

## MORTALITY FROM EXTERNAL CAUSES IN CHILDREN AGED ONE TO NINE YEARS OLD MORTALIDADE POR CAUSAS EXTERNAS EM CRIANÇAS DE UM A NOVE ANOS MORTALIDAD POR CAUSAS EXTERNAS EN NIÑOS DE UNO A NUEVE AÑOS

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### ABSTRACT

This cross-sectional study aimed at identifying and describing mortality profiles due to external causes in children aged one to nine years old living in Minas Gerais, Brazil from 2005 to 2010. It is based on the Mortality Information System. The study used multiple correspondence analyses to establish a link between cause of death, nature of injury and other variables. The highest mortality rates were from traffic accidents (especially as pedestrians and car passengers) and accidental drowning. Cause of death in children aged one to four and in those aged five to nine were fairly similar. The researchers drew multiple correspondence analyses highlighting the association of traffic accidents with white children aged 5 to 9 years in more developed municipalities and accidental drownings in those aged 1 to 4 in less developed municipalities. Appropriate child supervision, use child restraint system, and home accident prevention campaigns were recommended.

**Keywords:** Mortality; Child; Accidents; Violence.

### RESUMO

Objetivou-se identificar perfis de mortalidade por causas externas em crianças de um a nove anos residentes em Minas Gerais. Estudo transversal com base no Sistema de Informações sobre Mortalidade, que utilizou a técnica de análise fatorial de correspondência múltipla para avaliar a associação entre causa básica de morte, natureza da lesão e demais variáveis. As maiores taxas de mortalidade foram observadas nas mortes por acidentes de transporte, especialmente em pedestres e ocupantes de automóvel, mortes por afogamento e submersão acidentais. As características dos óbitos em crianças de um ano a quatro e de cinco a nove anos apresentaram-se bastante similares. Foram traçados perfis por meio da análise de correspondência múltipla, destacando-se a associação dos acidentes de transporte com crianças da raça branca de cinco a nove anos em municípios mais urbanizados, afogamentos em meninos de um a quatro anos em municípios menos urbanizados. A supervisão constante de pais e responsáveis, especialmente nos momentos de lazer das crianças, o uso de equipamentos de segurança nos automóveis, além de campanhas para prevenção de acidentes domésticos, são as ações sinalizadas.

**Palavras-chave:** Mortalidade; Criança; Acidentes; Violência.

### RESUMEN

El objeto del presente estudio fue identificar los perfiles de mortalidad por causas externas en niños de uno a nueve años que viven en Minas Gerais. Se trata de un estudio transversal basado en el Sistema de Información sobre Mortalidad que utilizó la técnica de análisis factorial de correspondencias múltiples para analizar la asociación entre la causa básica de muerte, el tipo de lesión y otras variables. Las tasas de mortalidad más elevadas se observaron en las muertes por accidentes de tránsito, especialmente en peatones y ocupantes de vehículos, las muertes por ahogamiento y sumersión accidentales. Las características de las muertes en niños de uno a cuatro años y de cinco a nueve años son bastante similares. Se trazaron perfiles por medio del análisis de correspondencias múltiples, destacándose la asociación de los accidentes de transporte con niños de tez blanca de 5 a 9 años en las zonas más urbanizadas y ahogamientos en niños de 1 a 4 años en las muertes por ahogamiento y sumersión accidentales zonas menos urbanizadas. Se recomienda la supervisión constante de padres y responsables especialmente durante los momentos de ocio de los niños, el uso de equipamientos de seguridad en los coches además de campañas para la prevención de accidentes en el hogar como medidas importantes por implementar.

**Palabras clave:** Mortalidad; Niño; Accidentes; Violencia.

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## INTRODUCTION

Accidents and violence are the predominant cause of death among children. Excluding infant deaths, external causes are the leading cause of child death in this country.<sup>1,2</sup>

According to the United Nations Children's Fund (UNICEF), millions of children die from accidents every year or are left with permanent sequelae worldwide.<sup>3</sup> In Brazil, every year, one in ten children is taken to hospital at least once due to physical trauma. Such events answer for 20% of the hospitalization rates and leave more than 200,000 children and young people with lifelong disabilities.<sup>4</sup>

The underlying external cause of death is road accidents, drownings, other accidental threats to breathing and violence.

The most common injuries resulting from these are head/face trauma as well as upper and lower limbs trauma.<sup>5,6</sup> These injuries have been described in morbidity studies and emergency services. Studies on the external causes of mortality amongst children that describe injuries ensued are scarce.<sup>7</sup>

The characteristics of the deceases vary according, amongst other factors, to the victim's age, sex, colour or race.<sup>8</sup> The number of deaths from external causes in children is expected to rise dramatically due to environmental changes and an increased exposure to risk, especially in developing countries.<sup>3</sup>

Considering the influence of external causes in infant morbidity and mortality rates and that most deaths could be avoided through the adoption of preventive measures, this study aimed at identifying mortality profiles of children aged one to nine years old in the state of Minas Gerais, Brazil. The researchers analysed the links between cause of death, injury and resulting trauma (nature of the injury) and other variables.

## METHODOLOGY

This is a cross-sectional study that analysed deaths from external causes in children one to nine years of age living in the state of Minas Gerais. The deaths occurred between 2005 and 2010 and data were obtained from the Mortality Information System – SIM/ DATASUS/MS.

Population data were based on interpolation between two censuses (2000 and 2010) carried out by the Brazilian Institute of Geography and Statistics (IBGE) for the years of this study. For this, the geometric annual growth rates for each age group based on the following formula were calculated:  $r = (P2 / P1)^{1 / 10} - 1$ , being  $r$  the geometric rate of annual population growth ( $P1$  for year 2000 and  $P2$  year 2010). After that, the researchers made an estimate of the population of each age, sex and race/colour group for the period 2005-2010.

The independent variables were the year of death, sex, race/colour, and percentage of municipal urban development. The main cause of death was the dependent variable.

The analysis of mortality in children was stratified in age groups one to four and five to nine. The years of the occurrence of deaths were grouped into biennia for more stability of rates. Race/colour variable classified participants as white and non-white (this included black, brown, yellow and indigenous population due to the low frequency of the last two). The percentage of urban development, obtained through IBGE data, was divided into tertiles 18-59%, 60-79% and 80-100% of development.

Data on the variables were organized in tables. Descriptive analysis used Statistical Package Program for Social Sciences (SPSS). Proportional mortality and mortality rates were calculated for each variable by age and groups of causes. In order to calculate the average annual rates of mortality, the researchers used the total number of individuals for each year in the corresponding age group. Calculation of specific rates considered sex, race/colour and municipality of residence (urban development category) of the population.

Missing data referent to race/colour and percentage of municipal urban development (which totalled 131 and 4, respectively) were excluded from the analysis.

The study analysed cause of death according to underlying cause and multiple causes. The underlying cause usually employed in official mortality statistics was defined as circumstances of the accident or violence which produced the fatal injury. Multiple causes encompassed all causes mentioned in the death certificate regardless of their classification as basic, consequential or contributing, as proposed by Santo.<sup>7</sup> Duplicates and multiplication of diagnoses were eliminated, so that causes mentioned in a single certificate belonging to the same group would only be used once.

Regarding the multiple causes, the researchers opted to study only those related to the nature of the lesion described in the three-digit groupings, categories and subcategories in Chapter XIX of the ICD-10 - Injury, poisoning and other consequences of external causes (S00 - T98).

The associations between multiple cause of death (underlying cause and nature of the injury) and other variables were analysed through the factorial multiple correspondence analysis according to Rezende.<sup>9</sup> Correspondence analysis, especially suited to describe large volumes of data, allows visualization of the most important relationships of a large set of variables. The results are presented as graphs without inferential testing in Cartesian axes systems which present the categories of each variable and where the relationships between them can be observed, from the distance between dots. The distance between two points in the graph is relatively evaluated. Variables more distant from the axis are the most important and contribute the most to variation. Closer variables have the same conditions observed (correlated) and the variables in opposite quad-

rants are antagonistic (negative correlation).<sup>7,9</sup> The study of associations used the Statistical Analysis System (SAS).

The present research complies with National Council Health Resolution No 466/2012<sup>10</sup> regarding ethical principles of research involving human subjects. Since databases used are in the public domain, free and available online at the DATASUS/MS site personal or institutional submission to the Research Ethics Committee was not necessary.

## RESULTS

The researchers identified 766 death records of children aged one to four years old and 767 of children aged five to nine years old. Table 1 shows average mortality rate in the period was 11.7 to children aged one to four years old, stable in the studied period; the rate for those aged five to nine years old was 8.9 and declining during the study period. The rates were higher in non-white males in both age groups and lower in the municipalities with the highest percentage of urban development for the one to four years old. Highest mortality rates were observed in traffic accidents (especially as pedestrians and car passengers), accidental drowning and submersion and undetermined intents. Deaths from other accidental threats to breathing amongst children aged one to four years old and deaths from injury among those aged five to nine are worth mentioning (Table 2).

Table 1 - Mortality due to external causes in children by age group, according to the variables analysed. Minas Gerais, 2005-2010

| Variable                         | 1 to 4 years old |              |             | 5 to 9 years old |              |            |
|----------------------------------|------------------|--------------|-------------|------------------|--------------|------------|
|                                  | N                | %            | Rate        | N                | %            | Rate       |
| <b>Biennia</b>                   |                  |              |             |                  |              |            |
| 2005-2006                        | 268              | 34.9         | 11.7        | 303              | 39.5         | 9.9        |
| 2007-2008                        | 260              | 33.9         | 11.9        | 239              | 31.2         | 8.0        |
| 2009-2010                        | 238              | 31.1         | 11.4        | 225              | 29.3         | 7.8        |
| <b>Total</b>                     | <b>766</b>       | <b>100.0</b> | <b>11.7</b> | <b>767</b>       | <b>100.0</b> | <b>8.9</b> |
| <b>Sex</b>                       |                  |              |             |                  |              |            |
| Male                             | 446              | 58.2         | 13.4        | 493              | 64.3         | 10.9       |
| Female                           | 320              | 41.8         | 8.9         | 274              | 35.7         | 6.2        |
| <b>Race/colour</b>               |                  |              |             |                  |              |            |
| White                            | 324              | 46.8         | 9.2         | 296              | 38.6         | 7.5        |
| Non-white                        | 368              | 53.1         | 10.9        | 414              | 54.0         | 8.4        |
| <b>Rate of urban development</b> |                  |              |             |                  |              |            |
| 18-59%                           | 111              | 14.5         | 13.4        | 93               | 12.1         | 7.8        |
| 60-79%                           | 135              | 17.6         | 13.4        | 132              | 17.2         | 9.3        |
| 80-100%                          | 519              | 67.8         | 11.0        | 539              | 70.3         | 8.5        |

Source: SIM/SINASC- DATASUS/Health Department 2005-2010.

Note: Rates calculated per 100,000

Unknown cause of death excluded - Race/Colour: 131; urban development: 4

Table 2 - Mortality rates due to external causes in children according to underlying cause of death and age group, 2005-2010

| Underlying cause of death             | 1 to 4 years old |            |             | 5 to 9 years old |              |            |
|---------------------------------------|------------------|------------|-------------|------------------|--------------|------------|
|                                       | N                | %          | Rate        | N                | %            | Rate       |
| Road accidents                        | 254              | 33.2       | 3.9         | 365              | 47.6         | 4.1        |
| Pedestrian                            | 109              | 14.2       | 1.7         | 146              | 19.0         | 1.6        |
| Cyclist                               | 2                | 0.3        | 0.0         | 21               | 2.7          | 0.2        |
| Motorcyclist/ Tricycle                | 5                | 0.7        | 0.1         | 6                | 0.8          | 0.1        |
| Car passenger                         | 83               | 10.8       | 1.3         | 99               | 12.9         | 1.1        |
| Other ground transportation accidents | 48               | 6.3        | 0.7         | 82               | 10.7         | 0.9        |
| Other road accidents                  | 7                | 0.9        | 0.1         | 11               | 1.4          | 0.1        |
| Falls                                 | 31               | 4.0        | 0.5         | 34               | 4.4          | 0.4        |
| Exposure to mechanical force          | 23               | 3.0        | 0.4         | 18               | 2.3          | 0.2        |
| Drowning and submersion               | 181              | 23.6       | 2.8         | 150              | 19.6         | 1.7        |
| Other accidental threats to breathing | 47               | 6.1        | 0.7         | 23               | 3.0          | 0.3        |
| Electric current/Temperature          | 1                | 0.1        | 0.0         | 8                | 1.0          | 0.1        |
| Exposure to smoke, fire and flame     | 38               | 5.0        | 0.6         | 19               | 2.5          | 0.2        |
| Poisonous plants and animals          | 36               | 4.7        | 0.5         | 22               | 2.9          | 0.2        |
| Exposure to forces of nature          | 6                | 0.8        | 0.1         | 6                | 0.8          | 0.1        |
| Accidental poisoning                  | 11               | 1.4        | 0.2         | 2                | 0.3          | 0.0        |
| Accidental exposure to other factors  | 18               | 2.3        | 0.3         | 23               | 3.0          | 0.3        |
| Legal intervention                    | 0                | 0.0        | 0.0         | 0                | 0.0          | 0.0        |
| Medical complications                 | 4                | 0.5        | 0.1         | 4                | 0.5          | 0.0        |
| Consequences of external causes       | 1                | 0.1        | 0.2         | 1                | 0.1          | 0.0        |
| Self-harm                             | 0                | 0.0        | 0.0         | 1                | 0.1          | 0.0        |
| Aggressions                           | 43               | 5.6        | 0.7         | 43               | 5.6          | 0.5        |
| Undetermined intent                   | 72               | 9.4        | 1.1         | 48               | 6.3          | 0.5        |
| <b>Total</b>                          | <b>766</b>       | <b>100</b> | <b>11.7</b> | <b>767</b>       | <b>100.0</b> | <b>8.9</b> |

Source: SIM/DATASUS SINASC/Health Department 2005-2010 Rates calculated per 100,000.

The study of associations through the analysis of multiple correspondences for the group of one to nine year olds was carried out together due to the similarity of the results. The researchers identified four mortality profiles that are described in Figure 1.

Deaths of car passengers and pedestrians happened more often amongst those aged five to nine, white and living in more developed municipalities. Resulting injuries were multiple trauma, intracranial and head trauma.

Drowning and other accidental threats to breathing occurred in children aged one to four, male, residing in less urbanized municipalities. Associated injuries were asphyxia and foreign body penetration in natural orifices.

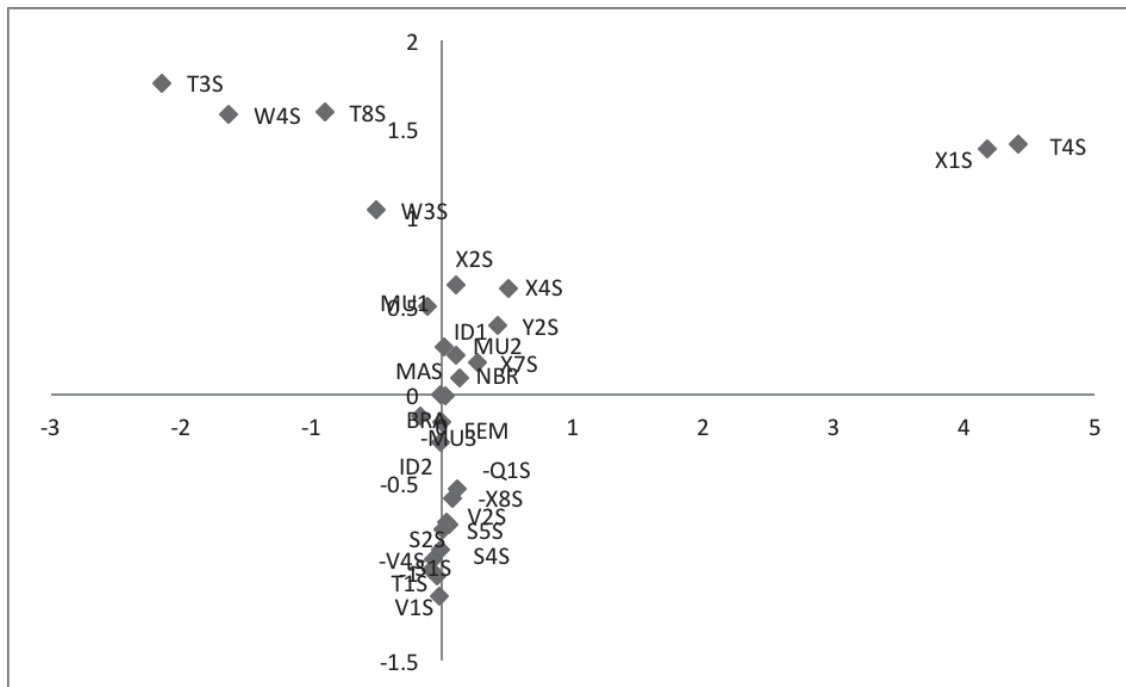


Figure 1 - Graphical representation of the relationship between underlying cause of death, injuries and variables in children aged one to nine years old. Minas Gerais, 2005-2010.

- |  |   |   |
|--|---|---|
| MAS male sex                               | V4S car passenger                         | S1S intracranial injury                         |
| FEM female sex                             | V5S other road accidents                  | S2S other head injuries                         |
| BRA race/white                             | W3S drowning                              | S4S abdominal trauma                            |
| NBR race/non-white                         | W4S other accidental threats to breathing | S5S thoracic trauma                             |
| ID1 children 1 to 4                        | X1S exposure to fire/smoke/flames         | T1S multiple trauma                             |
| ID2 children 5 to 9                        | X2S poisonous animals and plants          | T3S penetration foreign body in natural orifice |
| MU1 municipality with 18-59% urbanization  | X4S accidental poisoning                  | T4S burns                                       |
| MU2 municipality with 60-79% urbanization  | X7S other aggressions                     | T8S asphyxia                                    |
| MU3 municipality with 80-100% urbanization | X8S firearm accident                      | Y2S undetermined intent                         |
| V1S pedestrian                             | Q1S sharp/penetrating object              |   |
| V2S cyclist                                | Y2S Event of undetermined intent          |   |

Deaths from aggression through sharp/penetrating object and firearm were more associated with female children living in more urbanized municipalities. Chest and abdomen injuries were the most reported. The research also identified deaths due to bicycle accidents in this age group.

Events of undetermined intent, contact with poisonous animals or plants and accidental poisoning occurred generally amongst one to four years old, non-white, living in cities with a 60 to 79% of urbanization. However, the most important cause of death in this age group was injuries due to exposure to fire/smoke/flame.

## DISCUSSION

Mortality profiles demonstrated through multiple correspondence analyses allowed the researchers to describe the deaths in more detail. In the group of one to four years old

death by drowning in males living in less developed municipalities were the most common. In the group of five to nine years old death in traffic accidents were more common amongst white children living in more urbanized municipalities.

The prevalence of deaths from accidents and violence amongst male individuals has also been described in other studies.<sup>6,11,12</sup> Different gender stereotypes and attitudes that confer more freedom to boys and are more vigilant over girls could explain such findings.<sup>8</sup> The highest prevalence of deaths from external causes amongst non-white children was also observed in other studies. This aspect needs to be further studied given socioeconomic differences between white and non-white individuals in Brazil.<sup>13,14</sup>

The present study findings corroborated results from other Brazilian studies on the predominance of deaths from traffic accidents.<sup>4,5</sup> Child victims were injured as pedestrians or car passengers. Such deaths are more strongly associated with children

aged five to nine years old, since they are more likely to travel by car with parents or relatives.<sup>12</sup> However, mortality rates amongst five to nine years old presented a decline in the period studied.

This tendency can be attributed to programmes and public policies aimed at reducing traffic accidents and raise population awareness. It may have also been influenced by more strict laws regarding the use of baby/toddler car seat and the Dry Law which aims at zero BAC and imposes severe penalties to those driving under the influence of alcohol.<sup>14-17</sup> Nevertheless, a current study carried out in Brazil demonstrates that most children treated in emergency services and involved in traffic accidents were not using restraint systems.<sup>17</sup> Another research carried out from 2005 to 2011 demonstrated a reduction in the number of deaths amongst children under 10 years, although with no statistically significant difference.<sup>16</sup> Though public policies and laws are stricter, there are failures in monitoring and penalizing traffic offenders.<sup>14,16</sup>

As observed in other studies<sup>15,16</sup>, socio-economic aspects may be behind the death rate of white children who travel as car passengers since white families are more likely to own a car which increases the chance of such accidents.<sup>14</sup> The main injuries in this type of accident are head and multiple traumas, which corroborates study finding carried out between 2009 and 2011.<sup>17</sup>

Deaths by drowning and submersion are associated with children aged one to four years, living in less urbanized municipalities. The mortality rate amongst this age group requires the implementation of programmes to raise awareness regarding supervision of children during water activities, as well as fencing risk areas and requesting the presence of lifeguards in public places.<sup>6,11</sup> The occurrence of such deaths in less urbanized municipalities may be associated with access to the vast hydrographic network in the state of Minas Gerais which makes it difficult for local authorities to provide lifeguards and monitoring. Changes in the attitudes of families towards safe conduct and monitoring of children should be encouraged.<sup>6,11</sup>

Another identified profile regards death rate of female children in more developed municipalities. The main cause of death in such cases was aggression by firearm unspecified weapon or sharp/penetrating object. The associated injuries were chest and abdomen trauma. Such findings confirm results in the literature that describes this population as the most susceptible to aggression.<sup>2,5,17</sup> More urbanized municipalities seem to be more favourable to violence, especially against vulnerable individuals. The reasons are social and economic inequality, decrease in the role of the state regarding public policies, faulty safety measures, general stress generated by the current scenario.<sup>18,19</sup>

Undetermined external causes were reported frequently as cause of death and were associated with municipalities with 60-79% urbanization. Lack of access to diagnostic resources and family refusal to detail the occurrence of deaths in these

municipalities are to blame.<sup>20</sup> This context stresses the need for investment to define intentionality and improve quality of information in death records. The determination of intent and specificity of the event is important to obtain more accurate statistics that would subsidize future interventions. The increase in this type of cause of death is disturbing because it hides the intention which led the child death, which hinders prevention and health promotion programmes.<sup>20</sup>

## FINAL CONSIDERATIONS

The characteristics of the deaths in the group of children aged one to four and that of children aged five to nine were quite similar. The most prevalent cause of death in both age groups was drowning, being run over by a car or road accidents involving child passengers. Four mortality profiles were defined by the association of cause of death, nature of injury and other variables. The research highlights that prevention of childhood accidents relies on the role of the health professional in the preventability of deaths from external causes, especially offering parental guidance on the risks at each stage of development and promoting a safe environment. It is up to this professional also to pay attention to possible signs of aggression that occur mostly in female children living in more developed municipalities. During interviews with families, that professional should pay attention to any evidence of aggressive behaviour or risk situations.

Parents and caregivers living in less urbanized cities with ample access to watercourses should be made aware of the need of constant supervision during children's leisure time.

In large urban centres, more attention should be paid to the crossing of streets and highways. In addition, the use of car restraint equipment appropriate to children's size and age is recommended. Furthermore it is indispensable to increase road traffic monitoring. A fast and effective healthcare service is also very important given the life threatening nature of injuries, such as multiple and head trauma.

Local health authorities in small cities which do not have sufficient diagnostic resources should emphasize to health professionals the importance to detail the cause of death during home interviews when that is undetermined. The researchers stress the importance of home safety campaigns in large cities, addressing drowning, pedestrian and car accidents.

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