J Urban Health (2023) 100:63–75
https://doi.org/10.1007/s11524-022-00683-x

Decomposing the Intraurban Malnutrition Gap Between Poor and Non-poor Children in Colombia

Decomposing the Intraurban Malnutrition Gap Between Poor and Non-poor Children in Colombia

Gustavo Romero · Ernesto Cardenas · Ana María Osorio

Accepted: 11 August 2022 / Published online: 19 December 2022

Abstract In Colombia, although it can be said that, on average children living in urban areas have better quality of life than their rural peers, it is also true that within cities, there are high levels of socioeconomic inequality. Our objective is to identify the contribution of the factors that explain the gap in stunting and excess weight between poor and non-poor children under 5 years of age in urban areas of Colombia. We use data from the 2015 National Nutritional Status Survey, and two nonlinear decomposition techniques based on the classical decomposition method developed by Blinder-Oaxaca. With a sample of 6877 observations, the results show that the intraurban gap of stunting between poor and non-poor children in urban areas is 4.8 percentage points. Its main determinants are the mother's educational level (46.5%), affiliation to the health system by the mother (19.4%), and assisted delivery in a medical institution (16.6%). For excess weight, the gap is − 2.1 percentage points, and its main determinants are the mother's educational level (39.2%) and birth attended by a physician (21.8%). This study suggests the coexistence of a double burden of malnutrition (DBM) in children under 5 years of age living in urban areas of Colombia. Stunting is associated with low-income levels while excess weight is associated with higher income levels. The identification of the main determinants of DBM and its relative importance, constitutes a contribution for public policy makers aimed at reducing socioeconomic gaps.

Keywords Child malnutrition · Stunting · Excess weight · Intraurban gap · Poor · Non-poor · Colombia

G. Romero
International Doctorate School of the University of Murcia (EIDUM), PhD Program in Economics (DEcIDE), Murcia, Spain

E. Cardenas (✉)
School of Economics, Sergio Arboleda University, Bogotá, Colombia
e-mail: ernestocardenasprieto@gmail.com

A. M. Osorio
Pontificia Universidad Javeriana, Cali, Colombia

Introduction

On average, in Latin America, children living in urban areas have better levels of quality of life than their rural peers. However, within cities, there are high levels of socioeconomic inequality [1]. In fact, quality of life indicators for children living in urban areas are far from equitable in Latin America [2]. In Colombia, intraurban inequality has increased as a consequence of internal migration processes due to violence in rural areas [3], international migration [1, 4], and the impact of the COVID-19 health crisis that has unequally affected the poorest [5].

In this manuscript, we focus on intraurban child malnutrition inequalities. Malnutrition issues include obesity and stunting and are of great concern due to their impact on health and economic outcomes. In terms of health, stunted children have a higher probability of dying during their first 5 years of life, and they are more prone to get sick and perform worse at school [6, 7]. In addition, stunting generates difficulties in cognitive and motor development throughout life, reflecting lower productivity and lower contribution to the growth of the economy [8, 9]. Similarly, excess weight represents a problem from the first 5 years of life, leading in many cases to stigmatization and depression, and to overweight in the rest of a child's life. It can also have very serious repercussions on health such as coronary heart disease, type 2 diabetes, hypertension, high levels of total cholesterol or triglycerides, stroke, sleep apnea and respiratory problems, liver and gallbladder disease, osteoarthritis, and gynecological problems [10, 11]. The global economic impact of excess weight is estimated to be approximately 2 trillion dollars annually, putting a strain on health care systems and budgets [12]. There is also evidence between the growth of socioeconomic disparities and the relationship with excess weight in childhood [10].

Regarding economic outcomes, children with malnutrition problems are expected to be less productive in the future, thus negatively affecting their future income levels, employment opportunities, and possibilities to escape poverty [13]. Indicators such as stunting (low height-for-age) and excess weight (overweight and obesity) have been used to assess present and future well-being conditions in childhood because of the serious consequences they can have on such outcomes [10, 12]. Additionally, households with malnourished children see their economic conditions affected due to increased health expenditures, while for society in general the costs of the health system increase due to higher demand [13].

General Trends

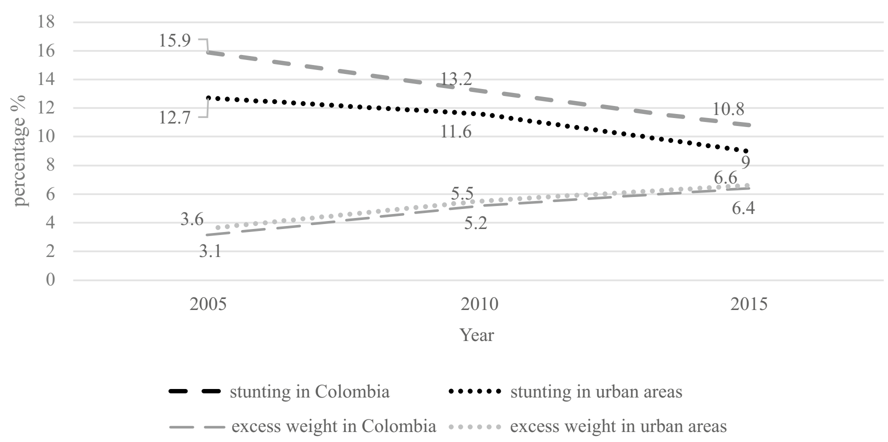
According to a UNICEF report [14], there was a decrease in stunting globally (from 29.3% in 2005 to 23.3% in 2015), and an increase in excess weight (from 5.1% in 2005 to 5.7% in 2015).

Figure 1, based on data from the National Nutritional Status Survey (ENSIN), shows that in Colombia the percentage of children under 5 years of age with stunting decreased from 15.9% (2005) to 10.8% (2015), whereas excess weight has been growing at higher rates from 3.1% (2005) to 6.4% (2015), in line with global figures.

The presence of obesity and undernutrition in the same unit of analysis (e.g., city, country, individual, household) is known as double burden of malnutrition (DBM). Currently, DBM affects most low- and middle-income countries [15, 16].

In general, socioeconomic inequalities in terms of wealth, gender, family socioeconomic status, area of origin, wealth level of children's neighborhoods, and the regions where they live are highly associated with inequalities in children's health outcomes, including child malnutrition [17]. There is evidence of sociodemographic disadvantages in the intergenerational processes of malnutrition [18] and there is an inverse association between the socioeconomic status

Fig. 1 Trends in stunting and excess weight prevalence for children under 5, Colombia 2005–2015



of parents and the nutritional status of children [19]. This demonstrates that the level of household income is a resource that can guarantee the supply of nutritional food and products that generally improve children's health. It has been pointed out that the characteristics of the area where children live affect their malnutrition status and that most of the nutritional gap between urban and rural areas, is mainly due to characteristics such as better parental education and/or better household economic situation [20]. Maternal education has been shown to have a high degree of importance in malnutrition indicators both in Colombia [6, 21, 22] and in countries such as Ethiopia [23], Bangladesh [24], Philippines [25], Peru, Kyrgyzstan, Nepal, Senegal, and Ethiopia [26].

Most studies on child malnutrition have focused on the analysis of socioeconomic gaps i.e., between poor and non-poor [27–30] and malnutrition, or between urban and rural areas [31]. However, very few analyze the existence of intraurban malnutrition gaps [20, 32]. There are no studies linking socioeconomic gaps with DBM at the urban level for Colombia. To the best of our knowledge, this study is the first to make such an analysis. The aim of this paper was to identify the relative importance of the factors that explain the gap in stunting and excess weight between poor and non-poor children under 5 years of age in urban areas of Colombia. We contribute to the literature by identifying the role of the main determinants of children's malnutrition in explaining the poor/non-poor urban malnutrition gap and its relative importance using non-linear decomposition techniques.

Methods

Data

The data used in this study were taken from the ENSIN 2015, which is the most recent available data, that were released in 2019. The survey was made up of the non-institutional civilian population that usually reside in households throughout the country. It has been conducted every 5 years since 2005 and is one of the population surveys of strategic interest for public policy. The survey is nationally representative and covers urban and rural areas: six regions, 14 sub-regions and 33 departments (first administrative division), including the Capital District (Bogotá). The survey collects information on body measurements and biological tests, according to international standards, which allows for international comparisons, and uses a multi-stage, stratified, clustered, and probabilistic sample.

In 2015, 44,202 households were interviewed in 295 municipalities. The survey included 12,910 children under 5 years of age, of which 9244 lived in urban areas. Considering the fact that questions relating to the number of prenatal checkups, place of birth, and whether birth was attended by a physician were only asked for the latest live births, the sample was reduced to 7558. The final sample corresponds to $n = 6877$ responses after excluding responses with "missing values" or "don't know/no response."

Outcome Variables

Two outcome variables related to malnutrition were used. The first variable was stunting. A child is considered to be stunted when the height-for-age Z-score is below minus two standard deviations (-2SD) from the median reference established according to the World Health Organization-WHO growth standards [33]. This anthropometric indicator is key to measure well-being in childhood to the extent that it reflects inadequate nutrient intake in the long term and is associated with poor socioeconomic conditions [6, 34]. The second indicator, excess weight, is calculated from the body mass index (BMI), which uses height and weight measurements to estimate the amount of body fat a person has. When the Z-score for BMI is above two standard deviations ($+2$SD) of the reference median, it is considered overweight [35].

Operationally, the child malnutrition outcome variables, Y_i, are binary variables that can only have two outcomes for each observation i. $Y_i = 1$ when the child suffers from malnutrition according to the definitions of the two outcome variables described above, and, $Y_i = 0$ in any other case.

Explanatory Variables

Following the conceptual framework proposed by the authors and detailed elsewhere [6, 26, 34, 36], that combine structural and intermediate determinants for child health, we have included the following variables.

Child's characteristics: sex (Boy or girl), ethnicity (Afro-Colombian, indigenous or non-ethnic), birth interval (first birth, <24 months or ≥ 24 months) and breastfeeding (Yes or no). Mother's characteristics: age at childbirth (≤ 19, 20–29 or >30), education level (No education, primary, secondary, or higher), number of prenatal checkups attended (≤ 3 or ≥ 4), BMI (≤ 18.5, 18.5–25, ≥ 25), health system affiliation (contributor, subsidized or unaffiliated), delivery attended by a health professional (Yes or no), and delivery in a health institution (Yes or no). Household's characteristics: region (Atlántico, Oriental, Orinoquía, Central, Pacífico or Bogotá) and wealth index (categorized by quintiles). The bottom two quintiles of the wealth index are identified as "poor" and the others as "non-poor." This classification is consistent with previous studies [29, 32].

Statistical Analysis

First, for the intraurban gap analysis, we quantified the socioeconomic inequality for each child nutritional status indicator and calculated a concentration index (CI) using the concentration curve. The concentration curve was used to visualize whether it was above or below the equality line and to attribute a greater number of poor or non-poor people to the malnutrition indicator. In constructing the curve, the "Y" axis determined the cumulative percentage of children in a state of malnutrition, and the "X" axis the percentage of children classified according to household wealth status, starting with the poorest quintile. The CI is positive when the concentration curve is below the diagonal, and negative when it is above the diagonal [37, 38].

In addition, considering that our outcome variables were dichotomous, we used the Yun and Fairlie's decomposition techniques [39, 40] which are based on the Oaxaca and Blinder's seminal works [41, 42].

Yun's non-linear decomposition allows us to explain the difference in the probability of being stunted or excess weighted between our two groups of interest, i.e., poor, and non-poor, as the sum of two independent effects: characteristics and coefficients. The characteristics effect measures the portion of the gap that is explained by existing differences in the socioeconomic characteristics between the two groups. The coefficients effect measures the part of the gap that can be attributed to structural, unobservable differences. This technique also allowed us to identify the individual contributions of each characteristic to explain the difference in outcomes through the detailed decomposition [39].

Similarly, Fairlie's decomposition technique estimates the characteristics (explained) and coefficients (not explained) effects, and detailed decomposition. This technique has been widely used in the literature, exploring the possible causes of racial and gender differences in many economic studies, and provides similar results to the original applications of the Blinder-Oaxaca technique [40].

These two techniques address (in different ways) the so-called path dependency problem for non-linear decompositions, in which the relative contribution of each characteristic in the detailed decomposition is sensitive to the order of replacement of values from one group into the other [40]. We calculated the characteristics and coefficients effects, and the detailed decomposition using the two decomposition techniques to check the robustness of our results.

Data analysis was conducted using Stata v14. To calculate the Yun decomposition with the explained and unexplained components, we used the *oaxaca* command with the *logit* option. For the Fairlie decomposition we used the *fairlie* command. To calculate the CI and plot the concentration curve we used the command *conindex*.

Results

Descriptive Statistics

The prevalence of stunting in urban Colombian children was 8.6%, and the excess weight was 6.4%. Table 1 shows the malnutrition indicators between urban poor and non-poor children. Poor children had a higher prevalence of stunting (11.4%) than non-poor children (7.8%), but they had a lower prevalence of being overweight (4.9%) than non-poor children (6.8%). Additionally, Table 1 shows descriptive statistics for the explanatory variables for poor and non-poor children. There were notable intraurban differences between poor and non-poor children. Regarding ethnicity, there are more Afro-Colombian and Indigenous children in the poor group. With regards to children who had no siblings at birth, we found a difference of 10.4 percentage points (pp)

Table 1 Sample characteristics by poor and non-poor children under 5 years of age in urban areas, Colombia 2015

Variables	% total	% poor	% non poor	Difference	Pearson chi^2 (p)
Stunting	8.6	11.4	7.8	3.5	0.001***
Excess weight	6.4	4.9	6.8	− 1.9	0.001***
Children's characteristics					
Sex					0.178
Boy	51.1	49.3	51.7	− 2.4	
Girl	48.8	50.7	48.3	2.4	
Ethnicity					0.001***
Afro-Colombian	8.7	16.8	6.3	10.5	
Indigenous	1.9	5.7	0.7	5.0	
Not belonging to an ethnic group	89.4	77.5	93.0	− 15.5	
Birth interval					0.001***
First birth	48.6	40.6	51.0	− 10.4	
< 24 months	5.7	7.6	5.2	2.5	
≥ 24 months	45.7	51.8	43.8	8.0	
Currently breast-feeding					0.001***
Yes	32.0	33.3	31.6	1.7	
No	68.0	66.7	68.0	− 1.3	
Mother's characteristics					
Age when the child was born					0.001***
≤ 19	21.9	27.5	20.2	7.3	
20–29	51.7	49.0	52.5	− 3.6	
> 30	26.4	23.6	27.3	− 3.7	
Educational level					0.001***
No education	4.5	11.2	2.5	8.6	
Primary	26.0	40.4	21.7	18.7	
Secondary	60.0	46.4	64.1	− 17.7	
University	9.5	2.0	11.6	− 9.7	
Number of prenatal checkups					0.001***
3 or less	7.1	11.4	5.8	5.7	
4 or more	92.9	88.6	94.9	− 6.4	
Affiliation to health system					0.001***
Contributory regime	50.8	18.6	60.4	− 41.7	
Subsidized regime	45.4	75.7	36.3	39.4	
Not affiliated	3.8	5.7	3.3	2.4	
Birth attended by a physician					0.001***
No	3.2	5.4	2.5	2.8	
Yes	96.8	94.6	97.5	− 2.8	
Birth took place in a medical institution					0.001***
No	0.8	2.4	0.3	2.1	
Yes	99.2	97.6	99.7	− 2.1	
Body Mass Index					0.739
18.5 or less	3.2	4.4	2.9	1.5	
18.5–25	44.9	46.8	44.4	2.4	
25 or more	51.9	48.8	52.8	− 4.0	
Household's characteristics					
Region					0.001***

Table 1 (continued)

Variables	% total	% poor	% non poor	Difference	Pearson chi^2 (p)
Atlántico	23.9	44.1	17.8	26.3	
Oriental	15.7	8.1	18.1	−9.9	
Orinoquia	3.2	8.1	1.8	6.3	
Bogotá	18.7	4.4	23.0	−18.5	
Central	23.5	21.8	24.0	−2.2	
Pacífico	15.0	13.6	15.5	−1.9	

*$p<0.10$, **$p<0.05$, ***$p<0.01$

between poor (40.6%) and non-poor (51%). Mothers who were under 19 years old when the child was born presented a difference of 7.3 pp between the poor (27.5%) and the non-poor (20.2%). There was a large difference in the mother's education level between poor and non-poor children, revealing that 51.6% of the mothers of poor children, had primary school education at most, as opposed to the mothers of non-poor children, who had mostly had secondary- and/or higher-level education (75.7%). Non-poor children were mostly affiliated to a contributory health system (60.4%), in contrast to poor children with 75.7%, who were affiliated to the subsidized system. The above-normal body mass index (>25 kg/m^2) of the mothers of non-poor children (52.8%) showed a difference of 4 pp with respect to the mothers of poor children (48.8%).

Finally, it can be seen that more than 47% of children under 5 years of age living in urban areas were located in the Central and Atlántico regions, with the highest concentration of poor children being in the Atlántico region (44.1%). The highest concentration of non-poor children were located mainly in the Central region of the country (24%) and the capital city Bogotá (23%).

Figure 2 shows the distributions of the *Z*-scores of the anthropometric indicators by level of wealth. With reference to stunting, the poor showed a greater deviation to the left of the mean. However, in the case of the excess weight indicator, the distributions deviated to the right of the mean, with a slight difference between the non-poor and the poor. The *Z*-scores for the malnutrition indicators intuitively describe the double burden of malnutrition, since there was evidence of greater malnutrition in the poor and at the same time, greater excess weight in the non-poor.

Index and Concentration Curve

The concentration index for stunting was −0.19, with a SD of 0.02. The negative value indicates that there was a greater probability of stunting in poor children in relation to children with a higher level of wealth. Additionally, the concentration index for excess weight was 0.12 (SD = 0.03). The positive value represents a greater probability of excess weight for non-poor children in relation to poor children.

In Fig. 3, the concentration curves for the two malnutrition indices (consistent with the CI) show that stunting was above the equality line and excess weight was below.

Decomposition Analysis

Table 2 presents the findings of the intraurban gap between poor and non-poor using Yun's decomposition. Stunting presented a gap of 4.8 pp against the poor. Its main explanatory determinants were the mother's educational level (46.5%), affiliation to the health system (19.4%), and giving birth in a health institution (16.6%). The gap between poor and non-poor for excess weight showed a difference of −2.1 pp, 50% of which was explained by the effects of characteristics (endowments). The determinants with the highest percentage of participation were the mother's educational level (39.2%), delivery attended by a medical professional (21.8%), and affiliation to the health system (20.3%). In the coefficient effects, the mother's body mass index was the only statistically significant variable, explaining 69.3% of the gap.

In the results obtained through Fairlie's decomposition, it can be seen that the values were very

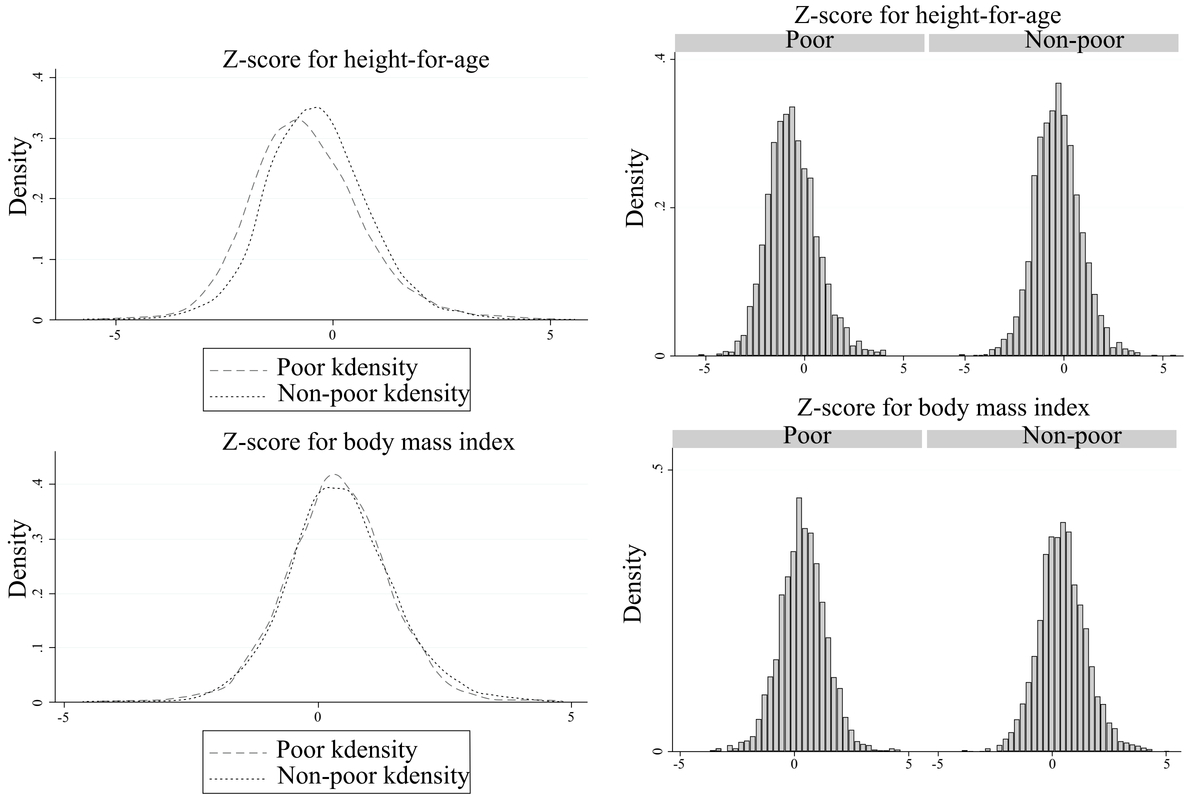


Fig. 2 Histogram and Kernel density of *Z*-scores for poor and non-poor children under 5 years of age in urban area, Colombia 2015. **a** *Z*-score for height-for-age. **b** *Z*-score for body mass index

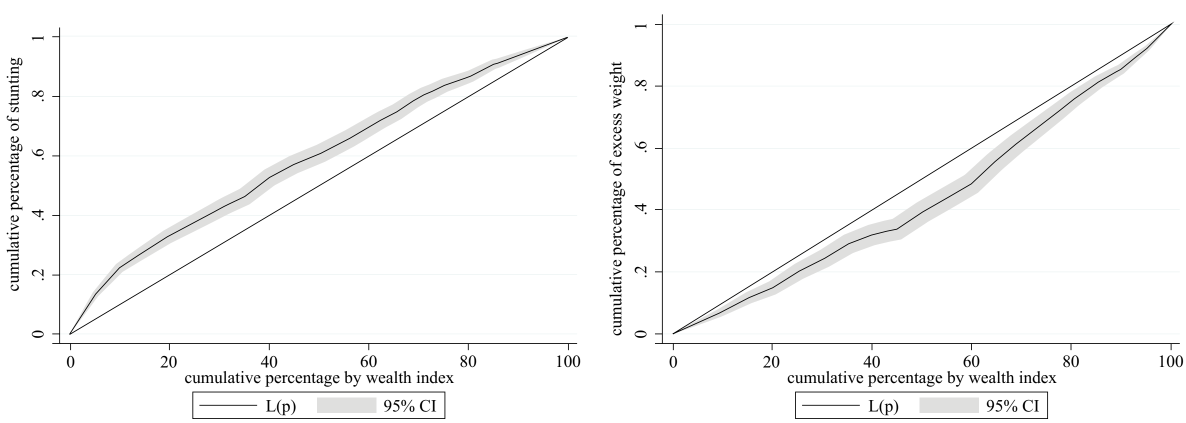


Fig. 3 Colombia 2015. Concentration curves in malnutrition indicators, for children under 5 years of age in urban areas, Colombia 2015

similar to those found by Yun's decomposition, which strengthens the results of the decomposition of the gap between poor and non-poor. For the stunting indicator, the characteristics effect explained the gap to a greater extent. Specifically, the mother's education, breastfeeding and prenatal controls were those that drove this indicator. In relation to excess weight, the variables; child's sex, mother's body mass index and birth attended by a medical professional, were shown to be statistically significant. The results for Fairlie's

Table 2 Decomposition of the poor and non-poor gap for children under 5 years old in urban areas, Colombia 2015

Stunting					Excess weight			
	Coef	$P>\|z\|$			Coef	$P>\|z\|$		
Poor	0.118	0.000***			0.053	0.000***		
Non-poor	0.070	0.000***			0.074	0.000***		
Difference	0.048	0.000***			−0.021	0.000***		
Explained (*characteristics effect*)	0.026	0.000***			−0.010	0.000***		
Unexplained (*coefficients effect*)	0.022	0.000***			−0.010	0.046**		
	Characteristics effect		Coefficients effect		Characteristics effect		Coefficients effect	
Variables	54%		46%		50%		50%	
	Coef	$P>\|z\|$	Coef	$P>\|z\|$	Coef	$P>\|z\|$	Coef	$P>\|z\|$
Sex	−0.000 (−1.2%)	0.243	−0.004	0.845	−0.000 (3.5%)	0.204	−0.000	0.987
Ethnicity	0.001 (2.5%)	0.728	−0.084	0.023**	−0.001 (9.2%)	0.515	−0.004	0.870
Birth interval	0.001 (3.9%)	0.109	−0.023	0.174	−0.001 (4.9%)	0.235	−0.005	0.679
Breastfeeding	−0.002 (−7.1%)	0.004***	0.009	0.721	0.001 (−4.6%)	0.187	0.014	0.375
Mother's age when child born	0.002 (7.4%)	0.021**	0.030	0.177	−0.000 (2.9%)	0.599	−0.014	0.401
Mother's educational level	0.012 (46.5%)	0.000***	−0.040	0.201	−0.004 (39.2%)	0.033**	−0.029	0.146
Number of prenatal checks	0.003 (13.4%)	0.003***	−0.048	0.281	−0.000 (3.6%)	0.706	0.020	0.536
Body Mass Index	0.000 (1.0%)	0.458	0.022	0.192	−0.000 (3.1%)	0.453	0.027	0.010***
Affiliation to health system	0.005 (19.4%)	0.066*	−0.018	0.441	−0.002 (20.3%)	0.302	0.002	0.919
Birth attended by a physician	−0.001 (−5.3%)	0.240	−0.066	0.153	−0.002 (21.8%)	0.020**	0.025	0.353
Birth took place at a medical institution	0.004 (16.6%)	0.001***	0.080	0.190				
Region	0.001 (2.9%)	0.366	−0.022	0.090*	0.000 (−3.7%)	0.508	0.002	0.808
Constant			0.186	0.059*			−0.050	0.446
Group effects	Coef	$P>\|z\|$	Coef	$P>\|z\|$	Coef	$P>\|z\|$	Coef	$P>\|z\|$
Demographic factors	0.002 (8.1%)	0.366	−0.133	0.007***	−0.001 (13.9%)	0.426	−0.007	0.833
Maternal characteristics	0.016 (61.1%)	0.000***	−0.027	0.647	−0.005 (44.0%)	0.028**	0.019	0.670
Health care use and access	0.008 (30.7%)	0.006***	−0.004	0.947	−0.000 (42.1%)	0.046**	0.027	0.417

Demographic factors: sex, birth, interval, ethnicity, region. Maternal characteristics: mother's age when child born, mother's educational level, breastfeeding, number of prenatal checks, body mass index. Health care: affiliation to health system, birth attended by a physician, birth took place at a medical institution. $*p<0.10$, $**p<0.05$, $***p<0.01$

decomposition are reported in Table 3 of the "Appendix" section.

Discussion and Conclusion

This study made it possible to identify the contribution of the factors that explain the gap in stunting and excess weight between poor and non-poor children under 5 years of age in urban Colombia. It is important to emphasize that this study was carried out in the context of a highly unequal country in socioeconomic terms and allows for providing inputs for the creation of public policy, particularly aimed at reducing socioeconomic gaps, which should be directed at the indicators associated with the double burden of child malnutrition.

Stunting in children under 5 years of age, as previously mentioned, has been reduced in the last 10 years. However, the results show that the gap between the poor and non-poor in urban Colombia persists in malnutrition indicators.

From the non-linear decomposition of Yun and Fairlie based on the classical Blinder-Oaxaca decomposition, the probability of stunting in poor children was 4.8 pp higher than that of non-poor children. Fifty-four percent of this difference can be explained by the characteristics effect of the explanatory variables themselves. This suggests that if we could give poor children the higher contributing characteristics that non-poor children have, this 54% of the gap would disappear. In other words, the distribution of determinants in the characteristics effect plays an important role in explaining the gap. This result corroborates the socioeconomic inequalities in health observed in the literature [2, 29, 32, 37].

The group effects results indicated that the set of mother's characteristics is the most important group of variables for explaining urban children's malnutrition gap in Colombia. After the group of maternal characteristics, access to and use of medical care services was the next most significant group of variables in explaining the gap.

The most relevant characteristic within the group of maternal characteristics was the mother's educational level. The importance of maternal education in explaining malnutrition gaps is a common finding in the literature [6, 8, 21, 24, 25, 29, 35]. Our results suggested that the role of education was crucial in the case of Colombia as well. Specifically, the mother's educational level explained 46.5% of the children's stunting gap and 39.2% of the children's excess weight gap within urban zones. In India, the mother's educational level explained 11% of the same children's stunting gap within urban zones [32]. In general, lower levels of maternal education can negatively influence lifestyles, affecting the decisions made about essential issues in the household. In addition, mothers with lower levels of education have fewer employment opportunities and may be less able to identify and solve health problems [19]. Higher educational levels were associated with higher use of health services. Education can provide socially valued skills and give women a higher status which increases self-confidence and facilitates social interaction. Mothers with a higher educational level are able to access better health and nutritional services [25].

In Colombia, high levels of income inequality are associated with high inequalities in access to quality education [43, 44]. Thus, it is difficult for poor women to access high-quality education and better job opportunities. This may help explain the important weight of the mother's educational level in the case of stunting. In the case of excess weight, women with high levels of education may have better-paid jobs in the skilled job market and more sedentary lifestyles, including more frequent use of electronic devices and feeding their children with fast food [21, 45, 46]. A previous study found that the mother's educational level is important in explaining children's stunting gap between rural and urban areas in Colombia [21]. However, the present study highlighted the importance of the mother's educational level in the context of urban areas.

Evidence of the significant validity of having access to the number of prenatal checkups recommended by the WHO in 2015, and having a child delivered in a health institution such as a hospital, helps to reduce inequalities in child health in the short term [47].

The socioeconomic gap in the excess weight indicator was prevalent among the non-poor, with 2.1 pp above the poor. Part of this gap was attributed to the characteristics effect, revealing that the statistically significant variables are "birth attended by a physician at the time of delivery" and "mother's educational level."

The other part of the gap that is “unexplained” (which presents the coefficients effect), was given to the payoffs of the characteristics. In the findings, the mother’s body mass index was the only variable with statistical significance, and accounted for 69.3% of the coefficients effect. This finding suggests the presence of structural factors such as the inherited biological or cultural factors affecting child’s excess weight through the mother’s body mass index.

Moreover, previous studies have shown that variables relating to lifestyle and eating habits are related to the mother’s body mass index, and in turn show an intergenerational association with indicators of excess weight and obesity [45, 48]. To increase the robustness of the findings in relation to excess weight, a logistic regression was performed using a subsample with information relating to the lifestyle and eating habits of preschool children, from 3 to 5 years of age (we used this range of age due to data availability from the survey). The analysis found that weekly consumption of cookies, not eating at home habitually, and physical activity were determinant variables, which increased the probability of being overweight. These results can be provided on request.

The fact that the mothers of “non-poor” children have a higher level of education increases the probability of enter to the labor market, causing a change of routine within the household. These changes will probably increase children´s fast food consumption, due to a lack of time. Moreover, their diet is likely to be strongly influenced by the wide offer of processed food products, technology, the media, and devices such as cell phones, PCs, and television [45, 46].

The analysis of the association between malnutrition indicators and the explanatory variables mentioned above, revealed social inequity. Our findings are consistent with studies conducted in other developing countries such as Nepal, Ethiopia, Senegal, Peru [26], Malawi [20], Egypt, Jordan, Yemen [49], and India [50]. Those studies have used Blinder-Oaxaca decomposition or other techniques such as quantile regression decomposition [51], and conclude that the socioeconomic determinants commonly associated with child malnutrition are parental education and access to the health system. Our results agree with the preponderance of the effects of characteristics over the effect of coefficients in explaining the gap in child malnutrition. However, the effect of the coefficients that the mother’s body mass index may have on a child’s excess weight (whether due to dietary changes or practices, lack of physical activity or sedentary behaviors) played an important role in the analysis and the objective of our study.

The findings allow us to affirm that ensuring that mothers have a high school and/or higher level of education could be a public policy for the protection of children. Attending secondary school reinforces healthy sexual and reproductive behaviors, appropriate dietary practices, and promotes women’s empowerment [45].

The reported findings have very different policy implications. First, public policies aimed at reducing the stunting gap should focus on programs promoting mothers’ education and thus strengthen issues such as exclusive breastfeeding, methods of complementary feeding, and prenatal care during pregnancy. It is also necessary to expand health services coverage for lower-income levels [52]. Second, regarding the excess weight gap, public policies must promote more healthy lifestyles, including appropriate sleep time, balanced nutritional intake and physical activity, or active play in the children’s daily routine, and moderate use of social media and screen entertainment devices. Thus, there is an evident need for integrated actions between health and education professionals (including children and family members), to plan and implement strategies to prevent and combat childhood obesity, embedded in lifestyle changing habits [53].

Some limitations of the present study are that urban areas are not homogeneous between regions. It is possible that variables that can contribute to the identification of the gap are not included in the survey (such as the mother’s autonomy) or have been left out of the estimates (such as context variables including the average education of mother’s in the community, among others [6]). For future studies, we recommend expanding research into the qualitative data to strengthen the evidence [26, 54], including the relationship between malnutrition with the type of education that mothers should have, breastfeeding practices, complementary feeding of the child, lifestyles, habits, and dietary changes. The gap between poor and non-poor, and the coexistence of the double burden of child malnutrition, has shown that child malnutrition indicators (stunting and excess weight) are strongly associated with the socioeconomic position of the household. This finding is a contribution to those in charge of public policies aimed at reducing socioeconomic gaps and their contributors in urban Colombia.

Finally, excess weight is not a problem that is exclusive to high-income households, since the poor also have a prevalence of this indicator. Therefore, it is even more necessary to implement prevention policies in poor communities since they present a double burden of malnutrition.

Acknowledgements The authors gratefully acknowledge the Colombian Ministry of Health for providing the database used in this research.

Author Contribution Gustavo Romero: data curation, methodology, software, validation, formal analysis, writing—original draft.

Ernesto Cárdenas: conceptualization, formal analysis, methodology, writing—review & editing, supervision.

Ana Osorio: conceptualization, methodology, formal analysis, writing—review & editing, supervision.

Funding Not applicable.

Data Availability Data are available upon request from the repository of the Ministry of Health and Social Protection of Colombia.

Code Availability Not applicable.

Appendix

Table 3 Fairlie's decomposition of the poor and non-poor gap for children under 5 years old in urban areas, Colombia 2015

	Stunting		Excess weight	
	Coef		Coef	
Poor	0.118		0.053	
Non-poor	0.070		0.074	
Difference	0.048		0.021	
Explained *(characteristics effect)*	0.027		-0.004	
Variables	Characteristics effect		Characteristics effect	
	Coef	$P>\|z\|$	Coef	$P>\|z\|$
Sex	− 0.002	0.071*	− 0.001	0.030**
	− 5.7%		36.3%	
Ethnicity	0.003	0.334	0.000	0.987
	10.8%		1.0%	
Birth interval	0.000	0.913	− 0.001	0.425
	0.5%		17.7%	
Breastfeeding	− 0.004	0.007***	0.000	0.909
	− 16.2%		− 1.4%	
Mother's age when child born	0.0006	0.486	0.000	0.661
	2.3%		− 9.5%	
Mother's educational level	0.015	0.00***	− 0.000	0.872
	55.5%		− 11.7%	
Number of prenatal checks	0.006	0.009***	− 0.001	0.551
	22.1%		14.8%	
Body Mass Index	0.000	0.193	− 0.001	0.049**
	1.6%		24.8%	
Affiliation to health system	0.001	0.893	− 0.001	0.809
	2.2%		23.7%	
Birth attended by a physician	− 0.001	0.806	− 0.001	0.072*
	− 2.5%		12.9%	
Birth took place at a medical institution	0.005	0.075*	0.000	0.800
	20.2%		− 8.7%	
Region	0.002	0.37		
	9.1%			

$^*p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$

References

1. Habitat ONU. Estado de las Ciudades de América Latina y el Caribe. Published online 2012. http://onu org pe/noticias/estado-de-las-ciudades-de-america-latina-y-el-caribe-2012. Accessed 5 May 2021.
2. Born D, Colamarco V, Delamónica E, Minujín A. South American children's quality of life: intra-urban disparities along life-cycle indicators. *Appl Res Qual Life*. 2019;14(3):799–817. https://doi.org/10.1007/s11482-018-9607-2.
3. Gómez Builes GM, Astaiza Arias GM, Minayo MC. Las migraciones forzadas por la violencia: el caso de Colombia. *Cien Saude Colet*. 2008;13(5):1649–60. https://doi.org/10.1590/s1413-81232008000500028.
4. Migración Colombia. Distribución Venezolanos en Colombia corte a 30 de Septiembre. https://migracioncolombia.gov.co/infografias/distribucion-venezolanos-en-colombia-corte-a-30-de-septiembre. Published 2020. Accessed 16 Nov 2021.
5. NU.CEPAL. *El desafío social en tiempos del COVID-19*. http://hdl.handle.net/11362/45527. Published 2020. Accessed 9 Nov 2021.
6. Osorio AM, Romero GA, Bonilla H, Aguado LF. Socioeconomic context of the community and chronic child malnutrition in Colombia. *Revista de Saúde Pública*. 2018;52:73. https://doi.org/10.11606/s1518-8787.2018052000394.
7. UNICEF. Improving child nutrition: the achievable imperative for global progress. https://data.unicef.org/resources/improving-child-nutrition-the-achievable-imperative-for-global-progress/. Published 2013. Accessed 6 Mar 2021.
8. McGovern ME, Krishna A, Aguayo VM, Subramanian S. A review of the evidence linking child stunting to economic outcomes. *Int J Epidemiol*. 2017;46(4):1171–91. https://doi.org/10.1093/ije/dyx017.
9. Barrera-Dussán N, Fierro-Parra EP, Puentes-Fierro LY, Ramos-Castañeda JA. Prevalencia y determinantes sociales de malnutrición en menores de 5 años afiliados al Sistema de Selección de Beneficiarios para Programas Sociales (SISBEN) del área urbana del municipio de Palermo en Colombia, 2017. *Univ Salud*. 2018;20(3):236.
10. Stamatakis E, Wardle J, Cole TJ. Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *Int J Obes*. 2009;34(1):41–7. https://doi.org/10.1038/ijo.2009.217.
11. National Heart, Lung, Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: *The Evidence Report*. 1998;6(6):464.
12. UNICEF. La obesidad no es una tendencia imparable. https://www.unicef.org/colombia/historias/la-obesidad-no-es-una-tendencia-imparable. Published 2020. Accessed 12 Mar 2021.
13. Todaro MP, Smith SC. *Economic Development*. Pearson Books; 2020.
14. Keeley B, Little C, Zuehlke E. The state of the world's children 2019. Children, food and nutrition: growing well in a changing world. https://www.unicef.org/media/63016/file/SOWC-2019.pdf. Published 2019.
15. Hanandita W, Tampubolon G. The double burden of malnutrition in Indonesia: social determinants and geographical variations. *SSM - Population Health*. 2015;1:16–25. https://doi.org/10.1016/j.ssmph.2015.10.002.
16. Popkin BM, Corvalan C, Grummer-Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet*. 2020;395(10217):65–74. https://doi.org/10.1016/s0140-6736(19)32497-3.
17. Uthman OA. A Multilevel analysis of individual and community effect on chronic childhood malnutrition in rural Nigeria. *J Trop Pediatr*. 2009;55(2):109–15. https://doi.org/10.1093/tropej/fmn093.
18. Hasan MM, Uddin J, Pulok MH, Zaman N, Hajizadeh M. Socioeconomic Inequalities in child malnutrition in Bangladesh: do They Differ by Region? *Int J Environ Res Public Health*. 2020;17(3):1079. https://doi.org/10.3390/ijerph17031079.
19. Braveman P, Gottlieb L. The social determinants of health: it's time to consider the causes of the causes. *Pub Health Rep*. 2014;129(1_suppl2):19–31. https://doi.org/10.1177/00333549141291s206.
20. Mussa R. A matching decomposition of the rural–urban difference in malnutrition in Malawi. *Health Econ Rev*. 2014;4(1):1–10. https://doi.org/10.1186/s13561-014-0011-9.
21. Cardenas E, Osorio AM, Barandica OJ, Pico Fonseca SM. Mind the Gap! Socioeconomic Determinants of the stunting urban-rural gap for children in Colombia. *Child Indic Res*. 2022;15(2):415–32. https://doi.org/10.1007/s12187-021-09880-7.
22. Garcia S, Sarmiento OL, Forde I, Velasco T. Socio-economic inequalities in malnutrition among children and adolescents in Colombia: the role of individual-, household- and community-level characteristics. *Public Health Nutr*. 2013;16(9):1703–18. https://doi.org/10.1017/s1368980012004090.
23. Bukulu D, Kalu A. Determinants of stunting among children age 6-59 months, Siraro district, west arsi zone, Oromia region, Ethiopia. *J Health Med Nurs*. 2020. https://doi.org/10.7176/jhmn/74-01.
24. Sarker AR, Sultana M, Sheikh N, et al. Inequality of childhood undernutrition in Bangladesh: a decomposition approach. *Int J Health Plann Manage*. 2020;35(2):441–68. https://doi.org/10.1002/hpm.2918.
25. Ulep VG, Uy J, Casas LD. What explains the large disparity in child stunting in the Philippines? A decomposition analysis. *Public Health Nutr*. 2021:1–36. https://doi.org/10.1017/s136898002100416x.
26. Bhutta ZA, Akseer N, Keats EC, et al. How countries can reduce child stunting at scale: lessons from exemplar countries. *Am J Clin Nutr*. 2020;112:894S-904S. https://doi.org/10.1093/ajcn/nqaa153.
27. Chauhan BG, Chauhan S, Chaurasia H. Decomposing the gap in child malnutrition between poor and non-poor in Sierra Leone. *J Public Health (Germany)*. 2019;27(1):119–27. https://doi.org/10.1007/s10389-018-0924-6.
28. Kumar A, Mohanty SK. State of child health among poor and non-poor in urban India. *Genus*. 2011;67(1):1–19.
29. Joe W, Mishra US, Navaneetham K. Inequalities in childhood malnutrition in India: some Evidence on Group

Disparities. *J Hum Dev Capabilities*. 2009;10(3):417–39. https://doi.org/10.1080/19452820903048886.
30. Wagstaff A, Watanabe N. *Socioeconomic inequalities in child malnutrition in the developing World*. World Bank Policy Res Work Pap. 2000;(2434).
31. Van de Poel E, O'Donnell O, Van Doorslaer E. Are urban children really healthier? Evidence from 47 developing countries. *Soc Sci Med*. 2007;65(10):1986–2003.
32. Kumar A, Singh A. Decomposing the gap in childhood undernutrition between poor and non-poor in urban India, 2005-06. *PLoS One*. 2013;8(5). https://doi.org/10.1371/journal.pone.0064972.
33. OMS, Organización Mundial de la Salud, OMS. Metas mundiales de nutrición 2025 Documento normativo sobre retraso del crecimiento. *World Heald Org*. 2017;(9):1–12. https://apps.who.int/iris/bitstream/handle/10665/255735/WHO_NMH_NHD_14.3_spa.pdf
34. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. *Popul Dev Rev*. 1984;(10):25–45.
35. Ekholuenetale M, Tudeme G, Onikan A, Ekholuenetale CE. Socioeconomic inequalities in hidden hunger, undernutrition, and overweight among under-five children in 35 sub-Saharan Africa countries. *J Egypt Public Health Assoc*. 2020;95(1). https://doi.org/10.1186/s42506-019-0034-5.
36. Grossman M. The human capital model. *Handb Health Econ*. 2000;1:347–408.
37. Mokalla TR, Mendu VV. Risk factors and socioeconomic inequalities in undernutrition among children 0-59 months of age in India. *Int J Popul Stud*. 2020;5(2):14–23. https://doi.org/10.18063/ijps.v5i2.1125.
38. Wagstaff A, O'Donnell O, Van Doorslaer E, Lindelow M. *Analyzing health equity using household survey data: a guide to techniques and their implementation*. World Bank Publications; 2007.
39. Yun MS. Decomposing differences in the first moment. *Econ Lett*. 2004;82(2):275–80. https://doi.org/10.1016/j.econlet.2003.09.008.
40. Fairlie RW. Addressing path dependence and incorporating sample weights in the nonlinear Blinder-Oaxaca decomposition technique for logit, probit and other nonlinear models. *Stanford Institute for Economic Policy Research Working Paper*. 2017;(17):1–26. https://siepr.stanford.edu/sites/default/files/publications/17-013.pdf
41. Oaxaca R. Male-Female wage differentials in urban labor markets. *Int Econ Rev (Philadelphia)*. 1973;14(3):693–709. https://doi.org/10.2307/2525981.
42. Blinder AS. Wage discrimination: reduced form and structural estimates. *J Hum Resour*. 1973;8(4):436–55. https://doi.org/10.2307/144855.
43. Barrera-Osorio F, Maldonado D, Rodríguez C. Calidad de la educación básica y media en Colombia: diagnóstico y Propuestas. *Documentos de Trabajo (Universidad del Rosario)*. 2012;126:1–73.
44. Delgado M. La educación básica y media en Colombia: retos en equidad y calidad. http://hdl.handle.net/11445/190. Published 2014. Accessed 18 Feb 2021.
45. Egerter S, Braveman P, Sadegh-Nobari T, Grossman-Kahn R, Dekker M. An examination of the many ways in which education can influence health, including how educational attainment affects health across generations and the social and economic advantages it represents: issue brief no. 5. *Educ Health*. Published online 2011:232–245. https://doi.org/10.1016/B978-0-12-375678-7.00309-6
46. Gwozdz W, Sousa-Poza A, Reisch LA, et al. Maternal employment and childhood obesity – A European perspective. *J Health Econ*. 2013;32(4):728–42. https://doi.org/10.1016/j.jhealeco.2013.04.003.
47. Solar O, Irwin A. Social determinants , political contexts and civil society action : a historical perspective on the Commission on Social Determinants of Health. *Health Promot J Aust*. 2006;17(3):180. http://search.proquest.com.ezproxy.liv.ac.uk/docview/207439318?accountid=12117
48. Ortiz-Félix RE, Cárdenas-Villareal VM, Moral de la Rubia J, Ruvalcaba Rodríguez MD, Hernández-Carranco RG. Predictores maternos del índice de masa corporal del hijo pre-escolar y escolar. *Arch Latinoam Nutr*. 2015;65(3):158–65.
49. Sharaf MF, Rashad AS. Regional inequalities in child malnutrition in Egypt, Jordan, and Yemen: a Blinder-Oaxaca decomposition analysis. *Health Econ Rev*. 2016;6(1). https://doi.org/10.1186/s13561-016-0097-3.
50. Nie P, Rammohan A, Gwozdz W, Sousa-Poza A. Developments in undernutrition in Indian children under five: a decompositional analysis. *SSRN Electron J*. 2016. https://doi.org/10.2139/ssrn.2769201.
51. Aheto JMK. Simultaneous quantile regression and determinants of under-five severe chronic malnutrition in Ghana. *BMC Public Health*. 2020;20(1):1–12. https://doi.org/10.1186/s12889-020-08782-7.
52. UNICEF. Nutrition, for every child. UNICEF Nutrition Strategy for 2020-2030. https://www.unicef.org/media/92031/file/UNICEF%20Nutrition%20Strategy%202020-2030.pdf. Published 2020. Accessed 25 Jun 2021.
53. World Health Organization. WHO expert working group meeting on RSV surveillance based on the GISRS platform, 2–3 February, 2016, Starling Hotel & Conference Center, Geneva, Switzerland. https://apps.who.int/iris/bitstream/handle/10665/252625/WHO-OHE-PED-GIP-2016.7-eng.pdf. Published 2016. Accessed 8 Sept 2021.
54. Huicho L, Vidal-Cárdenas E, Akseer N, et al. Drivers of stunting reduction in Peru: a country case study. *Am J Clin Nutr*. 2020;112(Supplement_2):816S-829S. https://doi.org/10.1093/ajcn/nqaa164.

According to Migration Colombia, in recent years, more than 1,750,000 Venezuelans have migrated to Colombia, with about 40% located in the country's five main cities [4].