Mother characteristics and Neonatal Mortality Risk in Brazil between 2006 and 2016

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Abstract

Neonatal mortality has become the biggest (>60%) component of infant mortality in Brazil, and a major concern once it's reduction appears to be more challenging than post-neonatal deaths, as they depend more on pregnancy and childbirth factors than sanitary and health conditions. The aim of this study was to evaluate maternal factors on the neonatal mortality risk in Brazil, between 2006 and 2016. The features used were mother's race/skin color, years of education, marital status and age. Data came from IBGE and two systems of information from DATASUS: SIM, for mortality, and SINASC, for births. The final sample was composed of 29.737.962 children. Visualization and classification methods were used to draw conclusions from the sample, allowing to assist in making better-informed decisions about the needs of newborns. This study found that unmarried, low educated mothers presented a considerably higher risk for neonatal deaths, along with mothers outside the 20-34 age group.

Keywords: Infant Mortality, Neonatal Mortality, Mother Health, Demographic Features, Brazil

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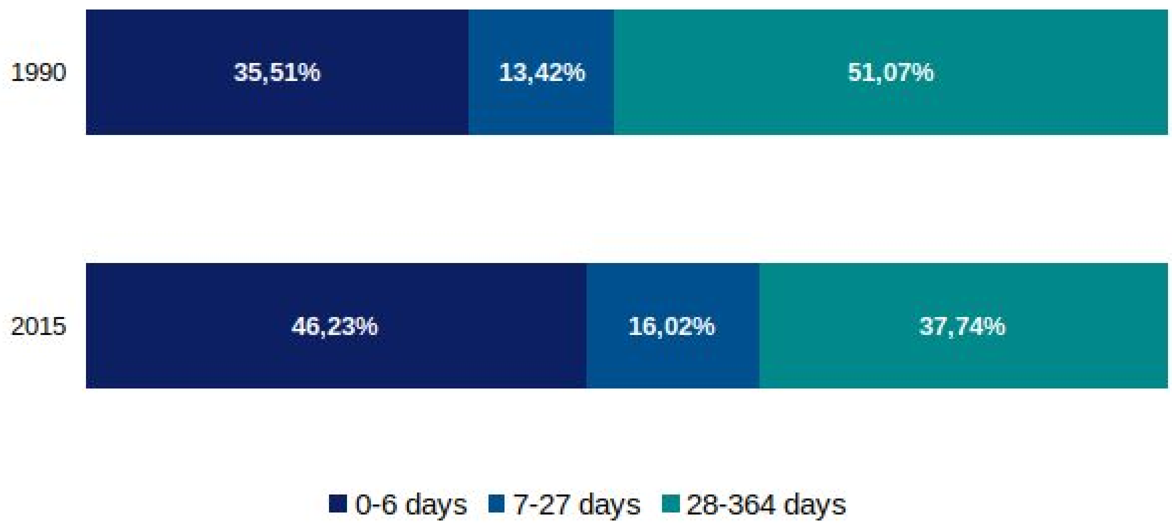
Introduction

Infant mortality is considered one of the best indicators of a population's standard of living and social well-being, and its decline presents itself as a remarkable success of governments, civil society, academia and health professionals in the past two centuries. Global mortality declined five times in the last 65 years, reaching 4.5% in 2015. In Brazil specifically, it was reduced more than 10 times in the same period (WHO, 2019). Nonetheless, disparities between developed and developing countries show us how much work there is left to do. The fact that poor countries can have ten times a developed country mortality rates is a proof that we're dealing with a high percentage of avoidable deaths.

Reduction in child mortality rates is listed as one of United Nations (UN) Sustainable Development Goals for 2030, and it was before one of UN's Millennium Development Goals for 2015, which aimed to reduce child mortality rates (CMR) by two thirds between 1990 and 2015, a goal that Brazil achieved in 2011. Infant mortality global rate declined from 65 deaths per 1000 live births, in 1990, to less than 30 by 2018, a huge improvement, but still far from the rate considered acceptable by the World Health Organization (WHO), that is of 10 deaths per 1000 live births. That becomes significant as more than 60% of the early child deaths are due to conditions that could be prevented or treated with access to simple, low-cost interventions. Those avoidable deaths are one of the main focus of the UN goal for 2030 (WHO, 2011; ODS, 2019).

Figure 1. Neonatal and post-neonatal deaths in 1990 and 2015, Brazil.



Source: IBGE, ODS, 2019

Monitoring CMR and its risk factors is essential to evaluate public policy and development. The measurement proves to be a strong indicator of socioeconomic conditions, such as poverty, access to education and health services (MAIA, SOUZA & MENDES, 2012). A thorough study of its determinants can be of great help in better targeting public policy funding, which is increasingly possible with data collection policies and online platforms that make them available, such as DATASUS, a department of Brazil’s ministry of health, responsible for collecting, processing and disseminating public health information.

In Brazil, the CMR has constantly decreased in the past decades (Figure 1), mainly at the expense of post-neonatal deaths - those between 28 days and a year - and factors related to sanitary conditions. On the other hand, neonatal deaths - those between 0 and 27 days - have decreased at a much lower pace, especially because of pregnancy and childbirth related factors, problems which are harder to cope and extend to the perinatal period (DUARTE, 2007).

The neonatal mortality, or mortality between the birth and 28th day of life, has become the biggest challenge in fighting infant mortality, as it corresponds to the majority of the deaths nowadays, and aggregates several biological, social-economic and care factors. Neonatal mortality rates (NMR) have decreased, but at the same time became the main focus of public policy regarding infant mortality because of its proportion.

The greater availability and quality of health data in Brazil enables more precise analysis of this problem on nationwide scale. Along with the data and the increasing importance of neonatal deaths on infant mortality, a greater number of studies have been published covering different factors, regions and methods concerning neonatal deaths.

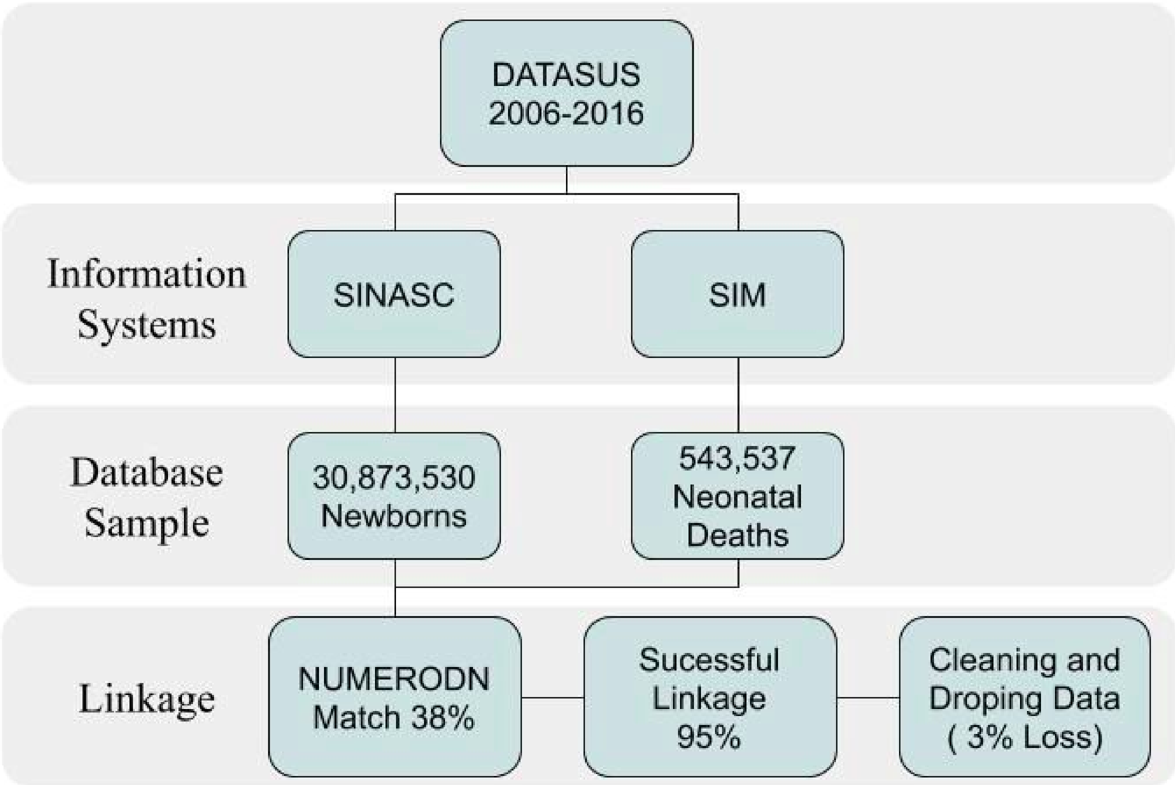
The choice of this study, to observe maternal factors over neonatal mortality, considers the schema proposed by Mosley and Chen (2003), where a hierarchical model is based on the hypothesis that socioeconomic factors determine behaviors, which have impact on biological factor. Mosley and Chen, on their influential paper, assess that mortality studies usually have a bias towards the social or biological approach, isolating the external determinants according to the field of study. Therefore, even if biological factor are directly responsible for death, this information may be insufficient to provide adequate recommendations and develop efficient public policy. Maternal characteristics also share the advantage of being early available when compared to childbirth or pregnancy related factors. Moreover, many studies have shown the predictive power of those factors. (Kleinman et al., 1991; de Lima, 2010) .

This study gathers analysis and discussion over neonatal mortality in Brazil, considering the broader perspective available through the nationwide sample collection, and using data visualization techniques and classifications to draw conclusions from the sample. It aims to help predict risk of neonatal death evaluating maternal characteristics importance on that matter, considering the years between 2006 and 2016 in Brazil.

Material and Methods

The present study is an observational, retrospective cohort study based on secondary data of births and deaths of infants in Brazil between 2006 and 2016. Data came from two sources, Sistema de informação sobre mortalidade (SIM — Mortality Information System) and Sistema de Informação sobre Nascidos Vivos (SINASC- Live Birth Information System), both hosted on DATASUS (Health Informatics Department of the Brazilian Ministry of Health). Figure 2 illustrates the process of linkage between the two databases, SIM and SINASC, where it concerns to the characteristics selected for the study, as well as data cleansing. The main problem with the datasets is the availability of a common variable between the datasets, enabling a successful merge. The common variable, Number of Live Birth Statement (NUMERODN) was fulfilled only in 38% of the cases, or 208.391 deaths out of 543.437, despite the fact that it is mandatory to fill this field. From this percentage, it was possible to link 95% of the cases, resulting in a large dataset. That presents a major barrier for public policy improvement, since the most vulnerable places are also the ones with weaker data coverage (FRIAS, 2008; PEDRAZA, 2012).

Figure 2: Flowchart of the linkage process with data from SIM and SINASC



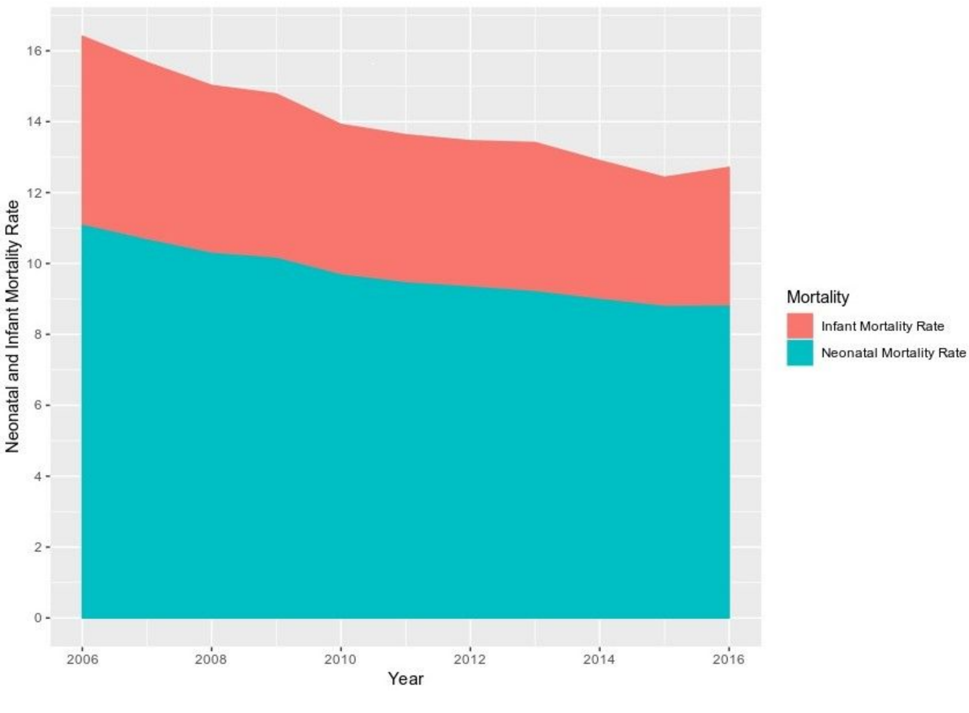
For the present investigation, the variables concerning mother characteristics were divided as the following: maternal age (10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50 or more years), maternal education (0, 1-3, 4-7, 8-11, 12 or more), marital status (single, married/stable relationship, widowed, separated/divorced) and race/skin color (white, black/brown, yellow/indigenous). The later, race/skin color, was missing in 50% of the entries, so it is better to remove it than to use some method to input the missing data. It's best not to make decisions on such inconsistent data. For the decision trees, feature groups have been combined into broader categories, enabling a cleaner visualization.

Descriptive statistics were calculated for the all variables in order to analyze the main determinants of the neonatal death risk in Brazil. The methods used to manipulate data and produce the visualizations were Python programming language (3.6) along with Pandas, Matplotlib and Seaborn modules. Also LibreOffice Calc and Google Drawings were used for visualizations.

Results

Between 2006 and 2016, infant mortality had a considerable decrease in Brazil. However, while post-neonatal mortality dropped by 27%, neonatal mortality reduced only 20% in the same period, reaching the level of 9 deaths for every 1000 births, as shown below (Figure 3).

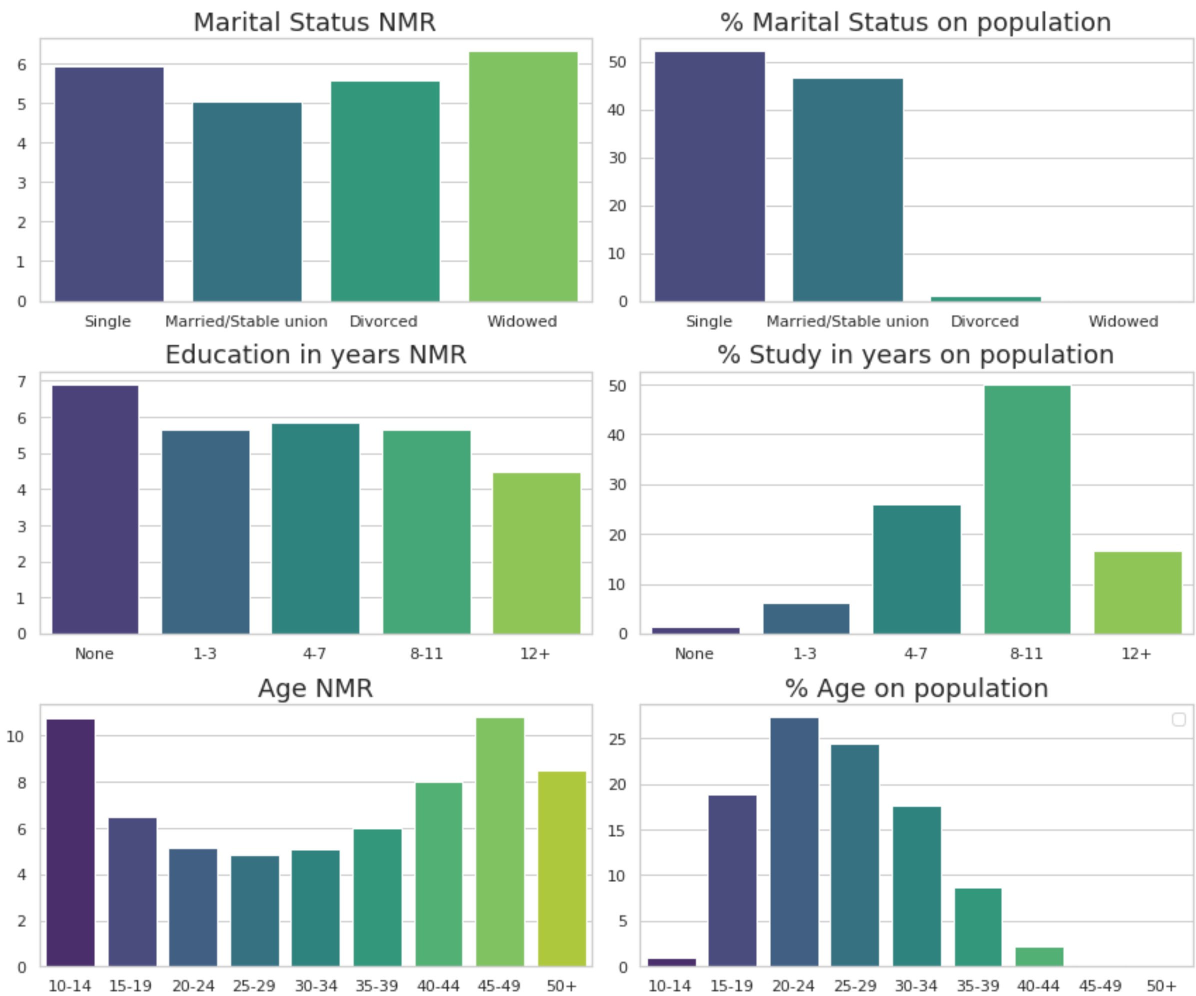
Figure 3: Contribution of neonatal mortality rate on infant mortality rate, 2006-2016



Source: IBGE (2006-2016)

Figures 4 shows characteristics of the sample based on the available sample, the proportion of each group and also their neonatal mortality rates. Most mothers had between 8 and 11 years of education (50 %), and in spite of the difference, mortality rates were similar for mothers between 1 and 11 years of study. Those with a considerable amount above that, with 12 years of education or more (16 %), were the group where mortality rates decreased notably. Although a small part of the population (1,3%), mothers with no education have much greater risk of losing their babies in the first 28 days, with a rate at least 20% higher than the other groups.

Figure 4: Neonatal mortality rate by feature and distribution through population

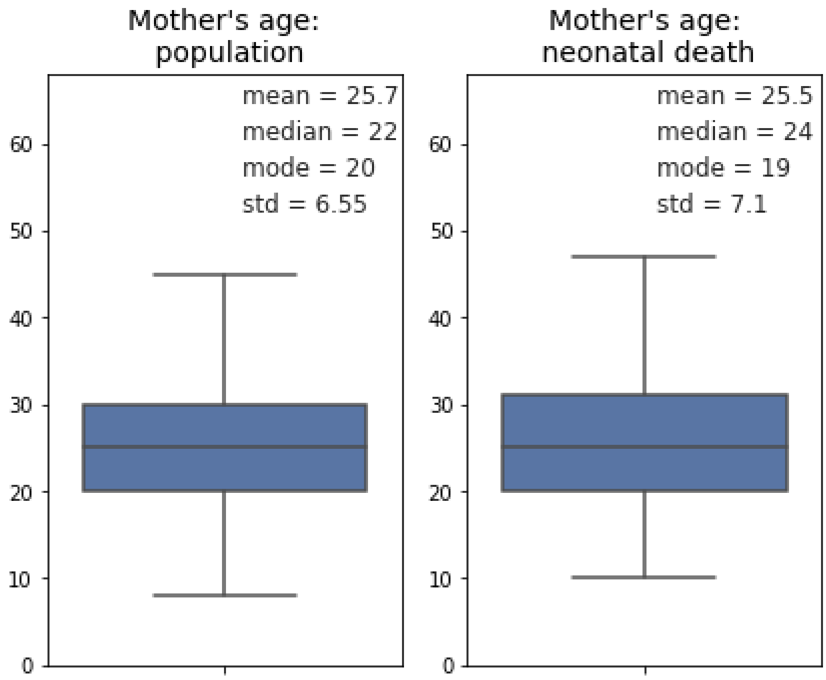


Source: SIM, SINASC, 2006-2016

Both marital status and race/skin color had groups concentrating more than 97% of the samples, while others stayed with the rest. Also, unmarried woman surpassed married/stable relationship, reaching 53% of the total.

Age is the feature with more groups in the distribution. Women are more healthy and fertile between 20 and 34 years old, where the births concentrate (78%) and risks are lower. Due to the correlation between older pregnancy and planned parenthood, women in their 30s do have a low NMR as well. The choice of having children later in life, due to cultural and career changes in the life of women, has pushed the average age of the births. Women above 40 have a much greater risk of infant death, but the biological causes are well documented, and those women are in smaller proportion than the other sensible group: young woman. There is a great amount of mothers between 15 and 19 years old (19,7%), some are even younger, and their higher NMR is related to a number of factors, whose explanation could be on cultural, education, assistance and biological issues. The boxplot on Figure 5 shows how the standard deviation is increased on the neonatal deaths group, even though the great amount of 20-34 years old women strongly pushes the average to a center, and the deviation to a smaller range. Considering 78% of the mothers are between 20 and 34 years old, the standard deviation shift is considerably high.

Figure 5: Mother’s age Boxplots, general population and neonatal death, 2006-2016

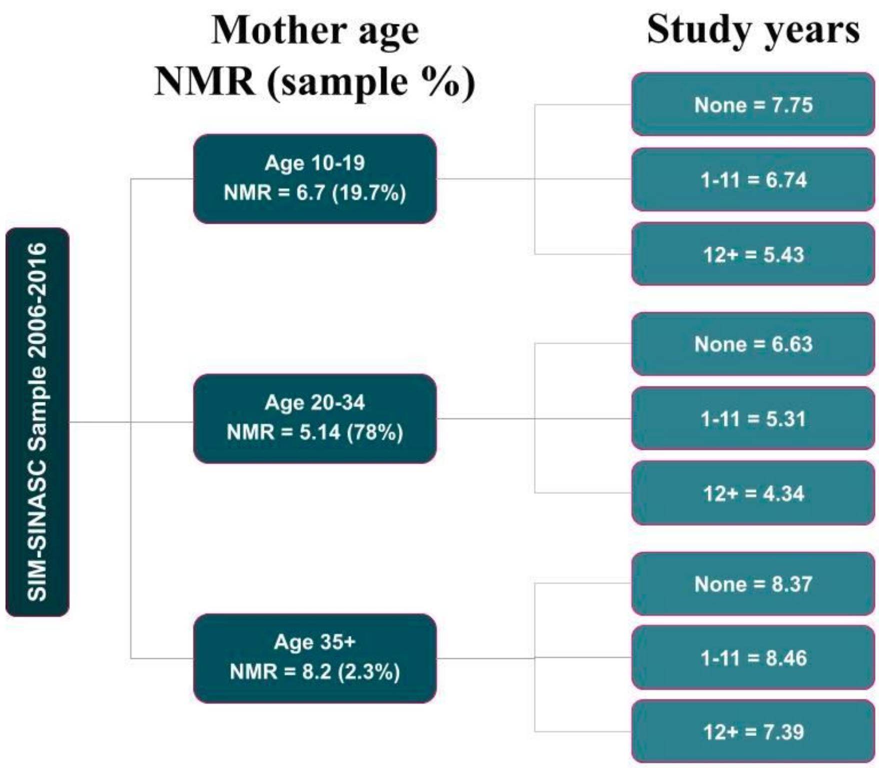


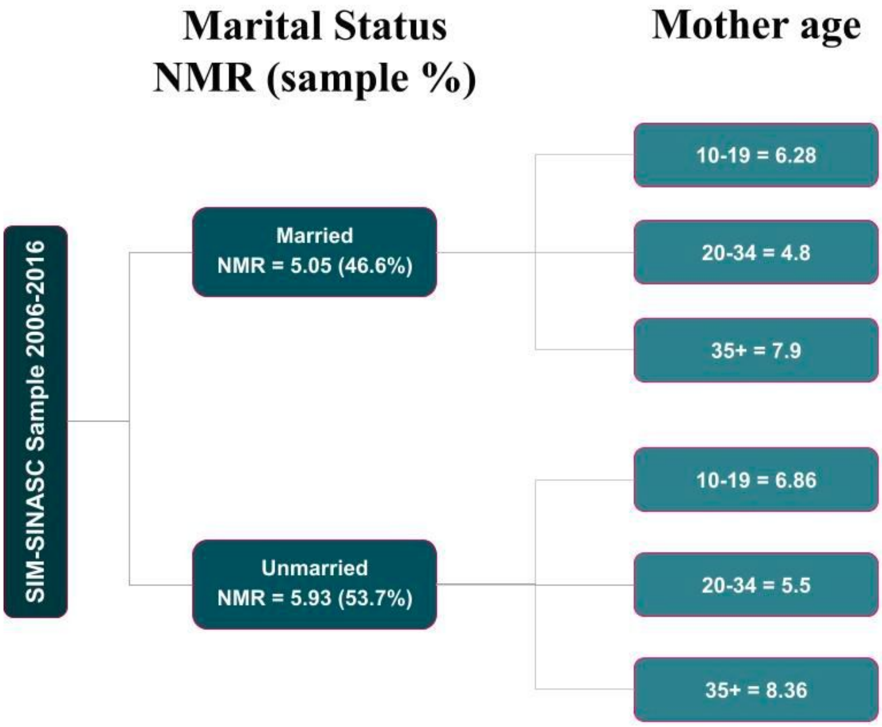
Source: SIM, SINASC, 2006-2016

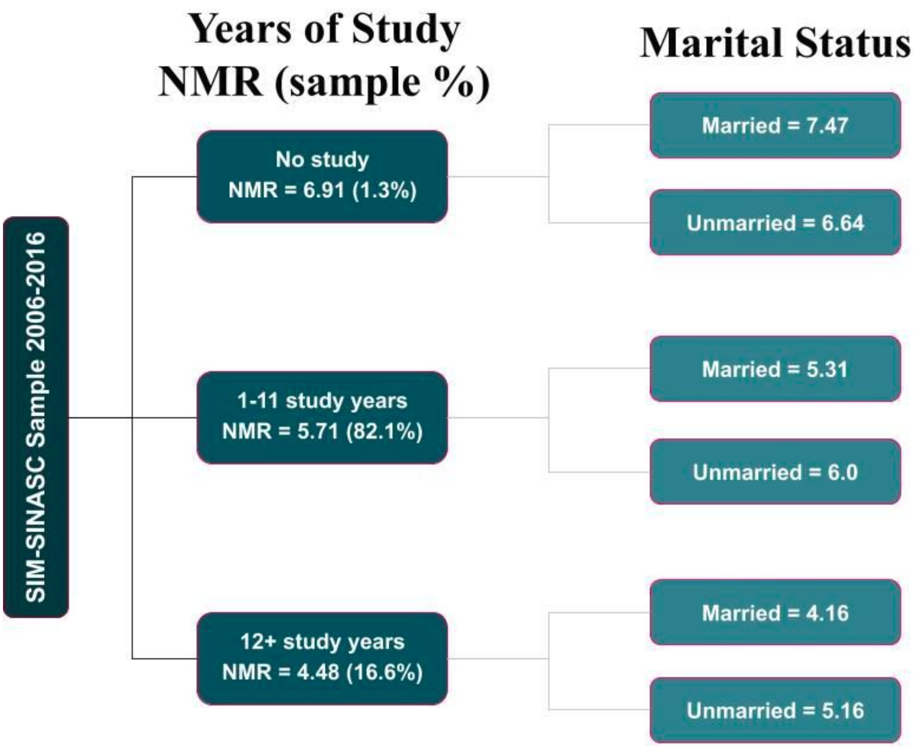
The last visualizations (Figures 6, 7 and 8) are a group of three decision trees. The elaboration of these trees aims to combine the effect of two variables on the neonatal mortality rate of the sample. The middle boxes contain the NMR and the percentage of the group within the sample. The node boxes on the right contain only the NMR for each combined feature.

Starting from each feature group, we see how it adds to the following. Older mothers, for example, even with higher education, have rates only comparable to young mothers with no education. Differences become sharper when higher risk groups are summed up, as with the comparisons of marital status and education in the last tree. Study years, the feature under greater influence of public policy, is a path for reducing rates in the following years, once it has less than 20% of the population. It is important to remember that even a group with 1% of the sample has over 2000 deaths, a significant sample despite the percentage.

Figure 6, 7 and 8: Decision trees combining study years, age and marital status







Source: SIM, SINASC, 2006-2016

Discussion

Quality and availability of data persist as an issue for better results concerning infant mortality research in Brazil. Many studies have assessed the importance of looking at mother’s characteristics to understand the distribution of neonatal mortality, doing so on smaller scale than a nationwide sample. The present study is an effort to provide some information in that condition. The quality of the data makes the accuracy of the responses difficult, that happens in such a way that this large database must still be analyzed as a sample. According to Lourenço et al. (2013), half of the preventable deaths on neonatal children were due not to newborn health, but to the mother condition before the birth. The selected features, early available as they are, must help detect those cases more rapidly.

The least available feature, race/skin color, is target of many studies in Brazil, and presents a big issue concerning historical inequalities. Cardoso et al. (2005) found that in 2002, infant mortality rate of black kids in Brazil exceeded by at least 30% the rate for white kids, according to different estimates by the authors. Another study (Caldas et al., 2017) compared data from IBGE and SIM-SINASC for race and found black babies had almost 100% higher risk of death than white babies in the first year, while difference between white and brown was less than 10%. On her doctoral thesis, Cunha (2001) presents similar trends for data between 1977 and 1993. At the moment, she could not distinguish black and brown population with the data available, merging both categories under the same label ‘black’.

The present study concerning mother’s age confirms the expectations and results of scholars. Lima (2010) found strong evidence for both socioeconomic and biological issues with regard to adolescent mothers risk of infant death. Young mothers were the only age segment with an increase in fertility rates in the previous decades, even though contraceptive methods are widespread nowadays. The increase is attributed to cultural changes in social expectations for adolescent woman. Both sexual morality and career plans for women are under a great shift since 1970. While in Latin America the average age for mothers has decreased in the past decade, to around 20 to 24 years old, on developed countries the average increased greatly, above 28. Older mothers, with more than 35 years old, face different challenges. They tend to have better education, planned pregnancy and greater care with both medical and emotional conditions. Despite that, age comes with the incidence of diseases like diabetes and hypertension, both associated with higher mortality risk for the babies.

In 1990, Monteiro presents a relative mortality risk table by study year. The results found, at that moment, that mother with 10 or more years of study have half the risk to lose their babies in the first month than mothers with 1 to 4 years of study. A mom with no education, in its turn, has a NMR three times higher. Surprisingly, mother’s education effect on mortality risk doubles after the neonatal period. The author attributes it to a phase where the mother is no longer under medical supervision. Another reason for those differences is access to rights, more widespread among better educated mothers. Also the ability to correctly assess the onset of any symptoms is correlated with education.

From 1990 until today a lot has changed. Access to information and standardization of health services diminished the impact of maternal education on the life outcome. Still, this variable has an explanatory power, which needs to be better distinguished from its correlation to wealth and availability of good services. Recent articles, like the one by Santos and Moura (2016) confirm the trend, as our SIM-SINASC sample did, but not with the deep approach given by Monteiro. More recently, Fonseca et al. (2017) shows that NMR for low educated mothers decreases at a much slower pace. Their sample, considering the state of Rio de Janeiro between 2004 and 2010, presents no retraction on neonatal mortality rates for the less educated mothers.

Marital status is the least studied feature when dealing with infant mortality. There are two major groups, and many studies are ran considering only those two. According to Arntzen et al. (1996), unmarried mothers were younger, less well educated and had a lower socioeconomic status than the married mothers. It suggests that this criteria is under the scope of other strong indicators. No article in Brazil was exclusively dedicated to the relation between infant mortality rates and marital status.

A systematic review and meta-analysis of neonatal mortality risk factors in Brazil (Veloso et al., 2019) was recently released. It shows mother age above 35 years old and the absence of a partner as the greatest predictors of neonatal death outside the medical scope. It confirms the results found on this study, but does not consider the role of study years on reducing mortality rates.

Conclusion

Throughout this work, exploratory data analysis of the SIM and SINASC databases was performed. As a result, various graphical interpretations were developed, such as decision trees, boxplot and barplots.

It was possible to evaluate maternal characteristics from this quantitative perspective, along with demographic, biological and cultural elements later developed in the discussion. On this part, many studies were considered for each group of features, allowing a broad picture of the discussion about the role of maternal characteristics in neonatal mortality.

This study found that unmarried, low educated mothers presented a considerably higher risk for neonatal deaths, along with mothers outside the 20-34 age group, endorsing the thesis that maternal characteristics are relevant for the observed outcome.

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