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Social determinants of gastrointestinal malformation mortality in Brazil: a national study

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ABSTRACT

Introduction In Brazil, approximately 5% are born with a congenital disorder, potentially fatal without surgery. This study aims to evaluate the relationship between gastrointestinal congenital malformation (GICM) mortality, health indicators, and socioeconomic factors in Brazil.

Methods GICM admissions (Q39–Q45) between 2012 and 2019 were collected using national databases. Patient demographics, socioeconomic factors, clinical management, outcomes, and the healthcare workforce density were also accounted for. Pediatric Surgical Workforce density and the number of neonatal intensive care units in a region were extracted from national datasets and combined to create a clinical index termed 'NeoSurg'. Socioeconomic variables were combined to create a socioeconomic index termed 'SocEcon'. Simple linear regression was used to investigate if the temporal changes of both indexes were significant. The correlation between mortality and the different indicators in Brazil was evaluated using Pearson's correlation coefficient.

Results Over 8 years, Brazil recorded 12804 GICM admissions. The Southeast led with 6147 cases, followed by the Northeast (2660), South (1727), North (1427), and Midwest (843). The North and Northeast reported the highest mortality, lowest NeoSurg, and SocEcon Index rates. Nevertheless, mortality rates declined across regions from 7.7% (2012) to 3.9% (2019), a 51.7% drop. The North and Midwest experienced the most substantial reductions, at 63% and 75%, respectively. Mortality significantly correlated with the indexes in nearly all regions ($p<0.05$).

Conclusion Our study highlights the correlation between social determinants of health and GICM mortality in Brazil, using two novel indexes in the pediatric population. These findings provide an opportunity to rethink and discuss new indicators that could enhance our understanding of our country and could lead to the development of necessary solutions to tackle existing challenges in Brazil and globally.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Congenital malformations often demand highly complex surgical procedures and can be life-threatening without access to appropriate surgical care. Social determinants can be a particularly relevant variable in these patients' outcomes. Despite indexes correlating health and socioeconomic development, knowledge gaps related to the intersection between sociodemographic, health system conditions and pediatric surgical outcomes remain. In this study, we sought to use available child and maternal health indicators and group them into two compound indexes that could reflect these two determinants of child health.

WHAT THIS STUDY ADDS

⇒ In this study, we identified a possible association between gastrointestinal congenital malformation mortality and social determinants of health, as evidenced by a significant correlation between mortality rate decrease and improvement of surgical and social indexes across all regions and in Brazil.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This analysis might aid stakeholders and policymakers in effectively comprehending the distinct needs of surgical conditions across the country, taking into account the varying availability of resources, and ultimately guiding the formulation of policies aimed at reducing child mortality rates.

INTRODUCTION

Congenital anomalies afflict approximately 6% of children worldwide each year, with gastrointestinal malformations being among the most prevalent.[1 2] These malformations often require highly complex surgical procedures and can be life-threatening without access to appropriate surgical care.[2] In Brazil, congenital anomalies represent the second leading cause of disability-adjusted life year (DALY) loss in children under 1 year of age.[3]

There is growing recognition that the outcomes for children affected by these conditions are not solely determined by medical care. Mortality is frequently related to social determinants of health (SDH). These determinants include factors beyond medical care

that are significantly influenced by social policies, and play a crucial role in shaping health outcomes. In 2008, the WHO Global Commission on the Social Determinants of Health identified inequities in the conditions in which people are born, live, work, and age, driven by inequities in power, money, and resources that drive inequities in health as increasing mortality.[4] SDH can be particularly relevant in congenital malformations. A recent study on gastrointestinal congenital malformations (GICMs) evidences how a country's income is significantly associated with GICM mortality, with rates ranging from only 5.6% in high-income countries (HICs) to 39.8% in low-income countries (LICs).[2]

Despite being classified as an upper middle-income country, Brazil exhibits significant social disparities between and within its regions. Some regions' socioeconomic indicators resemble HICs, while others resemble LICs.[5] These translate into disparate health outcomes related to barriers around access, capacity, and provision of care. In 2020, Brazil's degree of wealth inequality measured by the Gini coefficient reached 48.9, one of the highest in the world.[6] According to a World Bank report, from 2021, approximately 150 million people in Brazil live in extreme poverty, with children and adolescents being particularly vulnerable to this challenging socioeconomic environment.[7] These numbers can translate into disparate congenital disease incidences and outcomes, with the regional incidence of congenital defects in Brazil varying from 2% to 6%.[8–10] Therefore, Brazil was chosen as a research subject due to its significant regional disparities.

Interestingly, despite existing health and surgical indicators there is, to our knowledge, there is a lack of measures that could express the reality of a heterogeneous country like Brazil and a complex disease like GICM, in addition to a gap in information regarding the relationship between congenital disease mortality and sociodemographic factors. Indicators such as the low Human Development Index (HDI), per capita income, sanitation, and also clinical and healthcare professionals' indicators, play a crucial role in determining health outcomes.[11–13] Evaluating these potential associations may help further understand the complex national context and propose strategies to improve healthcare delivery.

This study aims to evaluate the mortality rate from GICMs and investigate correlations with social and clinical indicators across Brazilian regions.

MATERIALS AND METHODS

Data collection methods and data sources

We designed a comprehensive two-way ecological study to investigate the association between GICM mortality and selected socioeconomic indicators in Brazil. We considered the inter-regional variability of Brazilian social conditions and the changes in these conditions from 2012 to 2019.

Table 1 ICD-10 of the selected gastrointestinal congenital diseases used in this study ('other congenital malformations of the digestive system (Q38–Q45)')

ICD-10	Disease
Q38	Other congenital malformations of the tongue, mouth and pharynx
Q39	Congenital malformations of the esophagus
Q40	Other congenital malformations of the upper digestive tract
Q41	Absence, atresia, and congenital stenosis of the small intestine
Q42	Absence, atresia, and congenital stenosis of the colon
Q43	Other congenital malformations of the bowel
Q44	Congenital malformations of the gallbladder, biliary tract and liver
Q45	Other congenital malformations of the digestive system

ICD, International Classification of Diseases.

We gathered data from several resources, including DATASUS (Brazil's SUS Health System Informatics Department), the Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics), and Cadastro Nacional de Estabelecimentos de Saúde (Brazilian National Register of Health Facilities). For each time point and region of Brazil, the following data were collected and tabulated: population, number of pediatric surgeons, number of anesthesiologists, number of grade III neonatal beds, gross domestic product (GDP), under-1 child mortality, maternal mortality, teenage pregnancy rate, lack of sanitation-associated mortality, number of children diagnosed with GICM, and mortality rate associated with GICM.

Gastrointestinal congenital disease information

International Classification of Diseases (ICD)-10 codes Q38–Q45 (table 1) were included as GICM and used to search diagnoses in the DATASUS system. This government-funded database and reporting system represents 60–70% of all hospital admissions and requests the hospitals to submit monthly reports on various diagnostic and procedural statistics, including the causes of morbidity or mortality of patients. It is important to stress that we included all children admitted with a diagnosis of GICM (ICD-10 Q38–Q45), regardless of whether they were treated or not.

Indexes

The authors, a group of pediatric surgery and global surgery specialists, meticulously selected all indicators by considering those endorsed by the WHO and UNICEF as robust measures of socioeconomic development.[14] After selecting a few indicators, the authors came to a consensus to use, from the available Brazilian databases

consulted, those indicators that had a stronger potential connection with child healthcare, as will be presented in detail.

Neonatal Surgical Care Index

We developed the concept of the Neonatal Surgical Care (NeoSurg) Index, explicitly tailored to measure the availability of resources for high-quality neonatal surgery, according to the Optimal Resources For Children's Surgical Care document.[15]

The NeoSurg Index combines the Pediatric Surgical Workforce (PSWF—the sum of available pediatric surgeons, anesthesiologists, and neonatal nurses per 1000 live births) with the number of neonatal intensive care unit (NICU) beds per 1000 live births, according to the following formula: (PSWF+NICU)/2. We opted to combine these two indicators, as neonatal surgical outcomes rely strongly on both the presence of qualified pediatric surgeons and on the neonatal care facilities capable of providing adequate resuscitation and perioperative care. This index could assist in assessing the local availability of both professionals and facilities that allow the performance of complex neonatal surgery.

The Childhood Related Socio-Economic Index

The Childhood Related Socio-Economic (SocEcon) Index was developed as an attempt to investigate the relationship between the outcome of the treatment of GICM and the levels of socioeconomic development of specific areas. Initially, it would seem that the HDI would be the most appropriate to evaluate those conditions. The HDI is a summary measure of average achievement in three key dimensions of human development: a long and healthy life, being knowledgeable, and having a decent standard of living, and is calculated as the geometric mean of normalized indices for each of the three dimensions. Although extremely useful for evaluating a country or region's life conditions, this index is also non-specific and fails to address specifically the determinants of child health. Additionally, this index is not presently available, every year, for all the different regions of Brazil.

Lack of sanitation or adequate hygiene conditions is strongly related to both maternal and newborn health.[16 17] This indicator has been already used in different Child Health Indexes such as the Child Health Score (CIESIN/YCELP) proposed by the Millennium Challenge Corporation,[13] which is calculated as the average of three, equally weighted indicators:

1. Access to improved sanitation: produced by the WHO and the UNICEF, and measures the percentage of the population with access to facilities that hygienically separate human excreta from human, animal, and insect contact.
2. Access to improved water: universal access to safe drinking water is a fundamental need and human right, and securing its access would reduce illness and death, especially among children. It is included as an intermediate outcome indicator in the core set of indicators for the Global Nutrition Monitoring Framework, by the WHO and UNICEF, measuring the percentage of the population with easy access to at least 20 L of water.[12 18]
3. Child mortality (ages 1–4 years): produced by the United Nations Inter-agency Group for Child Mortality Estimation, this indicator measures the probability of dying between ages 1 and 4 years.[19]

Maternal health, specifically maternal mortality, has also been associated with neonatal health as it expresses the access of the mother to perinatal health facilities and professionals, which influence the prevention of gestational complications and the eventual prenatal diagnosis of congenital defects.[20]

Furthermore, teenage pregnancy is associated with a higher risk of socioeconomic disadvantage, mental health problems, and substance use during pregnancy, which may be associated with an increased incidence of birth defects.[21 22] Statistically, young pregnant women attend prenatal appointments less frequently, particularly in rural areas, and their newborns more frequently develop respiratory failure and sepsis.[23] Additionally, teenage pregnancy has been correlated with preterm births.[24] This is critical, as a higher percentage of neonatal morbidity has been associated with gestational age equal to or lower than 37 weeks of gestation.[24]

Although under-5 mortality is the most used indicator of child mortality in global health, we decided to use the under-1 childhood mortality in this index, as the most prevalent cause of death, and DALY in this age group is more strongly related to newborn health which is the focus of our study.[25 26]

Based on the above considerations, we created, for this study, the SocEcon Index (a child health-related socioeconomic index) combining five of the aforementioned determinants of child health and socioeconomic indicators:

- Gross national product (GNP) per capita (US$)
- Under-1 general childhood mortality (U1CM-%)
- Teenage pregnancy rate (TP-per 100.000 women)
- Maternal mortality rate (MM-per 1000 births)
- Hygiene-related mortality (HRM-per 100.000 inhabitants)

These indicators were associated using the following formula (GNP–U1CM–TP–MM–HRM)/5. In this formula, we used the negative value of the last four indicators to reflect the fact that lower values of those indicators reflect better living conditions.

Statistical analysis

The data collected were stored in an Excel document and standard descriptive statistics were applied. Before analysis, data were analyzed for completeness, and duplicates were removed. Also, to comply with the Brazilian laws of data protection, all data were unidentified before analysis. Data were analyzed using the GraphPad Prism V.10 package. Continuous variables (if normally distributed) were described in terms of mean+SD. Mortality is

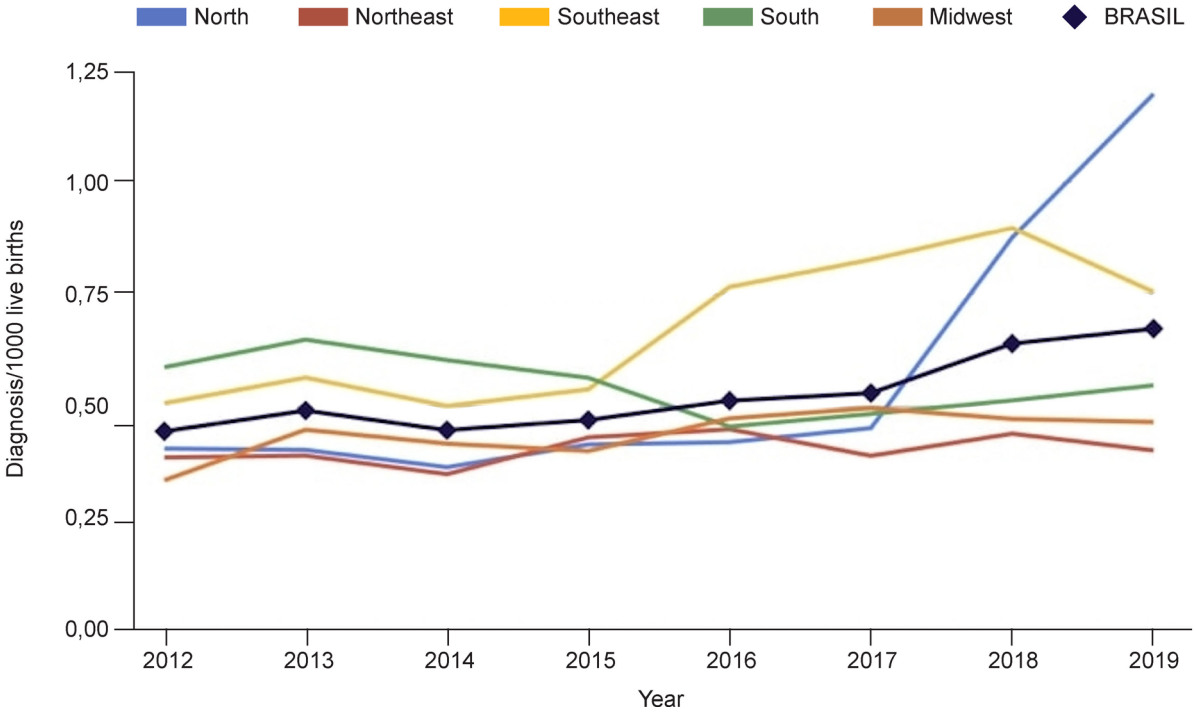


Figure 1 Number of gastrointestinal congenital anomaly diagnosis per 1000 live births, by region, from 2012 to 2019.

described as the percentage of deceased children with a diagnosis of GICM.

The primary outcome was defined as the mortality associated with GICM. The yearly evolution of the GICM mortality and both indexes were displayed and analyzed nationally and at a regional level. Simple linear regression was used to investigate if the temporal changes of both indexes were significant. The correlation between mortality and the different indicators in Brazil and the different regions was evaluated using Pearson's correlation coefficient. A correlation coefficient was considered statistically significant if $p<0.05$.

RESULTS

Demographics

From 2012 to 2019, Brazil recorded a total of 12804 patients diagnosed with gastrointestinal malformations (codes Q39–Q45). These cases were distributed regionally as follows: 1427 in the North, 2660 in the Northeast, 6147 in the Southeast, 1727 in the South, and 843 in the Midwest.

Congenital gastrointestinal anomaly diagnosis by region

The number of children diagnosed with GICM registered in our national database increased across all regions from 2012 to 2019 (figure 1). Throughout this time frame, the total number of congenital gastrointestinal anomaly cases increased by 39.4% nationally (figure 1). This increase varied across the Brazilian regions, and it was more pronounced in the North (from 125 to 376 diagnoses) and Southeast regions (from 584 to 833 diagnoses). Meanwhile, the Northeast region experienced a relatively stable incidence (321 and 315) ($p=0.3168$), the Midwest region witnessed a small increase from 77 to 112 diagnoses over the same period, and the South region evidenced a slow non-significant decline ($p=0.083$), with diagnoses decreasing from 224 in 2012 to 211 in 2019. Figure 1 summarizes the number of GICM diagnosed per 1000 live births, by region, from 2012 to 2019.

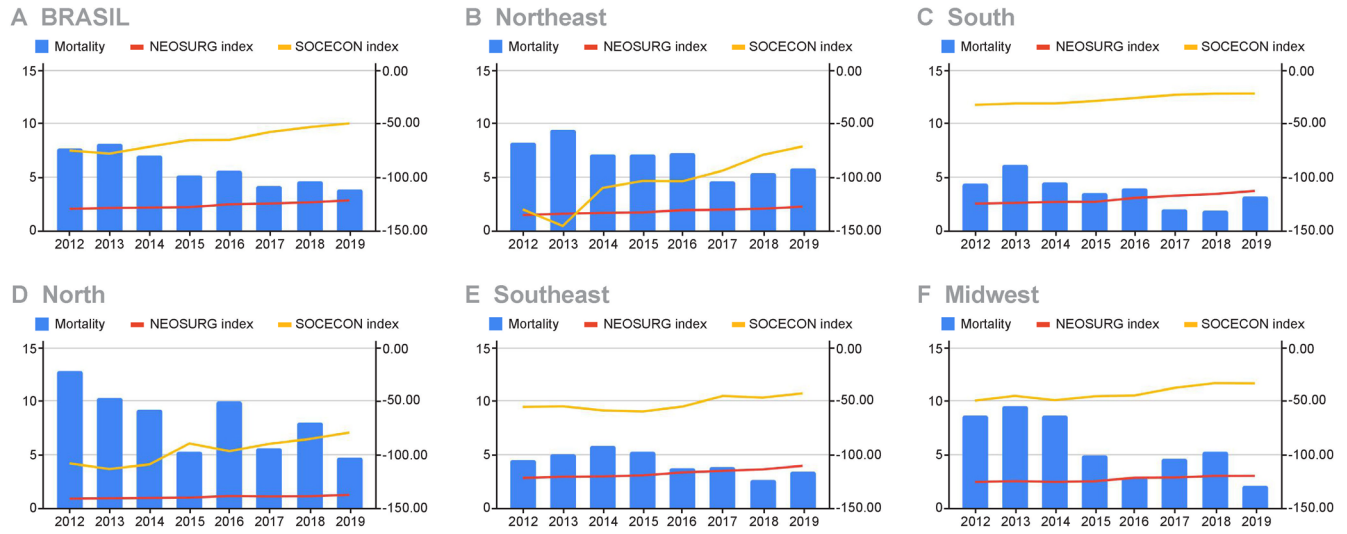
Mortality by region

Overall, mortality associated with GICM in Brazil decreased from 7.7% in 2012 to 3.9% in 2019, representing a 51.7% reduction. The degree of this reduction varied between regions and was more pronounced in the North and Midwest regions at 63% and 75%, respectively. The North region, which had the highest gastrointestinal mortality rate in 2012 (12.8%), dropped to 4.73% in 2019.

The Northeast region presented the second-highest gastrointestinal mortality rate in 2012 (8.21%) when compared with the other Brazilian regions. Concomitantly, these two regions are the ones displaying lower NeoSurg (respectively, 0,91 and 1,48 in the North and Northeast regions) and SocEcon (respectively, −107 and −129 in the North and Northeast regions) Indexes in the same year, while nationally, these indexes were respectively, 2.05 and −75.04.

From 2012 to 2019, both indexes improved in Brazil as a whole. Linear regression analysis showed a significant although variable improvement in both indexes across the different regions of Brazil, with a drop in GICM mortality.

The correlation between the evolution of GICM mortality with the different indicators is summarized at the bottom of figure 2. There was a significant correlation



Pearson's correlation coefficient	North	Northeast	Southeast	South	Midwest	Brazil
Mortality vs. NEOSURG index	-0.643	-0.775	-0.803	-0.729	-0.793	-0.884
p value	0.090	0.024	0.017	0.040	0.019	0.004
Mortality vs. SOCECON index	-0.807	-0.882	-0.808	-0.822	-0.649	-0.958
p value	0.016	0.004	0.015	0.012	0.082	0.000

Figure 2 Temporal variation and indicators of mortality due to GICM from 2012 to 2019. This figure illustrates the annual variation in mortality rates associated with GICM across Brazil and its regions, alongside the developed NeoSurg and SocEcon indicators. The left y-axis pertains to the mortality rates, while the right y-axis reflects the values for the NeoSurg and SocEcon Indexes. Each panel represents a different geographical area, arranged as follows: Brazil (A), NorthEast (B), South (C), North (D), South East (E) and MidWest (F). GICM, gastrointestinal congenital malformation; NeoSurg, Neonatal Surgical Care Index; SocEcon, Childhood Related Socio-Economic Index.

between mortality and the included indexes in practically all regions ($p<0.05$). Exceptions were the North region (where correlation with NeoSurg Index was not statistically significant, ($p=0.0897$) and the Midwest region (where correlation with SocEcon Index was not statistically significant, $p=0.0819$).

DISCUSSION

GICMs account for a significant proportion of congenital anomalies and can be fatal without access to complex surgical care. Understanding how SDH and access to clinical care intersect and influence patient outcomes is essential. In this study, we identified a possible association between GICM mortality and SDH, as evidenced by a significant correlation between a decrease in mortality rates and improvement of both NeoSurg and SocEcon Indexes. Moreover, we found a significant GICM mortality reduction in all regions of Brazil. This decline was more pronounced in the North, Northeast, and Midwest regions, where the higher mortality rates, all above 8%, were found in 2012. Data from 2019 show that all five regions of Brazil have reduced GICM to below 6%. Additionally, we observed an increase in GICM incidence across all regions from 2012 to 2019.

These indexes were developed to assess specific child health determinants in different regions, considering unique health components and regional disparities.[27–29] The NeoSurg and the SocEcon Index scores demonstrated a strong correlation with GICM mortality in most regions. In 2012, GICM mortality stood at 7.77%, aligning with figures typical of lower middle-income countries (LMICs). By 2019, it had decreased to 3.86%, comparable with HICs.[2] Mortality decrease coincided with improvements in both the NeoSurg and SocEcon Indexes. Notably, regions with higher 2012 mortality rates also exhibited lower NeoSurg scores (0.91 and 1.48, respectively) and SocEcon scores (−107.96 and −129.95, respectively). Interestingly, the Midwest region, which experienced the most significant mortality decrease, had a substantial SocEcon Index growth (17%). This suggests that the SocEcon Index may have had a more pronounced impact on mortality reduction in this region.

Healthcare inequality is highly prevalent throughout Latin America.[30] For instance, Brazil comprises five regions with significant differences and inequities.[31] The South and Southeast regions, which presented the lowest mortality rates in our study, are characterized by their wealth and hold most of the nation's GDP.[32] The Southeast region, the second-smallest region in Brazil, holds over 44% of the country's population and contributes to over half of the national GDP.[33] Yet, this national economic concentration has decreased in recent years, and other regions, such as the Midwest, have experienced an increase in GDP.[33]

Interestingly, the Midwest region has its particularities. In 2012, this region had a high GICM mortality rate but had NeoSurg and SocEcon Indexes comparable with the wealthier South and Southeast regions. This might be explained by the fact that this region exhibits the most pronounced income inequality nationwide, as evidenced

by a Gini coefficient of 0.58.[33] This region combines polarized rural and urban settings. Rural settings consist of large farming areas with low population density, scattered urban centers, and limited access to high-quality perinatal and neonatal care. In contrast, the urban setting includes the Federal district, where Brasília, the country's capital, is located. The Federal district displays high social indicators, including the highest GDP per capita and HDI in the country, and accommodates prestigious neonatal care centers.[34] Still, it is remarkable that, from 2012 to 2019, GICM mortality in this region decreased from 8.63 to 2.14, the lowest of all the five regions. This improvement was also associated with an improvement of both NeoSurg (22.58%) and SocEcon (32.51%) Indexes.

Lastly, we have the North and Northeast regions. From a demographic perspective, the North region is the largest in Brazil, covering 45.27% of the country's territory.[32] However, it is the second least populated and one of the poorest regions, with a small share of the national GDP and population.[35] Its NeoSurg Index in 2012 was 0.91, the lowest among the regions, and its SocEcon Index (−107.96) was the second lowest in the country. Of note, this region has a comparatively low specialized health workforce density. For instance, in Acre, one of the states that compose this region, there are only two registered pediatric surgeons.[27] However, both indexes showed a significant improvement (40.33% and 26.66%, respectively), and GICM mortality reduced from 12.8% to 4.73%. This is likely attributed to rooted regional social demographic barriers that historically impact neonatal surgery, and any improvement in social conditions and healthcare access might significantly reduce GICM mortality.

Similarly, the Northeast region presented the lowest SocEcon Index in 2012 (129.25) and the second lowest NeoSurg Index (1.48). Although both indexes significantly improved from 2012 to 2019, the mortality rate reduction was only 28% (from 8.21% to 5.87%), and in 2019, this region still displayed the highest mortality rate. A possible explanation might reside in the profound economic and social differences among the different states and municipalities that compose the Northeast region. This region contributes to 13.4% of Brazil's GDP, and approximately 40% of the population lives in poverty.[28 35] Despite the existence, in the larger urban centers, of adequate facilities to treat newborns with complex anomalies, around 15 million people live in rural areas, and it is highly probable that many patients do not have access to essential healthcare resources.

Regarding these last two regions, the North and Northeast, it is noticeable that despite improvements, these regions still display the poorer NeoSurg and SocEcon Indexes and also have the highest mortality rates in the country. This might indicate that more focused interventions, aiming to improve socioeconomic, educational, and health conditions, should be implemented in these regions to bring them to national levels and possibly improve neonatal outcomes.

Insufficient congenital anomaly registries and limited national research may contribute to the lack of comprehensive data on congenital defect prevalence and incidence.[2] Over the examined period, GICM significantly increased. However, it is not clear if these numbers represent an actual increase in these malformations' incidence, an increase in the proportion of patients accessing care, or an improvement in the reporting and registration of new cases. This trend may be attributed to the growing availability, number, and diversity of diagnostic tools, including prenatal diagnosis with the potential for treatment even before birth in certain cases.[36 37] For instance, in 2017, there has been a major public health policy implementation influenced by the Pan American Health Organization meeting.[38] This strategy focused on overcoming healthcare workforce barriers, developing formal education and training programs for multidisciplinary professionals, which could be reflected in the significant increase in pediatric and neonatal diagnosis in lower-resource regions of Brazil. The North region, for example, increased the number of formal pediatric and neonatal nursery educational opportunities, between 2017 and 2019, from 100 to 124 courses.[39] Yet, despite significant increases in diagnosis and decrease in mortality, access is not uniformly distributed among different states and regions of the country. Such disparities in access could result in delays in diagnosis and treatment, as well as under-reporting.

Understanding the impact SDH may have on congenital disease mortality is crucial to correctly assess the efficacy of current efforts for care improvement and to allocate resources specific to each region's needs adequately. Therefore, our study might aid stakeholders and policymakers in comprehending the distinct surgical condition needs nationwide, accounting for the varying availability of resources, and ultimately guiding the formulation of policies aimed at reducing child mortality rates, including district hospital referral systems improvement and increasing access to antenatal ultrasound for early detection of conditions like GICM, along with upskilling staff for effective birth management. Furthermore, the study underscores the importance of comprehensive policies embracing social determinants and targeting specific regions, notably the North and Northeast. Moreover, it advocates a holistic rethink of healthcare at all levels, emphasizing the necessity for social reconstructions and deep-rooted solutions to strengthen the healthcare system and effectively address child mortality.

This study is not without limitations. We recognize the flaws in our national databases, specifically regarding hospital reporting, which can result in incomplete or inaccurate information. However, prior studies have validated these databases as sufficiently representative for research purposes.[29 40] Additionally, we acknowledge that our study is based on data from a single country and may not apply to other settings. However, it is worth noting that Brazil's states exhibit a similar socioeconomic

diversity to many other LMICs. Regarding factors that could play a crucial role in gastrointestinal malformation's mortality, several additional factors should be analyzed, including prenatal diagnostics, mode of delivery, the level of hospital specialization, and transportation and referral time from district hospitals to treatment centers. Our study did not adjust for these potential confounding factors, which remains a limitation. Furthermore, our study did not individually analyze each social variable or disease. The primary aim was to assess whether different regions of Brazil could offer the necessary conditions for providing specialized pediatric surgical care. Yet, individual analyses of social variables and diseases are necessary but were not a component of this study. We also recognize that including all gastrointestinal diseases from Q39 to Q45, despite most being surgical, can be less severe or even unspecific. Hence, the inclusion of different ICD diagnoses could influence the results; still, we sought to use a pool of diverse pediatric surgery disorders that might reflect the conditions offered to treat children in need of pediatric surgery care. Lastly, our selection of variables was based on established indicators that were readily accessible and held socioeconomic significance, aiming for a broad understanding of healthcare and social resources. However, future studies are needed to validate this tool and to further expand these variables to explore intersectional aspects and other healthcare outcomes, including quality of care and quality of life, more comprehensively.

CONCLUSION

Our study highlights the correlation between SDH and GICM mortality in Brazil, using two novel indexes designed to assess medical care access (NeoSurg) and socioeconomic factors (SocEcon) in the pediatric population. These findings provide an opportunity to rethink and discuss new indicators that could enhance our understanding of our country and could lead to the development of necessary solutions to tackle existing challenges in Brazil and globally.

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Contributors AG and JB-S conceived this research. AG, LT, and JB-S defined the study design and methodology. AG administered the research project. JB-S implemented the software's search strategy code. AG, AR, LT, AGM, MC, BOT, SBM, and LE reviewed and collected the data. AG and JB-S cleaned the data. JB-S conducted the formal analysis. JB-S validated the replication of the study findings. AG and JB-S contributed to the visualization by preparing the figures and tables. AG, AR, LT, AGM, MC, BOT, SBM, LE, and JB-S wrote the first draft. AG is the guarantor. All authors reviewed the manuscript. JB-S supervised the research project. All authors approved the final version.

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