

# Socioeconomic inequalities in health problems in the first two years of life: 2015 Pelotas Birth Cohort

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## Research Article

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# Abstract

**Background:** Brazil is characterized by an unfinished agenda of health inequalities which could cause greater occurrence of concomitant health problems in the childhood. **Objective:** the aim of this study was to evaluate the socioeconomic inequalities of health problems in the early childhood (up to 24 months of age) in the 2015 Pelotas Birth Cohort.

**Methods:** Prospective cohort study, including all births that occurred in the city of Pelotas/RS between January 1 and December 31, 2015. The outcomes were health problems presented by the children at 12 and 24 months: cough, difficult breathing, diarrhea, ear pain, pneumonia, urinary infection, hospitalization, and other health problems. Socioeconomic inequalities were measured applying Slope Index of Inequality (SII) and Concentration Index (CIX) and using wealth index and maternal schooling as socioeconomic variables. Poisson regression was used to evaluate the association between the number of health problems and socioeconomic variables.

**Results:** The perinatal sample was comprised of 4275 children. At 12 and 24 months, approximately 74% and 44% presented 1 or more and 2 or more health problems, respectively. For all period, the average number of health problems was 2.9 (sd 2.0). Higher frequencies were observed for children belonging to the poorest income quintile and with lower maternal education, except for 1 or more health problems at 24 months. The greatest absolute and relative inequality was observed for 2 or more health problems at 12 months (SII -0.23, CI95% -0.29; -0.18 and CIX -0.19, CI95% -0.25; -0.14). Inequalities were smaller (2 or more problems) and absent (1 or more problems) at 24 months. There is an opposite dose-response relationship for the accumulation of health problems.

**Conclusion:** The study confirms inequalities due to health problems in Brazilian children, especially in the first year of life.

## Background

More recent evidence has shown an association between childhood health and chronic diseases and adult multimorbidity (1–3). The most common health problems in early childhood are acute and infectious diseases, particularly in the respiratory and digestive systems.

A recent systematic review has shown an association between asthma and later development of Chronic Obstructive Pulmonary Disease (COPD) (OR = 7.23 95% CI 5.05–10.33) (3). A possible explanation (which has not been confirmed) is that airway inflammation, and remodeling caused by uncontrolled asthma can progress from reversible bronchospasm to irreversible airway obstruction (4).

Stressful factors occurring in childhood and adolescence were associated with the occurrence of cardiovascular disease in adulthood (OR = 2.14; 95% CI, 1.56–2.94), but the pathophysiological mechanisms have not been fully clarified (5). A study with 4731 older adults found a strong association between the presence of stressful factors in childhood and multimorbidity (1).

Social, economic, cultural, ethnic/racial, psychological and behavioral factors influence the occurrence of health problems (6). Social determinants play a decisive role, making it possible to observe the unequal health conditions of different groups, even in differentiated access to the health system (7–10). A study by Russell and collaborators showed that cumulative socioeconomic disadvantage increases the potential for developing chronic illness in early childhood (11).

Understanding events that interfere with children's health and identifying individuals with the greatest burden of childhood morbidity can help to prioritize and carry out interventions to prevent later chronic diseases (9, 12, 13). The progressive process of population aging, increasing exposure to environmental factors, changes in lifestyles, and progress in the effectiveness of health care have led to an increase in the prevalence of chronic non-communicable diseases globally. Multimorbidity has become a priority for public health considering its prevalence, severity, impact on quality of life, and management (14).

Therefore, the aim of this study was to evaluate the socioeconomic inequalities of health problems in the first two years of life (up to 24 months of age) in the 2015 Pelotas Birth Cohort.

## **Methods**

### **Sample**

Prospective cohort study, containing data from the 2015 Birth Cohort, which included all births that occurred in the city of Pelotas/RS between January 1 and December 31, 2015. Mothers living in the urban area of the municipality were included. Individuals born in this period whose mothers resided in the district of Jardim América and Colônia Z3 were also included maintaining comparability with the other birth cohorts carried out in Pelotas/RS (1982, 1993 and 2004).

The participants' mothers were interviewed shortly after delivery in the hospital, and were invited to join the perinatal study, addressing various aspects of prenatal care, socioeconomic and demographic profile, in addition to maternal, home and newborn characteristics (15). Following the 2015 cohort, other studies took place at three, 12, 24 and 48 months. At three and 12 months, the interviews were carried out in the households and at 24 and 48 months, most of them at the clinic of the Health Research Center. A team of interviewers was properly trained and qualified for the work. In addition to questions, measurements were taken at all follow-ups, such as weight and height of both the mother and the child (15). In this study, we used variables from the perinatal, three, 12- and 24-months follow-ups.

The 2015 Birth Cohort project was submitted and approved by the Research Ethics Committee of the School of Physical Education of the Federal University of Pelotas, under protocol number 26746414.5.0000.5313. All mothers interviewed signed an informed consent form, agreeing to participate in the study.

### **Outcomes**

Outcomes were health problems presented by the children at 12 and 24 months of age, reported by the mother or guardian during the interviews. The outcomes were operationalized through the following questions, in both follow-ups: cough “Has < CHILD > had any cough since < day of the week > last week?”; difficult breathing “Has < CHILD > had difficulty in breathing since < day of the week > last week?”; diarrhea “Has < CHILD > had diarrhea since < day of the week > two weeks ago?”; Any other health problem “Has < CHILD > had any other health problem since < day of the week > two weeks ago?”; ear pain “Has < CHILD > ever had ear pain?”; pneumonia “Has < CHILD > ever had pneumonia?”; urinary infection “Has < CHILD > had any urinary infection since birth?”; hospitalization “Has < CHILD > been admitted to hospital since birth?”. The difference between the follow-ups is that for ear pain, pneumonia, urinary tract infection and hospitalization, at 24 months the questions about the last follow-up (if after 12 months the child had presented any of these problems). The 2015 cohort questionnaires are available at: [http://www.epidemioufpel.org.br/site/content/coorte\\_2015/questionarios.php](http://www.epidemioufpel.org.br/site/content/coorte_2015/questionarios.php).

For analysis purposes, outcomes were grouped into  $\geq 1$  (at 12 and 24 months),  $\geq 2$  (at 12 and 24 months) and number of health problems (up to 24 months).

## Main exposures

The main exposures of this study were maternal schooling in complete years (0–4/5–8/9–11/12 or more) and wealth index based on family income in Brazilian currency (in quintiles - first poorest quintile and fifth richest quintile), both collected in the perinatal wave.

## Covariates

Some independent variables collected in the perinatal study were included in the model as confounders: gestational age at birth (in days), child sex (female/male) and birth weight (in grams) and, also a variable collected in the follow-up of three months of age: breastfeeding status (exclusive/predominant/partial/weaned).

## Statistical analysis

Analyses were performed using Stata<sup>®</sup> 15.0. We performed a descriptive analysis and obtained the prevalence for categorical variables and means with respective standard deviations for numerical variables.

We calculated two indexes to measure inequalities: the Slope Index of Inequality (SII) and the Concentration Index (CIX). The SII shows the absolute difference, in percentage points, between extreme coverage, in this case, mothers with less (0–4 years) and more (12 years or more) educated and the poorest and richest quintile, using a logistic regression model. The CIX is based on a scale ranging from – 1 to + 1, where zero represents an uneven distribution, both in education and family income. Positive CIX values suggest that the distribution is in favor of more educated and wealthier mothers. The SII presents absolute inequality while CIX relative inequality (8). We also performed the prediction calculation using the margins and marginsplot commands to predict the number of health problems up to 24 months of age according to maternal education and family income.

## Results

The initial sample consisted of 4275 children, with the smallest sample size analyzed being 3857 children (adjusted models - outcome number of health problems up to 24 months). Half of the sample was female, with a mean of 269 days of gestational age and 3171 grams of birth weight. The average income was close to three thousand reais (standard deviation = 4361). Most mothers had nine years of schooling or more (65.2%). At three months, 44.7% of the children were exclusively breastfed. At 12 and 24 months, 74.1% and 73.9% had some of the health problems assessed, with cough and ear pain being the most frequent. The frequency of two or more health problems was similar at 12 and 24 months, approximately 44%. At two years, children had, on average, 2.9 health problems with a standard deviation of 2 (Table 1).

Table 1  
Sample description. 2015 Pelotas Birth Cohort

<b>Variables</b>	<b>% or mean (sd)</b>
<b>Perinatal (n = 4275)</b>	
Female sex	49.4
Gestational age (in days)	269 (16)
Birth weight (g) (n = 4259)	3171 (574)
Wealth, family income (in Brazilian currency) (n = 4273)	3064 (4361)
<b>Maternal schooling at birth (n = 4274)</b>	
0–4	9.2
5–8	25.6
9–11	34.1
12 or more	31.1
<b>Three months</b>	
<b>Breastfeeding (n = 4102)</b>	
Exclusive	44.7
Predominant	7.4
Partial	24.4
weaned	23.5
<b>12 months</b>	
<b>Health problems (n = 4017)</b>	
Cough	39.1
Difficulty breathing	22.5
Diarrhea	13.6
Other health problem	15.1
Ear pain	32.6
Pneumonia	7.5
Urinary infection	3.4
Hospitalization	16.8
a - n = 4011	

<b>Variables</b>	<b>% or mean (sd)</b>
1 or more problems <sup>a</sup>	74.1
2 or more problems <sup>a</sup>	44.2
<b>24 months</b>	
Health problems (n = 4011)	
Cough	43.3
Difficulty breathing	22.2
Diarrhea	14.8
Other health problem	15.3
Ear pain	30.6
Pneumonia	5.9
Urinary infection	4.1
Hospitalization	7.9
1 or more problems <sup>b</sup>	73.9
2 or more problems <sup>b</sup>	43.5
Number of health problems <sup>c</sup> (12 + 24 months) (n = 3892 <sup>d</sup> )	2.9 (2.0)
a - n = 4011	

b - n = 4002

c – sum of all health problems reported up to 24 months

d – Valid information to health problems up to 24 months

At 12 months, the concomitant health problems were higher among children belonging to the poorest income quintile and with lower maternal education. At 24 months, the occurrence was higher among children with lower purchasing power ( $p = 0.025$ ) and education ( $p = 0.015$ ) for two or more health problems. There was no statistically significant difference for the occurrence of 1 or more problems according to income and education at 24 months (Fig. 1).

We observed an absolute and relative inequality for one or more and two or more problems at 12 months and two or more problems at 24 months. The highest magnitude was observed for two or more problems at 12 months, for absolute inequality according to education (SII= -0.23) and income (SII= -0.19) (Table 2).

Table 2  
 Absolute (SII) and relative (CIX) inequalities according to maternal schooling and wealth. 2015  
 Pelotas Birth Cohort

Health problems	Maternal schooling		Wealth, family income	
	SII (IC95%)	CIX (IC95%)	SII (IC95%)	CIX (IC95%)
12 months				
1 or more	-.19 (-.24; -.14)	-.04 (-.05; -.03)	-.18 (-.22; -.13)	-.03 (-.05; -.02)
2 or more	-.23 (-.29; -.18)	-.08 (-.10; -.06)	-.19 (-.25; -.14)	-.06 (-.08; -.04)
24 months				
1 or more	.00 (-.05; .05)	.00 (-.01; .01)	-.02 (-.07; .03)	-.01 (-.02; .01)
2 or more	-.08 (-.13; -.02)	-.03 (-.05; -.01)	-.09 (-.14; -.03)	-.03 (-.05; -.01)
*Note: SII – Slope Index of Inequality; CIX – Concentration Index				

When adjusting the analyses for sex and socioeconomic indicators, the associations were maintained only for two or more problems at 12 months, even after additional adjustment for breastfeeding pattern, gestational age, and birth weight. The number of health problems up to 24 months showed a linear association with education and income regardless of the adjustment (Table 3).

Table 3

Crude and adjusted analysis of health problems indicators and socioeconomic variables. 2015 Pelotas Birth Cohort.

Health problems	Maternal schooling*			Wealth, family income*		
	Crude	Adjusted 1	Adjusted 2	Crude	Adjusted 1	Adjusted 2
	PR (95%CI)					
12 months						
1 or more	<b>1.07 (1.03; 1,12)</b>	1.05 (1.00; 1.10)	1.04 (1.00; 1.09)	<b>1.05 (1.02; 1.08)</b>	1.03 (1.00; 1.06)	1.03 (1.00; 1.06)
2 or more	<b>1.16 (1.11; 1.22)</b>	<b>1.11 (1.05; 1.18)</b>	<b>1.11 (1.05; 1.18)</b>	<b>1.10 (1.06; 1.13)</b>	<b>1.04 (1.01; 1.09)</b>	<b>1.04 (1.01; 1.09)</b>
24 months						
1 or more	1.00 (0.96; 1.04)	0.99 (0.95; 1.03)	0.99 (0.95; 1.03)	1.01 (0.98; 1.03)	1.01 (0.98; 1.04)	1.01 (0.98; 1.04)
2 or more	1.05 (1.00; 1.11)	1.03 (0.97; 1.09)	1.03 (0.97; 1.10)	<b>1.04 (1.01; 1.08)</b>	1.03 (0.99; 1.07)	1.03 (0.99; 1.07)
Number of health problems (12 + 24 months)	<b>1.09 (1.07;1.11)</b>	<b>1.06 (1.04; 1.09)</b>	<b>1.07 (1.04; 1.09)</b>	<b>1.05 (1.04; 1.07)</b>	<b>1.03 (1.01; 1.05)</b>	<b>1.03 (1.01; 1.04)</b>
* Dose response relationship. Prevalence ratio (PR) represents the linear risk according to the decrease of the maternal schooling and wealth categories.						

Adjusted 1: sex and socioeconomic indicator (maternal schooling or wealth)

Adjusted 2: adjusted 1, breastfeeding, gestational age and birth weight

After adjustment, children with mothers with less and more education had, on average, 3.2 and 2.7 health problems, respectively. Children with lower purchasing power presented 3.1 health problems versus 2.8 for those in the richest quintile (Fig. 2).

## Discussion

The evidence here presented suggests inequalities in the occurrence of health problems, mainly related to the accumulation of morbidities in the first year of life. We observed absolute and relative inequalities for both ages (12 and 24 months). In addition, the average number of health problems was higher among

children whose mothers had less education and belonged to lower-income families, with a dose-response relationship.

The observed inequalities confirm the body of evidence on the influence of social determinants on the health situation of populations. Identifying a greater occurrence of health problems among children belonging to family groups with lower purchasing power is in line with the findings on the long-term effect of socioeconomic inequalities in the higher occurrence of chronic diseases in adulthood (16). In addition to other factors throughout the life cycle, such as healthy habits and obesity, the greater burden of acute problems in childhood may be associated with the chance of a chronic low-grade inflammation in adulthood, indicating another possible causal path for the cumulative effect of socioeconomic position on the pathophysiology of chronic diseases and mortality risk (3, 17–19).

The observed inequalities are related to the living conditions of families who experience difficulties providing adequate care and protection for health problems (20), mainly respiratory ones. Pelotas-RS is a city with high levels of humidity and severe winter, which makes quality housing, public transport, education system, and access to goods and services even more necessary, ensuring, as much as possible, the protection of children from breathing problems. On the other hand, a factor that may attenuate these inequalities is the protection generated by exclusive breastfeeding, which is greater among children with lower purchasing power (55% vs. 28% and 57% vs. 34%, compared to the extremes of education and income quintiles, respectively). Even so, this possible protection does not seem to be sufficient to mitigate the differences between children from different socioeconomic positions.

In addition, children up to 12 months of age may have a lower immune response when compared to those aged two years, that is, they may be more susceptible to health problems. In this study, lower maternal education and lower income were statistically associated with two or more health problems among children aged 12 months. Not only a lower immune response but also socio-economic conditions may influence child health. Studies have identified that children from families with lower socio-economic status, less education, or even brown or black skin color presented a higher risk of unfavorable health conditions (21, 22).

Hospitalization and pneumonia were health conditions whose prevalence drew our attention, especially among 12-month-old children. However, other problems such as coughing and difficulty breathing, which are part of the diagnosis for asthma, were also alarming for both 12-month and 24-month-old children. Regarding hospitalization, a study carried out in the 2004 cohort of Pelotas/RS observed similar prevalence to those identified in the present study. This prevalence was reduced at four and six years of age (9). Pneumonia is a major cause of hospitalization among children (9, 23, 24), and in some more severe cases, it can progress to death, especially among children under 12 months of age (23, 25). However, after vaccination against the main causative agents of the disease (12 months), the prevalence of pneumonia decreased considerably, remaining stable or without a notable reduction among children from families with lower purchasing power (26).

We are aware that our study may have some limitations. The possibility of a recall bias due to the temporality of the questions should be considered, which could underestimate our findings. However, we believe that all health problems investigated are very marked at this stage of life (children up to two years old). Another limitation could be the use of cough and difficulty breathing in the score for health problems together with pneumonia and hospitalization, considering that these two problems are part of the diagnosis of asthma. Nevertheless, the association was maintained when we performed sensitivity analyzes removing cough and difficulty breathing from the health problem score. Finally, we obtained all health problems through a report by the mother or guardian, and we did not perform objective measures (medical records, for example) to assess these health problems among the children.

## Conclusion

This study confirms inequalities in the occurrence of health problems among Brazilian children. The remarkable difference found in the first year of life signals the impact of socioeconomics on health status before health interventions which seem to reduce inequalities over time (e.g., vaccination and respiratory problems up to 12 months). Despite the advances of the Brazilian health system in improving maternal and child health conditions (27, 28), actions to reduce social inequalities (the cause of the causes) (29) are still necessary to avoid medium- and long-term effects of increased exposure to health problems in early life. To sum up, this study highlights the relevance of the concomitant assessment of problems that better capture the socioeconomic differences in health problems in children up to 24 months of age.

## Abbreviations

COPD  
Chronic Obstructive Pulmonary Disease  
CIX  
Concentration Index

## Declarations

### Availability of data and materials

The data that support the findings of this study are available from the 2015 Pelotas (Brazil) Birth Cohort, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are, however, available from the “Centro de Pesquisas Epidemiológicas (CPE) of Pelotas, RS, Brazil” on request by the publications committee upon reasonable request at [cpublicacoes.coortspelotas@gmail.com].

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### **Author information**

BPN, ADB made substantial contributions to the conception and design of the work; BPN, TRF conducted the statistical analyses and wrote the first draft of the work; and VIAM, BHL, MCG, MPTS reviewed the drafting work critically and made significant intellectual contribution to interpretation of the data. All authors approved the submitted version of the manuscript and agreed to be accountable for all aspects of the work in ensuring that issues related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript

### **Ethics declarations**

The 2015 Birth Cohort project was submitted and approved by the Research Ethics Committee of the School of Physical Education of the Federal University of Pelotas, under protocol number 26746414.5.0000.5313. All mothers interviewed signed an informed consent form, agreeing to participate in the study. The research involving were performed in accordance with the Declaration of Helsinki and the relevant guidelines and regulations.

### **Consent for publication**

Not applicable

### **Competing interests**

The authors declare that they have no competing interests.

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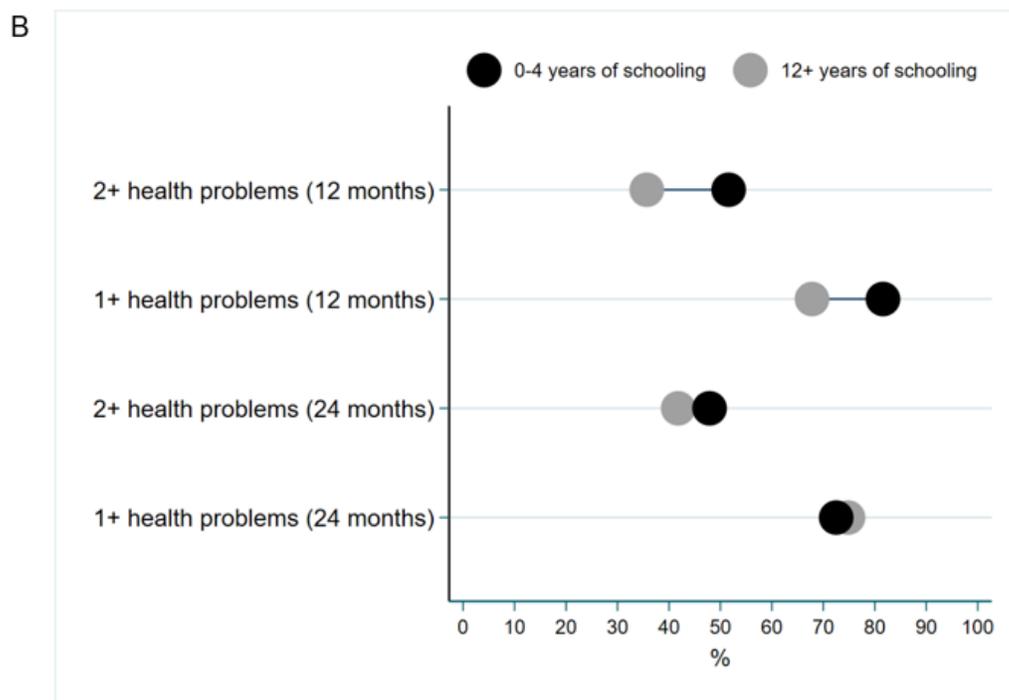
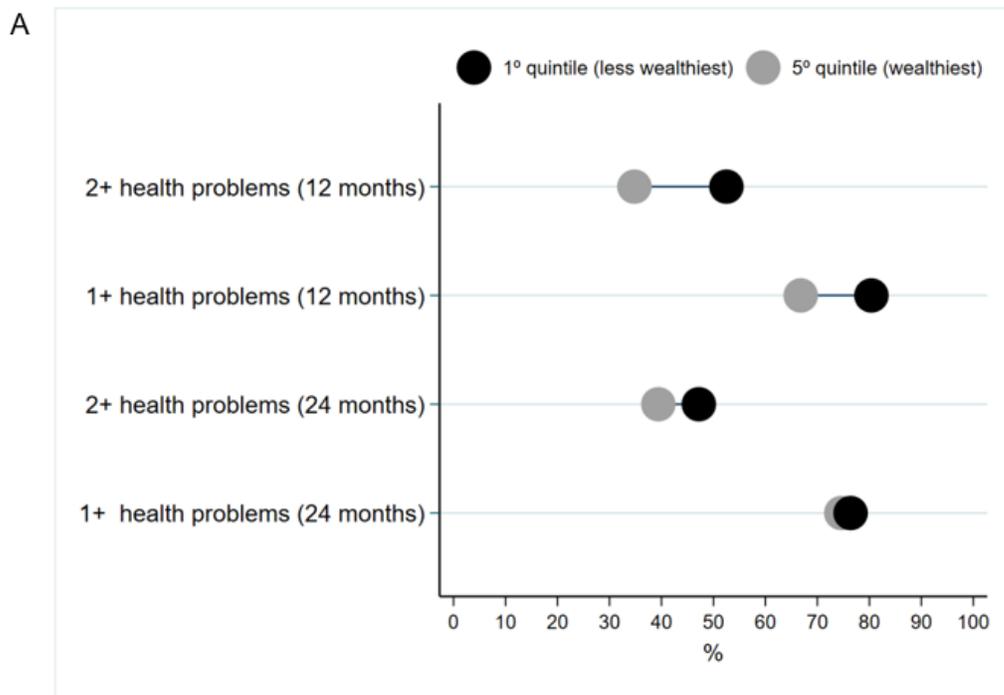
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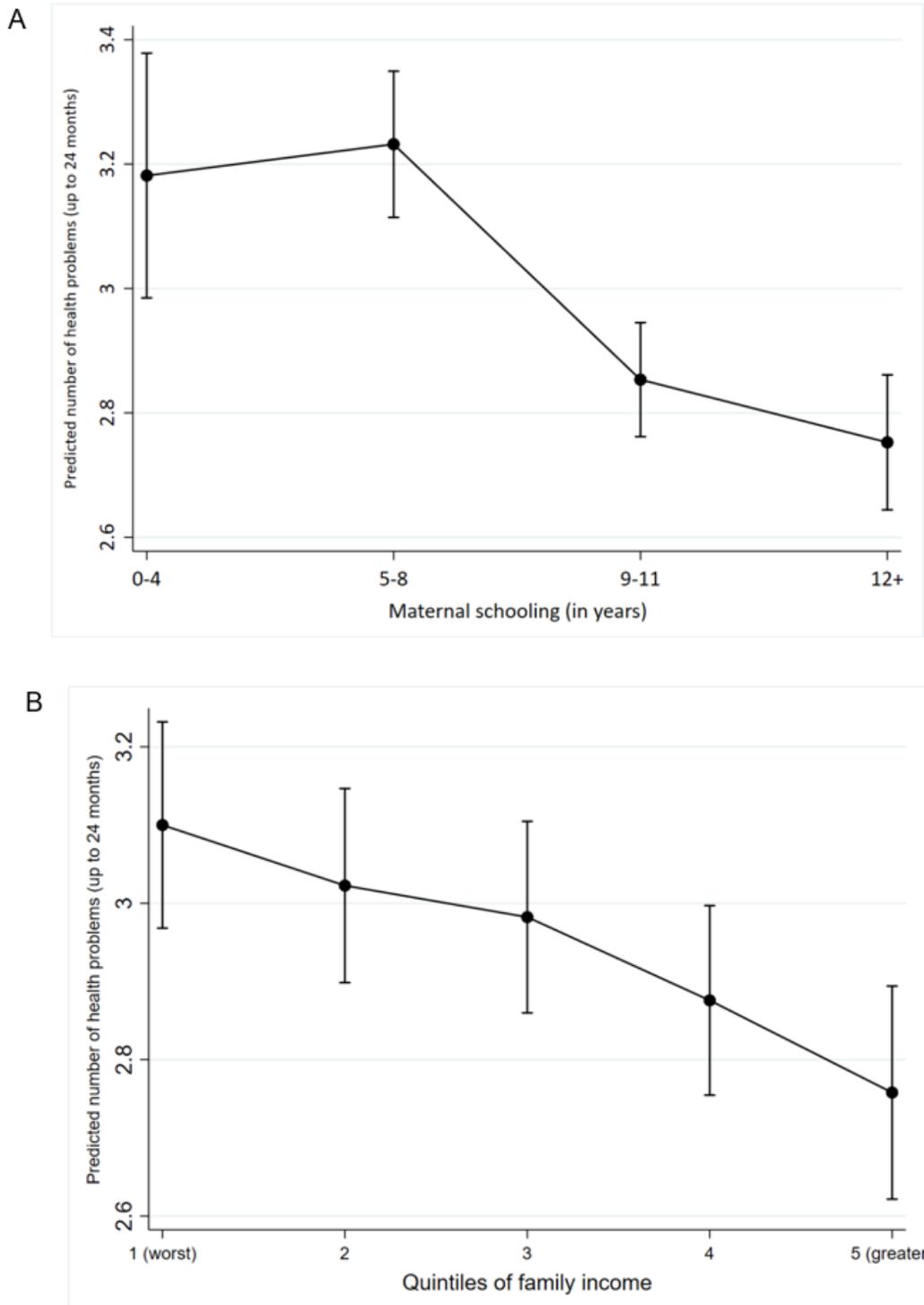
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## Figures



**Figure 1**

Health problems at 12 and 24 months according to extremes of wealth quintiles (A) and maternal schooling (B). 2015 Pelotas Birth Cohort.



**Figure 2**

**Predicted number of health problems up to 24 months of age according to maternal schooling (A) and wealth (quintiles of family income) (B). 2015 Pelotas Birth Cohort**