


ORIGINAL ARTICLE

Double burden of malnutrition in 115 Latin American cities: An ecological analysis

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Funding information

Wellcome Trust

Abstract

Background: Using harmonized aggregated data on health and socioeconomic environments in Latin American cities (from the Salud Urbana en América Latina (SALURBAL) study), we assessed the association of city-level contextual factors with the prevalence of the double burden of malnutrition (DBM) in urban settings.

Methods: This ecological study used aggregated survey data from 115 Latin American cities within five countries (Colombia, El Salvador, Guatemala, Mexico and Peru) collected between 2008 and 2016. DBM was defined as the coexistence of stunting in children under 5 years and overweight/obesity among adult women at the city-level. We ran ordinal logistic regression models to examine macrolevel contextual factors that might explain the city-level DBM. Independent variables were city-level socioeconomic development index, women educational attainment and women labor force.

Results: Out of 115 Latin American cities, 19 cities from five countries were experiencing a moderate to high burden of stunting and simultaneously a very high burden of overweight/obesity in adult women. All cities had overweight/obesity prevalence above 40%. A poor social environment, higher levels of women education and greater women labor force at the city level were associated with greater levels of DBM.

Conclusion: Some Latin American cities are still facing moderate and high DBM, while all cities are experiencing an alarming high burden of overweight/obesity. Social macro-level factors such as poor social environment, high women education and high women labor force were associated with the coexistence of stunting in children and overweight/obesity in adult women.

KEYWORDS

double burden, malnutrition, obesity, overweight, socioeconomic factors, stunting

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INTRODUCTION

The Latin American region is facing a rapid increase in the prevalence of overweight/obesity among adults and children, while, simultaneously some countries have not yet reduced stunting and micronutrient deficiencies.¹ This coexistence of undernutrition alongside overweight or obesity is well known as the double burden of malnutrition (DBM).² The DBM can occur at country, city, community, household and individual level.² DBM is driven by increased economic development and the concurrent nutrition transition characterized by changes in dietary and physical activity patterns derived from exposure to obesogenic environments.^{2–4} In addition, ongoing migration from rural to urban areas, and inadequate access to health care services as a result of poverty, and broader social determinants have also contributed to DBM at city-level.^{2,3} For decades, most Latin American countries were focused on addressing undernutrition leaving aside interventions for other forms of malnutrition. This, among other factors, explains the coexistence of a high burden of undernutrition and overweight/obesity at all different levels (individual, household, city and national).^{1,5} All this poses a significant challenge to cities committed to the New Urban Agenda which was adopted at the United Nations Conference on Housing and Sustainable Urban Development in 2016, this agenda aims to be a universal framework of actions for housing and sustainable urban development,⁶ and to countries' commitment to the wider Sustainable Development Goals agenda.⁷

Some factors that define the quality of urban life results in greater vulnerability among the urban poor.⁸ These include a greater reliance on cash income for food and nonfood purchases, limited access to urban agriculture, greater women labor force, greater availability of services but larger inequalities in access, reliance on energy-dense foods, poor access to water and exposure to obesogenic environments.^{8–10} Therefore, urban settings are home to a large number of populations at risk of DBM, particularly women and young children.¹⁰ For example, a study of 47 developing countries found that the urban poor had higher rates of stunting and mortality than their rural counterparts.¹¹

The prevalence of DBM at the household level (households with children with stunting and a mother with excess weight) in Latin American countries ranges from 20% in Guatemala to 13% in Ecuador, 8% in Mexico, 6% in Uruguay, 5% in Colombia and 3% in Brazil.¹² However, national averages can mask patterns of disparities in terms of nutritional indicators within countries. There are calls for city estimates to inform appropriate interventions and policies at the subnational level.¹³ In addition, there is a recent focus on identifying macrolevel contextual factors of DBM (e.g., environmental and societal fragility, internal conflict, political factors, lack of democracy, food insecurity, socioeconomic factors)^{13–16} and to design and implement integrated interventions to address simultaneously undernutrition and excess weight (double-duty actions) as most interventions have not been designed to address potential tradeoffs between child undernutrition and maternal overnutrition.¹⁷ This approach is crucial because without

consideration of the macro-level context, interventions and programs to address DBM may fail or underperform.^{14,18} There is a lack of evidence on how social environment and gender-related factors, such as women education and women labor force at city-level, shape DBM. Therefore, our objective was to estimate the DBM at city-level in Latin American cities and to examine whether city-level contextual factors such as social environment, women educational attainment and women labor force are associated with city-level prevalence of the DBM.

METHODS

Study setting

This study was conducted as a part of the SALURBAL (Salud Urbana en América Latina) research project.¹⁹ SALURBAL has compiled and harmonized health, social and physical environment data on all cities with a population above 100 000 ($n = 371$ cities) in 11 Latin-American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, El Salvador, Guatemala, Mexico, Nicaragua, Panama and Peru).²⁰ For this study, we used data from cities with anthropometric information in surveys; 115 cities in five countries [Colombia ($n = 27$), El Salvador ($n = 3$), Guatemala ($n = 1$), Mexico ($n = 65$) and Peru ($n = 19$)] collected between 2008 and 2016.

Health survey data

For Colombia (2015), El Salvador (2008), Guatemala (2015), Mexico (2012) and Peru (2016) we used data from nationally representative cross-sectional health surveys (detailed information for each survey is provided in Supporting Information S1: Table 1). For this analysis, we used aggregated data for children under-five and nonpregnant women 18–49 years. For both women and children, weight and height were objectively measured in all surveys following standard procedures. Among children, the cutoff for stunting was based on the WHO child growth standards²¹ (a height-for age Z-score ≤ -2). Height-for-age z-scores of < -6 or > 6 were considered biologically implausible and were excluded. Among women, we calculated body mass index (BMI) as weight in kilograms divided by height in square meters. We defined overweight/obesity in adult women as BMI ≥ 25 kg/m², according to the WHO recommendation.²² We used these anthropometric data to estimate city-level prevalence for stunting in children under 5 years, overweight/obesity in adult women, and DBM (coexistence of stunting in children under 5 years and overweight/obesity in adult women).

Outcome variable at city-level

Double burden of malnutrition: DBM at city-level was defined as the coexistence of stunting in children under 5 years and overweight/obesity in adult women. The

TABLE 1 Categories of double burden of malnutrition based on cross-classification of prevalence of stunting in children and overweight/obesity in adults.

Overweight/obesity prevalence in adults	Stunting prevalence in children under five years			
	≥30%	20%–29%	10%–19%	<10%
≥40%	Very high	High	Moderate	Low
30%–39%	High	High	Moderate	Low
20%–29%	Moderate	Moderate	Moderate	Low
<20%	Low	Low	Low	Low

prevalence thresholds that were used to determine whether a city is experiencing DBM were based on those recently proposed by Shekar and Popkin²³ (see Table 1). These cutoffs are based on those based using the WHO Multi-centre Growth Reference Study for children²⁴ and those proposed on the Lancet series of DBM for overweight/obesity in adults (see Table 1).²

We also classified cities as with low (<10%), moderate (10%–19%), high (20%–29%) or very high (≥30%) burden of stunting²⁴ and as with low (<20%), moderate (20%–29%), high (30%–39%) and very high (≥40%) burden of obesity.²

Exposure variables at city-level

Socioeconomic development index

Available census data were compiled from each country/city that matched the survey year as closely as possible (See Supporting Information S1: Table 1). Three variables were selected to represent city-level socioeconomic development: 1. Water access (% households with access to piped water), 2. Sanitation (% households with access to a municipal sewage network), and 3. Overcrowding (% households with more than three people per room). We created a city-level socioeconomic development index to proxy economic development by summing the standardized Z-scores of the three variables (after reversing overcrowding) and divided by three (assuming equal weighting of all variables). Then, for descriptive analysis, this index was categorized in tertiles to represent low, middle, and high socioeconomic development at city-level.

Women educational attainment

It was defined as the proportion of women population aged 25 years or older who completed secondary education or above. Data were obtained from national census data based on educational attainment and was harmonized across cities and countries. Completed secondary education was considered to be attained at 12 years of education. We

standardize it to a mean of zero and standard deviation (SD) of one. Then, for descriptive analysis, it was categorized in tertiles to represent low, middle, and high women educational attainment at city-level.

Women labor force

It was defined as the proportion of total labor force who are female among the population 15 years of age or above. While each country has different age thresholds at which minimum working age is defined, a uniform definition threshold of ≥15 years was selected. Data were obtained from national census data and harmonized across cities and countries. We standardize it to a mean of zero and SD of one. Then, for descriptive analysis, it was categorized in tertiles to represent low, middle, and high women labor force at city-level.

Statistical analysis

First, we estimated city-level standardized prevalence and 95% confidence intervals (CI) for stunting in children under 5 years and overweight/obesity in adult women. Prevalence was standardized using as reference the population structure of all SALURBAL cities combined. This standardization partially accounts for potential survey nonresponse or oversampling probabilities (enhancing representativeness compared to raw prevalence rates), and adjusts for potential confounding due to differences in population structure across cities (see Supporting Information Material). Descriptive plots depicting standardized prevalence of stunting and overweight/obesity were constructed. Second, based on the standardized prevalence rates for stunting and overweight/obesity, we classified cities as experiencing or not DBM. We examined categories of DBM by tertiles of socioeconomic development index, women education attainment and women labor force.

Finally, since DBM (outcome variable) is an ordinal variable (low, moderate, high and very high) we ran ordinal logistic regression models to identify the main contextual predictors of the city-level DBM. We used ordinal logistic regression because this method allows us to model the probability of a city's DBM level moving from one category to another (i.e., from low to moderate or from moderate to high), considering the ordered nature of the outcome variable. Independent variables were city-level socioeconomic development index, women educational attainment, and women labor force (continuous variables) and were modeled separately to estimate the univariable association of city-level predictors with DBM. When modeling city-level socioeconomic development index as exposure, we adjusted for country to account for any unmeasured factors and differences across countries.¹⁸ When modeling women education attainment, we adjusted for social environment and country, and when modeling

women labor force as exposure, we adjusted for women educational attainment, social environment, and country. These adjustments were made to determine associations independently from other city-level characteristics. We tested the proportional odds assumption of the ordinal regression models to make sure that the same increase/decrease is found between categories of the outcome variable.

To run these models, we linked the survey data with the census data. All analyses were conducted in Stata version 16.0 using the ologit command.

RESULTS

Of the 115 Latin American cities analyzed, the prevalence of stunting and overweight/obesity was significantly high. The number of cities facing a moderate burden of stunting (between 10% and 19%) in children under 5 years was 14 (12.2%). These cities were primarily located in Colombia, Mexico, Peru and El Salvador. The number of cities experiencing a high burden (between 20% and 29%) of stunting were 5 (4.3%). A high burden of stunting was observed exclusively in cities from Guatemala and Peru. Regarding overweight/obesity in adult women, all 115 cities from five countries (100%) were facing a very high burden ($\geq 40\%$), highlighting a widespread public health problem across the region (see Figure 1).

Regarding social contextual variables, cities from Colombia and Mexico have the highest scores for city-level socioeconomic development, followed by Peru, Guatemala, and El Salvador (see Supporting Information S1: Figure 1). While, cities from Peru and Colombia have the highest adult female population who completed secondary education (see Supporting Information S1: Figure 2) It is important to highlight that

all cities from five countries have similar scores for women labor participation (see Supporting Information S1: Figure 3).

DBM at the city-level was low in 96 cities (83.5%), moderate in 14 cities (12.2%) and high in 5 (4.3%) cities (see Figure 2A). Cities from El Salvador, Colombia, Mexico and Peru were experiencing a moderate DBM and cities from Guatemala and Peru were experiencing a high DBM (see Figure 2B and Supporting Information S1: Table 2).

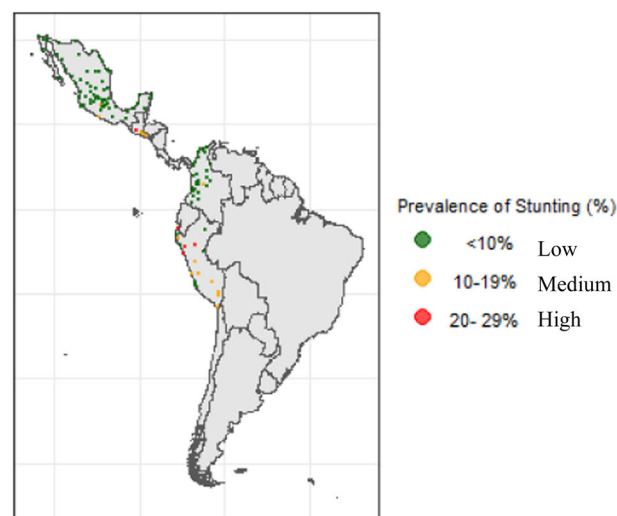
When examining DBM at city-level by socioeconomic development, we found that cities with moderate and high DBM are predominantly within the lowest tertiles of the socioeconomic development index. By contrast, DBM at city-level is higher in the higher tertiles of women educational attainment and women labor force (see Figure 3).

The association between DBM at city-level and city-level contextual variables is shown in Table 2. Our first observation is that further adjustment for confounders strengthened the association for two of the contextual variables, almost quadrupling in the case of women labor force, and attenuated the association with women educational attainment.

In the adjusted analyses, although not significant, we found that for 1 SD increment in city-level socioeconomic development, the odds of moving to a more severe level (i.e., low to moderate or moderate to high) of the DBM decreased by 17%. This indicates a potential protective consequence of higher socioeconomic development against worsening DBM levels.

Conversely, for 1 SD increase in women educational attainment, the odds of moving to a more severe level of DBM increased by 1.69 times (95% CI: 1.11, 2.57). Similarly, for a 1 SD increase in women's labor force participation, the odds increased by 3.86 times (95% CI: 1.19, 12.49). These results suggest that higher women's educational attainment and labor force participation are associated with a greater

Stunting in children under five years



Overweight/obesity in adult women

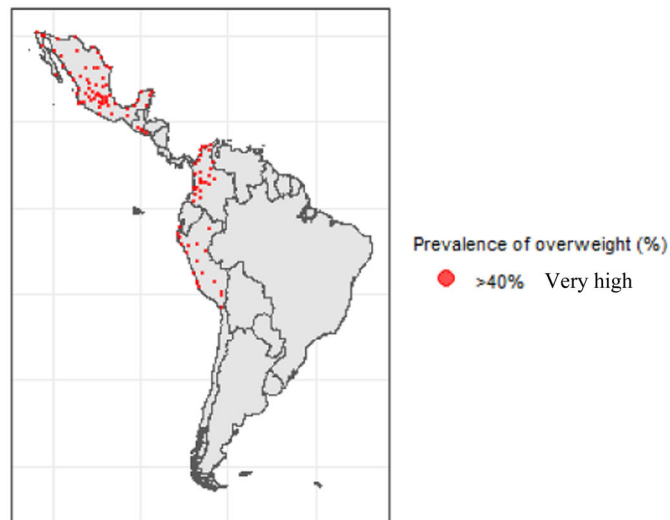


FIGURE 1 Prevalence of stunting in children under five and overweight/obesity in adult women in 115 Latin American cities (2008–2016). Stunting in children under 5 years. Overweight/obesity in adult women. Each point represents one city within a country.

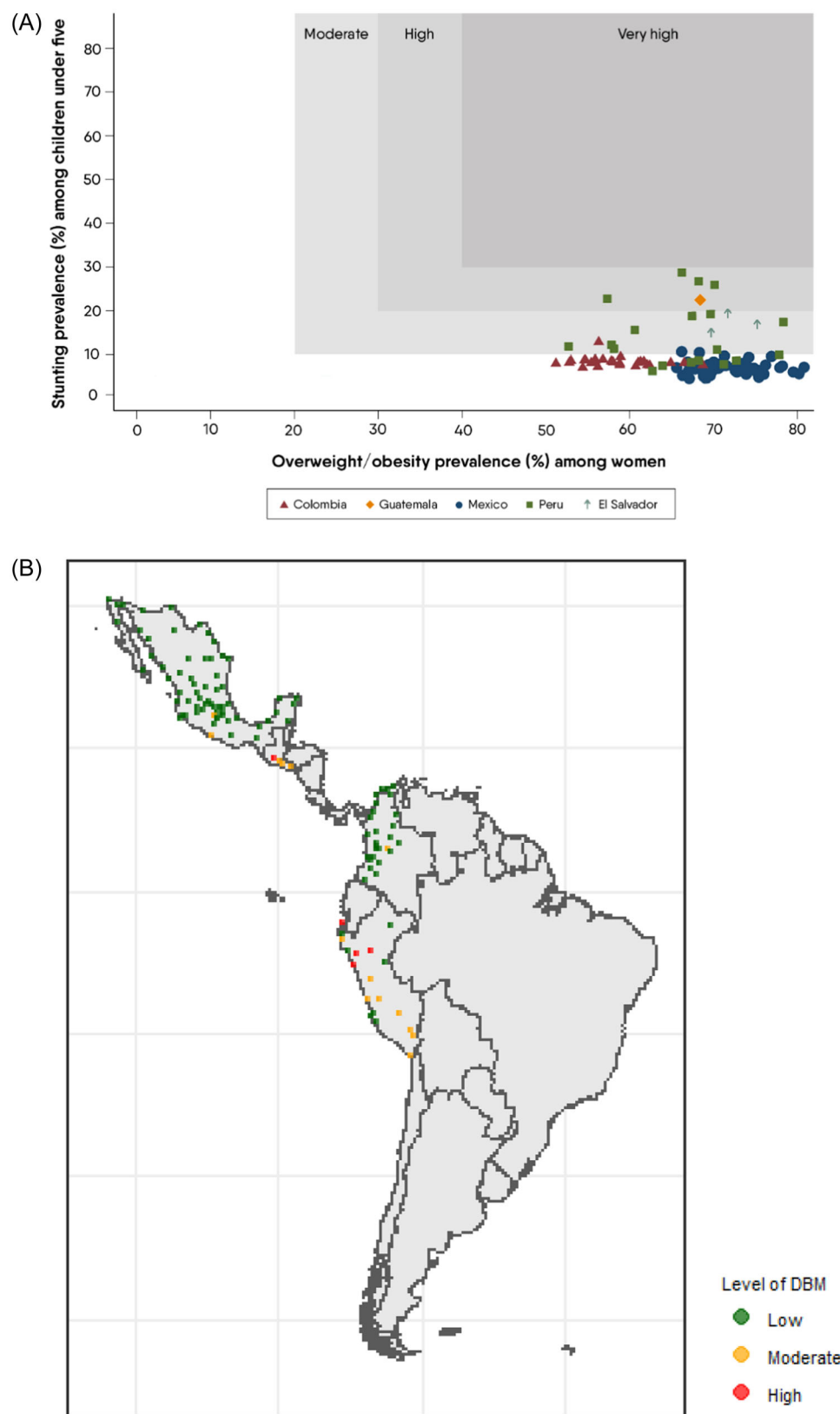


FIGURE 2 (A–B) City-level double burden of malnutrition in 115 Latin American cities (2008–2016).

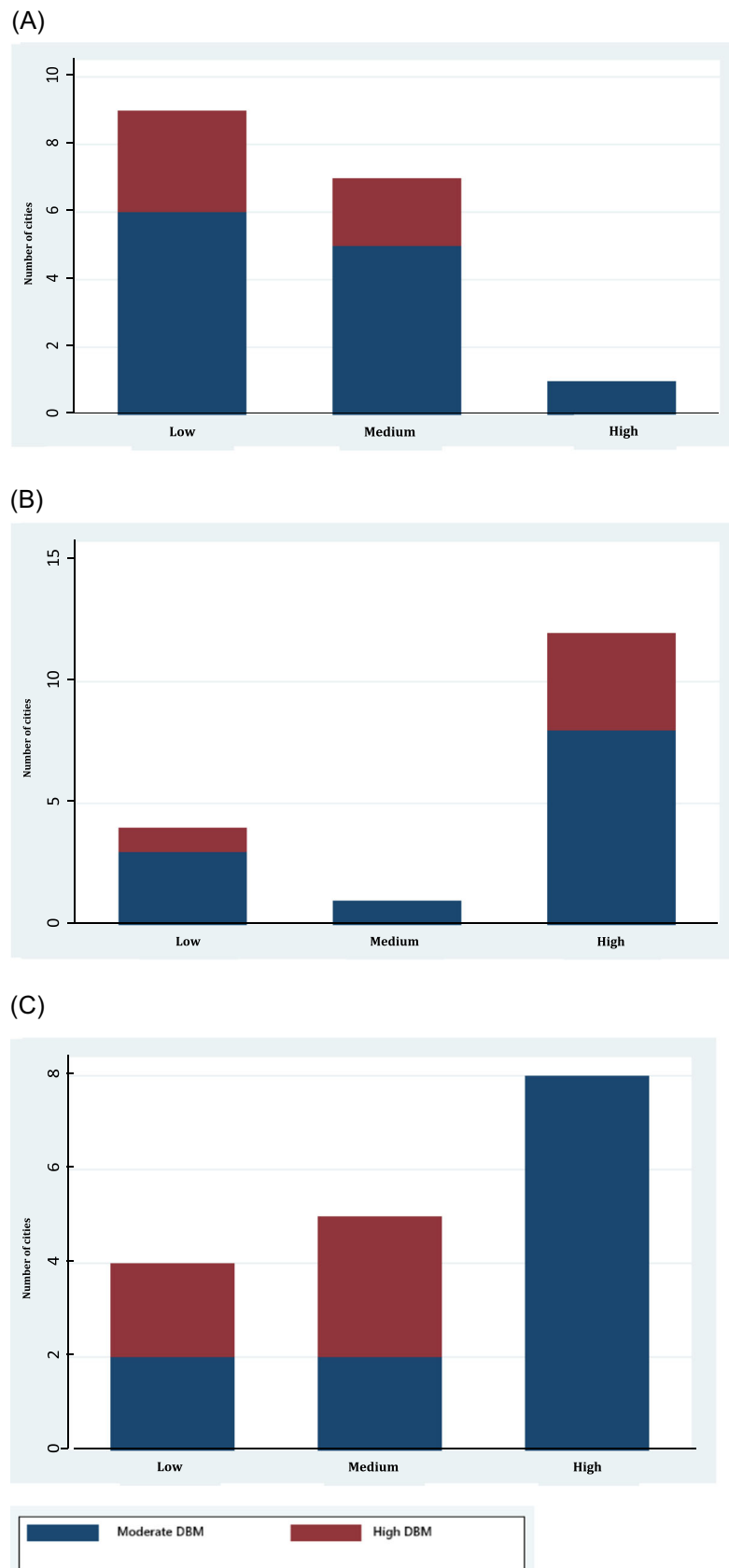


FIGURE 3 Number of cities with moderate or high double burden of malnutrition by city-level socioeconomic development index, women educational attainment and women labor force (2008–2016). (A) Socioeconomic development index. (B) Women educational attainment. (C) Women labor force.

TABLE 2 Proportional odds ratios and (95% CI) for double burden of malnutrition at city-level according to city-level socioeconomic development index, women educational attainment and women labor force ($n = 115$ cities).

	Double burden of malnutrition	
	Unadjusted	Adjusted
Socioeconomic development index	0.69 (0.55, 0.85)	0.83 (0.65, 1.06)
Women educational attainment	2.19 (1.46, 3.29)	1.69 (1.11, 2.57)
Women labor force	1.17 (0.33, 2.01)	3.86 (1.19, 12.49)

Note: The probability to move to a severe level of DBM (i.e., low to moderate or moderate to high) is the same between categories because of the proportional odds assumption. This means that the effect of an independent variable is constant for each increase in the level of the response.

likelihood of a city experiencing more severe levels of DBM (see Table 2).

DISCUSSION

Using aggregated data from 115 Latin American cities, we found that 19 cities from five countries were experiencing a moderate to high burden of stunting in children under 5 years and simultaneously a very high burden of overweight/obesity in adult women at the city-level. Cities with moderate DBM were located in El Salvador, Colombia, Mexico and Peru while cities with high city-level DBM were located in Guatemala and Peru. A poor social environment, higher levels of women education and women labor force at the city level were associated with greater probability of moving across levels of DBM.

In our analysis, a higher proportion of cities facing a moderate and high DBM were cities with low socioeconomic development. This result reflects increasing overweight/obesity among less developed cities that have not reduced stunting yet. Our results are consistent with an analysis carried out in Brazilian municipalities, that found that the DBM was lower in municipalities with lower household overcrowding, a marker for socioeconomic development.¹⁶ Reduced adequate housing and sufficient living space are considerable obstacles to buying food in bulk and at lower cost.⁹ In addition, our results are consistent with another study from low-and middle-income countries (LMIC) that reported estimates of the DBM at national level (high burden of stunting in children and overweight/obesity in adult women).² This study showed that, in the last decades, DBM increased in the poorest LMIC.² Poor household conditions including poor access to water, poor diet quality, and exposure to obesogenic food environments are some of the key factors related to DBM in poor urban settings.^{2,11,25} In addition, Guatemala and Peru, both countries with high indigenous population, are facing ethnic inequities in malnutrition in all its forms.^{5,26} Ethnicity has been associated with poverty and inadequate access to education and health. Also, to

long-term vulnerability to obesity.²⁷ These among other factors, could explain the great prevalence of high DBM in these countries.

In contrast, a higher proportion of women education and women labor force at city-level were associated with a higher chance to move to a severe level of DBM. Women with complete secondary education and greater labor participation may face time management issues due to lack of childcare support and because roles and responsibilities around food are heavily gendered contributing to an increment of their work burden.^{8,28} As a consequence urban households may rely more on ultra-processed food products, eat out or increase consumption of street foods, which can be a cheap source of energy and a time saver.^{8,16,29–31} Women's participation in the labor force along with access to modern technology have shifted the demand for convenience foods and also sharply decreased the time women spend on food preparation and cooking.³⁰ In addition, urban women could have less active recreational activities, and poor management care for themselves and their young children. All these factors are related to the nutrition transition that Latin American countries are facing.^{1,32}

Furthermore, women in the labor force (formal and informal sector) are faced with misaligned health policies and public health messaging. For example, in many countries maternity leave is shorter (12–14 weeks) than the World Health Organization's recommendation of exclusive breastfeeding for 6 months.³³ Return to work has been identified as a key factor that contributes to breastfeeding cessation³⁴ and breastfeeding has the potential to address malnutrition in children and reduce the risk of becoming overweight in parous women.^{17,35} Furthermore, women face incompatible schedules between full-time working hours and daycare opening hours.^{28,36} Women have traditionally taken the responsibility for childrearing and housework therefore carrying out the bulk of the unpaid work. It is now increasingly recognized that women's disproportionate contribution to unpaid care activities puts real constraints on the time available for other activities. Budlender³⁷ Food system transformation and public health messaging on fresh food preparation and healthy diets may be at odds with women's realities.

In Latin America, women's participation in the labor force has increased during the last decades.^{38,39} It is an important driver of development and economic growth and some infant health outcomes such as lower infant mortality rates in Latin American cities.^{40,41} However, evidence regarding the impact of maternal work on childcare and feeding practices is inconclusive. Breastfeeding duration and the timing of introduction of complementary foods are generally poorer in urban areas where women's labor force participation is higher.^{8,42} Based on our results, it will be crucial to implement interventions to prevent negative nutritional consequences for women and their children. Some examples to address this are social programs focused on extending hours in federal elementary schools in Mexico and extending childcare hours in Colombia and Chile.^{36,43} Increasing policy attention to

childcare services can provide opportunities for promoting not only children's and women's social and economic rights but their nutritional status.

Our results advocate for policies that (1) improve the city-level social and food environments in which children develop and grow, (2) support environments and caregivers to optimize caregiving practices including extension of maternity and paternity leave, extending hours in schools, provision of free childcare facilities and promotion of healthy school food environments and (3) support inter-sectoral policies to provide work stability and more flexible working hours. In so doing, we expect to reduce the social vulnerability of women and young children and support women in their home, work and community environments and avoid victim blaming to an already overstretched population group. In addition, we showed that all cities had a very high burden of overweight/obesity (prevalence $\geq 40\%$) in adult women showing that we should consider to reevaluate overweight/obesity prevalence thresholds. Also, we should advocate for policies that take into account malnutrition as a whole and avoid dichotomy of undernutrition versus overweight, especially for the most vulnerable population.

Our study had strengths and limitations. The strengths of the study include the use of harmonized data on 115 cities in five countries. Furthermore, using the socio-economic development index for cities allowed for the assessment of social development in addition to only economic development of Latin American cities.⁴⁴ Our study provides novel important information on the dynamics of DBM and build on our understanding on how macrolevel contextual factors shape DBM. However, surveys and census differ by country and number of cities differs hence the association between DBM and contextual factors may not reflect the current dynamic of DBM in urban settings. We attempted to address this by adding a country variable in models. Another limitation is the lack of data of peri-urban and slums settings and city-level measurements may mask dynamics within the cities which are worth exploring in future research. Finally, although we showed that women's labor force participation was positively associated with DBM, we were not able to distinguish between women working either in the formal or informal sector. In Latin America nearly half of workers in the informal sector are women.⁴⁵ Mothers who work in the informal sector do not enjoy minimum wages, maternity leave or social security.³³ Therefore, they are at risk of household economic, health and nutritional shocks.³³ However, this analysis makes comparable estimates of DBM prevalence at the city-level available, this will allow policy-makers to have data of DBM in urban settings and prioritize interventions to address it. In addition, our analyses assessed city-level determinants of the city-level DBM recognizing that stunting and obesity have common drivers and did not analyze stunting and excess weight by separate. Our ecological study may help to adopt integrated interventions to address DBM and not siloed interventions for stunting or excess weight.

In conclusion, some Latin American cities are still facing moderate and high double burden of malnutrition, while all cities in our study are experiencing an alarming high burden of overweight/obesity. Social macro-level factors such as poor social environment, higher levels of women education and women labor force are associated with the coexistence of stunting in children and overweight/obesity in adult women. Therefore, there is an urgent call to improve social policies and transform traditional patterns of childcare to address the double burden of malnutrition.

AUTHOR CONTRIBUTIONS

The authors' responsibilities were as follows: Mónica Mazariegos, Brisa N. Sánchez and Carolina Pérez-Ferrer conceived and designed the study; Mónica Mazariegos conducted the statistical analysis; Mónica Mazariegos drafted the first draft of the original manuscript. All authors (Mónica Mazariegos, Brisa N. Sánchez, Ana Ortigoza, Kari Moore, María F. Kroker-Lobos, Manuel Ramírez-Zea, Olga L. Sarmiento, J. Jaime Miranda, Carolina Pérez-Ferrer) contributed to the interpretation of data discussed in the manuscript, revised the manuscript and approved its final version. Mónica Mazariegos, Kari Moore and Carolina Pérez-Ferrer had access to and verified the data.

ACKNOWLEDGEMENTS

The authors acknowledge the contribution of all SALURBAL project team members. For more information on SALURBAL and to see a full list of investigators see <https://drexel.edu/lac/salurbal/team/>.

SALURBAL acknowledges the contributions of many different agencies in generating, processing, facilitating access to data or assisting with other aspects of the project. Please visit <https://drexel.edu/lac/data-evidence> for a complete list of data sources. This work was supported by the Salud Urbana en América Latina (SALURBAL) project (Urban Health in Latin America), funded by Wellcome [205177/Z/16/Z]. More information about the project can be found at www.lacurbanhealth.org. The funding sources had no role in the analysis, writing or decision to submit the manuscript.

CONFLICT OF INTEREST STATEMENT

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The SALURBAL project welcomes queries from anyone interested in learning more about its data set and potential access to data. To learn more about SALURBAL's data set, visit <https://drexel.edu/lac/> or contact the project at salurbal@drexel.edu.

ETHICS STATEMENT

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Drexel University Institutional Review Board with ID #1612005035 and by appropriate site-specific IRBs.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Mazariegos M, Sánchez BN, Ortigoza A, et al. Double burden of malnutrition in 115 Latin American cities: an ecological analysis. *Reprod Female Child Health*. 2024;3:e103. doi:10.1002/rfc2.103