SES: socioeconomic status; NOA: Northwest Argentina; NEA: Northeast Argentina
* Significant to 95%

We found that the Patagonian region had both the highest rates of obesity and the highest rates of SES disparities in obesity. The Patagonian region is both more rural and prone to colder weather than the rest of the country; however, while these two factors have been associated with overall higher rates of obesity in other parts of the world due to lifestyle and biological factors[18, 19], associations with increased disparities due to urbanicity or climate in Argentina are underexplored.

In countries such as the United States, region of inhabitance has been found to be a significant predictor of obesity rates, even surpassing race or socioeconomic status[20]. However, in Argentina, we found that socioeconomic status is a more important predictor than region of residency. In Argentina, unlike the U.S, diet and exercise levels may not differ dramatically between regions. However, diet may differ within regions by socioeconomic stats due to access to healthy food or food cost, which may contribute to disparities in obesity by SES[21]. Our findings are in line with analyses from other countries that have reported socioeconomic disparities that surpass regional disparities in effect; one study in Spain found that differences in BMI between the Northern and Southern regions were driven mainly by women and by years of schooling (their proxy for SES), a pattern that was noted in our data as well[6]. This study noted an average north-south BMI difference of 0.55 kg/m^2 for women and 0.128 kg/m^2 for men[6].

This study has a few limitations. Although the use of BMI to determine obesity is commonplace, BMI calculation does not take into account muscle mass, bone density, or body fat percentage, making its use as a measure of obesity susceptible to misclassification[22]. Men are particularly susceptible to the flaws of BMI and are more often misclassified as obese than women[22]. Further, 2018 ENFR is only representative of areas of population 5000 or more, so results could differ in smaller towns. Nevertheless, it is estimated that 70% of Argentinean population live in one of the 31 biggest cities of the country, while only 8% is rural (lives in town of less than 2000 people)[23]. Lastly, our models do not account for possible mediating factors such as diet and exercise, or other comorbidities.

As obesity rates continue to increase for those of low socioeconomic status around the world and in countries such as Argentina, the need for comprehensive public health measures on national and regional levels are imperative. Although Argentina does count with a governmental structure for the evaluation of obesity (including the Office for the Promotion of Health and Control of Non-communicable Diseases and a national data source)[24], the country lacks regulations present in other parts of Latin America such as taxes on sugar sweetened beverages, regulations of marketing on foods or foods in schools, and programs that promote physical activity, nutrition education, family agriculture, and healthier environments[24].

These data should be used to guide both preventative and interventionist public health measures to address obesity. Policies should aim to address drivers of disparities considering not only regional differences, but also gender and SES in particular. Further research is needed to understand the drivers behind these disparities, with a specific emphasis on investigating why these disparities vary in size across regional and provincial boundaries as well as between men and women.

Conflicts of interest: None to declare

References

1. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev* 2012; 70: 3-21.
2. Gaudin Y, Pareyón Noguez, R. Brechas estructurales en América Latina y el Caribe: una perspectiva conceptual-metodológica. Documentos de Proyectos: United Nations; 2020. En: *https://www.cepal.org/es/publicaciones/46435-brechas-estructurales-america-latina-caribe-perspectiva-conceptual-metodologica*; accessed September 2022.

3. Jiwani SS, Carrillo-Larco RM, Hernández-Vásquez A, et al. The shift of obesity burden by socioeconomic status between 1998 and 2017 in Latin America and the Caribbean: a cross-sectional series study. *Lancet Glob Health* 2019; 7: e1644-e54.

4. CDC. Adult obesity prevalence maps. In: Division of Nutrition PA, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, editor.: CDC; 2022. In: h*ttps://www.cdc.gov/obesity/data/prevalence-maps.html*; accessed September 2022.

5. Ellis A, Fry R. Regional health inequalities in England. *Regional Trends* 2010; 42: 60-79.

6. Di Paolo A, Gil Trasfi J, Raftopoulou A. What drives regional differences in BMI? Evidence from Spain. En: *https://www.ub.edu/irea/working _papers/2018/201808.pdf*; accessed September 2022.

7. Instituto Nacional de Estadística y Censos (INDEC) - Secretaría de Gobierno de Salud de la Nación. 4 Encuesta National de Factores de Riesgo. indec.gob.ar: Instituto Nacional de Estatistica y Censos 2019. In: *https://www.indec.gob.ar/indec/web/Nivel4-Tema-4-32-68*; accessed September 2022.

8. Eidt RC, Calvert, Peter and Donghi, TH. Argentina Encyclopedia Britannica: Encyclopedia Britannica; 2022. In: *https://www.britannica.com/place/Argentina;* accessed September 2022.

9. Howe LD, Galobardes B, Matijasevich A, et al. Measuring socio-economic position for epidemiological studies in low- and middle-income countries: a methods of measurement in epidemiology paper. *Int J Epidemiol* 2012; 41: 871-86.

10. Fleischer NL, Diez Roux AV, Alazraqui M, Spinelli H, De Maio F. Socioeconomic gradients in chronic disease risk factors in middle-income countries: evidence of effect modification by urbanicity in Argentina. *Am J Public Health* 2011; 101: 294-301.

11. Linetzky B, De Maio F, Ferrante D, Konfino J, Boissonnet C. Sex-stratified socio-economic gradients in physical inactivity, obesity, and diabetes: evidence of short-term changes in Argentina. *Int J Public Health* 2013; 58: 277-84.

12. De Maio FG, Linetzky B, Virgolini M. An average/deprivation/inequality (ADI) analysis of chronic disease outcomes and risk factors in Argentina. *Popul Health Metr* 2009; 7: 8.

13. Tumas N, Rodríguez López S, Bilal U, Ortigoza AF, Diez Roux AV. Urban social determinants of non-communicable diseases risk factors in Argentina. *Health Place* 2022; 77: 102611.

14. Economic Comission for Latin America and the Carribean. Medición de la pobreza por ingresos: actualización metodológica y resultados. In: Nations U, editor. 2 ed. Metodologías de la CE-PAL2018. In: *https://repositorio.cepal.org/bitstream/handle/11362/44314/1/S1800852_es.pdf*; accessed September 2022.

15. Pou SA, Diaz MDP, Velázquez GA, Aballay LR. Sociodemographic disparities and contextual factors in obesity: updated evidence from a National Survey of Risk Factors for Chronic Diseases. *Public Health Nutr* 2021: 1-13.

16. Wardle J, Waller J, Jarvis MJ. Sex differences in the association of socioeconomic status with obesity. *Am J Public Health* 2002; 92: 1299-304.

17. Dribe M, Breschi M, Gagnon A, et al. Socio-economic status and fertility decline: insights from historical transitions in Europe and North America. *Popul Stud (Camb)* 2017; 71: 3-21.

18. Center for Disease Control and Prevention. More obesity in US rural counties than in urban counties. In: https://www.cdc.gov/media/releases/2018/s0614-obesity-rates.html; accessed September 2022.

19. von Hippel P, Benson R. Obesity and the natural environment across US counties. *Am J Public Health* 2014; 104: 1287-93.

20. Division of nutrition PA, and obesity, National Center for Chronic Disease Prevention and Health Promotion. Adult Obesity Prevalence Maps. In: Prevention CoDCa, editor. CDC2022. In: *https://www.cdc.gov/obesity/data/prevalence-maps.html*; accessed September 2022.

21. Zapata M, Rovirosa A, Carmuega E. Urbano y rural: diferencias en la alimentación de los hogares argentinos según nivel de ingreso y área de residencia. *Salud Colect* 2019; 15: e2201.

22. Burkhauser RV, Cawley J. Beyond BMI: the value of more accurate measures of fatness and obesity in social science research. *J Health Econ* 2008; 27: 519-29.

23. Poblacion Urbana en Argentina: Evolucion y distribucion espacial a partir de datos censales. In: *https://www.argentina.gob.ar/sites/default/files/2021/04/poblacion_urbana_dnp30dejunio.pdf* accessed September 2022.

24. Palacios C, Magnus M, Arrieta A, Gallardo H, Tapia R, Espinal C. Obesity in Latin America, a scoping review of public health prevention strategies and an overview of their impact on obesity prevention. *Public Health Nutr* 2021; 24: 5142-55.

Appendix 1 | Sensitivity analysis. Obesity prevalence comparison between combined and education only definition of socioeconomic status by region and province, Argentina, 2018

	Men		Women	
	Combined SES: low SES vs. middle/high SES %; p-value	**Only Education: low SES % vs. middle/high SES %; p-value**	**Combined SES: low SES % vs. middle/high SES %; p-value**	**Only Education: low SES % vs. middle/ high SES %; p-value**
Overall	**33.2 vs. 28.6; 0.027**	**34.6 vs. 28.7; 0.004**	**38.5 vs. 26.0; < 0.001**	**42.5 vs. 27.0; < 0.001**
Regional				
Metropolitana	35.8 vs. 28.0; 0.07	36.8 vs. 29.2; 0.08	40.0 vs. 23.1; < 0.001	44.1 vs. 24.4; <0.001
Pampeana	30.2 vs. 28.3; 0.54	31.8 vs. 27.5; 0.18	38.0 vs. 29.2; < 0.001	40.2 vs. 30.1; < 0.001
Northwest	30.5 vs. 35.7; 0.18	31.7 vs. 32.4; 0.84	38.1 vs. 27.2; < 0.001	44.7 vs. 27.6; < 0.001
Northeast	29.2 vs. 25.0; 0.34	31.0 vs. 24.7; 0.10	33.4 vs. 23.0; < 0.001	37.2 vs. 24.7; < 0.001
Cuyo	36.4 vs. 29.7; 0.28	38.9 vs. 29.4; 0.12	40.1 vs. 26.4; 0.01	44.2 vs. 28.0; 0.002
Patagonia	40.4 vs. 28.5; < 0.001	41.3 vs. 29.5; 0.004	42.9 vs. 29.0; <0.001	46.1 vs. 29.0; < 0.001
Provincial				
City of BA	31.2 vs. 23.6; 0.24*	38.6 vs. 22.8; 0.03*	26.5 vs. 18.1; 0.11	28.9 vs. 18.7; 0.084
Province BA	35.72 vs. 29.1; 0.11	35.8 vs. 30.9; 0.23	40.1 vs. 27.8; < 0.001	44.3 vs. 28.5; < 0.001
Catamarca	28.3 vs. 25.9; 0.76	31.1 vs. 24.4; 0.40	36.3 vs. 38.2; 0.80**	41.7 vs. 35.2; 0.42**
Cordoba	28.7 vs. 22.1; 0.25*	32.1 vs. 21.0; 0.05*	35.1 vs. 26.4; 0.13	37.3 vs. 27.6; 0.10
Corrientes	21.9 vs. 32.5; 0.22	23.8 vs. 27.8; 0.60	37.4 vs. 28.0; 0.21*	43.0 vs. 28.2; 0.04*
Chaco	26.3 vs. 14.3; 0.13*	30.6 vs. 14.4; 0.02*	30.9 vs. 14.9; 0.02	34.1 vs. 19.9; 0.03
Chubut	40.5 vs. 18.3; < 0.001	40.7 vs. 21.0; 0.01	42.6 vs. 34.3; 0.25*	48.8 vs. 30.2; 0.01*
Entre Rios	26.7 vs. 28.6; 0.74**	27.7 vs. 26.8; 0.87**	32.6 vs. 32.6; > 0.99**	35.3 vs. 30.0; 0.31**
Formosa	31.5 vs. 36.8; 0.48	31.8 vs. 34.2; 0.73	29.4 vs. 21.9; 0.22	32.5 vs. 22.9; 0.09
Jujuy	31.7 vs. 39.9; 0.32	33.7 vs. 34.0; 0.97	37.1 vs. 30.1; 0.35*	45.1 vs. 29.1; 0.02*
La Pampa	48.1 vs. 17.4; < 0.001	50.0 vs. 21.9; 0.002	37.3 vs. 25.7; 0.11	37.6 vs. 27.6; 0.18
La Rioja	39.3 vs. 43.4; 0.68	37.3 vs. 42.7; 0.62	35.2 vs. 29.6; 0.48	38.8 vs. 30.3; 0.34
Mendoza	39.8 vs. 29.6; 0.28	41.4 vs. 30.7; 0.24	37.1 vs. 24.6; 0.11	39.9 vs. 26.6; 0.09
Misiones	36.9 vs. 22.9; 0.04*	36.6 vs. 28.6; 0.25*	34.3 vs. 25.5; 0.18	37.6 vs. 26.6; 0.06
Neuquen	30.4 vs. 31.0; 0.95**	32.3 vs. 28.8; 0.70**	50.1 vs. 22.6; < 0.001	52.7 vs. 24.4; 0.001
Rio Negro	44.8 vs. 33.0; 0.10*	47.0 vs. 32.6; 0.04*	37.2 vs. 31.2; 0.23	39.0 vs. 31.2; 0.17
Salta	30.3 vs. 28.7; 0.83	35.1 vs. 25.4; 0.12	35.0 vs. 26.8; 0.20*	41.9 vs. 26.0; 0.01*
San Juan	35.3 vs. 36.7; 0.89**	39.3 vs. 33.0; 0.52**	46.2 vs. 31.0; 0.08*	51.4 vs. 30.5; 0.01*
San Luis	26.3 vs. 19.8; 0.36	29.0 vs. 19.9; 0.21	41.8 vs. 27.0; 0.04	49.4 vs. 29.5; 0.01
Santa Cruz	44.7 vs. 36.2; 0.44	42.1 vs. 41.0; 0.92	45.0 vs. 29.3; 0.05*	43.56 vs. 33.2; 0.22*
Santa Fe	26.7 vs. 39.1; 0.06	29.6 vs. 33.8; 0.51	42.2 vs. 28.1; 0.02	45.4 vs. 30.1; 0.01
Santiago	29.7 vs. 40.0; 0.32*	34.9 vs. 28.1; 0.46*	35.6 vs. 40.8; 0.55**	42.3 vs. 31.8; 0.19**
Tucuman	29.4 vs. 38.3; 0.29	25.6 vs. 39.0; 0.07	43.6 vs. 17.2; < 0.001	49.3 vs. 23.1; < 0.001
Tierra del Fuego	48.9 vs. 27.6; 0.10	48.8 vs. 28.2; 0.11	36.1 vs. 26.7; 0.39	44.8 vs. 25.0; 0.10

SES: socioeconomic status; BA: Buenos Aires
* Change in significance between definitions of SES
** Change in direction of relationship between SES and obesity prevalence between definitions of SES

Appendix 2 | Sensitivity analysis. Obesity association with age, SES, and region by sex and by combined and education only definition of SES

	Men		Women	
	Combined SES: Odds Ratio: (CI 95%)	**Only Education: Odds Ratio: (CI 95%)**	**Combined SES: Odds Ratio: (CI 95%)**	**Only Education: Odds Ratio: (CI 95%)**
Regression Model 1: Covariates – age, SES				
Age	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.01, 1.02)
SES	OR: 1.17 (0.97, 1.42)	OR: 0.90 (0.74, 1.08)	OR: 1.71 (1.45, 2.02)	OR: 0.57 (0.48, 0.68)
Regression Model 2: Covariates – age, SES, and region				
Age	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.02, 1.03)	OR: 1.02 (1.01, 1.02)
SES	OR: 1.17 (0.96, 1.43)	OR: 0.90 (0.74, 1.08)	OR: 1.72 (1.45, 2.03)	OR: 0.57 (0.48, 0.68)
Pampeana	OR: 0.88 (0.69, 1.13)	OR: 0.88 (0.69, 1.13)	OR: 1.05 (0.85, 1.30)	OR: 1.05 (0.85, 1.31)
Northwest	OR: 1.03 (0.79, 1.33)	OR: 1.04 (0.81, 1.35)	OR: 1.09 (0.88, 1.36)	OR: 1.15 (0.93, 1.43)
Northeast	OR: 0.85 (0.64, 1.12)	OR: 0.85 (0.65, 1.12)	OR: 0.87 (0.89, 1.11)	OR: 0.91 (0.72, 1.15)
Cuyo	OR: 1.06 (0.76, 1.48)	OR: 1.06 (0.76, 1.49)	OR: 1.12 (0.83, 1.48)	OR: 1.12 (0.84, 1.50)
Patagonia	OR: 1.23 (0.94, 1.60)	OR: 1.22 (0.94, 1.60)	OR: 1.29 (1.02, 1.62)*	OR: 1.24 (0.99, 1.56)*

SES: Socioeconomic Status; OR: odds ratio; CI: confidence interval
* Change in significance between definitions of SES