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Trends in inequalities in undernutrition mortality among children under 5 years and older adults over 60 years

Tendencias en la mortalidad por desnutrición en menores de 5 años y mayores de 60 años

Undernutrition inequalities among children and adults

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Author contributions:

All authors conceived the original idea; collected and analyzed the data; interpreted the results; and wrote and reviewed the paper.

Introduction: Children under 5 years of age living in poor areas and with low availability of healthy food have higher risk of undernutrition-related mortality. However, this relationship among older adults is not well established.

Objective: To analyse trends in socioeconomic inequalities in undernutrition-mortality in children under five years of age and adults over 60 years old in municipalities of Colombia during 2003-2009 and 2010-2016.

Materials and methods: ecological study of trends during 2003 and 2016. The study population consisted of children under five years of age and adults over 60 years of age residing in the Colombian municipalities during the study period. We estimated smoothed and standardized mortality rates by fitting a hierarchical Bayesian model and explored their relationship with five socio-economic area-level variables.

Results: In most of the municipalities, undernutrition-related mortality was three times higher in older adults compared to children. Moreover, the difference between municipalities in the risk of undernutrition-related mortality showed a marked reduction. Finally, it was observed that the poor and less developed municipalities have higher rates of undernutrition-related mortality in children, but on the contrary, wealthier territories have higher rates in older adults.

Conclusions: although most of the municipalities have decreased their mortality rates due to undernutrition in children under five and older adults, the socioeconomic conditions of the municipalities influence differently the risk of mortality for children and for older adults. This implies the need to develop age-specific strategies to close social gaps when structural conditions of the areas are taking into account.

Keywords: Malnutrition; infant mortality; spatial analysis; health status disparities; social determinants of health.

Introducción. Niños menores de 5 años que viven en zonas pobres y con poca disponibilidad de alimentos saludables tienen un mayor riesgo de mortalidad por desnutrición. Sin embargo, esta relación entre los adultos mayores no ha sido bien establecida.

Objetivo. Analizar las tendencias de las desigualdades socioeconómicas en mortalidad por desnutrición en menores de cinco años y adultos mayores de 60 años; en los municipios de Colombia durante 2003-2009 y 2010-2016.

Materiales y métodos. estudio ecológico de tendencias entre 2003 y 2016. La población de estudio estuvo conformada por niños menores de cinco años y adultos mayores de 60 años residentes en los municipios colombianos durante el período de estudio. Fueron estimados riesgos de mortalidad suavizados y estandarizados ajustando un modelo Bayesiano Jerárquico, con el cual además se exploró su relación con cinco características socio-económicas.

Resultados. En la mayoría de los municipios, la mortalidad por desnutrición fue tres veces mayor en los adultos mayores que en los niños. Además, las diferencias inter-municipales en el riesgo de mortalidad mostraron una marcada reducción. Finalmente, se observó que los municipios pobres y menos desarrollados tienen riesgos más altos de mortalidad infantil por desnutrición, pero, por el contrario, los territorios más ricos tienen riesgos más altos para los adultos mayores.

Conclusiones. las condiciones socioeconómicas de los municipios influyen de manera diferente en el riesgo de mortalidad de niños y adultos mayores. Esto implica la necesidad de desarrollar estrategias específicas por edad para cerrar brechas sociales que tengan en cuenta las condiciones estructurales de las áreas.

Palabras clave: desnutrición; mortalidad infantil; análisis espacial; disparidades en el estado de salud; determinantes sociales de la salud.

Historically, undernutrition primarily affected children under 5 years of age. However, its influence on the health condition of older adults is now more well-known (1). Undernutrition is the pathological state that results from the inadequate consumption of one or more essential nutrients. It involves weight loss associated with caloric and protein deficits and low levels of other specific nutrients that are necessary for an adequate homeostasis of the organism (2). In the case of children, those who are affected by this condition have limitations in their physical, mental, and psychomotor development. They can suffer biochemical and physiological disorders such as growth delays, cognitive impairments and a lower physical and intellectual capacity (3). In older adults, undernutrition increases the risk of mortality, hospitalization, hip fractures, and institutionalization due to the reduction of functional autonomy (1).

The surveillance system Health Situation Analysis (ASIS) (4), shows that in Colombia there was a decreasing trend in the undernutrition-related mortality rate in children under five from 14.87 to 6.82 deaths per 100,000 children under five between 2005 and 2014, respectively. In the case of older adults, the study by Cardona et al. (5) found that for Colombia in 2008, the mortality rate from nutritional deficiency in those over 65 years was 34.5 deaths per 100,000 people over 65 years of age. The same study also highlighted the great intra-country variability in mortality risk, with the department of Vaupes having the highest rate (550.5 deaths per 100,000 people over 65 years) and Tolima having the lowest (13.5 deaths per 100,000 people over 65 years)(5). Other departments that exceeded the national rate were Guaviare, Guainía, Bolívar, and Atlántico.

In relation to the determinants of undernutrition-related mortality, one of the most important factors is the family poverty level, for whom situations of financial restriction mean limited access to healthy food (6). In older adults, it is associated with living alone, having a deficient social support network, and having limited functional ability (7).

Different studies have emphasized the relationship between undernutrition and the place of residence. The literature shows that children and older adults living in poor areas have a higher risk of undernutrition (6,8), as do those living in areas with a low availability of healthy food (9). Additionally, there are other factors associated with undernutrition, especially in children, such as unfavorable socioeconomic conditions related to inadequate sanitation (10), food, and health care practices (11,12).

In Colombia, the levels of poverty and development in the municipalities are very heterogeneous. Therefore, it is possible to assume that these conditions contribute to an unequal distribution of the undernutrition-related mortality. The purpose of this study was to establish if differences between municipalities exist regarding their undernutrition-related mortality rates in children under five years of age and in adults over 60 between 2003 and 2016. Additionally, we aimed to determine the relationship of those mortality rates with the socioeconomic conditions of the municipalities.

Materials and methods

This was a longitudinal ecological study to analyze aggregated data of Colombian residents under five and older than 60 years of age, between 2003 and 2016. The

geographic units of analysis were: six regions, 18 subregions, and 1096 municipalities.

In order to improve the municipal estimates, a geographic map was created at this level where the non-municipalized areas were added to their respective cities. Likewise, the four municipalities created after 2005 were regrouped into their original municipalities. Additionally, the municipalities of Archipiélago de San Andrés, Providencia and Santa Catalina were excluded because they did not have contiguous or neighboring geographic areas that allowed reliable municipal estimates of their mortality risks. Consequently, this study analyzed data from 1096 municipalities (figure 1).

Information sources

Data on deaths was obtained from vital statistics available on the National Administrative Department of Statistics's website (13) and aggregated according to the geographic units of analysis. Data of municipal socioeconomic characteristics was obtained from the National Public Health Surveillance System, the United Nations Development Programme (UNDP), and the National Planning Department.

Variables

Dependent variables: Two aggregated variables were analyzed:

1) Municipal undernutrition mortality rate in children under five years old per 100,000 inhabitants under five years old, and

2) Municipal undernutrition mortality rate in people over 60 years old per 100,000 inhabitants over 60 years old.

Undernutrition deaths were defined as those with a primary cause of death coded according to the 10th Revision of the International Classification of Diseases as

undernutrition (E40-to-E46), other nutritional deficiencies (E50.0-to-E64.9) or nutritional anemia (D50.0-to-D53.9).

Independent variables: Municipal socioeconomic conditions

- ***Percentage of population with unsatisfied basic needs (NBI):*** Measured in 2005, it characterizes the poverty of the municipalities by quantifying the proportion of people experiencing at least one of the following conditions: overcrowding, inadequate housing, inadequate water supply, lack of sewers, and poor school attendance (14). Municipalities were categorized into quintiles, with the lowest quintile comprising the wealthiest municipalities and the highest one comprising the poorest municipalities.
- ***Human development index (HDIm):*** Measured in 2005, it represents the degree of development achieved by a municipality in terms of: quality of life, education, and gross domestic product per capita (GDP) (15). Municipalities were categorized into quintiles, with the lowest quintile including municipalities with low human development and the highest one, municipalities with very high human development.
- ***Multidimensional poverty index (MPI):*** It identifies multiple deficiencies in the areas of health, education, and living standards in the period 2005-2014. Municipalities were categorized into quintiles, with the lowest quintile consisting of the richest group of municipalities and the highest one made up by the poorest municipalities (16).
- ***Institutional capacity of the municipal government (in spanish Índice de desempeño integral):*** This index sorts and compares municipalities between 2006 and 2015 based on the following aspects: effectiveness in meeting the

goals of their development plans, efficiency in the provision of basic services, compliance with the budget execution requirements defined by law, and administrative and fiscal management. The municipalities were classified into four performance groups: outstanding or satisfactory, medium, low, and critical (17).

- ***Dynamics of the index of water quality for human consumption-IRCA 2007-2010:*** The IRCA measures the water quality risk for human consumption (18), classifying the municipalities into five water-quality risk groups: none, low, medium, high, and unviable sanitary risk. Given the variability of the index during the available period (2007, 2008, 2009, and 2010), its dynamics pattern was analyzed and summarized into one variable for the present analysis. The resultant variable classifies the municipalities into five groups: improving (municipalities with constant changes toward the no-risk category), constant positive (municipalities oscillating between the no-risk or low-risk categories), constant negative (municipalities oscillating between the low, medium, high or unviable sanitary risk categories), and worsening (municipalities with constant changes towards the unviable sanitary risk category).

Data processing

For the descriptive analysis, national and regional mortality age-specific crude rates were estimated for two periods: 2003-2009 and 2010-2016. For this, the total number of undernutrition deaths (under five years-old or over 60 years-old) was used as the numerator. The denominator was either the total population of children under five years-old or people over 60 years-old, multiplied by 100,000.

For the municipal rate estimates, a Bayesian hierarchical model proposed by Besag, York and Mollie (BYM) was used to obtain smoothed rates for the total period: 2003-2016 (19). This model improved the precision of the estimated rates, especially for those municipalities with a low number of deaths due to undernutrition and/or a small population. In brief, this model combined the aggregated number of deaths in each municipality with the average of the neighboring municipalities, thus decreasing the variability of the estimates. The BYM model was specified as follows:

$$Y_i \sim Binomial(n_i, p_i)$$

$$log(p_i) = \beta_0 + v_i + u_i$$

where n_i is the denominator in each municipality. The rate in each municipality i is represented by p_i. The model has two random effects that represent non-spatial and spatial variability, v_i, and u_i. These effects allow for the estimation of the smoothed rate for each municipality through the equation $exp\ (\beta_0 + v_i + u_i)$. The *a priori* distributions of spatial effects was assigned through an intrinsic conditional autoregressive (ICAR) distribution, with variance σ_v^2, while for the non-spatial effects, a Normal distribution with zero mean and variance σ_u^2 was used (19). A half-normal distribution with a mean of 0 and a precision of 0.0001 was assigned to the standard deviations σ_v and σ_u (20). For the parameter $\propto$, a Normal "vague prior" distribution was assigned.

This model estimated the smoothed mortality rate (SMR) with their corresponding 95% credible interval for each municipality. It also estimated a posteriori probability (PrP); which indicates whether each municipality had a smoothed rate significantly

higher than that of the Colombian rate (p<0.05). This was calculated as $PrP_i = Probability\ (smoothed\ P_i > rate\ in\ Colombia)$.

The model was estimated by using the INLA (integrated nested Laplace approximation) method available in the INLA library of the statistical package R.2.15.3 (21,22).

Statistical analysis

Tables and maps were used for the descriptive analysis of regional and municipal estimates by period and age-group.

To analyze the relationship between the municipal smoothed rates and the socioeconomic conditions, the ecological Bayesian hierarchical model was extended at level 2 to include socioeconomic (SE) variables. NBI, HDIm and MPI were categorized into quintiles and included in separated models as four dummy variables (QSE), with the less poor or less developed areas serving as the reference group. For the other two socioeconomic variables, outstanding performance and risk free water quality were used as reference:

$$log\ (p_{it}) = \beta_0 + \sum_{j=1}^{4} \beta_j QSE_{(j-3),i} + v_i + u_i$$

where each municipality is represented as i. β_j represents the effect of the category of the socioeconomic variable on the smoothed rates. By using, $exp\ [\beta_j]\ (j = 1, \dots, 4)$ the results of the models are presented as the relative risk (RR) of mortality in each socioeconomic group, along with the corresponding 95% credible intervals (95% CI).

This research protocol was approved by the Ethics Committee of the health Area of the Universidad de Antioquia reference number 161 (09/March/2017).

Results

In Colombia, between 2003 and 2016 a total of 2,754,943 deaths were reported, of which 24,388 were due to undernutrition, estimating a rate for the period of 3.85 per 100,000 inhabitants. According to the age group, 23.8% (n=5,804) of the total mortality due to undernutrition corresponded to children under five years-old, and 61.4% (n=14,974) to people over 60 years old. The estimated rate during the period was 8.6 deaths per 100,000 children under five and 24.5 deaths per 100,000 adults over 60.

Comparing the two periods (2003-2009 vs 2010-2016), a general decrease in the mortality rates was found. For children under five years-old, the rate reduced from 10.0 to 7.2 deaths per 100,000. In those over 60 years-old, the rate changed from 26.0 to 23.2 deaths per 100,000.

In relation to mortality by region (figure 2), Atlantic and the Orinoquía-Amazonía regions showed the higher mortality risks for children under five in the two periods. In the case of those over 60 years, Atlantic, Oriental, Pacific, and Orinoquía-Amazonía regions showed the highest risks in both periods and the smallest decreases over time.

Figure 3 displays the smoothed mortality rates (SMR) by municipality for the whole period. Areas with the highest risk for children under five years were located at the north of the country within the subregions of Guajira-Cesar-Magdalena, followed by Barranquilla (metropolitan area), Atlantic, and Pacific Coast. In contrast, the lowest mortality risks were observed in the municipalities of the subregions of Medellín

and Bogotá. In the case of mortality for people over 60 years, municipalities with the highest risk were located within the subregions of Atlantica, Oriental, Pacific, and Orinoquía-Amazonía.

Table 1 describes the distribution of deaths from undernutrition according to the socioeconomic indicators. For those under five years, the risk of mortality was higher in municipalities with a higher proportion of the population with unsatisfied basic needs, less development, and poorer and worse overall performance, evidencing a negative social gradient of undernutrition for this age group. In contrast, those over 60 have a positive social gradient of undernutrition, showing higher risks of mortality in municipalities with better economic advantages and development (table 2).

Consistent with these findings, Table 2 shows the results of the ecological regression. According to the results for children under five, the risk of dying from undernutrition is higher in the poorest municipalities, that is, in areas that have higher unsatisfied basic needs, less development, a critical comprehensive performance, and a low or medium risk of drinking water quality. In these municipalities the risk is approximately 50% higher than in reference municipalities. The risk of mortality from undernutrition in children under five years of age was not statistically associated with water quality.

In contrast, the results in adults over 60 show higher risks of mortality from undernutrition in more developed municipalities, that are affluent and without water quality risk, significantly exceeding the risk of mortality from undernutrition when compared with reference municipalities. The risk of mortality from undernutrition in

adults was not statistically associated with water quality or with the municipality's comprehensive performance.

Discussion

In general, it was found that in Colombia the mortality due to undernutrition decreased during the period 2003-2016. Moreover, risk maps reveal substantial geographic variation in the size of the risks; which is reducing over time. Most importantly, an association was observed between mortality caused by undernutrition and socioeconomic indicators of the municipalities.

The results highlighted a more significant decrease in the risk of undernutrition-related mortality for children under five years of age than for people older than 60 years-old. This finding may be explained by the fact that in Colombia, nutritional policies have focused mainly on the population under five years of age in the process of meeting development objectives millennium development goals (MDGs) and sustainable development goals (SDGs) that include the eradication of hunger, the decrease of child mortality and undernutrition, and the development of food and nutrition surveillance systems (23).

However, although in general a decreased trend was observed, there are still regions sowing a high risk of child mortality. It is possible for example that the high under five mortality rates in the municipalities of the Atlantic region can be explained, in part, by the presence of the large mining and energy companies that have caused a decrease in food production due to the lack of water sources (11).

In the region of Orinoquía and Amazonia, the highest rates of mortality due to undernutrition in children under five years of age could be explained because this region has the highest rates of chronic (29.5%) and global undernutrition (7.5%) in

this age group compared to the rest of the country (13.2 and 3.4%, respectively) (24). Also, this region is the territory with the highest percentage of indigenous communities. The food production and eating patterns in these communities have changed, deteriorating their identity by assuming different cultural patterns that cause the loss of food sovereignty and the substitution of native foods for products that must be purchased (25), limiting the food availability due to low income levels (26).

On the other hand, although all regions have decreased their mortality rates due to undernutrition in children under five, the poorest municipalities continue to have the highest rates. Consistent with the literature review, some of the social conditions of the municipalities associated with higher mortality rates due to malnutrition are the lack of potable water, the scarce institutional infrastructure for carry out social and health programs, low social security coverage and difficulties for the food distribution and supply chain (27).

In terms of public policy, although all regions have decreased their mortality rates due to undernutrition in children under five, the poorest municipalities continue to have the highest rates. This finding implies the need to develop specific strategies to close social gaps.

The situation found in relation to mortality in adults over 60 is different. Here, the mortality rates have decreased very little and are higher in more developed and more affluent municipalities. This phenomenon shows that this population group, due to different factors, such as limited income, does not have adequate access to food, influencing their health status and developing processes that make them even more vulnerable in this stage of life (28-30). The lower mortality rates in the

poorest municipalities may be because they are located in rural areas where there is a greater availability of food from family farming, the breeding of small animals, self-sufficiency, and family support for obtaining food (31,32).

The risk of mortality due to undernutrition in the urban population over 60 years of age is a global challenge because many of the world's largest cities are found in the least developed countries. In these countries, in contrast to the situation in industrialized countries, the aging process is not occurring slowly, and families or states have the resources to respond. Inequalities are found in these urban centers, such as those that show the health conditions of older adults. For example, in Colombia, according to the 2015 National Survey of Health, Welfare and Aging (*Salud, Bienestar y Envejecimiento, SABE*), eight out of 10 older adults live in urban areas (78.1%), and of the total population surveyed, 30% do not receive assistance from the state or the family (33).

In conclusion, the mortality from undernutrition in children under five is an unmet objective and remains a social issue because the rates continue to be high and affect the poorest municipalities. Simultaneously, the mortality from undernutrition in adults over 60, especially in residents of urban areas, constitutes a huge challenge due to the accelerated growth of the number of inhabitants in cities in the developing world and the aging population.

Limitations of the study

A special consideration related to data quality has to be made. Research on causes of deaths registration in Colombia shows that this process has improved considerably in the last 30 years presenting a positive tendency to improve (34). Cendales and Pardo (34) state that: “It is possible that the classification of

Colombia rises to the category *country with high quality* in the certification of mortality since our percentage of deaths certified as signs, symptoms and ill-defined conditions is less than 10%. Likewise the last WHO's coverage report of death shows that Colombia´s coverage rose from 79.9% in the period 1990-1994 to 88.1% in 1995-1999, 93.1% in the period 2000-2004, and 98.5% in 2009".

For the above mentioned we assumed data used in our study are enough quality. An initial review of the data found that 40% of municipalities consistently reported zero cases of undernutrition in children under five years-old, whereas 9% of the municipalities reported zero cases of mortality in those over 60 years. The present analysis assumed that all zero counts represented a true absence of cases in the year analyzed. To improve the accuracy of the municipal estimates, the mortality and population counts were aggregated in a single period (2003-2016). With this, undernutrition rates were estimated for each of the 644 municipalities that reported at least one case of mortality in children under five years and for the 992 municipalities that reported at least one case of mortality in those over 60 years old. Besides, we used the Bayesian model, which averages the data of neighboring municipalities, conservatively decreasing the possible quality/under-registration problems of some municipalities.

On the other hand, being an ecological study, our findings can only contribute to the evidence of a possible association between inequality in malnutrition and urban territory conditions, but we cannot affirm that this is necessarily a causal relationship. Additionally, although this design allowed us to detect and evaluate socioeconomic inequalities in malnutrition, it is not possible to identify whether inequalities in the risk of malnutrition among municipalities are due in large part to

the characteristics of the municipalities (contextual effect) or to the differences between the individuals residing in them (compositional effect). This design does not allow for evaluating the role of individual conditions such as confounders, mediators or modifiers of the effect of the municipality. In this sense, the deepening of the ecological relationships found in this study could be explored with a multilevel analysis that takes into account the exploration of both individual and contextual factors.

Finally, we stress the importance of considering the results of this study to be extrapolated only at the area-level. Given the aggregated nature of the data, it would be erroneous to assume that the statistical association between the socio-economic variables at the municipal level would be equal to the association between the corresponding variables at the individual-level. A multilevel analysis would be the next step in this research to properly explore both individual and municipal-level relationships.

Conflicts of interests

The authors declare that there is no conflict of interest.

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Table 1. Mortality rate (per 100,000) due to undernutrition in **individuals under 5 years** and **over 60 years** according to municipal socioeconomic indicators. Colombia, 2003-2016

	UNDER 5 YEARS		**OVER 60 YEARS**	
	N (5,804)	**RR CI (95%)**	**N (14,974)**	**RR CI (95%)**
Percentage of the municipal population with unsatisfied basic needs (NBI)				
Richer	1211	3.92 (3.70 - 4.14)	8437	21.8 (21.4 - 22.3)
Quintile 2	903	11.0 (10.3 - 11.8)	2510	32.4 (31.1 - 33.7)
Quintile 3	742	12.4 (11.5 - 13.3)	1594	30.6 (29.1 - 32.2)
Quintile 4	1308	18.1 (17.1 - 19.0)	1402	25.4 (24.1 - 26.7)
Poorer	1625	20.1 (19.1 - 21.1)	1011	18.9 (17.8 - 20.1)
Municipal-level human development index (HDIm)				
Less development	1530	20.0 (19.0 - 21.0)	878	17.4 (16.2 - 18.5)
Quintile 2	918	13.7 (12.8 - 14.6)	1518	26.8 (25.5 - 28.2)
Quintile 3	927	15.4 (14.4 - 16.4)	1346	25.7 (24.3 - 27.1)
Quintile 4	718	10.6 (9.87 - 11.4)	1832	28.1 (26.8 - 29.3)
More development	1661	4.99 (4.75 - 5.23)	9368	23.4 (23.0 - 23.9)
Multidimensional poverty index (MPI)				
Poorer	1343	16.8 (15.9 - 17.7)	937	18.3 (17.1 - 19.4)
Quintile 2	942	15.0 (14.1 - 16.0)	1255	25.2 (23.8 - 26.6)
Quintile 3	951	14.9 (13.9 - 15.8)	1641	30.0 (28.6 - 31.5)
Quintile 4	467	8.19 (7.45 - 8.94)	1600	28.2 (26.9 - 29.6)
Richer	1500	4.41 (4.18 - 4.63)	9854	23.9 (23.4 - 24.4)
Comprehensive performance index				
Outstanding/ Satisfactory	699	3.10 (2.87 - 3.33)	5356	19.2 (18.7 - 19.7)
Medium	1397	8.30 (7.87 - 8.74)	5305	31.6 (30.7 - 32.4)
Low	2060	13.3 (12.8 - 13.9)	3747	26.7 (25.9 - 27.6)
Critical	1047	18.7 (17.6 - 19.9)	879	23.3 (21.7 - 24.8)
Dynamics of the index of water quality for human consumption-IRCA				
Getting better	1066	12.8 (12.1 - 13.6)	1873	26.8 (25.6 - 28.0)
Positive constant	1668	8.29 (7.89 - 8.69)	5288	23.9 (23.3 - 24.6)
Negative constant	1560	7.07 (6.72 - 7.42)	5343	23.3 (22.6 - 23.9)
Worse	297	8.54 (7.57 - 9.51)	856	23.5 (21.9 - 25.0)

RR: Relative risk
CI (95%): 95% credible interval

Table 2. Regression Mortality risk due to undernutrition in individuals **under 5-years** and **over 60 years** according to municipal socioeconomic indicators. Colombia, 2003-2016.

	Under 5 years-old	**Over 60 years-old**
	RR (95% CI)	**RR (95% CI)**
Percentage of the municipal population with unsatisfied basic needs (NBI)		
Richer	1.00	1.00
Quintile 2	1.43 (1.11 - 1.80)	0.97 (0.84 - 1.10)
Quintile 3	1.56 (1.19 - 2.01)	0.93 (0.80 - 1.08)
Quintile 4	2.09 (1.60 - 2.68)	0.82 (0.70 - 0.96)
Poorer	2.12 (1.60 - 2.75)	0.63 (0.52 - 0.74)
Municipal-level human development index (HDIm)		
Less developed	1.00	1.00
Quintile 2	0.80 (0.66 - 0.96)	1.45 (1.26 - 1.67)
Quintile 3	0.76 (0.61 - 0.93)	1.50 (1.29 - 1.73)
Quintile 4	0.63 (0.49 - 0.79)	1.52 (1.29 - 1.77)
More developed	0.52 (0.41 - 0.66)	1.61 (1.37 - 1.88)
Multidimensional poverty index (MPI)		
Poorer	1.00	1.00
Quintile 2	1.27 (1.00 - 1.60)	0.98 (0.86 - 1.10)
Quintile 3	1.50 (1.17 - 1.89)	0.97 (0.84 - 1.10)
Quintile 4	1.62 (1.27 - 2.04)	0.83 (0.72 - 0.96)
Richer	1.75 (1.35 - 2.23)	0.56 (0.48 - 0.66)
Comprehensive performance index		
Outstanding/ Satisfactory	1.00	1.00
Medium	1.26 (1.03 - 1.54)	1.00 (0.90 - 1.12)
Low	1.41 (1.14 - 1.73)	1.00 (0.88 - 1.12)
Critical	1.42 (1.08 - 1.84)	0.92 (0.76 - 1.10)
Water quality		
Risk free	1.00	1.00
Low risk	1.21 (1.02 - 1.42)	0.86 (0.78 - 0.95)
Medium risk	1.39 (1.04 - 1.81)	0.94 (0.79 - 1.10)
High risk	1.08 (0.77 - 1.47)	0.78 (0.60 - 0.99)
Healthy Inviable	1.24 (0.75 - 1.91)	0.54 (0.35 - 0.80)
Dynamics of the index of water quality for human consumption-IRCA		
Getting better	1.00	1.00
Positive constant	0.96 (0.78 - 1.18)	1.02 (0.89 - 1.16)

Negative constant	0.95 (0.78 - 1.14)	1.05 (0.93 - 1.19)
Worse	0.80 (0.59 - 1.05)	0.96 (0.80 - 1.15)

RR: Relative risk
CI (95%): 95% credible interval

Figure 1. Administrative levels in Colombia: Regions (in colors), subregions (with numbers), and municipalities (in light gray). Colombia, 2005

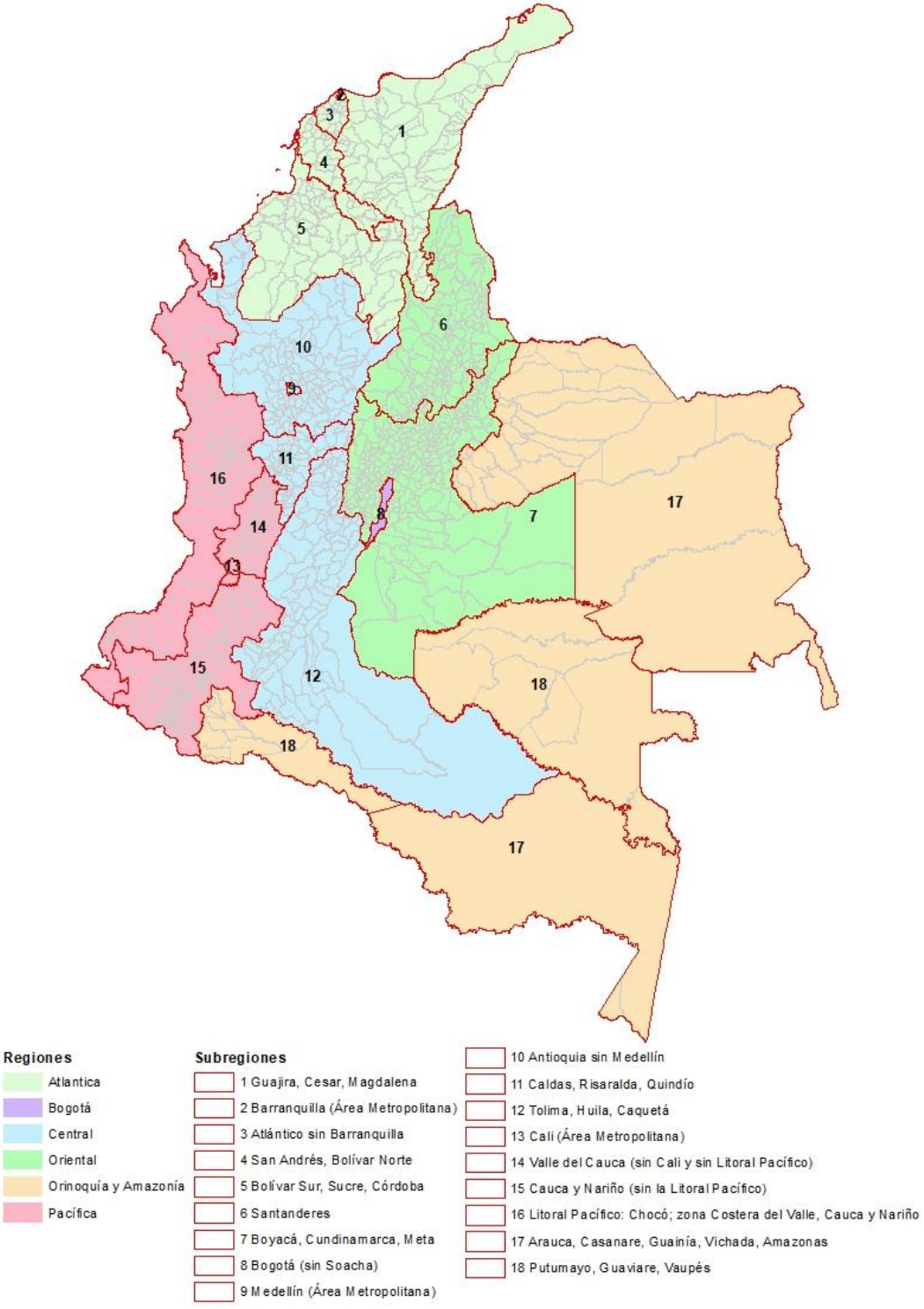


Figure 2. Mortality rate per 100,000 inhabitants due to undernutrition in children under five years and over 60 years according to regions. Colombia. 2003-2016

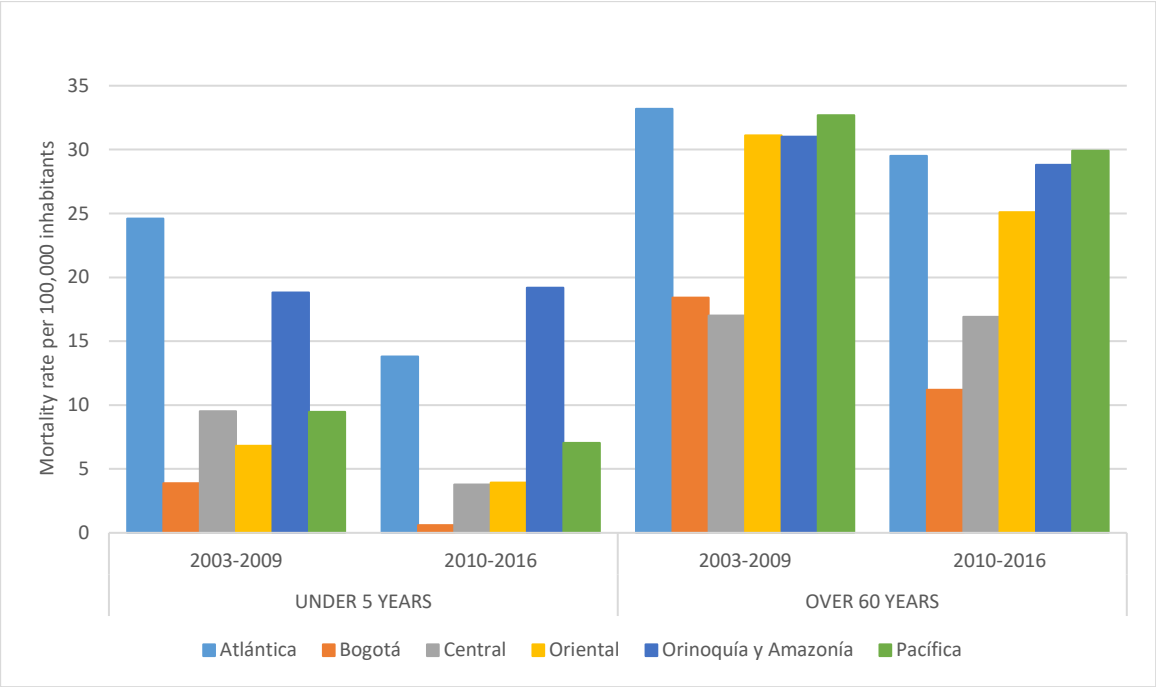
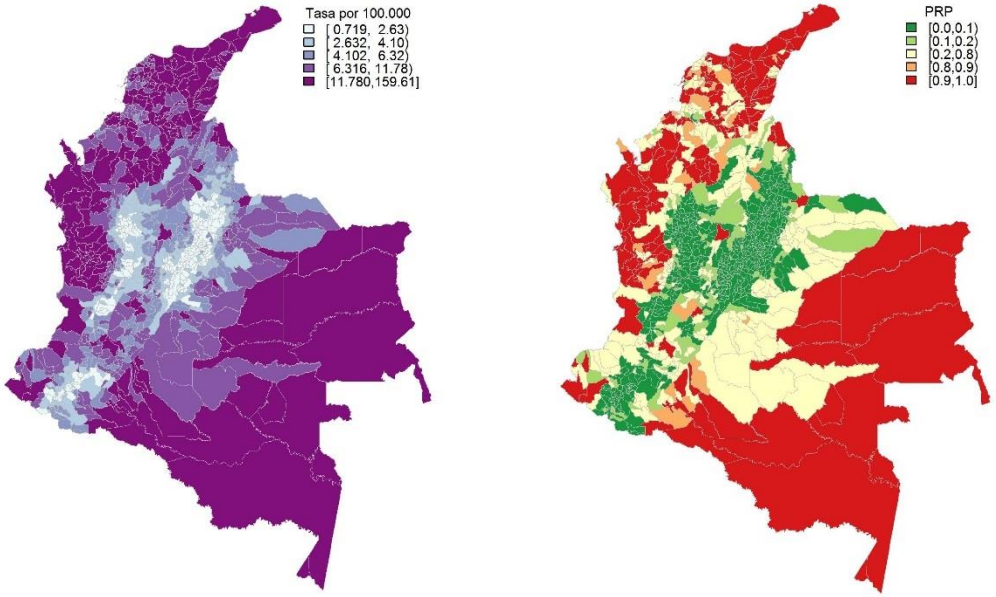


Figure 3. Distribution of smoothed mortality rate (SMR) per 100.000 for undernutrition during (2003 and 2016) in children under 5 years-old and adults over 60 years-old. Next to each mortality map there is a map with the probability that the SMR are above the national rate (PrP). Red colour indicates a probability of 90-100% that an SMR is higher than the Colombian rate and green colour indicates with the same probability that it is lower.

Mortality in under 5 years-old



Mortality in adults over 60 years-old