

Poorly Defined Natural Causes of Death Before and After the COVID-19 Pandemic

Causas Naturais de Morte Mal Definidas Antes e Depois da Pandemia de COVID-19

Causas Naturales de Muerte Mal Definidas Antes y Después de la Pandemia de COVID-19

RESUMO

Objetivo: Analisar a ocorrência e a evolução temporal das causas naturais mal definidas de óbito antes e após a pandemia de COVID-19. **Métodos:** Estudo descritivo e analítico baseado em dados secundários de mortalidade, utilizando a Classificação Internacional de Doenças (CID-10/11). Foram analisadas variáveis sociodemográficas e cadeias causais do óbito. **Resultados:** Observou-se aumento das causas mal definidas durante o período pandêmico, seguido de redução após 2021. Houve predominância no sexo masculino, em faixas etárias intermediárias e em grupos socialmente vulneráveis, com elevada frequência de causas imediatas inespecíficas e ausência de causas intermediárias. **Conclusão:** Apesar da redução pós-pandemia, as causas mal definidas persistem, evidenciando limitações na certificação do óbito.

DESCRIPTORES: Mortalidade; Causas de morte; COVID-19; Sistema de Informação em Saúde; Atestado de óbito.

ABSTRACT

Objective: To analyze the occurrence and temporal trends of ill-defined natural causes of death before and after the COVID-19 pandemic. **Methods:** A descriptive and analytical study based on secondary mortality data, using the International Classification of Diseases (ICD-10/11). Sociodemographic variables and the causal chains of death were analyzed. **Results:** An increase in ill-defined causes of death was observed during the pandemic period, followed by a reduction after 2021. There was a predominance among males, individuals in middle age groups, and socially vulnerable populations, with a high frequency of nonspecific immediate causes and the absence of intermediate causes. **Conclusion:** Despite the post-pandemic reduction, ill-defined causes of death persist, highlighting limitations in death certification.

DESCRIPTORS: Mortality; Causes of death; COVID-19; Health Information System; Death certificate.

RESUMEN

Objetivo: Analizar la ocurrencia y la evolución temporal de las causas naturales mal definidas de muerte antes y después de la pandemia de COVID-19. **Métodos:** Estudio descriptivo y analítico basado en datos secundarios de mortalidad, utilizando la Clasificación Internacional de Enfermedades (CIE-10/11). Se analizaron variables sociodemográficas y las cadenas causales de la muerte. **Resultados:** Se observó un aumento de las causas mal definidas durante el período pandémico, seguido de una reducción después de 2021. Hubo predominio en el sexo masculino, en grupos de edad intermedios y en poblaciones socialmente vulnerables, con alta frecuencia de causas inmediatas inespecíficas y ausencia de causas intermedias. **Conclusión:** A pesar de la reducción posterior a la pandemia, las causas mal definidas persisten, evidenciando limitaciones en la certificación de la muerte.

DESCRIPTORES: Mortalidad; Causas de muerte; COVID-19; Sistema de Información Sanitaria; Certificado de defunción.

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INTRODUCTION

Ill-defined causes of death represent a persistent challenge to the quality of mortality statistics and to the formulation of public health policies. According to the World Health Organization, these causes are predominantly classified in Chapter XVIII of the International Classification of Diseases (ICD-10/11), which encompasses signs, symptoms, and ill-defined conditions, as well as selected codes from other chapters that do not provide adequate etiological information¹. The widespread use of these so-called “garbage codes” compromises epidemiological analyses, obscures the true burden of disease, and hinders timely public health responses.^{2,3}

Historically, periods marked by major pandemics have been associated with restrictions on postmortem investigations, whether due to religious prohibitions, fear of contagion, or structural limitations of health care systems. These restrictions have contributed to underreporting, diagnostic uncertainty, and delays in understanding the pathophysiology of emerging diseases. The COVID-19 pandemic has reignited this debate, given the strain on health services, the reduction in the number of clinical autopsies performed, and the increased use of nonspecific causes of death on death certificates.⁴

In Brazil, despite advances in mortality surveillance, ill-defined causes of death remain unevenly distributed across regions and population

groups.^{2,5} The Federal District, due to its administrative significance and relatively favorable socioeconomic indicators, constitutes a strategic setting for evaluating the patterns of deaths from ill-defined natural causes before, during, and after the COVID-19 pandemic.

This study aimed to analyze the temporal evolution of ill-defined natural causes of death in the Federal District between 2018 and 2023, as well as to examine their sociodemographic patterns and the characteristics of the redefined causal chains, discussing the implications of limitations in postmortem investigations in the context of a public health crisis.

METHOD

Study Design and Data Source

This is a descriptive, observational, and analytical study based on secondary mortality data. All deaths classified as natural causes that occurred in the Federal District (DF), Brazil, from January 1, 2018, to December 31, 2023, were analyzed. Mortality data were obtained from the Mortality Information System (SIM) through the Health Situation Information and Analysis Office (GSIAS) of the Federal District Health Secretariat, following a formal request by the author.

The database consisted of anonymized individual death records containing sociodemographic variables (sex, age, race/skin color, and educational level), as well as information regarding the causal chain of death, as recorded on the Death

Certificate (immediate, intermediate, and underlying causes). All data handling and analysis procedures complied with the General Data Protection Law (Law No. 13,709/2018 - LGPD) and national information security standards; no information that would allow for the identification of individuals was accessed.

Definition and Classification of Causes of Death

Deaths were classified according to the 10th and 11th revisions of the International Classification of Diseases (ICD-10/ICD-11). For the purposes of this study, ill-defined causes of death (ICD) were identified using a combined analytical approach, based on international recommendations for assessing the quality of mortality data.²

Initially, causes that were ill-defined in the strict sense were identified, corresponding predominantly to Chapter XVIII of the ICD-10 (codes R00-R99), which encompasses ill-defined symptoms, signs, and conditions.¹

In a second step, a set of ICD-10/ICD-11 codes with low explanatory power was included when recorded as the sole cause of death or when associated exclusively with other nonspecific diagnoses. Although formally valid within the ICD framework and classified outside Chapter XVIII, these codes do not allow for etiological interpretation when used in isolation.^{2,3} This group included, among others, codes related to sudden death (e.g., R96, I46), old age (R54), mental and behavioral disorders due to alcohol or tobacco

use (F10.2, F17.2), schizophrenia (F20.9), and intrauterine hypoxia (P20.0), when reported without a description of a plausible causal sequence.

The inclusion of these codes served an analytical and critical purpose, seeking to evaluate their functional role as indicators of etiological uncertainty in death certification, without questioning their formal validity within the ICD classification system. In this sense, CMDs were understood not as classification errors, but as markers of informational limitations in the process of certifying the cause of death.^{2,3}

Deaths were considered inconsistent when the information available on the Death Certificate was insufficient to establish a plausible causal chain between the recorded conditions and the fatal outcome.

Analytical Redefinition of Underlying Causes of Death

When possible, an analytical redefinition of the underlying causes of death was performed post hoc, based on the information available in the Death Certificate, the described clinical context, and epidemiological plausibility. The purpose of this procedure was to estimate the extent to which poorly defined categories could be narrowed through analytical review, recognizing that such redefinition does not replace a formal postmortem investigation.³

The redefinition process was conducted systematically and conservatively, preserving the original ICD coding while allowing for an analytical assessment of alternative underlying causes. The objective was not to correct the official coding but to estimate the potential contribution of improved postmortem investigation practices toward reducing ill-defined causes in health information systems.^{2,3}

Study Population and Analysis Period

The study population comprised all deaths from natural causes recorded in the Federal District during the analyzed period. In total, 10,990 natural deaths were identified, of which 697 met the criteria for classification as ill-defined causes of death.⁵

To analyze temporal trends and the impact of the COVID-19 pandemic, the study period was stratified into three phases:

- Pre-pandemic period: 2018–2019
- Pandemic peak period: 2020–2021
- Post-peak/transition period: 2022–2023

Variables Analyzed

The variables analyzed included sex (male/female), age group, race/skin color (white; Black/Brown; other/unknown), educational attainment (no schooling, elementary school, high school, higher education, and unknown), and characteristics of the causal chain of death (presence or absence of an immediate, intermediate, and underlying cause).

Statistical analysis

Descriptive analyses were performed to characterize the temporal evolution and sociodemographic distribution of ill-defined causes of death. Associations between ill-defined causes of death and categorical variables were assessed using Pearson's chi-square test. When the test's assumptions were not met due to low expected frequencies, Fisher's exact test was used.

The magnitude of the associations was estimated using odds ratios (OR), along with their respective 95% confidence intervals (95% CI). A statistical significance level of 5% ($p < 0.05$) was adopted. The analy-

ses were conducted considering the total population of deaths recorded during the study period, rather than a sample.

Ethical Considerations

Since this was a study based on secondary, anonymized data from official health information systems, submission to a research ethics committee was not required under current Brazilian law. All procedures adhered to the ethical principles applicable to research involving human data, ensuring confidentiality, information security, and responsible use of the data.

RESULTS

Between 2018 and 2023, 10,990 deaths from natural causes were recorded in the Federal District, of which 697 were classified as ill-defined natural causes (Figure 1; Table 1). A proportional increase in deaths from ill-defined causes was observed during the COVID-19 pandemic period, peaking in 2021, followed by a significant decrease in 2022 and 2023 (Table 1).

Figure 1. Natural deaths and proportion of ill-defined natural causes, Federal District, Brazil, 2018–2023.

Note: Natural deaths correspond to the total number of deaths classified as natural causes in the Federal District during the analyzed period. Poorly defined natural causes include deaths coded according to ICD-10/11 as poorly defined causes *stricto sensu* and codes with low explanatory power (“garbage codes”), in accordance with World Health Organization criteria

Table 1. Deaths from natural causes and proportion of ill-defined natural causes, Federal District, Brazil, 2018–2023.

Year	Total natural deaths (n)	Ill-defined natural causes (n)	Proportion of ill-defined causes (%)
2018	1,725	100	5.80
2019	2,105	122	5.80
2020	2,318	133	5.74
2021	2,013	162	8.05
2022	1,993	118	5.92
2023	836	62	7.42
Total	10,990	697	6.34

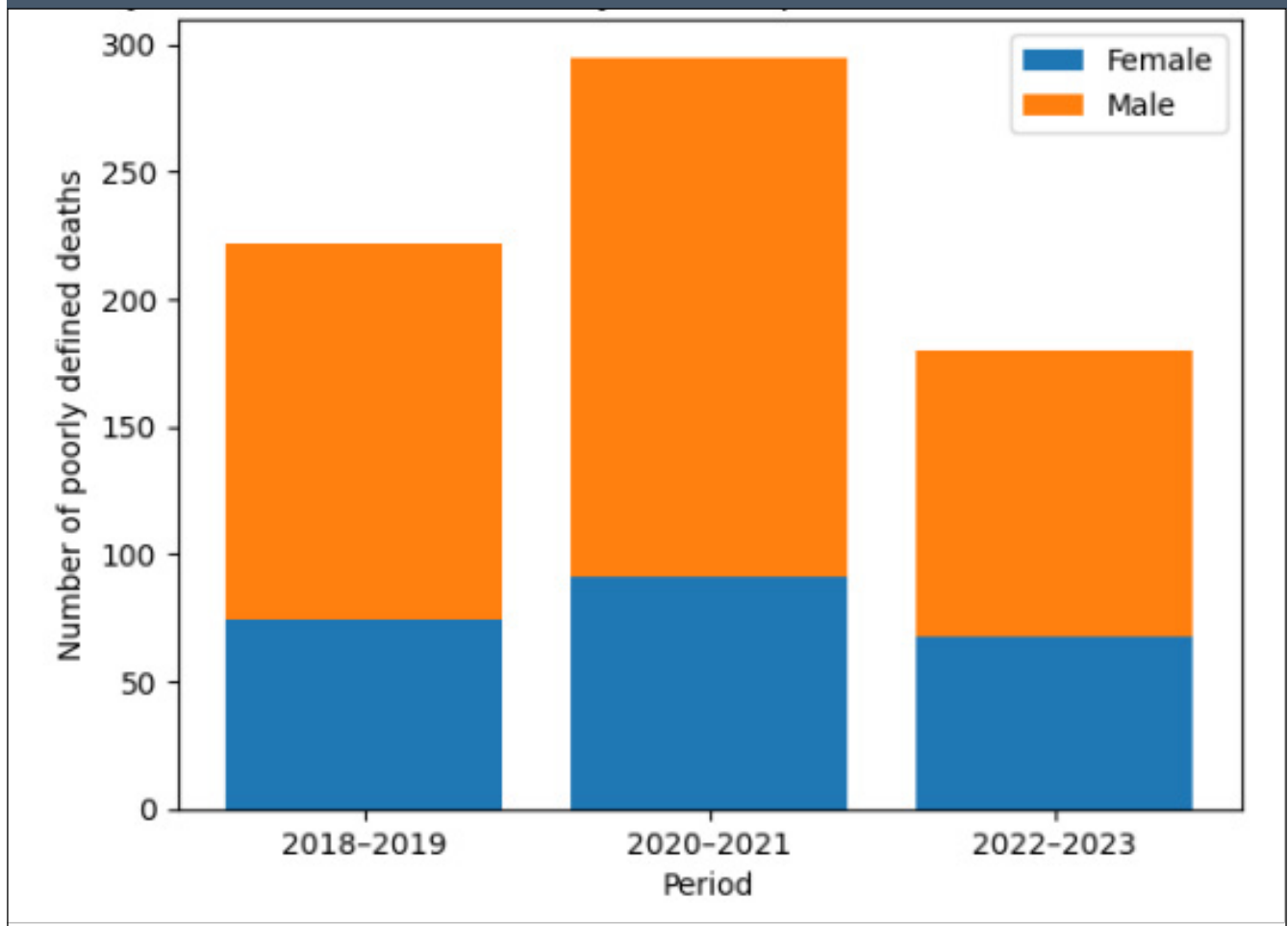
Note: Natural deaths correspond to all deaths classified as natural causes recorded in the Federal District between 2018 and 2023. Ill-defined natural causes include deaths coded as ill-defined causes in the strict sense and those coded under ICD-10/ICD-11 codes with low explanatory power, in accordance with World Health Organization recommendations.

Male deaths predominated in all years analyzed, especially among individuals aged 40 to 59 years, while among women, higher proportions were observed in older age groups

(Figure 2). Statistically significant associations were identified between sex and age group, race/skin color, and educational attainment. Ill-defined causes occurred more frequent-

ly among men, individuals classified as Black or Brown, and those with low or intermediate levels of education (Table 2).

Figure 2. Proportional distribution of ill-defined natural deaths by sex and age group, Federal District, Brazil, 2018–2023.



Source: Author's own analysis based on data from SIM/GIASS.

Table 2. Distribution of deaths from ill-defined natural causes by sex, Federal District, Brazil, 2018–2023.

Variable	Category	n	%
Sex	Female	233	33.4
	Male	464	66.6
Age group (years)	0–19	47	6.7
	20–39	85	12.2
	40–59	245	35.1
	60–79	173	24.8
	≥80	147	21.1

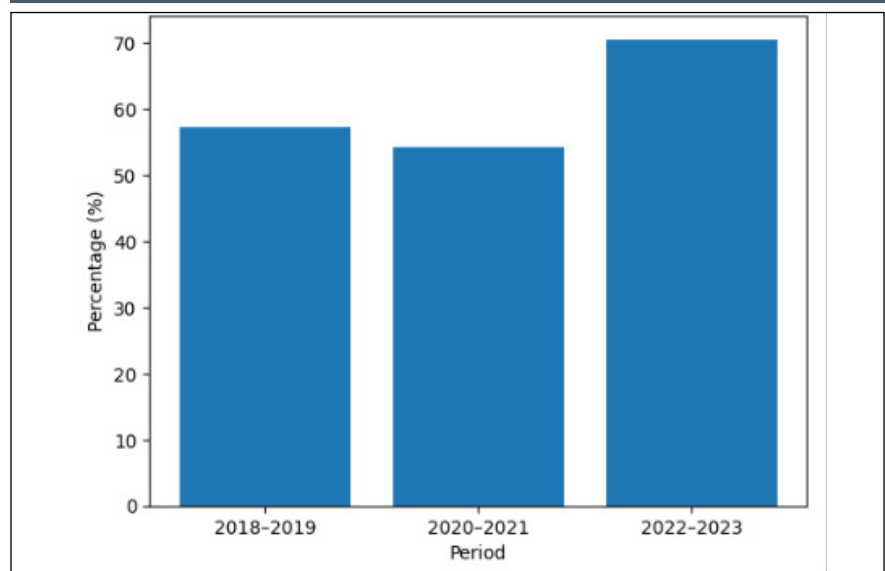
Race/Ethnicity	Black	80	11.5
	White	255	36.6
	Brown	320	45.9
	Indigenous	3	0.4
	Yellow	3	0.4
Education	No education	30	4.3
	Elementary school	93	13.3
	Upper elementary school	160	23.0
	High school	149	21.4
	Incomplete higher education	165	23.7
	Completed higher education	64	9.2
	Not reported	36	5.2
Total		697	100

Note: The data correspond to all deaths classified as ill-defined natural causes recorded in the Federal District between 2018 and 2023. The proportions were calculated using the total number of deaths from ill-defined natural causes ($n = 697$) as the denominator. The categories for race/, and educational attainment follow the standardization of the Mortality Information System (SIM). Detailed distributions can be found in the Supplementary Material (Tables S1–S4).

Analysis of the causal chains revealed a predominance of nonspecific immediate causes, such as instantaneous death, sudden death from unknown causes, and other ill-defined conditions. The absence of intermediate causes was frequent, exceeding 50% of cases in several years of the historical series, which highlights significant gaps in the completion of death certificates. When recorded, the most common intermediate causes included senility and mental and behavioral disorders related to alcohol use.

Overall, ill-defined natural deaths showed a sharp increase during the peak of the pandemic (2020–2021), followed by a decrease in the post-peak period (Figure 3). However, the persistent predominance of male deaths and the consistently high proportion of cases without intermediate causes—exceeding 50% in all periods—indicate that improvements in the quality of mortality data remain partial and uneven, extending beyond the acute phase of the COVID-19 pandemic.

Figure 3. Presence and absence of intermediate causes in ill-defined natural deaths, Federal District, Brazil, 2018–2023.



Source: Prepared by the authors based on mortality records coded according to ICD-10/ICD-11.

DISCUSSION

The present study revealed a significant increase in ill-defined natural causes of death during the COVID-19 pandemic period in the Federal District, followed by a partial reduction in subsequent years. These findings do not reflect limitations inherent to the International Classification of Diseases, but rather the restrictions imposed on death certification processes in contexts of

overburdened health services, reduced diagnostic capacity, and limitations in postmortem investigation, as outlined in the methodological framework adopted.

The combined analytical approach—which considered both ill-defined causes in the strict sense and ICD codes with low explanatory power when used in isolation—enabled a more comprehensive assessment of the etiological uncertainty present in mortality records. The high frequency of nonspecific immediate causes, such as instantaneous death,

sudden death of unknown cause, and other ill-defined conditions, combined with the recurrent absence of intermediate causes, highlights the scarcity of clinical information available at the time the death certificate is completed, especially during periods of health crises.

The observed sociodemographic inequalities are consistent with the national and international literature, which points to a higher incidence of ill-defined causes among socially vulnerable populations. The predominance of these deaths among men, individuals classified as Black or Brown, and those with lower levels of education suggests that structural inequalities are linked to diagnostic imprecision, even in contexts with relatively favorable socioeconomic indicators, such as the Federal District.

The analytical redefinition of underlying causes, conducted in a conservative and systematic manner, demonstrated that some of the deaths initially classified as ill-defined could plausibly be associated with infectious diseases, cardiovascular events, neoplasms, and mental and behavioral disorders related to the use of psychoactive substances. It should be emphasized that this procedure was not intended to correct ICD coding, but rather to estimate the potential impact that a more in-depth postmortem investigation could have on reducing the etiological opacity of mortality statistics. The persistence of poorly defined categories even after this analytical redefinition highlights the intrinsic limitations of death certifica-

tion in the absence of consistent clinical information or systematic postmortem investigation.

Mental and behavioral disorders related to alcohol and tobacco use repeatedly emerged as intermediate or underlying causes when additional information was available, reinforcing their role as relevant determinants of mortality that tend to remain hidden when death registration is limited to nonspecific terminal events. Similarly, the frequent identification of senility as an intermediate or underlying cause reflects its use as a substitute category in contexts of insufficient clinical documentation, rather than as an etiological entity in its own right.

Taken together, these findings reaffirm the historical and contemporary relevance of postmortem investigation—including clinical autopsy and minimally invasive methods—as fundamental tools for refining mortality data. Beyond their diagnostic value, such approaches contribute to a more accurate understanding of the burden of disease, facilitate the identification of emerging pathophysiological patterns, and support more equitable and evidence-based public health responses, especially in public health emergency scenarios.

CONCLUSION

Unspecified natural causes of death showed a significant increase in the Federal District during the COVID-19 pandemic, accompanied by persistent

sociodemographic inequalities and significant gaps in the documentation of causal chains of death. Although a partial reduction was observed after the pandemic peaked, nonspecific diagnoses remained frequent, indicating that improvements in the quality of mortality data were incomplete and heterogeneous.

The findings of this study suggest that a significant portion of the etiological opacity observed in mortality statistics stems from limitations in death certification processes, especially in contexts of overburdened health services and restricted diagnostic capacity. The analytical redefinition of underlying causes highlighted the potential impact of more thorough postmortem investigations in reducing the use of uninformative categories, without calling into question the formal validity of the International Classification of Diseases.

Strengthening death investigation practices, including alternative and minimally invasive diagnostic strategies, is essential for improving the quality of mortality data, reducing the use of codes with low explanatory power, and better preparing health systems for future public health emergencies. In this regard, improving the quality of death certification is a central element for producing reliable information, health planning, and the formulation of more equitable public policies.

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Supplementary Tables S1–S4

Supplementary Tables S1–S4 summarize the data on deaths from ill-defined natural causes that occurred in the Federal District, Brazil, from 2018 to 2023.

Table S1. Sociodemographic distribution of deaths from ill-defined natural causes

Variable	Category	Female n (%)	Male n (%)	Total n (%)
Age group (years)	40–59	45 (≈25–41)	155 (≈37–59)	200 (≈30–40)
Age group (years)	60–79	54	131	185
Race/Ethnicity	Black/Brown	≈60%	≈55%	≈57%
Education	≤ High school	≈65%	≈70%	≈68%

Table S2. Immediate causes of death according to ICD-10/11

Immediate causes	Female n (%)	Male n (%)	Total n (%)
Instantaneous death / Sudden death	≈30–70%	≈45–70%	≈50–65%
Other ill-defined causes (R99)	≈25–55%	≈20–35%	≈25–40%

Table S3. Presence of intermediate causes on death certificates

Intermediate cause	Female	Male	Total
Absent	55–80%	50–80%	≈60–70%
Present	20–45%	20–50%	≈30–40%

Table S4. Redefined root cause groups (post-certification analysis)

Redefined underlying cause group	Female n (%)	Male n (%)	Total n (%)
Infectious diseases	≈15–25%	≈10–20%	≈15–20%
Cardiovascular diseases	≈10–20%	≈15–25%	≈15–22%
Neoplasms	≈10–18%	≈12–20%	≈12–18%
Mental and behavioral disorders	≈20–35%	≈25–40%	≈25–38%