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REVIEW ARTICLE

Infant mortality associated with social inequities: scoping review

Mortalidade infantil associada às iniquidades sociais: revisão de escopo

Laíze Rúbia Silva Corrêa[1], Nataly Yuri Costa[1], Gabriela Xavier Pantoja[1], Ana Kedma Correa Pinheiro[2], Ivaneide Leal Ataide Rodrigues[1], Laura Maria Vidal Nogueira[1]

ABSTRACT

Objective: To map and characterize research on infant mortality associated with social inequities in children under one year of age. **Method:** Scoping review performed according to recommendations from the Joanna Briggs Institute and the Systematic Reviews and Meta-Analyses Extension for Scoping Review (PRISMA-ScR), from March to April/2021, in MEDLINE, LILACS and CINAHL databases. Primary studies, systematic reviews, meta-analyses, guidelines and descriptive reports in Portuguese, English and Spanish, published between 2015 and 2021 were included. **Results:** Of the 7,016 publications, 61 were selected and grouped according to the mother's socioeconomic profile and healthcare, showing social inequities such as low schooling, low income, domicile in rural areas and difficulty in accessing quality care as determinants of infant mortality. **Conclusions:** Overall, there was a wide production of studies on infant mortality associated with social vulnerabilities.

Descriptors: Mortality; Infant Mortality; Social Determinants of Health; Socioeconomic Factors; Review.

RESUMO

Objetivo: Mapear e caracterizar pesquisas sobre mortalidade infantil associada às iniquidades sociais em menores de um ano. **Método:** Revisão de escopo realizada segundo recomendações do Joanna *Briggs Institute* e o *Systematic Reviews and Meta-Analyses Extension for Scoping Review* (PRISMA-ScR), no período de março a abril/2021, nas bases MEDLINE, LILACS e CINAHL. Foram incluídos estudos primários, revisões sistemáticas, metanálises, *guidelines*, diretrizes e relatórios descritivos, nos idiomas português, inglês e espanhol, publicados entre 2015 e 2021. **Resultados:** Das 7.016 publicações, 61 foram selecionadas, e agrupadas segundo o perfil socioeconômico da mãe e a oferta em saúde, evidenciando-se as iniquidades sociais como: baixa escolaridade; baixa renda; domicílio em zona rural e, dificuldade de acesso a assistência de qualidade como determinantes para a mortalidade infantil. **Conclusões:** Observou-se a ampla produção de estudos acerca da mortalidade infantil associada as vulnerabilidades sociais em um panorama geral.

Descritores: Mortalidade; Mortalidade Infantil; Determinantes Sociais da Saúde; Fatores Socioeconômicos; Revisão.

[1]Universidade do Estado do Pará (UEPA) – Belém (PA), Brazil. E-mails: laizerubia@gmail.com, nataly.costa@aluno.uepa.br, gabriela.pantoja@aluno.uepa.br, ana.pinheiro@aluno.uepa.br, ivaneide.rodrigues@uepa.br, lauravidal@uepa.br

[2]Universidade Federal do Rio de Janeiro (UFRJ) – Rio de Janeiro (RJ), Brazil. E-mail: anakedmaenf@gmail.com

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INTRODUCTION

Infant mortality, characterized by the death of children under one year of age, is an important indicator of the health level and socioeconomic development of a population. Infant mortality is related to social, economic, environmental and governmental determinants. Poor care for women and children are among factors influencing the incidence of this indicator. It is associated with low weight and prematurity at birth, pregnancy in adolescence or under 20 years of age or over 40 years of age, low quality of antenatal care, difficult access to health services, low assistance during labor and birth, low income, illiteracy, respiratory infections, among others[1].

Global strategies such as the Millennium Development Goals and the Sustainable Development Goals[2] have prioritized impact goals to reduce child deaths, seeking to eliminate those from preventable causes by reducing Social Inequities, conceptualized as social inequalities that can be prevented. Such inequalities reflect the little investment in public policies of a structural nature, such as basic sanitation, access to drinking water and sanitary sewage, in addition to the deprivation of health services and precariousness in the social environment[3].

Infant mortality rates dropped significantly between years 2000 and 2015, after implementation of the Millennium Development Goals[2]. However, the international literature highlights that African and Indian countries exhibit high and sustained rates of infant mortality due to structural difficulties and minimal maternal education that prevented the search for timely care, in addition to the lack of hope in receiving healthcare, a reality where social inequities are constant[4-6].

Brazil reached the goal of reducing the infant mortality rate by two thirds, going from 29 deaths per thousand live births in 2000 to 13.80 deaths per thousand live births in 2015[7]. However, the reduction in infant mortality in Brazil occurred heterogeneously. The North and Northeast regions[8] were the most affected given the worsening of social markers, such as socioeconomic inequality; precarious antenatal care; peregrination in antepartum and inadequate childbirth care due to the difficulty of accessing health services in comparison to rates in the South and Southeast regions[9-12].

Given the importance of this health indicator associated with factors that determine and worsen infant mortality, and the need to systematize this knowledge, the objective of this study was to map and characterize studies on infant mortality associated with social inequities in children aged under one year.

METHOD

A scoping review study to map the studies available in the literature[13].

The protocol was registered in the Open Science Framework on April 20, 2021 (https://osf.io/xj3u7). The recommendations of the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis, which comprise seven stages, were followed in the development of the study[13]: title and review questions; inclusion criteria; search strategies; screening and selection of evidence; data extraction; data analysis; presentation of results.

The PCC strategy — P: population, relative to study participants; C: concept, related to interventions and C: context, about the research scenario — was used in the development of the guiding question[13] and resulted in the following: What studies on infant mortality associated with social inequities in children under one year of age are available in the literature? Population: infants aged under one year; Concept: infant mortality associated with social inequities; and Context: open.

Primary studies, systematic reviews, meta-analyses, guidelines, descriptive, and reports addressing infant mortality associated with social inequities in children under one year of age, in Portuguese, English and Spanish, published between 2015 and 2021 were included. It is note that in 2015 the period established in the Millennium Development Goals for reduction of infant mortality in the world ended in 2015, and it is important to know the post-global pact scenario. Studies that did not have infant mortality (<1 year) associated with social inequities as a study object were excluded.

The search was performed between March and April 2021 in databases of the Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed, Latin American and Caribbean Literature in Health Sciences (LILACS) and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Descriptors and keywords extracted from the Health Sciences Descriptors (DeCS) and their English equivalents from the Medical Subject Headings (MeSH) were used, with a specific combination for each database.

As an example, the search strategy used in the LILACS database was as follows: (tw:("Mortalidade Neonatal" OR "Mortalidade Infantil Tardia" OR "Mortalidade Pós-Neonatal" OR "Mortalidade de Menores de um Ano de Idade" OR "Mortalidade do Lactente" OR "Mortality, Infant" OR "Neonatal Mortality" OR "Postneonatal Mortality" OR "Mortalidad Infantil Tardía" OR "Mortalidad Neonatal" OR "Mortalidad Neonatal Tardía" OR "Mortalidad Post-Neonatal" OR "Mortalidad Tardía del Lactante" OR "Mortalidad del Lactante" OR "Infant Death") OR mh:("Mortalidade Infantil" OR "Morte infantil")) AND (tw:("Determinante de Saúde" OR "Health Social Determinant" OR "Health Structural Determinant" OR "Determinante de Salud" OR "Aspectos Socioeconômicos" OR "Desigualdade" OR "Iniquidade" OR "Iniquidades das Políticas Econômicas" OR "Iniquidades das Políticas Econômicas e Sociais" OR "Nível de Vida" OR "Padrão de Vida" OR "Factor, Socioeconomic" OR "Standard of Living"

OR "Social Inequality" OR "Aspectos Socioeconómicos" OR "Desigualdad" OR "Factor Socioeconómico" OR "Inequidad" OR "Inequidad de las Políticas Económicas" OR "Inequidad de las Políticas Económicas y Sociales" OR "Estándar de Vida") OR mh:("Determinantes Sociais da Saúde" OR "Fatores socioeconômicos")) AND (db:("LILACS") AND la:("pt" OR "es" OR "en")) AND (year_cluster:[2015 TO 2020]). The Boolean operators OR and AND were used for combinations where tw is to 'word', mh is to 'subject', db is to 'database', and la is to 'language'.

The selection of articles was performed in four steps: a) search formed by the combination of keywords contained in the title, abstract, and descriptors or keywords of retrieved articles and application of the existing filters in each database, compatible with eligibility criteria; b) exclusion of duplicate articles using the Zotero Reference Management Software, version 5.0.96, developed in the United States of America, year 2021; c) pre-selection of articles relevant to the objective of the study by reading the title and abstract, d) reading of pre-selected articles in full, identifying their relevance to the study more precisely, excluding those that did not fit the inclusion criteria.

Procedures of data selection and extraction were performed by two researchers independently. Initially, the selection of articles was performed by consensus and automatically accepted. Any disagreement was resolved by consensus with the presence of a third reviewer.

A Microsoft Office Excel, version 2016, developed in the United States of America, form was created for the extraction and organization of data, based on JBI models of data extraction scripts for scoping analysis, in which the characteristics of studies were recorded. The form was tested by the team before its use and data mapping was done independently and in duplicate, resulting (consensus) in the following sections: year of publication, type of evidence, title, country, continent, journal and objective.

The extracted results were descriptively mapped, and analyzed by the occurrence of concepts and characteristics of the study. These are presented in narrative and tabular format, following the Methodology for JBI Scoping Reviews[14] recommendations. The writing of the final report was guided by the Preferred Reporting Items for Systematic reviews and Meta-Analyses Extension for Scoping Review (PRISMA-ScR) checklist[14].

RESULTS

A total of 7,016 documents were found through the search strategies in each database; 6,056 were removed after applying the inclusion and exclusion criteria, and 112 for being duplicates. A total of 848 titles and abstracts were kept for analysis, resulting in the selection of 236 for full reading, of which 112 were excluded for not showing adherence to the object of study; 27 for not showing association with social inequities; and 30 for extrapolating the age group beyond one year of age. Thus, the sample consisted of 61 articles. The description of the search process and the selection of articles is shown in Figure 1.

According to Chart 1, most studies were published in Brazil (12/61), followed by Ethiopia (8/61) and the United States of America (7/61). The predominant languages were English (50/61) and Portuguese (10/61). Regarding the year of publication, most were concentrated in 2019 (14/61), followed by 2021 (12/61) and 2015 (11/61).

As for methodological design, 57 (57/61) were quantitative studies; cross-sectional studies were the most recurrent (24/57), followed by cohort studies (15/57), ecological (10/57), case-control (6/57), systematic review (1/57), and a descriptive longitudinal study (1/57). Three (3/61) qualitative studies were identified, and one (1/61) mixed method case-control study (quantitative/qualitative) (Chart 1).

Regarding the theme of studies, 29 (47.54%) addressed the association of infant mortality with inequities directed to socioeconomic aspects, 10 (16.40%) highlighted infant mortality associated with inequities in health services and

Figure 1. Flow of the selection process of the scoping review studies adapted from PRISMA-ScR[14], 2015–2021

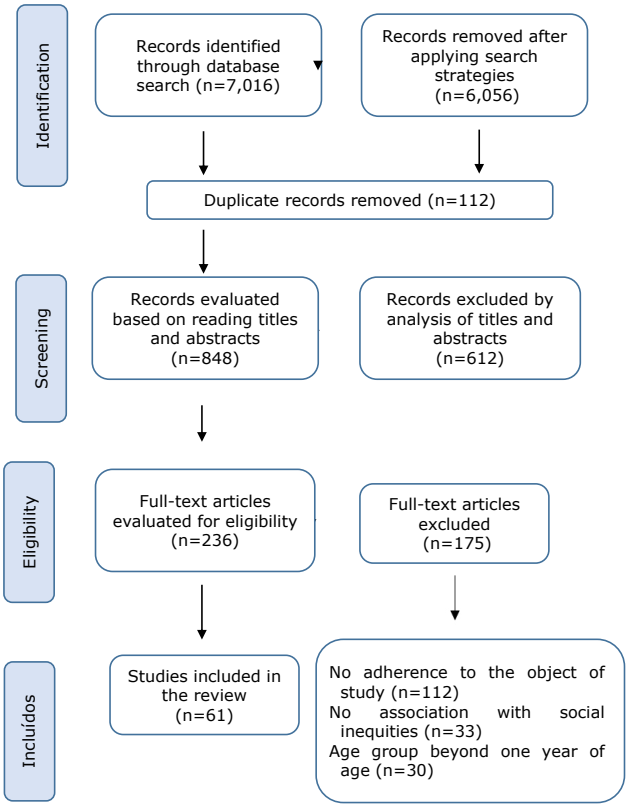

Chart 1. Characterization of publications on infant mortality associated with social inequities in children under one year old, 2015–2021

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
The socio-economic determinants of infant mortality in Nepal: analysis of Nepal Demographic Health Survey 2011[15]	2015/Nepal	Cohort study/ n=5,391	Multivariate logistic regression.	Infant mortality associated with socioeconomic factors such as schooling and maternal occupation and living in rural areas.
The Relationship between Parental Socioeconomic Status and Mortality in Premature Infants in Hospitals[16]	2015/ran	Cross-sectional study/n=114	Questionnaire and analysis by chi-square and Fisher methods.	Fetal death associated with cultural and socioeconomic status, age and maternal education.
Factores sociodemográficos y seguimiento prenatal asociados a la mortalidad perinatal en gestantes de Colombia[17]	2015/ Colombia	Cross-sectional study/n=14,754	Binary logistic regression model.	Sociodemographic characteristics and antenatal control affect the frequency of perinatal mortality in Colombian pregnant women.
Social equity in perinatal survival: a case-control study at hospitals in Kigali, Rwanda[18]	2015/Rwanda	Case-control study/n=702	Conditional logistic regression.	Living in a rural area and not having health insurance was associated with a higher risk of perinatal mortality rates in the capital of Rwanda, but maternal education and household goods were not.
Neonatal mortality in India's rural poor: Findings of a household survey and verbal autopsy study in Rajasthan, Bihar and Odisha[19]	2015/India	Cohort study/ n=189	Situational analysis.	The high proportion of neonatal deaths occur outside health facilities and birth asphyxia/injuries are the leading causes of death.
Inequalities in health: living conditions and infant mortality in Northeastern Brazil[20]	2015/Brazil	Ecological study/ n=not informed	Student's t-test.	Infant mortality showed a decline in territories with better living conditions.
Predictors for neonatal death in the rural areas of Shaanxi Province of Northwestern China: a cross-sectional study[21]	2015/China	Cross-sectional study/n=4,934	Lot Quality Assurance Sampling (LQAS).	Risk factors for neonatal death are related to multiparity, low educational level, lack of access to antenatal consultations in the first trimester of pregnancy and hospital delivery.
The Role of Empowerment in the Association between a Woman's Educational Status and Infant Mortality in Ethiopia: Secondary Analysis of Demographic and Health Surveys[22]	2015/Ethiopia	Cross-sectional study/n=45,952	Multivariate analysis.	Infant mortality is associated educational level, women's empowerment and socioeconomic conditions.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Place of Residence Moderates the Risk of Infant Death in Kenya: Evidence from the Most Recent Census 2009[23]	2015/Kenya	Cross-sectional study/ n=1,120,960	Multivariate analysis.	Infant mortality associated with the absence of drinking water and sanitation, low structural quality of housing and difficulty in accessing education, health services and family planning, especially in urban slums and rural areas.
Factors associated with neonatal deaths in Chitwan district of Nepal[24]	2015/Nepal	Mixed method case-control study/n=198	Interview and descriptive statistics.	Infant mortality associated with late emergency care for the newborn, low birth weight, low maternal education and antenatal care without adequate follow-up.
Factors associated with neonatal mortality in the general population: evidence from the 2007 Zambia Demographic and Health Survey (ZDHS): a cross sectional study[25]	2015/Zambia	Cross-sectional study/n=6,435	Questionnaire and interview.	Infant mortality was associated with rural residence, low birth weight, early age and low maternal schooling.
Regional Deprivation Index and Socioeconomic Inequalities Related to Infant Deaths in Korea[26]	2016/Korea	Cohort study/ n=7.810.689	Principal component analysis (PCA) method.	Regional deprivation was associated with infant mortality.
Ecological context of infant mortality in high-focus states of India[27]	2016/India	Ecological study/ n=not informed	Planned multiple regression analysis.	Association of infant mortality with socioeconomic inequalities, low maternal education and lack of knowledge about newborn care.
Factors associated with delay in care–seeking for fatal neonatal illness in the Sylhet district of Bangladesh: results from a verbal and social autopsy study[28]	2016/ Bangladesh	Cohort study/ n=331	Interview	Neonatal death without assistance. Economic and social beliefs delayed or prevented seeking care. Need to educate about danger signs for premature newborns, especially those born at home.
Spatial variations and regional inequalities in infant mortality in the State of Minas Gerais, Brazil[29]	2016/Brazil	Ecological study/ n=not informed	Empirical Bayesian method, and Carstairs and Morris.	The expansion of Primary Health Care and access to antenatal care were associated with a reduction in infant mortality.
Exploratory analysis of preventable first day mortality in Colombia[30]	2016/ Colombia	Cross-sectional study/ n=8,442,692	Time series analysis and linear regression analysis.	Infant mortality was associated with maternal low education, teenage pregnancy, being a single mother, unavailability of intensive care and living in rural areas.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Changes in Socio-Economic Inequality in Neonatal Mortality in Iran Between 1995-2000 and 2005-2010: An Oaxaca Decomposition Analysis[31]	2017/Iran	Cohort study/ n=113,957	Generalized Linear Model.	Improvement in maternal education and family financial status and access to health services were associated with reduced infant mortality.
Socioeconomic inequalities in neonatal and postneonatal mortality: Evidence from rural Iran, 1998–2013[32]	2017/Iran	Cohort study/ n=5,742,012	Multivariate regression model.	Association of infant mortality with precarious economic conditions, low maternal schooling and low birth weight.
Determinants of infant mortality in the Jequitinhonha Valley and in the North and Northeast regions of Brazil[11]	2017/Brazil	Case-control study/n=2,772	Semi-structured questionnaire and multiple logistic regression analysis.	Mother with a history of fetal and infant losses, inadequate antenatal care, living in rural areas and lack of care during labor, resulting in the woman's pilgrimage were associated with infant mortality.
Maternal education and age: inequalities in neonatal death[33]	2017/Brazil	Non-concurrent cohort study/ n=1,534,635	Probabilistic record linkage method.	Association of infant mortality with teenage mother or advanced age mother and low education.
Factors associated with infant Mortality in a Brazilian city with high human development index[34]	2017/Brazil	Retrospective cohort study/ n=7,887	Binomial logistic regression.	Being a teenage mother, duration of pregnancy <32 weeks, low birth weight, Apgar at 1 and 5 minutes of life <7 and the presence of congenital malformation were risk factors for deaths.
A case control study investigating factors associated with high infant death in Saiha district of Mizoram, India bordering Myanmar[35]	2017/India	Case-control study/n=195	Interview and analysis of secondary data.	Association of infant mortality with low maternal education, low birth weight, home birth, neonatal infections such as pneumonia, sepsis, and asphyxia, birth trauma, and raw areca nut ingestion during pregnancy.
Factors associated with preventable infant death: a multiple logistic regression[8]	2018/Brazil	Analytical Cross-sectional study/ n=4,674	Descriptive statistical analysis and hierarchical multiple logistic regression models.	Association of infant mortality with the lack of antenatal care, living in neighborhoods with an average family income <4 minimum wages, age ≤ 19 years, having one or more living children, and having two or more dead children; low Apgar score at fifth minutes and low birth weight (<2,500 g).

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Changes in neonatal mortality and newborn healthcare practices: descriptive data from the Bangladesh Demographic and Health Surveys 2011 and 2014[36]	2018/ Bangladesh	Cross-sectional study/n=17,842	Multivariate analysis.	Association of infant mortality with socioeconomic profile and sex, with evidence of a reduction in males and in families with higher purchasing power.
Inequity in infant mortality and pediatric services in Bogotá: a new model of analysis for Latin America. [Inequidad en mortalidad infantil y servicios pediátricos en Bogotá: nuevo modelo de análisis para América Latina][37]	2018/ Colombia	Longitudinal ecological study/ n=not informed	Gini coefficient and Pearson's correlation coefficient (r).	Correlation between infant mortality and unevenly distributed health services.
"A tragedy after giving birth": stories of women who have lost newborn children[38]	2018/Brazil	Descriptive qualitative study/ n=15	Interview.	Failures in healthcare services during labor were related to infant mortality.
Access to and use of health services as factors associated with neonatal mortality in the North, Northeast, and Vale do Jequitinhonha regions, Brazil[10]	2018/Brazil	Case-control study/n=2,184	Secondary data analysis.	Socioeconomic classes D and E, history of infant death, high-risk pregnancy, peregrination in antepartum, lack of antenatal care, absence of professional for the monitoring of labor, excessive waiting time for delivery, borderline preterm delivery, and malformation were factors associated with infant mortality.
Effect of antenatal care and social well-being on early neonatal mortality in Bangladesh[39]	2018/ Bangladesh	Cross-sectional study/n=44,207	Multivariate analysis of secondary data.	Antenatal care and women's social well-being have a protective effect on early neonatal mortality.
The effect of maternal education on infant mortality in Ethiopia: A systematic review and meta-analysis[40]	2019/Ethiopia	Systematic review study/n=5	Analysis with PRISMA 2009 and I^2 test.	The long-term impact of maternal education can contribute to reduce infant mortality.
Statistical analysis of socioeconomic and demographic correlates of perinatal mortality in Tigray region, Ethiopia: a cross sectional study[41]	2019/Ethiopia	Retrospective cross-sectional study/n=2,738	Descriptive statistics and logistic regression model.	Child sex, previous birth intervals, availability of toilets, wealth index, type of birth, maternal age, parity, place of residence, maternal occupation, and source of drinking water were the factors significantly associated with perinatal mortality.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Factors associated with perinatal mortality in Nepal: evidence from Nepal demographic and health survey 2001–2016[4]	2019/Nepal	Cohort study/ n=23,335	Logistic regression generalized linear latent and mixed models.	Women residing in the mountains, who do not use contraceptives, aged 15 to 24 years, with low education and without basic sanitation are associated with increased perinatal mortality.
Factors affecting neonatal mortality in the general population: evidence from the 2016 Ethiopian Demographic and Health Survey (EDHS)—multilevel analysis[5]	2019/Ethiopia	Cross-sectional study/n=10,641	Multilevel multivariable logistic regression analysis.	The probability of neonatal mortality was significantly associated with uneducated husbands, female births, twin births, preterm birth, and mothers without antenatal care.
Structural Racism and Odds for Infant Mortality Among Infants Born in the United States 2010[42]	2019/USA	Cohort study/ n=2,753,177	Multilevel logistic regression.	Educational and judicial indicators of structural racism were associated with infant mortality among blacks.
Trends and determinants of perinatal mortality in Bangladesh[6]	2019/ Bangladesh	Cross-sectional study/n=26,604	Cochran-Armitage test and logistic regression with generalized estimation equation.	Administrative division, type of cooking fuel, sex of child, maternal occupation, body mass index, birth interval, history of miscarriage, previous child deaths, total number of children under 5 years of age, mode of delivery, type of childbirth, access to participation in decision-making, paternal education and occupation were significantly associated with perinatal deaths.
Avoidable child mortality and social vulnerability in Vale do Jequitinhonha, Minas Gerais, Brazil[12]	2019/Brazil	Cross-sectional study/n=51	Analysis of SIM and SINASC data using chi-square test.	Women's health care during pregnancy and childbirth and newborn health care reduce neonatal deaths from preventable causes.
Determinants of hospital and non-hospital infant deaths in the municipalities of Jequitinhonha Valley, Minas Gerais[1]	2019/Brazil	Retrospective cross-sectional study/n=51	Secondary data analysis.	Out-of-hospital births have a higher risk of neonatal death due to the mother's socioeconomic and educational conditions.
Ecuadorian infant mortality linked to socioeconomic factors during the last 30 years. [Mortalidad infantil en Ecuador asociada a factores socioeconómicos durante los últimos 30 años][43]	2019/Ecuador	Ecological study/ n=21	Poisson regression.	Illiteracy and poverty are factors directly related to the infant mortality index.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
What Explains the Decline in Neonatal Mortality in India in the Last Three Decades? Evidence from Three Rounds of NFHS Surveys[3]	2019/India	Cohort study/ n=228,204	Secondary data analysis by multivariable decomposition.	High educational level, maternal health care, basic sanitation and improvement of health programs are linked to reduced infant mortality.
Privilege and deprivation in Detroit: infant mortality and the Index of Concentration at the Extremes[44]	2019/USA	Cross-sectional study/n=84,159	Log-Poisson regression models.	Infant mortality associated with skin color and unequal income distribution. Black newborns from families with lower economic power had a higher mortality rate.
State-level income inequality and mortality among infants born in the United States 2007–2010: A Cohort Study[45]	2019/USA	Cohort study/ n=16,145,716	Multilevel logistic regression.	Babies born in states with the greatest changes in income inequality between 1990 and 2007 to 2010 had more probability of infant and neonatal mortality.
Poverty, urban-rural classification and term infant mortality: a population-based multilevel analysis[46]	2019/USA	Cohort study/ n=2,551,828	Bivariate and multilevel logistic regression models.	High poverty and very rural counties remained associated with infant mortality at term, regardless of individual maternal sociodemographic, health, and obstetric factors.
Comparing socioeconomic inequalities between early neonatal mortality and facility delivery: Cross-sectional data from 72 low- and middle-income countries[47]	2019/USA	Cross-sectional study/n=679,818	Slope Index of Inequality and logistic regression.	Although mothers with socioeconomic advantages had greater access to the health facility after childbirth, there was no evidence of comparable greater survival.
Factors affecting infant mortality in the general population: evidence from the 2016 Ethiopian demographic and health survey (EDHS); a multilevel analysis[48]	2020/ Ethiopia	Cross-sectional study/n=10,641	Descriptive and analytic statistics, and bivariate and multivariate multilevel logistic regression models.	Infant mortality was associated with child sex, multiple births, prematurity and place of residence.
Individual and contextual determinants of infant mortality in Brazilian state capitals: a multilevel approach[9]	2020/Brazil	Case-control study/n=7,470	Analysis of SIM and SINASC data using a multilevel logistic model and interaction analysis.	Regional inequalities in risk models for infant mortality, ratifying the importance of biological determinants with mediation of socioeconomic and assistance factors in healthcare.
Inequalities and trends in Neonatal Mortality Rate (NMR) in Ethiopia: Evidence from the Ethiopia Demographic and Health Surveys, 2000–2016[49]	2020/ Ethiopia	Ecological study/ n=not informed	Secondary data analysis using the Health Equity Assessment Toolkit (HEAT) software.	Higher infant mortality among male newborns, newborns born to illiterate and poor women and those living in rural areas.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Social inequality in infant mortality in Angola: Evidence from a population based study[50]	2020/Angola	Ecological study/ n=16,109	Analysis of interviews using the Health Equity Assessment Toolkit (HEAT) software.	Infant mortality related to male sex, poor families with low education and from rural regions.
Spatial pattern of perinatal mortality and its determinants in Ethiopia: Data from Ethiopian Demographic and Health Survey 2016[51]	2020/ Ethiopia	Ecological study/ n=7,230	Statistical analysis using STATA software version 14.1 and multilevel logistic regression models.	Association of perinatal mortality with maternal age, resident of rural area, history of termination of pregnancy and place of delivery. There was no association of infant mortality with the level of education of the partners, greater wealth index, greater interval of deliveries, woman being the head of the family and the number of antenatal care follow-up.
Maternal and infant predictors of infant mortality in California, 2007–2015[52]	2020/USA	Retrospective cohort study/ n=4,503,197	Secondary data analysis. Simple linear regression; ANOVA; Tukey's honestly significant difference test; logistic regression modeling.	Infant mortality related to factors linked to the mother, such as education, smoking, obesity and socioeconomic status.
Maternal Health Care Services Access Index and Infant Survival in Nigeria[53]	2020/Nigeria	Cross-sectional study/n=12,511	Cox proportional hazards and Brass models.	Infant death was less experienced among women who had a complete Maternal Healthcare Services Access Index.
Structural racism, racial inequities and urban–rural differences in infant mortality in the US[54]	2021/USA	Ecological study/ n=16,469,521	Descriptive analysis.	Infant mortality associated with racial inequality and socioeconomic factors such as maternal schooling and living in rural areas.
Individual-and community-level determinants of neonatal mortality in the emerging regions of Ethiopia: a multilevel mixed-effect analysis[55]	2021/Ethiopia	Cross-sectional study/n=4,238	Binary logistic regression models/ hierarchical modeling.	Neonatal mortality related to maternal education, women who did not participate in their health decision-making, twin births, number of antenatal consultations and preceding birth interval.
Socio-demographic determinants of neonatal mortality in Algeria according to MICS4 data (2012–2013)[56]	2021/Algeria	Case-control study/n=1,047	Logistic regression.	Neonatal mortality associated with rural residence, low education and maternal age, birth rank "7 and over" and lower wealth indices.

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Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
Prevalence of neonatal near miss and associated factors in Nepal: a cross-sectional study[57]	2021/Nepal	Cross-sectional study/n=1,000	Simple and multiple logistic regression models.	Neonatal mortality associated with severe maternal morbidity and no formal education.
Preventable multiple high-risk birth behaviour and infant survival in Nigeria[58]	2021/Nigeria	Cross-sectional study/n=21,350	Descriptive statistics and survival analysis.	Infant mortality associated with socioeconomic factors such as: mothers with incomplete primary education or no schooling, region of residence and ethnicity.
The influence of the municipal human development index and maternal education on infant mortality: an investigation in a retrospective cohort study in the extreme south of Brazil[59]	2021/Brazil	Cohort study/ n=3,107	Bivariate analysis and Poisson regression.	Relates infant mortality to the municipal human development index and maternal schooling, maternal age and number of antenatal consultations.
Approximation of the Cox survival regression model by MCMC Bayesian Hierarchical Poisson modelling of factors associated with childhood mortality in Nigeria[60]	2021/Nigeria	Cross-sectional study/n=not informed	Hierarchical Poisson regression.	Risk for infant mortality related to low or no maternal schooling, poorer households, high level of community illiteracy, and states with a high proportion of the rural population.
Trends in infant mortality and stillbirth rates in Scotland by socio-economic position, 2000–2018: a longitudinal ecological study[61]	2021/ Scotland	Ecological study/ n=1,049,567	Binomial regression.	Levels of socioeconomic inequality associated with infant mortality rates, with greater inequality in mortality in the post-neonatal period.
Neonatal mortality in the central districts of Ghana: analysis of community and composition factors[62]	2021/Ghana	Longitudinal study/n=30,132	Questionnaire and the multilevel cox proportional hazard model.	Infant mortality is related to low maternal education, insufficient family wealth and not receiving the tetanus toxoid vaccine.
Socioeconomic inequalities and adverse pregnancy outcomes in the UK and Republic of Ireland: a systematic review and meta-analysis[63]	2021/United Kingdom and Republic of Ireland	Qualitative study/ n=35 studies	Systematic review and meta-analysis and use of the Grading of Recommendations Assessment, Development and Evaluation System (GRADE system).	Infant mortality is associated with low-level paternal and maternal occupation and social class, such as unemployment and low education, inadequate nutrition, and congenital malformations.
Revisit the correlates of infant mortality in Bangladesh: findings from two nationwide cross-sectional studies[64]	2021/ Bangladesh	Cross-sectional study/n=14,712	Cox proportional hazards model and Poisson regression.	The socioeconomic situation of the household, unemployment, maternal education and living in rural areas were associated with infant mortality.

Continue...

Chart 1. Continuation

Title	Year/country	Design/number of patients	Analysis interventions	Outcomes
The socio-economic status of families experiencing the sudden unexpected death of an infant – Is it possibly related to a higher rate of non-natural deaths among them[65]	2021/ Montenegro	Qualitative study/ n=115	Student's t-test and chi-square test, ANOVA and multinomial logistic regression with calculation of relative risk.	Low socioeconomic status, education and maternal unemployment, residence in rural areas, inadequate antenatal care and childbirth outside the hospital were associated with infant mortality.

Legend: ANOVA: Two-way analysis of variance; MICS4: Multiple indicator cluster survey conducted in Algeria; MCMC: Markov Chain Monte Carlo; NFHS: National Family Health Surveys; PRISMA: Preferred Reporting Items of Systematic Reviews and Meta-Analyses; SIM: Brazilian Mortality Information System; SINASC: Brazilian Live Birth Information System; UK: United Kingdom; USA: United States of America.

22 (36.06%) the two aspects: socioeconomic factors and health services (Chart 2).

DISCUSSION

Four themes were identified and organized into two groups, namely: Group I, related to evidence on infant mortality and social inequities to be discussed based on maternal characteristics, family income and housing in urban and rural areas; and Group II, in which publications addressed the characteristics of health services: access and quality. In this sense, the evidence identified concerns the mother's socioeconomic profile and the dynamics of health care.

Mother's socioeconomic profile

The social and economic profile of a population defines the social inequities to which they are exposed and consequently, the resulting health problems, in this case infant mortality. Low maternal education was identified as a determinant for high death rates in children under one year old[40], since it compromises the quality of self-care in the antenatal period and of the care provided to the newborn[39]. Results of a study involving 72 low-income countries confirmed a greater chance of survival for newborns of mothers with higher education, regardless of their socioeconomic class[47].

Investment in maternal schooling can reduce inequalities in neonatal death by up to 32%[30]. More stratified analyzes emphasized that the mother's primary education level led to a 28% reduction in infant mortality, and the high school level led to a 45% reduction compared to mothers without schooling[40].

Another determining factor identified in the studies was the woman's age at the time of delivery, highlighting the association between teenage pregnancy and infant death[8,15,19,25,33-34,52,56,59], and to problems that may lead to it, such as prematurity and low birth weight[3,9]. However, age of 40–54 years also showed an association with infant deaths, as cited in a study conducted between 2007 and 2015, in which only 3.8% of births in this age group were identified. However, deaths corresponded to 5.6% of the total analyzed, representing 69% compared to death in women aged 30-34 years[52].

Also in relation to the mother's social profile, the ethnic-racial aspect was a factor associated with infant mortality in the international scenario among indigenous women in Latin America, more precisely in Ecuador, where a 5.1% increase in infant mortality rate was identified[43]. Likewise, in the context of the black population, the infant mortality rate proved to be high and associated with low education and low socioeconomic status[42].

The greater social vulnerability present in some ethnic groups refers to inequality in income distribution and poor investment in education and health, with repercussions on infant deaths. Likewise, population strata living in greater social exclusion exhibit higher infant mortality rate, according to results of an American study, in which places with greater variations and inequalities in the population's income, presented a greater risk for infant and neonatal deaths[45].

In a study conducted in a municipality with economic indicators above the national average located in southern Brazil, the increase in per capita Gross Domestic Product (GDP) and lower unemployment burdens have repercussions on reduction of the infant mortality rate[34]. The findings revealed that well-structured public policies, employment opportunities and high economic and social development promote a protective effect on infant mortality given the attenuation of social inequalities[34]. Therefore, low socioeconomic status represents a risk factor for infant mortality, as discussed in other studies[1,10-11,20], and consequently, greater investment in public health programs mitigates the impact of economic crises on infant mortality.

Chart 2. Outcomes of studies according to the association between social inequities and infant mortality in children under one year, 2015–2021

Infant mortality associated with social inequities in the socioeconomic perspective
Aspects related to maternal characteristics
• Low maternal education is associated with higher infant mortality rate[2-8,11,21-23,25-27,32-33,35,41-45,49,52,54,58-60,62-65], and high neonatal mortality rate[3,19,36,49,55-57], avoidable mortality on the first day[30] and premature infant mortality in a neonatal intensive care unit[16].
• Low parental education is associated with infant mortality[15,51,63].
• The higher the level of maternal/parent education, the greater the reduction in infant mortality rate[26,31,40] and neonatal mortality rate[47].
• School attendance of women is associated with early neonatal mortality[5].
• Adolescent pregnancy/maternity is related to infant mortality[15,34], infant mortality rate is higher in younger women[8,25,33,52,56,59], neonatal mortality rate is higher in mothers aged < 20 years[19] and lower in mothers aged between 25 and 49 years[4].
• High perinatal mortality rate in mothers aged <20 years and ≥40 years[6], with significant risks for perinatal death at age >34 years[18] and a higher proportion of perinatal deaths in mothers aged 45–49, 35–39 and 40–49 years[41].
• Premature infant mortality in a neonatal intensive care unit is related to the employment status of mothers[16], as maternal occupation is a factor that increases the percentage of perinatal mortality[41] and the infant mortality rate was higher when parents have manual occupation[26].
• Being a single mother was a significant risk factor for preventable mortality on the first day[30].
Aspects related to family income
• Poverty[2,8,22,23,32,46,51,53,60,62] and segregation are directly related to high infant mortality rates[29,44].
• Living in poor families was significant for perinatal mortality[6,18], as perinatal deaths are higher in regions with worse poverty indicators[17].
• Family wealth index is a consistent factor in neonatal mortality rate[39,56], since the low index increases perinatal mortality[41]; infant mortality and early neonatal mortality are higher in poor and middle classes than in richer classes[15,19,26,39].
• Low socioeconomic status was associated with infant mortality[1,10,11,15,44,47,61,63-65] and neonatal mortality[36]; neonatal mortality rate increases due to sociodemographic factors[17], as it is mainly associated with socioeconomically disadvantaged populations[49]. However, in socioeconomic conditions above the national average, infant mortality was not associated with social inequities[34].
• Distal and proximal socioeconomic determinants are associated with infant mortality[15].
• Premature infant mortality in a neonatal intensive care unit is related to mothers' self-assessments of economic status[16].
• The increase in income inequality is a significant risk factor for infant and neonatal mortality[45].
• Skin color is associated with infant mortality[9,11] with higher infant mortality rate in blacks[44,54], children of black mothers[8] and African-American race[52]; than in white children. Racial disparities and structural racism in maternal education were considered a significant risk factor for infant and neonatal mortality among black babies[42].
• Data from 2010 showed that variability of the infant mortality rate for illiteracy and poverty remained the same, although it increased by 5.1% in the proportion of indigenous ethnicity[43].
• Inequality in infant mortality risk increased in neighborhoods with worse living conditions compared to areas with better living conditions[15,20]. Living in the periphery is related to infant mortality[24,44] and early infant mortality in a neonatal intensive care unit is related to mothers' self-assessments of the home situation[16].
• Lower neonatal mortality rate when natural gas is used for cooking[4] and higher perinatal mortality rate when solid fuel is used[6].
• Inadequate maternal nutrition was associated with infant mortality[3,35,63].

Continue...

Chart 2. Continuation

Aspects related to housing in rural and urban areas
• In rural areas, the neonatal mortality rate[36,49,56,60], the perinatal mortality rate[6] and the chances of neonatal mortality and infant mortality[2,23,25,31,39,46,51,53,54,58,64-65] are higher. Births in rural areas were related to infant mortality, which reduces as the level of urbanization increases[15,32]. Subsistence based on agriculture is associated with infant mortality [11] and higher perinatal mortality rate[6].
• Lack of basic sanitation was associated with infant mortality[3,21,23,35,53], lower neonatal mortality rate in families with sanitation facilities[4] and higher perinatal mortality rate when consuming untreated water and in the absence of better toilets[6,41].
• Infant mortality is directly related to the lack of access to health services in rural areas[48]. Avoidable mortality on the first day is related to poor management of pregnancy and childbirth among rural, vulnerable and peripheral populations[30].
Infant mortality associated with inequities from the perspective of health services
Aspects related to health services: access and quality
• Greater availability and access to health services during labor, delivery and the postpartum period contributed to a lower percentage of neonatal death[17,37,47], access to quality antenatal care reduces infant mortality rate[31], while the lack of assistance and unskilled care in antenatal care with less than four consultations, is considered a risk factor for high infant mortality rate[5,9,10-12,30,46,51,55,59,65] and for avoidable mortality on the first day[30].
• The increase in the number of beds generates better quality of life and lower perception of poverty[37].
• Work and care processes should be improved[34], as the quality of in-hospital obstetric and perinatal care reduces NMR, preventing neonatal deaths through antenatal care with adequate diagnosis and early treatment[8].
• Avoidable mortality on the first day was related to poor management of the pregnancy[30].
• Lack of access to health services contributes to increase the infant mortality[1,8,12,27,30,32,44,46,48,51,53], given the low income[48].
• Expanding access to health services would be effective in reducing infant mortality rate in vulnerable social groups.
• There is no[33] association between infant mortality and social inequities when there is access to health services[34].
• Delay, failure or inadequacy in the provision of care to the baby or in decision-making, professional negligence in medical care and treatment; and lack of advanced support in the treatment of complications is related to an increase in infant mortality rate[24] and directly influenced neonatal mortality rate[38].
• Peregrination in the health service was considered a risk factor for infant mortality[10,11].
• Factors related to infant mortality: prematurity[5,8,9,46], low weight[9,24,25] history of abortion[51], twin delivery[54].
• Home birth influences infant mortality rate[21]. Neonatal mortality rate was high in children whose mothers did not give birth in a medical center[3] and infant mortality was associated with childbirth outside the hospital environment[65]; 57% of neonatal deaths occurred at home and 12% occurred on the way to a health facility[19].
• Beliefs and economic and social barriers delay or prevent the search for care[28].

Such factors relate to social and economic determinants, intermediate factors directed to care aspects, and to proximal factors related to biological aspects[31]. In Nepal (Asian continent), an association of distal and proximal socioeconomic determinants with infant mortality was identified. Distal determinants are important predictors for the occurrence of infant deaths, as observed in results of the adjusted odds ratio of infant mortality; 1.66 (95%CI 1.00–2.74) in the middle class and 1.87 (95%CI 1.14–3.08) in the poorest class[15].

According to a study conducted in Bangladesh, also in Asia, women from the richest families had a 45% reduction in early neonatal mortality (OR=0.55; 95%CI 0.42–0.720) compared to poorer women[39]. Poverty and segregation were directly related to high infant mortality rates[29]. In this dimension of maternal health, inadequate maternal nutrition has been associated with infant mortality, directly related to family income, affecting the pregnant woman's dietary pattern and consequently, the health and quality of life of mother and child[16].

Unemployed women without a partner tend to be more vulnerable, since the lack of employment compromises income and therefore, women's health, which can lead to nutritional deficiency, maternal anemia, inadequate antenatal

care and obstetric complications, bringing harm to the child[30,41]. In this sense, low income directly affects maternal and child well-being and access to health services, influencing infant mortality rate[5,45].

The place of residence is highlighted as risk factor for infant mortality; living in a rural area is an unfavorable factor[3,15,31,39], especially in geographic areas very distant from urban perimeters, as this makes access to health services expensive and time-consuming[4,46]. Thus, measures to enable access to the health care network for children residing in remote locations are needed as a way to avoid infant deaths[1].

Note that populations living in rural areas are exposed to numerous social vulnerabilities, such as the lack of basic sanitation and drinking water, which showed an association with infant mortality[21,23,35,53], confirming the need to provide these essential services to the population.

A study conducted in India and Asia showed a direct association between high infant mortality rate and perinatal mortality, respectively, and the non-use of a toilet facility[3,6]. In Iran, an increase in the use of a toilet by 83% of the population reduced infant mortality[31]. The low quality of water consumed by mothers was related to perinatal mortality[41].

Health service: access and quality

The difficulty of geographical access to health services was addressed in several studies as a relevant cause for infant mortality[10,31]. Such difficulties are related to the mother's place of residence, demanding time-consuming and costly displacement, such as the riverside population (*ribeirinhas*), who often use precarious and privately owned transport, causing delays in receiving healthcare, which may compromise and/or worsen the child's general condition. A similar situation occurs with the population residing in rural areas, who face difficulties in displacement, given the precariousness of means of transport, which often leads them to opt for palliative methods based on traditional medicine[28]. Thus, living in urban areas favors access to basic and high-complexity health services, giving women the opportunity to have six or more antenatal consultations, with the possibility of addressing obstetric problems, preventing damage and reducing the occurrence of prematurity and low birth weight, thereby enabling safer and healthier deliveries and births[39].

A study that used the Social Determinants of Health to assess the circumstances in which individuals grow, live, work and age, and the systems in which the population is inserted, confirmed the importance of non-clinical aspects in the health status of individuals and populations[10]. In this sense, access to health services is essential for the prevention, treatment, cure and rehabilitation of people, especially in neonatal and child care, given their possible condition of social vulnerability.

The lack of timely services to pregnant women during antenatal care, labor, delivery, postpartum period and to the child has shown to be determinant for the increase in infant deaths, especially those classified as preventable[8,37,48,51]. This problem begins when the woman does not receive quality antenatal care, capable of monitoring the baby and detecting possible fetal complications. Several studies have found that antenatal and childcare consultations associated with adequate life habits of pregnant women reduce the chances of infant mortality[3,10-12,15,31-35].

A study conducted with mothers who lost their babies showed the association of neonatal deaths with delay in care during labor, concluding that 13 out of 15 deaths would have been avoided if delivery had been in a timely manner, and health professionals had detected the danger signs for the child[31,38]. The peregrination of women during labor was highlighted as a contributing factor to infant mortality, since the lack of knowledge about the service network resulted in going to various health services, exceeding the expulsive period and causing neonatal asphyxia[10-11].

In addition, inadequate care at the time of birth was reported as a consequence of the lack of preparation of health professionals in the management of childbirth, potentiated by the non-sensitive listening to women's reports of pain and discomfort[1,30,47].

Another important aspect related to quality care at birth was mentioned in a study conducted in Bangladesh, which concluded that home births without midwifery assistance, the unavailability of highly complex services such as the Neonatal Intensive Care Unit and social inequities, as those present in poverty, were determinants for infant mortality, especially among premature newborns[9].

A satisfactory Brazilian experience was reported in a study conducted in the state of Santa Catarina, in which results were far from those of the national reality; 99.8% of deliveries were in a hospital environment, 71.6% of pregnant women received an adequate number of antenatal consultations, and only 1.0% of births occurred in municipalities other than that of the mother's residence. Therefore, there are indications of access to health services and the existence of a care network to assist women during pregnancy and childbirth[34].

The limitations of this review were related to studies published in other languages that were not included, as well as those linked to other indexing bases that were not defined in inclusion criteria.

CONCLUSIONS

This review presents a global overview of the evidence on infant mortality related to social inequities, identifying that mothers' social characteristics and the difficulty in accessing qualified health services are directly related to infant

death. The comprehensive number of studies found and the distribution of research in several countries point to the impact of the theme in a global scenario.

The results obtained provided greater visibility and knowledge about infant mortality associated with social determinants of health, highlighting the repercussion of social inequities in infant mortality rate. The mapping and analysis of studies offer subsidies that guide nursing practices in the face of structural and social problems of the population. Finally, data from this review refer to the need for public health policies to face social inequities associated with infant mortality.

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