

Social inequalities in neonatal mortality and living condition

Desigualdades sociais na mortalidade neonatal e condição de vida

Abstract

Objective: To evaluate the association between the spatial distribution of neonatal mortality and living conditions, and to analyze trends in the social inequalities, related to this mortality, in Salvador, Bahia, Brazil, 2000 - 2006. **Methods:** The city's Information Zones, the unit of analysis used in this study, were grouped into strata reflecting high, intermediate, low and very low living conditions, based on a living conditions index (LCI). Neonatal mortality rates were calculated for each stratum. Spearman's correlation, linear regression and relative risks were used in the data analysis. **Results:** Neonatal mortality in Salvador was found to be associated with living conditions, with risks of 53, 56 and 59% greater, respectively, in the intermediate, low and very low strata, when compared to the high living conditions stratum. Only the intermediate living conditions stratum shows a significant decline in neonatal mortality ($\beta = -0.93$; $p = 0.039$). In the stratum of high living conditions, it was observed a stagnation of this mortality. **Conclusions:** Poorer living conditions were associated to higher risks of neonatal mortality. The slight decline in social inequalities, found in neonatal mortality, was due to a decline in the intermediate living conditions stratum. Although dependent on the access to quality healthcare services and life support technologies, a more consistent reduction in the neonatal mortality and its associated inequalities will only be achieved when broader-reaching public policies are implemented, improving the living conditions, and mainly focusing on priority groups.

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Resumo

Objetivos: Avaliar a associação entre distribuição espacial da mortalidade neonatal e condições de vida, e analisar as tendências das desigualdades sociais relacionadas a essa mortalidade, em Salvador, Bahia, Brasil, 2000 – 2006. **Métodos:** As Zonas de Informação da cidade, a unidade de análise utilizada nesse estudo, foram agrupadas em estratos de alta, intermediária, baixa e muito baixa condições de vida, com base em um Índice de Condições de Vida (ICV). Taxas de mortalidade neonatal foram calculadas para cada estrato. Correlação de Spearman, regressão linear e riscos relativos foram utilizados na análise de dados. **Resultados:** a mortalidade neonatal em Salvador mostrou-se associada às condições de vida, com risco de 53, 56 e 59% maior, respectivamente, nos estratos intermediários, baixa e muito baixa em comparação com o de alta condição de vida. Somente o estrato de condições de vida intermediário mostrou uma queda significativa na mortalidade neonatal ($\beta = -0,93$, $p = 0,039$). No estrato de condições de vida elevado, observou-se a estagnação desta mortalidade. **Conclusões:** Piores condições de vida foram associadas a maiores riscos de mortalidade neonatal. A ligeira redução das desigualdades sociais encontradas na mortalidade neonatal foi devida ao declínio na mortalidade do estrato de intermediária condição de vida. Embora dependente do acesso a serviços de qualidade de saúde e tecnologias de suporte à vida, uma redução mais consistente da mortalidade neonatal e das desigualdades só será alcançada quando forem implementadas políticas públicas de mais amplo alcance, melhorando as condições de vida, focalizando, principalmente, em grupos prioritários.

Palavras-chave: Mortalidade infantil. Condições sociais. Desigualdades em saúde. Condições sociais. Mortalidade. Fatores de risco.

Introduction

The relevance of social processes in the occurrence and distribution of diseases in human populations has been confirmed in numerous studies. One of the approaches to increase understanding of this relationship uses living conditions as a category of analysis, in which these are defined as the material conditions of existence of a given population¹. The role of living conditions in determining health problems has been evaluated, particularly in studies dealing with the determinants of infant mortality²⁻⁴.

Concerning neonatal mortality, as well as factors related to the quality of healthcare services, living conditions are considered equally important⁵⁻⁷. Studies relating living conditions with health differentials in populations, in general, indicate the existence of a socioeconomic gradient in which groups economically more deprived are in disadvantage compared to the most affluent.

Living conditions vary between groups and social classes in accordance with modes of appropriation and distribution of wealth in a historically situated social formation. These social differences are also reflected in the process of occupation of space⁸, and for this reason, the distribution of disease in the socio-geographical space is used as a strategy to study the social determination of diseases^{1,2,4,5,7,9-11}, enabling identification of possible differential factors in health resulting from social inequalities.

Striking differences are found in the distribution of neonatal mortality between the different regions of the world, reflecting existing social inequalities¹². For example, in 2004, the average neonatal mortality rate in Africa was 34 per 1,000 live births, approximately 8.5 times the rate found in developed countries, where the rate is around 4 per 1,000 live births¹³.

Evidence resulting from studies, carried out both worldwide^{14,15} and in Brazil¹⁶⁻¹⁹, show that the mediation of factors related to maternal and child healthcare in the determination of neonatal mortality is affected by living conditions. Therefore, social

inequalities also affect access to neonatal healthcare²⁰. In this context, reducing the extent of the social inequalities related to neonatal mortality represents a challenge to the health authorities, particularly in less developed countries. This concern is pertinent, since a persistently high risk of neonatal mortality is a factor that contributes greatly towards decelerating the decline in infant mortality or even preventing a decline^{21,22}.

Since the 1990s, neonatal deaths in Brazil have been responsible for the largest proportion of infant mortality^{16,23-26}. In 2008, the neonatal mortality rate was 10.3 per 1,000 live births²⁷ and, despite a decline of 24.3% compared to the year 2000, this rate was 2.6 and 2.1 times higher, respectively, in the same year compared to the rate for developed countries and countries with a similar degree of development²⁸. Instead of the decline in the neonatal mortality rate that was occurring in the country, there is now a tendency towards stabilization at levels that remain high²⁴. Furthermore, significant inequalities have been found in the distribution of the neonatal mortality rate within the different urban spaces and social groups^{3,7}.

Notwithstanding, in recent decades, Brazil has been the target of a variety of public policies aimed at the low-income population, particularly in the field of education and health²⁹. In Salvador, in the same period, access to basic services and consumer goods has also improved and the human development index (HDI) and per capita income have risen³⁰. Therefore, considering the increased vulnerability of children under one year of age to social policies, albeit compensatory, it has to be admitted that these actions may be capable of reducing the discrepancies in infant mortality rates between different social groups, resulting in a tendency of the rates to converge and reduction of the social inequalities associated with infant mortality, including its neonatal component.

The objective of this study was to evaluate the association between spatial

distribution of neonatal mortality and living conditions in Salvador, Bahia, Brazil and to analyze the trend in social inequalities related to this mortality between 2000 and 2006 under the assumption that the decline found in the risk of the neonatal death during this period was higher in areas of greater deprivation.

Methods

An ecological study was carried out in which the unit of analysis was the information zone (IZ), corresponding to areas into which the Metropolitan Region Development Company (CONDER) subdivided the city of Salvador, (Brazil), based on socioeconomic, physical and administrative infrastructure and planning criteria, on compatibility with the census sectors defined by the Brazilian Institute of Geography and Statistics (IBGE)³¹.

Data derived from birth and death certificates were supplied in digital form (CD-ROM) by the Bureau of Health Statistics of Salvador's Municipal Health Department³². The LOCALIZA³³ software, developed at the Collective Health Institute of the Federal University of Bahia, and the Google Earth internet tool were used to geo-reference the addresses given on the birth and death certificates. Demographic and socioeconomic data from the 2000 demographic census were obtained from IBGE³⁴. CONDER supplied the digital maps for each IZ (cartographic maps of the municipality) in shapefile format (shp), which is compatible with the ArcView GIS software, version 3.2 and TerraView.

Neonatal mortality rate (and its components of early and late neonatal deaths) and the living conditions index (LCI) for the year 2000 were the indicators used. The option for the use of a composite indicator instead of a multivariate analysis, including relevant variables, was mainly because we aren't seeking to show causal associations, but different patterns resulting from the interaction between social and biological processes from a more totalizing perspective. Furthermore, this strategy

allowed the comparison with results of previous infant mortality studies performed in Salvador, using the same approach.

The LCI, as constructed by Paim et al.⁹, corresponds to a composite index for each IZ, based on five proxy variables of living conditions derived from the 1991 census: income, education, sanitation, slum and people per bedroom. However, for the present study, this latter indicator could not be reproduced exactly because the information on the number of rooms serving as bedrooms per census sector for the year 2000 was unavailable. Then, it was used the people per room ratio. Three indicators (slum, income and the number of people per room) were listed in increasing order, while the remaining two (education and sanitation) were listed in decreasing order. A score was awarded, consisting of consecutive values, starting at 1, in accordance with their position in this order. The sum of the values of this score resulted in an overall score (LCI) for each IZ. These were arranged in increasing order and grouped into strata of relatively homogenous IZ, reflecting the strata of the population classified as having high, intermediate, low and very low living conditions. Higher LCI scores correspond to poorer living conditions. The neonatal mortality rate and its components were calculated for each IZ and stratum.

Spearman's correlation test was used to conduct an exploratory analysis of the association between the average annual neonatal mortality rate (and its components) for the 2000 - 2006 period and the LCI scores for each IZ. Social inequality in neonatal mortality was examined, together with its extent and trends, during the study period, by performing simple linear regression analysis and calculating relative risk (year by year for the 2000 - 2006 period), considering the high living conditions stratum as a reference, with a 95% confidence interval.

The study protocol was approved by the Internal Review Board of the Collective Health Institute, Federal University of Bahia (#012-09 CEP-ISC).

Results

Between 2000 and 2006, 5,097 neonatal deaths and 271,840 live births were registered to mothers living in Salvador. Only 8.0% of these deaths, and 0.7% of the births, could not be geo-referenced, because the addresses were missing or incomplete. The neonatal mortality rate for the municipality in this period, calculated from the geo-referenced data, was 17.4 per 1,000 live births.

Correlating the IZs with their respective LCI values, it was found that those with the most favorable living conditions were, in general, concentrated in the southern and eastern areas of the city, along a coastal strip, while the majority of the IZs, in which living conditions were low or very low, were found to be situated in the city center and in the western and northern areas. The majority of zones, in which living conditions were classified as intermediate, were situated in the southern part of the city, close to the IZs in which living conditions were classified as high. Neonatal mortality correlated positively with the living conditions index ($r = 0.2970$; $p = 0.049$), the same being true when early neonatal deaths were evaluated as a separate component ($r = 0.3054$; $p = 0.0031$).

When the data are analyzed year-by-year, high rates of neonatal mortality (ranging from 20.0 per 1,000 live births in 2000 to 17.1 per 1,000 live births in 2006) and substantial fluctuations in the velocity of the annual decline in neonatal mortality in each stratum of living conditions are noted. If compared only the first and final years of the study period, the risk of neonatal death in the high living conditions stratum remained largely unchanged, whereas an increase was found in the very low living conditions stratum and a decline in the other strata (Table 1). The median neonatal mortality rate was 11.8 / 1,000NV in the stratum of high life condition, and 16.9 / 1,000NV in the very low standard of living. Among the lower stratum (19.0%) and very low life condition (16.9%), there was a reduction of 11.1% in the value of this indicator (Figure).

However, linear regression analysis (Table 2) showed a decline in the annual neonatal mortality rates in all living conditions strata, with the greatest decline ($\beta = -0.93$) being found in the intermediate living conditions stratum, which was also

the only stratum in which a statistically significant difference was found ($p = 0.038$). The smallest decline was found in the very low living conditions stratum ($\beta = -0.021$; $p = 0.959$). Similar results were found for the early neonatal death component, except

Table 1 - Neonatal mortality rate and annual variation according to strata living conditions and year of occurrence. Salvador, (BA), Brazil, 2000 – 2006.

Tabela 1 - Taxa de mortalidade neonatal e variação anual de acordo com estratos de condições de vida e ano de ocorrência. Salvador (BA), Brasil, 2000 – 2006

Living condition	High		Intermediate		Low		Very low	
Year	NMR	Var%	NMR	Var%	NMR	Var%	NMR	Var%
2000	10.0	–	20.0	–	18.8	–	17.2	–
2001	12.3	23.7	18.7	-6.6	18.2	-3.6	19.7	14.3
2002	12.9	4.7	17.6	-5.8	18.1	-0.3	20.7	5.2
2003	9.7	-24.7	14.9	-15.9	19.7	8.9	20.4	-1.8
2004	11.6	19.5	17.3	16.7	16.9	-14.3	14.1	-30.9
2005	11.8	1.4	16.7	-3.8	17.5	3.7	17.4	23.6
2006	10.2	-13.2	17.1	2.6	15.5	-11.3	18.0	3.6
2000 – 2006	11.5	2.6	17.5	-14.7	18.0	-17.5	18.3	4.6

*Rates per 1000 live births. NMR: neonatal mortality rate; Var%: annual variation.

*Taxas por 1000 nascidos vivos. NMR: taxa de mortalidade neonatal; Var%: variação anual.

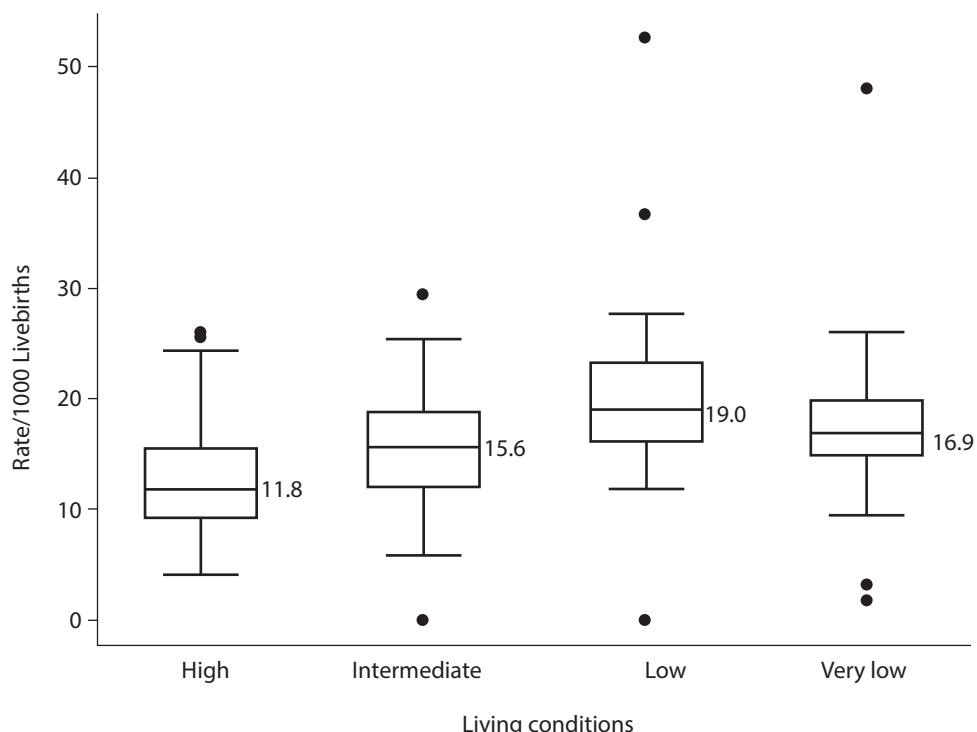


Figure - Neonatal mortality rates according to living conditions strata. Salvador (BA), Brazil, 2000 – 2006.

Figura - Taxas de mortalidade neonatal de acordo com estratos de condições de vida. Salvador (BA), Brasil, 2000 – 2006.

that, in this case, the difference found in the intermediate living conditions stratum was not statistically significant ($p = 0.055$). Concerning the late deaths component, a slight increase was found in the high and very low living conditions strata over the study period, while in the intermediate and low living conditions strata a decline occurred, with a tendency towards stabilization in the latter.

For the 2000 – 2006 period, as a whole, the average neonatal mortality rate was found to be lowest in the stratum in which living conditions were classified as high (11.5 per 1,000 live births). Results were similar when the early neonatal death rate was calculated as a separate component (9.0 per 1,000 live births). In the intermediate, low and very low living conditions strata, these indicators were 17.5, 18.0 and 18.3 per 1,000 live births, respectively. Overall, around 80% of these

cases consisted of early neonatal deaths. The relative risk (RR) of neonatal death and early neonatal death increased as living conditions deteriorated, neonatal mortality being 53, 56 and 59% higher in the intermediate, low and very low living conditions strata compared to the high living conditions stratum. These differences were statistically significant (Table 3).

As only the years of 2000 and 2006 are being taken into account, a greater decline (15.0%) in the RR of neonatal death was found in the intermediate living conditions stratum.

Discussion

The gradient found in the relationship between neonatal mortality and living conditions in the population in Salvador, Bahia, Brazil for the 2000 – 2006 period suggests that its distribution is a consequence

Table 2 - Linear regression coefficients (β) for the association between neonatal, early neonatal and late neonatal mortality rates and year of occurrence of death according strata of living conditions. Salvador (BA), Brazil, 2000 – 2006.

Tabela 2 - Coeficientes de regressão linear (β) para a associação entre mortalidade neonatal, neonatal precoce e neonatal tardia e ano de ocorrência do óbito de acordo com estratos de condições de vida. Salvador (BA), Brasil, 2000 – 2006.

Living condition	Neonatal Mortality		Early neonatal mortality		Late neonatal mortality	
	β	p-value	β	p-value	β	p-value
High	-0.17	0.717	-0.31	0.487	0.14	0.474
Intermediate	-0.93	0.038	-0.76	0.055	-0.17	-0.416
Low	-0.16	0.629	-0.17	0.580	0.003	0.979
Very low	-0.021	0.959	-0.18	0.635	0.16	0.328

Table 3 - Neonatal, early neonatal and late neonatal mortality rates* and relative risk according to strata of living conditions. Salvador (BA), Brazil, 2000 – 2006.

Tabela 3 - Taxas de mortalidade neonatal, neonatal precoce e neonatal tardia e risco relativo de acordo com estratos de condições de vida. Salvador (BA), Brasil, 2000 – 2006.

Living conditions	Neonatal mortality			Early Neonatal Mortality			Late Neonatal Mortality		
	Rate	RR	95%CI	Rate	RR	95%CI	Rate	RR	95%CI
High	11.5	1	–	9.0	1	–	2.5	1	–
Intermediate	17.5	1.53	1.33 – 1.74	14.5	1.62	1.38 – 1.87	3.0	1.21	0.89 – 1.63
Low	18.0	1.56	1.37 – 1.76	14.9	1.66	1.44 – 1.90	3.0	1.21	0.92 – 1.59
Very Low	18.3	1.59	1.39 – 1.79	15.2	1.68	1.45 – 1.3	3.1	1.25	0.95 – 1.65

*Per 1000 live births. RR: Relative Risk.

*A cada 1000 nascimentos com vida. RR: Risco Relativo.

of social inequalities. This finding is consistent with the results of other similar studies on neonatal mortality developed in Brazil^{3,7}, and particularly with the findings of studies conducted in Salvador, in the 1980s and 1990s, showing that, the areas in which infant mortality rates were higher, were precisely those inhabited by the more socioeconomically disadvantaged segments of the population^{2,35,36}. In general, the extremely deprived population is concentrated in these areas, which are marked by deficiencies in infrastructure and basic services³⁷ that exert a negative effect on the health conditions of the resident population. For the city of Salvador as a whole, there was a slight decline with a trend towards stabilization in the neonatal mortality rate²⁷. Nevertheless, when smaller population clusters in the city were examined, substantial differences were found in the velocity of decline, suggesting that some require greater surveillance and more effective actions.

The slight decline or almost no reduction in the risk of neonatal mortality found in the stratum of high living conditions may be indicative of predominance of causes of death, more difficult to be controlled in this stratum. Another possible hypothesis is the influence of higher proportion of cesarean deliveries, as has been observed in more developed areas, leading to greater frequency of live births with low birth weight or intrauterine growth retardation, which are important risk factors for neonatal mortality³⁸⁻⁴⁰. Moreover, as in this stratum, the prenatal, hospital care and better quality should be easier to access, the early detection of fetal problems and use of mechanisms of advanced life support may be helping to reduce the occurrence of stillbirths, but favoring the birth of children who previously would be considered unviable, although they are subject to early death⁴¹ and contribute, thereby, to neonatal death non-reduction. In addition, the lesser impact of improvements in the

environment and in maternal education level in more affluent groups may constitute one of the explanations, as discussed by Goldani et al.¹⁹.

Although the causes of neonatal deaths — that can be reduced by simple technology and health actions to the maternal segment and to the child, at birth — predominate in strata of low and very low living conditions, it seems that more investment are needed, since also in the strata in which these conditions are more favorable, the reduction in neonatal mortality was found to be negligible.

It should be emphasized that the only significant decline in the risk of neonatal death was detected in the intermediate living conditions stratum, in which the highest risks of neonatal death were found at the beginning of the study. These high rates of neonatal mortality are surprising, since this stratum refers to a spatial population clustering in which the zones forming it are predominantly situated in the southern region of the city, close to the IZs with high living conditions. The average levels of the socioeconomic indicators, on which classification of the intermediate living conditions stratum are based on, are only less favorable than those in the high living conditions stratum. Similar results were found for the state of Paraná, between 1997 and 2001, when the lowest neonatal mortality rates were found in clusters of the highest and lowest socioeconomic strata, with little difference in the rates between the two strata. According to these authors, this may be a consequence of factors other than socioeconomic determinants, for example factors related to healthcare, and the role these factors may play in intermediating between living conditions and health status⁴. A similar hypothesis was raised when the expected relationship between neonatal mortality rate and living conditions was not found in the state of Rio de Janeiro at the beginning of the 1990s⁵, and in the

municipality of Rio de Janeiro in 1995 concerning infant mortality⁴², indicating a need for interventions focused on the realm of healthcare services. On the other hand, in a study in the state of Ceará, the authors credited this inverse relationship to the existence of a better notification system in the municipalities, with high rates of infant mortality and better socioeconomic conditions, and the under-notification of deaths in areas with low rates of infant mortality and poorer living conditions⁴³. This may represent a plausible explanation for the finding of a higher neonatal mortality rate in the intermediate living conditions stratum compared to the low and very low living conditions strata in Salvador.

The limitations of this study are predominantly due to the quality of secondary data. Although in Salvador the Mortality Information System had coverage above 90% during the study period, some problems are still found as incorrect and incomplete filling of some fields in the Death Certificate⁴⁴, such as error in the classification of infant mortality (fetal/not fetal), as identified by Nascimento et al.⁴⁵, in that municipality. Also, what may be affecting the results of this research, are limitations inherent to ecological studies that include the scale used, mobility inter and intra-area, and heterogeneity intra-areas of that city, which correspond to geographic pre-defined administrative-divisions, rather than more homogenous areas, as to socioeconomic conditions. Furthermore, although the findings contradict expectations regarding the living conditions stratum, in which the greatest decline in the risk of neonatal death was found, it is reasonable to affirm that some reduction occurred in the inequalities associated with neonatal mortality in this city, as a consequence of the decline in risk in the intermediate living conditions stratum of the population, potentiated by the negligible variation in risk in the high living conditions stratum. The sanitary authorities need to pay particular attention

to the low living conditions strata in order to identify and intervene in the factors causing deceleration in the decline in neonatal mortality in this segment of the population.

Although the relevance of improvements and investments in prenatal care and childbirth in the prevention of neonatal deaths is recognized, the impact of healthcare and sanitary measures on infant mortality is limited, since they result in a decline up to a certain plateau, beyond which little progress is made, unless measures are implemented to deal with existing social inequalities⁴⁶. If more effective efforts to reach disadvantaged groups are not implemented, these inequalities are likely to persist^{47,48}. Therefore, reducing inequalities in health represents a necessary step towards reducing neonatal and infant mortality⁴⁹, even in countries in which rates are low⁵⁰. Concomitantly, actions dealing with multiple associated factors, that extend beyond healthcare should be implemented, such as education services and social work aimed at meeting the basic needs for guaranteeing pregnancy and childbirth in conditions favorable to safe survival, for instance⁵.

In Brazil, interventions in these areas have been hindered due to a lack of efficiency and the fragility of public policies of social protection, aimed at combating poverty and social inequality⁵¹. This negatively affects any attempts to promote improvements in living conditions that, in turn, could result in an increase in the health levels of the population⁵². Therefore, in view of the situation concerning neonatal mortality in Salvador, it becomes imperative to define and implement more broad-reaching public policies, aimed at improving living conditions and promoting the quality of healthcare in maternal and child health. Although these policies should necessarily involve all segments of the population, attention should be focused on priority groups.

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