

## Mortality surveillance in Brazil: factors associated with certification of unspecified external cause of death

Vigilância da mortalidade no Brasil: fatores associados à certificação de causa externa inespecífica de morte

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**Abstract** *This article aims to analyze the association between characteristics of death – type of certifier and place of death – and the odds of an external cause death being certified as unspecified in Brazil. Cross-sectional study of deaths due to external causes from the Mortality Information System, 2017. Unspecified external cause (UEC) is the outcome variable in the models. Type of certifier physician, place of death and the interaction of these variables were the explanatory variables. Confounders were controlled by multiple logistic regression. UEC were the initial underlying cause for 22% of the 159,720 deaths from external causes in Brazil and 31% of hospital deaths issued by coroners. After adjustment for confounders, the odds of UEC in a hospital death certified by a coroner was 98% greater (OR=1.98; 95%CI: 1.53; 2.56) than in a home/street death issued by another certifier. This was greater than the odds for certifications by coroners (OR=1.23; 95%CI: 1.14; 1.33) and hospital deaths (OR=1.44; 95%CI: 1.32; 1.58). External causes certified by coroners and/or occurring in hospitals have a higher presence of UEC than other deaths; and indicate the need for coordinated initiatives by the health and public security sectors.*

**Key words** *Forensic medicine, External causes, Data accuracy, Public Health Surveillance*

**Resumo** *O objetivo deste artigo é analisar a associação entre características do óbito – tipo de certificador e local do óbito – e a chance de um óbito por causa externa ser certificado como inespecífico no Brasil. Estudo transversal com dados do Sistema de Informações sobre Mortalidade de 2017. Causa externa inespecífica (CEI) é a variável desfecho nos modelos. As exposições de interesse foram tipo de médico certificador, local do óbito e a interação destas variáveis. Variáveis confundidoras foram controladas por regressão logística múltipla. As CEI foram a causa básica inicial de 22% dos 159,7 mil óbitos por causas externas no Brasil e 31% dos óbitos hospitalares emitidos por médicos-legistas. Após ajuste para confundidores, a chance de CEI em um óbito hospitalar certificado por legista foi 98% maior (OR=1,98; IC95%: 1,53; 2,56) do que em um óbito domiciliares/via pública emitido por outro certificador. Esta foi maior do que as chances para certificação por legista (OR=1,23; IC95%: 1,14; 1,33) e óbito hospitalar (OR=1,44; IC95%: 1,32; 1,58). As causas externas certificadas por médicos-legistas e/ou ocorridas em hospitais têm maior presença de CEI do que outras mortes; e indicam a necessidade de iniciativas coordenadas dos setores da saúde e segurança pública.*

**Palavras-chave** *Medicina legal, Causas externas, Confiabilidade dos dados, Vigilância em Saúde Pública*

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## Introduction

External causes represent a high percentage of mortality in Brazil contrasted with other countries<sup>1</sup>. Knowledge of specific information about these causes of death (CoD) is important for the development of public health policies<sup>2</sup>. However, unspecified external causes (UEC) of death have been a limitation that reduces the value of the statistics in different countries<sup>3-5</sup>. Assessment of external underlying cause of death data in Brazil found they were of medium quality, because they allocated more than 20% of deaths to categories with imprecise definitions<sup>4</sup>. This type of unspecified cause, which is considered invalid or little useful code for use in health policy<sup>2</sup>, has indicated the level of comprehensiveness and accuracy of the cause information in the Death Certificates (DC)<sup>3</sup>. It has necessitated adjustment in studies that use CoD data in extensive international comparisons<sup>6,7</sup>.

Over the past 15 years, efforts to investigate the set of unknown and unspecified causes have contributed to progress in the quality of mortality data in Brazil<sup>8-10</sup>. Without this data retrieval, some Brazilian states reach more than 30% of unspecified external causes. In 2017, the health sector qualified data from the Mortality Information System (SIM), reducing this type of cause from 21% to 14% (21.5 thousand). Even so, the UEC was higher than suicides in Brazil, homicides and suicides in São Paulo, and transport injuries and suicides in Rio de Janeiro<sup>11</sup>. Therefore, it is necessary to invest in further improvements in filling out the CoD records.

In Brazil, the medicolegal death investigation (MDI) system structure combines a medical and technical-scientific police investigation with judicial proceeding in open court<sup>12</sup>. Without establishing civil and criminal liability, the system intends to materialize facts that comprise the evidence for the definition of the legal CoD. The forensic autopsy strives to define the cause, moment and circumstances of the death, complemented by technical findings from the scene<sup>12,13</sup>. Operational equipment of the National Public Security System, forensic medicine institutes are under the guidelines of law enforcement agencies in the country<sup>14</sup>. On the other hand, the execution of all preparatory steps for the processing of DC data in the SIM is under municipal health authority and management of the National Health Surveillance Network<sup>15</sup>.

Actions to improve the death certification process would result in greater accuracy in documenting on the initial circumstances of the events that

led to an external cause, providing more reliable information for the prevention of violence and accidents<sup>2</sup>. More successful interventions in this direction, mitigating additional efforts in the health sector, depend on a broad and detailed understanding of the phenomenon. As a contribution to this debate, this study aimed to analyze the association between characteristics of death certification – type of certifying physician and place of death – and the likelihood of an external CoD being certified as an unspecified external cause in Brazil.

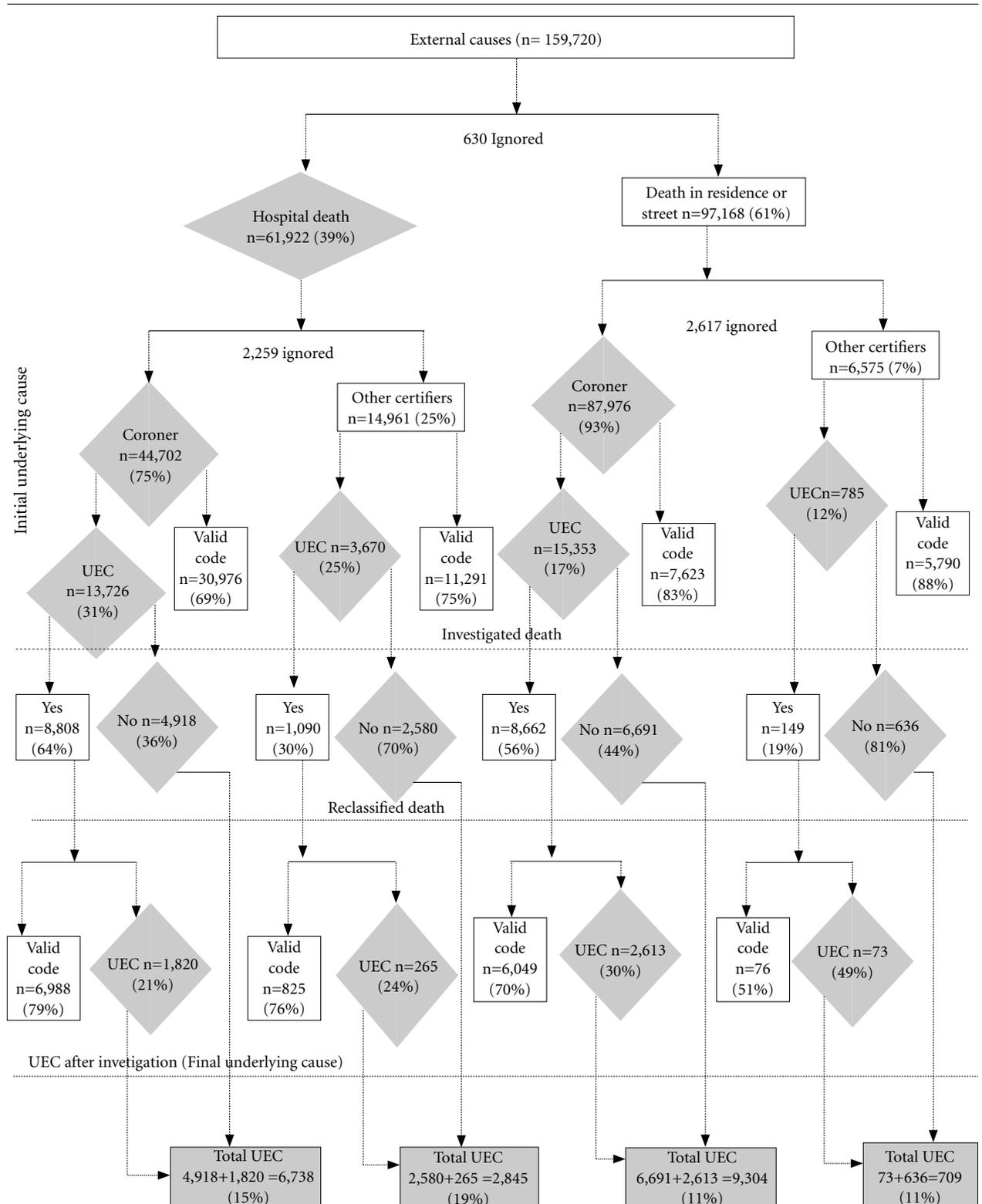
## Methods

This is a cross-sectional study. The study population is death notifications with an underlying cause due to external causes in Brazil in the year 2017. It was considered the original underlying cause, which is the one notified in the DC, prior to any modification resulting from improvement activities surveillance of mortality to improve the qualification of the registry<sup>16</sup>. Death data are from SIM 2017, from the Ministry of Health of Brazil. Information on the characteristics populations of the municipalities was obtained from the Brazilian Institute of Geography and Statistics (IBGE).

The dependent variable of interest – outcome – is nominal and refers to the certification of a CoD with UEC or with a well-defined cause. The UEC is the unspecified record on the circumstance of death due to external causes in the DC. This study adopted the Global Burden of Disease-2015 list<sup>17</sup>, whose codes of the International Classification of Diseases (ICD-10) are: road injuries unspecified (V87.0; V87.1; V87.4-V88.1; V88.4-V89.9); transport injuries unspecified (V99); unintentional injuries unspecified (X59); injuries by interpersonal violence unspecified (Y09); and injuries by undetermined intention (Y10-Y34). In addition, there was a group of another unspecified external causes W76; X40-X44; X47.0; X49; Y85-Y86; Y87.1-Y87.9; Y89.

The independent variables were selected from variables contained in the DC form, used in literature<sup>18,19</sup>, and classified into: explanatory and potential confounding.

The explanatory variables in the study refer to the “type of certifying physician” and the “place of death”. The variable “type of certifying physician” was categorized as a coroner or others type, including a physician from the death verification service, substitute physician, among others. The variable “place of death” was classified as hospital or others, including at home, street or other places (Figure 1).



**Figure 1.** Schematic representation of the frequency of death registration due to unspecified external causes, before and after investigation, according to the place of occurrence and the certifying physician, Brazil, 2017.

Note: Ignored data where death occurred (0.4%, n=630); type of certifying physician (3.1%, n=4,898). UEC: Unspecified external cause

Source: Mortality Information System/Ministry of Health.

The application of a directed acyclic graph (DAG), using the DAGitty tool (<http://dagitty.net/>), identified this minimum set of variables that need to be controlled in order to obtain valid results in the modeling. The potential confounding variables in the study are divided into two classes. Class 1 refers to the sociodemographic profile of the victims of external causes (proximal variables): sex (male; female), race/skin color (black is the sum of the black and brown skin color; other race - white, indigenous, Asian descendants); age groups (0 to 29 years, 30 to 49 years, 50 or more years); and education in years of study (data not informed, 0 to 7 years, 8 to 11 years, 12 or more years of study). In later stages of analysis, this grouping of categories of the variables age and education was done, based on the results of the Odds Ratio (OR) product of the simple logistic regression (univariate) to measure the association with the outcome. The categories were gathered by similarity in the OR values. Due to the important proportion of missing data in the education variable, we decided to keep a category of data without information, in order not to have the number of events reduced. Class 2 characterizes the municipalities where the event occurred (distal variables), classified into: metropolitan regions (yes, no) and population size of the municipality (small and medium-sized population - <100 thousand inhabitants; large-size -  $\geq 100.000$  inhabitants). The diagram explains the hypotheses adjacent to the model under study (Figure 2)<sup>20,21</sup>.

For the analysis of the association of explanatory variables (type of certifying physician and place of death) with the outcome (UEC) adjusted by confounders, the following steps were adopted. Initially, the presence of multicollinearity between the independent variables (explanatory and confounding) was verified, using the statistics Tolerance ( $>0.1$ ) and Variance Inflation Factors ( $VIF < 10$ ), resulting from multiple linear regression. Then, a univariate logistic regression analysis was performed to assess the association between each independent variable and the outcome (the UEC) and to estimate the crude ORs.

Finally, multiple logistic regression analyzes were performed to study the relationship between the explanatory variables and the chance of UEC, adjusting potential confounding variables. At this stage, the significance of the interaction between type of certifying physician (coroner and others) and place of death (hospital and others) was also assessed. The modeling process was carried out in a step-wise manner, from a simpler model to

a more complex model, with variables selected in the final model according to each variable's impact on the strength of the model when they were each included. The entry of potential confounding variables was based on the decreasing crude OR value, respecting the division of classes 1 and 2. The confounding variables were retained in the final model, in which the difference between the adjusted and unadjusted OR estimates of the explanatory variables was greater than 10%.

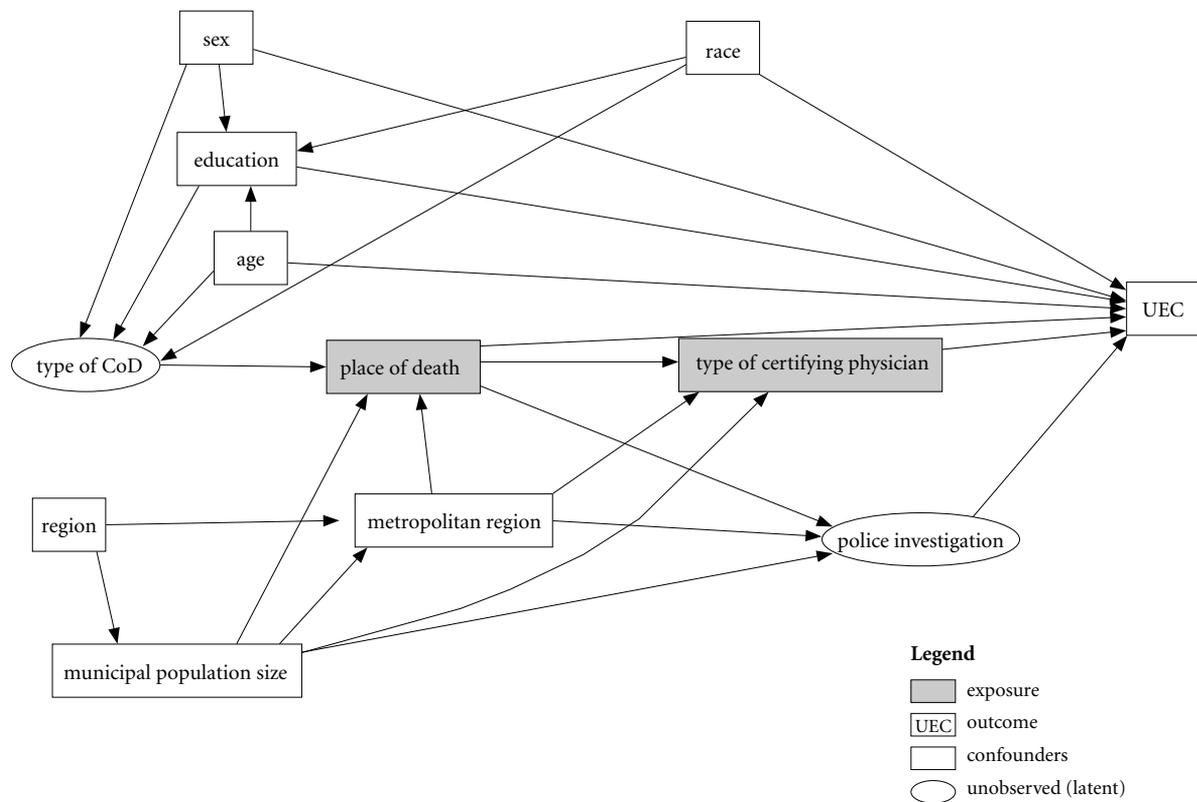
In univariate and multiple logistic regression analyzes, OR was adopted as a measure of association with its respective 95% confidence intervals. The Wald test evaluated the degree of significance of the coefficients at the level of 1%, making it a cut-off point for the selection of potential confounding variables during univariate analysis. Due to the large number of cases and in order to protect the study against statistically significant associations, but without epidemiological relevance, a statistical significance limit of  $p < 0.01$  was used, instead of the conventional  $p$ -value between 0.15 and 0.20 in the univariate and  $p < 0.05$  in the multiple. In the multiple analysis, the verification of the step-by-step adjustment and significance of the final model at 1% was analyzed by the Omnibus statistics, using the likelihood logarithm ( $-2 \text{ Log likelihood}$ ) for comparison and selection of the most appropriate model. The explanatory capacity of the model is given by the Nagelkerke test (adjusted pseudo  $R^2$ ). The program used in the statistical analysis was SPSS.

To test the effect of explanatory variables, without the control of the potential confounding variables, an intermediate model, model 1, was organized. Model 2 resulted from the inclusion of the best-adjusted independent variables.

In the final presentation of the results, in the chance of occurrence of an UEC, the effect of each of the explanatory variables in the presence of the second exposure variable was measured by the adjusted OR estimated by  $\exp^{\beta_1 + \beta_2 + \beta_3}$ , considering the combined effect of the exposure variables of interest ( $\beta_1$  and  $\beta_2$ ) with the effect of the interaction factor ( $\beta_3$ ), adjusted in the multiple logistic regression analysis by the confounders.

The primary material and methodological detailing can be accessed through the link: <https://data.scielo.org/dataset.xhtml?persistentId=doi:10.48331/scielodata.I7KH8J>.

This study used non-nominal secondary data, according to the Resolution of the National Health Council No. 510, of April 7, 2016, which establishes research standardization<sup>22</sup>.



**Figure 2.** Directed acyclic graph representing hypotheses about the relationships among exposure (place of death, type of certifying physician), outcome (unspecified external cause) and other covariates (potential confounders).

Notes: UEC (unspecified external cause); CoD (cause of death); Minimal sufficient adjustment sets for estimating the total effect of place of death, type of certifying physician on UEC: age, sex, education, race, metropolitan region, municipal population size and region.

Source: Mortality Information System/Ministry of Health.

## Results

Brazil recorded 159,720 deaths from external causes in 2017; 39% of these deaths occurred in hospitals and coroners certified 83% ( $n=44,702+87,976$  deaths) of DC. UECs comprised 22% of the initial underlying cause before investigation procedures and 14% of the final cause after investigation (Figure 1).

UEC was a higher proportion of external cause deaths in hospital (28%:  $n=13,726+3,670$  deaths), especially when the DC was certified by a coroner (31%), compared with external cause deaths at home or on the street (17%:  $n=15,353+785$  deaths). The investigation of UEC was greater in events certified by coroners both among hospital deaths (64%) and among non-hospital deaths (56%). UECs after investigation decreased between 16% and 6%, being more evident for hospital deaths certified by coroners:

reduction from 31% of initial causes to 15% of final causes (Figure 1).

Initially, we verified independent variables for the absence of multicollinearity; this was met (tolerance $>0.7$  and VIF $<1.5$ ). The excess of UEC (OR $>1$ ) reached statistical significance at 1% when comparing the explanatory variables of hospital death (OR=2.0) and certification by coroner (OR=1.08) in logistic regression without adjustment by independent variables. The frequency of UEC increases with the victim's age and education, being higher in females and in municipalities in the metropolitan region, and lower in small and medium-sized municipalities and among blacks (p-value $<0.001$ ). The variables referring to the municipal-level characteristics showed more robust OR (Table 1).

The intermediate multiple analysis (model 1), with only the explanatory variables included, increased the odds of coroner-certified deaths

(OR<sub>crude</sub>=1.08 and OR<sub>adjusted</sub>=1.56, 95%CI 1.44; 1.68) and hospital deaths (OR<sub>crude</sub>=2.00 and OR<sub>adjusted</sub>=2.40, 95%CI 2.21; 2.61) to be UEC (Table 2).

The results of the multiple regression showed that all potential confounding variables were significantly associated with the outcome variable and adjusted the OR of the explanatory variables (hospital death, certified by coroner and their

interaction). An exception was for the variables sex and education, which modified the OR of the exposures of interest to values below 10% and were maintained in the final model: in order to maintain comparability with other studies; and these variables would fit the structural criteria of confounders, as they would be common causes for the explanatory variables and the outcome (Table 2 and Figure 2).

**Table 1.** Frequency of mortality from unspecified external causes (initial cause), odds ratio and 95% confidence intervals, according to selected characteristics of death, Brazil, 2017.

Independent variables	Total		Unspecified external causes		$\beta$	Odds ratio crude	95%CI	p-value
	(n)	(%)	(n)	(%)				
External cause	159,720	100	34,641	21.7	-	-	-	-
<b>Explanatory</b>								
Place of death occurrence								
Residence/street	97,168	60.8	16,518	17.0	-	1.00	-	-
Hospital	61,922	38.8	18,022	29.1	0.695	2.00	1.96; 2.05	<0.001
Death certifying physician								
Another certifying	21,573	13.5	4,460	20.7	-	1.00	-	-
Coroner	133,249	83.4	29,173	21.9	0.073	1.08	1.04; 1.11	<0.001
<b>Confounders</b>								
Sociodemographic profile of the deceased								
Sex								
Male	130,546	81.7	27,321	20.9	-	1.00	-	-
Female	28,984	18.1	7,240	25.0	0.230	1.26	1.22; 1.30	<0.001
Age group (in years)								
≤29	60,945	38.2	10,606	17.4	-0.230	0.79	0.77; 0.82	<0.001
30-49	48,863	30.6	10,243	21.0	-	1.00	-	-
≥50	48,263	30.2	13,078	27.1	0.337	1.40	1.36; 1.44	<0.001
Race								
Another (white, yellow, indigenous)	57,886	36.2	12,944	22.4	-	1.00	-	-
Black	98,669	61.8	20,986	21.3	-0.064	0.94	0.92; 0.96	<0.001
Education (in years of study)								
Data not informed	35,276	22.1	6,545	18.6	-0.271	0.76	0.74; 0.79	<0.001
≤7	83,567	52.3	18,332	21.9	-0.061	0.94	0.91; 0.97	<0.001
8-11	33,810	21.2	7,775	23.0	-	1.00	-	-
≥12	7,067	4.4	1,989	28.1	0.271	1.31	1.24; 1.39	<0.001
Characteristics of the municipalities								
Metropolitan region								
No	65,449	41.0	9,028	13.8	-	1.00	-	-
Yes	94,254	59.0	25,610	27.2	0.847	2.33	2.27; 2.39	<0.001
Municipal population size								
Big city (≥100 mil)	97,441	61.0	26,470	27.2	-	1.00	-	-
Small, middle city (<100 mil)	62,262	39.0	8,168	13.1	-0.904	0.40	0.39; 0.42	<0.001

Notes: Ignored data: place of death (0.4%, n=630); type of certifying physician (3.1%, n=4,898); education (22%, n=35,075). p-value of the odds ratio calculated by the Wald test.

**Table 2.** Multiple models: Frequency of mortality from unspecified external causes, odds ratio and 95% confidence intervals, according to selected characteristics of death, Brazil, 2017.

Independent variables	Odds ratio crude	Model 1 <sup>a</sup>				Model 2 <sup>b</sup>			
		$\beta$	Odds ratio adjusted	95%CI	P-value	$\beta$	Odds ratio adjusted	95%CI	P-value
<b>Explanatory</b>									
Place of death occurrence									
Residence/street	1.00	-	1.00	-	-	-	1.00	-	-
Hospital	2.00	0.874	2.40	2.21; 2.61	<0.001	0.368	1.44	1.32; 1.58	<0.001
Death certifying physician									
Another certifying	1.00	-	1.00	-	-	-	1.00	-	-
Coroner	1.08	0.444	1.56	1.44; 1.68	<0.001	0.209	1.23	1.14; 1.33	<0.001
Interaction (Type of certifier and place of death)									
No	1.00	-	1.00	-	-	-	1.00	-	-
Yes	2.01	-0.134	0.87	0.80; 0.95	0.003	0.105	1.11	1.01; 1.22	0.024
<b>Confounders</b>									
Sociodemographic profile of the deceased									
Sex									
Male	1.00	-	-	-	-	-	1.00	-	-
Female	1.26	-	-	-	-	0.052	1.05	1.02; 1.09	0.002
Age group (in years)									
≤29	0.79	-	-	-	-	-0.273	0.76	0.74; 0.79	<0.001
30-49	1.00	-	-	-	-	-	1.00	-	-
≥50	1.40	-	-	-	-	0.238	1.27	1.23; 1.31	<0.001
Race									
Another (white, yellow, indigenous)	1.00	-	-	-	-	-	1.00	-	-
Black	0.94	-	-	-	-	0.100	1.10	1.07; 1.14	<0.001
Education (in years of study)									
Data not informed	0.76	-	-	-	-	-0.303	0.74	0.71; 0.77	<0.001
≤7	0.94	-	-	-	-	-0.093	0.91	0.88; 0.94	<0.001
8-11	1.00	-	-	-	-	-	1.00	-	-
≥12	1.31	-	-	-	-	0.195	1.22	1.14; 1.29	<0.001
Characteristics of the municipalities									
Metropolitan region									
No	1.00	-	-	-	-	-	1.00	-	-
Yes	2.33	-	-	-	-	0.559	1.75	1.69; 1.81	<0.001
Municipal population size									
Big city (≥100 mil)	1.00	-	-	-	-	-	1.00	-	-
Small, middle city (<100 mil)	0.40	-	-	-	-	-0.441	0.64	0.62; 0.67	<0.001

Notes: <sup>a</sup>Intermediate model with explanation variables only (without confounding variables); <sup>b</sup>Final model with explanation and confounding variables. P-value of the odds ratio calculated by the Wald test. The final model was able to explain 8.5% of the variations in the UEC record (Nagelkerke=0.085).

Source: Authors.

Controlling for these confounding variables, the greater odds of an external cause being a UEC persisted for deaths certified by a coroner (OR=1.23; 95%CI 1.14; 1.33), occurring in hospital (OR=1.44; 95%CI 1.32; 1.58) and the interaction between these two variables, (OR=1.11; 95%CI 1.01; 1.22), all of which were statistically

significant (Table 2). The combination of hospital deaths and coroner certified deaths, adjusted by the confounders, showed an OR of 1.98 (95%CI 1.53; 2.56), implying that a hospital external cause death certified by a coroner has 95% greater odds of being a UEC than a home/street external cause death issued by a certifying physi-

cian who does not belong to a forensic institute (Figure 3).

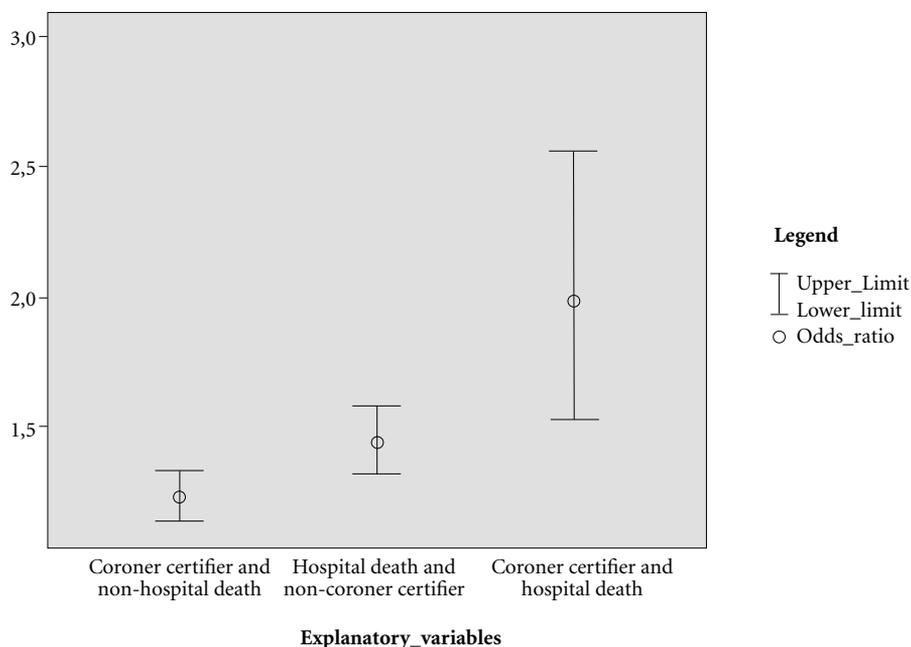
Among the confounding variables, there were increased odds of being a UEC for deaths of people of age 50 years or more, females, blacks and with 12 or more years of study, and for a municipality where the death occurred belonging to the metropolitan region. On the other hand, odds of a UEC decreased for people of under 30 years of age and schooling from 0 to 7 years of study or with data not informed, and for small and medium-sized municipalities (Table 2).

## Discussion

Given the high frequency of deaths in Brazil due to external causes, it is essential that these data are of sufficient quality to inform public health policy by providing specific detail about the nature of the death; that is, that deaths with a reporting an unspecified external cause are minimized.

This study has found that external cause deaths in Brazil certified by a coroner and that occurred in a hospital had a higher odd of reporting an unspecified external cause. The higher likelihood is amplified by the interaction of hospital death issued by a coroner. It is also notable that some confounding variables were shown to be associated with higher odds of UEC (metropolitan region, age 50 years or more, female sex, black and 12 or more years of study), and others had a protective effect (city < 100,000 inhab., age < 30 years and schooling from 0 to 7 years of studies or data without information).

The higher chance of a hospital death being UEC was similar to the findings for mortality from non-specific causes in the state of Amazonas and the elderly in Brazil<sup>18,19</sup>. Unlike the ill-defined causes (IDC) that were associated with death at home. In one of the studies, death certified by a coroner was strongly associated with excess IDC<sup>18</sup>. An equivalent association was reported in a cohort study in the USA<sup>23</sup>. It is important to



**Figure 3.** Adjusted Odds ratio of UEC with confidence interval, according to explanatory variables and the combined effect of the explanatory variables, Brazil, 2017.

Note: adjustment according to confounding variables for model 2 (final): sex, age group, race, education, metropolitan region and population size of the municipality.

Source: Authors.

note that the death of the elderly without medical assistance was a protective factor for non-specific causes, although strongly associated with IDC<sup>19</sup>.

The association of confounding variables with the UEC was similar to that seen in investigations of non-specific mortality to sex, age group, race<sup>18,19</sup>. The chance of UEC increasing with schooling is repeated in findings on non-specific deaths in Amazonas<sup>18</sup>. It contrasts a previous study that found a higher likelihood of unknown and unspecified causes in deaths of the elderly in cities with less than 100,000 inhabitants<sup>19</sup>, while for the UEC the opposite occurred.

The excess of UEC in people over 50 years of age may result from the greater difficulty in establishing an accurate diagnosis of the sequence of causes that led to death due to the coexistence of injuries and chronic diseases<sup>9,19</sup>. Considering our hypothesis that the hospital event increases the chance of coroners registering a UEC, certain types of causes that are recurrent in hospitalizations of women and older people would explain the excess of UEC in these subgroups, such as injuries involving falls, exogenous intoxications and sharp objects<sup>11,19</sup>. In turn, in large and metropolitan cities, injury victims would receive adequate hospital care faster than in other locations, such as the frequent violence against black people in the suburbs of large Brazilian cities. These hypotheses deserve to be verified through new studies.

In Brazil, a quarter of IDCs were issued by hospitals and a fifth by coroners<sup>24,25</sup>. Information from hospital records would not be fully used to certify causes<sup>26</sup>; or they may be disregarded as they are not official sources of the MDI system. In certain cases, it is likely that the DC will be issued before the coroner accesses test and police reports<sup>27</sup>. In addition, Incomplete documentation of hospital death and suspected violence would do little to assist the coroner in the most accurate description of CoD<sup>25</sup>.

There are even errors in filling in the logical sequence of the causal chain in the DC form<sup>28</sup>. The accuracy in reporting external causes also depends on the quality of findings produced by coroners and police experts. However, the establishment of facts may require additional police investigation and unfinished procedures at the time of issuing the DC. Precarious preliminary investigation of criminalistics results in poor report of complementary data<sup>13</sup>.

Another factor that hinders the production of high quality data and mortality surveillance is the certification of deaths outside the health sector. Certified by forensic institutes, there are dif-

ferent stakeholders in the external CoD, agents of the MDI system (police, coroner and justice) and public health. Ambiguous assignments between these government agencies commonly blur the responsibility for improving the recording of CoD<sup>29</sup>. The diagnosis of the external cause of death has a different reason for these two sectors.

The MDI system has the legal CoD as the main reason, operated by methods of validating the field of public security and justice with specific logic and grammar. Its determination is not the prerogative of the coroner; however, he must collaborate for his clarification<sup>13,14</sup>. This fact is supported by the principle of the doctor not being able to certify a cause as concrete, although very likely<sup>13</sup>. Thus, it is not uncommon for the coroner to register UEC, in order to avoid possible imprecision and punishment in the exercise of the function<sup>3,26</sup>.

This partly gives meaning to the possible resistance of the coroner to use information from hospital reports to fill out the DC, as they are produced outside this system<sup>16,27</sup>. Therefore, certification of the external cause is more complex than that of the natural cause. In non-violent deaths, the reporting of the causes is the sole responsibility of the physician; and based on the clinical history, certification of highly probable cause is acceptable, because the epidemiological purpose of the event overlaps<sup>2</sup>.

Possible limitations of the present study concern the secondary nature of the records. Although external causes of mortality are generally better informed and declared, there are regional differences in the quality and coverage of SIM<sup>26</sup>. The underlying and original CoD can be affected by coding and data processing failures. The circumscribed use of variables available on the SIM basis somewhat restricts the analysis of socio-demographic differences. In addition, there is a great variability in the data not explained by the selected variables, pointing to the need for further studies of qualitative and epidemiological dimensions.

Multiple have been recent initiatives to improve certification of the CoD in Latin America<sup>30</sup>. Few of them, however, deal with challenges for reducing UEC. Although the legal structure of MDI systems varies widely around the world, country experiences reveal good practices to deal with the impasses discussed in this article<sup>30,31</sup>. A example is the use of the bifurcated death form that separates personal information and registration of the CoD, allowing the coroner to consider exams and criminal reports later<sup>32</sup>.

Despite the decrease in IDCs in Brazil<sup>8,10</sup>, other unspecified causes remain high, partly reflecting the frequent certification with non-specific cause within hospitals and forensic institutes<sup>9,26-28</sup>.

In order to strengthen the mortality surveillance network for external cause in Brazil, the involvement of health and public security per-

sonnel and equipment is expected in coordinated initiatives to improve the reporting of the certified CoD. In addition, the results of the article may also be used as input for models of imputation of data with incomplete causes. In this way, documentation of injury mortality would form more accurate results to inform strategic public health prevention policies.

### **Collaborations**

All authors contributed to the design, planning and analysis of the study. AM Soares Filho also performed data acquisition and interpretation. All contributed to the drafting of the preliminary versions, approved the final version of the article and declared themselves responsible for all aspects of the work.

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