REVISTA DE ENFERMAGEM REFERÊNCIA

homepage: https://rr.esenfc.pt/rr/ ISSNe: 2182.2883





The Effect of COVID-19 on Mortality: Underlying Causes of Excess of Deaths in Mainland Portugal

O Efeito da COVID-19 na Mortalidade: Causas Subjacentes no Excedente de Óbitos em Portugal Continental El Efecto de la COVID-19 en la Mortalidad: Causas Subyacentes del Exceso de Muertes en Portugal Continental

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Received: 06.09.24 Aceite: 05.03.25



Abstract

Background: The excess mortality during COVID-19 pandemic is not completely explained by the infection.

Objectives: To assess the underlying causes of the excess mortality during the pandemic in mainland Portugal (MP).

Methodology: Deaths by underlying cause and population, by gender and age (< 60, 60-69, 70-79 and > = 80), for 2015-2019 and 2020-2021 were obtained from INE. Assessment of differences between periods using the standardized mortality ratio (SMR) and respective 95% confidence interval (95%CI). **Results:** The mortality due to "mental and behavioral disorders" was higher than expected in all groups, but particularly in younger (RPM = 168%; 95%CI:127-217) and older (RPM = 140%; 95%CI:137-144) women. Mortality due to "diseases of the genitourinary system" is higher than expected in older age groups, with SMR vbetween 110% (95%CI:105-114) and 113% (95%CI:104-122). Mortality due to "diseases of the circulatory system" is lower than expected in age groups up to 80 years old. **Conclusion:** "Mental and behavioral disorders" and "diseases of the genitourinary system" appear associated with vulnerability in the context of the COVID-19.

Keywords: COVID-19; excess mortality; causes of death; Portugal

Resumo

Introdução: O excedente de mortalidade durante a pandemia COVID-19 não é totalmente explicado pela infeção.

Objetivos: Avaliar causas subjacentes ao excedente de mortes, durante a pandemia, em Portugal Continental (PC).

Metodologia: Óbitos por causa subjacente e população, por género e idade (< 60, 60-69, 70-79 e > = 80), para 2015-2019 e 2020-2021 obtidos do INE. Avaliação de diferenças entre períodos através da razão padronizada de mortalidade (RPM) e respetivo intervalo de confiança a 95% (IC95%).

Resultados: A mortalidade por "doenças mentais e do comportamento" foi superior ao esperado em todos os grupos, particularmente em mulheres mais jovens (RPM = 168%; IC95%:127-217) e mais velhas (RPM = 140%; IC95%:137-144). Mortalidade por "doenças do sistema genito-urinário" é superior ao expectável em idade mais avançada, com valores de RPM entre 110% (IC95%:105-114) e 113% (IC95%:104-122). Mortalidade por "doenças do aparelho circulatório", é inferior ao expectável em grupos etários até aos 80 anos.

Conclusão: Os "transtornos mentais e do comportamento", e as "doenças do sistema genito-urinário" associam-se a vulnerabilidade no contexto de COVID-19.

Palavras-chave: COVID-19; excesso de mortalidade; causas de morte; Portugal

Resumen

Introducción: El exceso de mortalidad durante la COVID-19 no se explica completamente por la infección.

Objetivos: Evaluar las causas subyacentes del exceso de muertes durante la pandemia en Portugal continental (PC).

Metodología: Defunciones por causa subyacente y población, por sexo y edad (< 60, 60-69, 70-79 y > = 80), para 2015-2019 y 2020-2021 obtenido del INE. Evaluación de diferencias entre períodos utilizando la razón de mortalidad estandarizada (RPM) y el respectivo intervalo de confianza del 95% (IC del 95%).

Resultados: La mortalidad por "enfermedades mentales y Del comportamiento" fue mayor de lo esperado particularmente en mujeres más jóvenes (RPM = 168%; IC95%:127-217) y mayores (RPM = 140%; IC95%:137-144). La mortalidad por "enfermedades del aparato genitourinario" es mayor a la esperada en la mayor edad, con valores de RPM entre 110% (IC95%:105-114) y 113% (IC95%:104-122). La mortalidad por "enfermedades del sistema circulatorio" es menor de lo esperado en los grupos de edad de hasta 80 años.

Conclusión: Los "trastornos mentales y del comportamiento" y las "enfermedades del sistema genitourinario" aparecen asociados a vulnerabilidad durante el COVID-19.

Palabras clave: COVID-19; exceso de mortalidad; causas de muerte; Portugal

How to cite this article: Pires, C. S., Pimentel, M. H., & Teixeira, C. (2025). The effect of COVID-19 on mortality: underlying causes of excess of deaths in mainland Portugal. *Revista de Enfermagem Referência, 6*(4), e37486. https://doi.org/10.12707/RVI24.91.37486





Introduction

The recent COVID-19 pandemic has led to excess mortality worldwide. However, only one-third of the excess deaths reported between January 2020 and December 2021 were directly caused by SARS-CoV-2 infection (Wang et al., 2022). The excess mortality among individuals not infected with COVID-19 has been linked to the enormous strain placed on healthcare systems, which led to changes in their organization and restrictions on access to healthcare services. Surgeries, treatments, specialist consultations, screenings and primary care consultations were postponed, with resources being redirected to managing active COVID-19 cases and preventive measures such as vaccination (Peixoto et al., 2022).

While all EU countries were affected by the COVID-19 pandemic, its impact was uneven. Portugal was relatively spared during the first two waves but experienced its highest mortality peak during the third wave in January 2021 (60.5%; Eurostat, 2023), pushing healthcare resources to their limits.

Understanding the underlying causes of excess mortality is essential for identifying vulnerable population groups and designing strategies to address these vulnerabilities in the event of similar crises in the future. With this in mind, we considered it relevant to study the impact of COVID-19 on mortality in mainland Portugal in order to understand how the pandemic contributed to the persistent excess deaths among the resident population of mainland Portugal.

Background

The recent pandemic has led to excess mortality worldwide; however, only one-third of the excess deaths recorded between January 2020 and December 2021 were directly attributed to SARS-CoV-2 infection (Wang et al., 2022). In mainland Portugal, the difference in the mean number of deaths between the pandemic period (2020–2021) and the pre-pandemic period (2015–2019) reveals an excess of 13,018 deaths, 25% of which are not explained by SARS-CoV-2 infection (INE, 2024). It has been suggested that behavioral, social, and economic changes, especially during lockdowns, may have led to shifts in mortality from other causes, thereby contributing to the observed excess mortality (Wang et al., 2022).

Prior to the pandemic, the leading causes of death in Portugal in 2019 were diseases of the circulatory system and malignant tumors, accounting for 30% and 25% of total deaths, respectively (INE, 2024). The main risk factors for these conditions are preventable and their progression can be managed through public health interventions involving primary care services. Consequently, many of these deaths are considered avoidable with an effective and accessible healthcare system (World Health Organization [WHO], 2019). In 2019, the average avoidable mortality rate among countries of the Organization for Economic Co-operation and Development (OECD) was 126 deaths per 100,000 people. In Portugal, the rate was lower, at 109, which is a positive indicator of the country's healthcare services (OECD, as cited by Carneiro & Brito, 2023).

However, this scenario changed during the pandemic, leading to an increase in avoidable mortality. Several OECD countries, including Portugal, reported indirect effects of the pandemic on non-COVID-19-related mortality. These were caused by difficulties in accessing healthcare services, particularly for patients with severe or critical conditions, and delays in effective treatment, which contributed to worsening clinical outcomes (Carvalho et al., 2024). In Portugal, emergency department visits declined during the pandemic, likely due to fear of infection, but mortality among patients who did seek emergency care increased significantly compared to 2019, indicating more severe conditions at admission (Rodrigues et al., 2021). There were also delays in early cancer diagnoses in Portugal (Rafael et al., 2024) and postponement of surgeries, medical appointments, and diagnostic tests (Ferreira et al., 2023). In addition, there were changes in the organization of primary care services, with resources being reallocated to COVID-19-related activities. These changes limited the ability to address other conditions that, while initially perceived as less severe, may have progressively worsened over time (Outeirinho et al., 2023). These circumstances may explain the perceived decline in the health status of the Portuguese population following the COVID-19 pandemic (Ferreira et al., 2023), with an impact on overall mortality.

Understanding the excess mortality observed in Portugal during the pandemic period is essential. One approach is to analyze time series data on mortality by underlying cause of death, as reported on death certificates. The underlying cause is defined as "the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury" (WHO, 2025, p. 1). This analysis is essential for identifying the vulnerabilities that emerged during the pandemic and strengthening health policies capable of mitigating them in future scenarios where healthcare systems face significant strain (Peixoto et al., 2022).

Research question

What were the main underlying causes contributing to excess mortality during the COVID-19 pandemic in mainland Portugal?

Methodology

This is a descriptive epidemiological study based on the analysis of secondary, aggregated data (online data from the National Statistics Institute [INE]) obtained from demographic and health statistics for the Portuguese population (INE, 2024). The data included the number of deaths by underlying cause reported in mainland Portugal, along with population estimates, stratified by



gender and age group: 60-69, 70-79, and ≥ 80 years, covering the period from 2015 to 2021 for mainland Portugal (INE, 2024).

According to INE, the underlying cause of death is defined as the disease or injury that initiated the sequence of events leading to death (INE, 2024). All deaths registered in the INE database are assigned an underlying cause, regardless of whether a COVID-19 infection was also present.

This study included all deaths recorded by underlying cause, as aggregated in the INE database according to the European shortlist, which encompasses all major groups of the International Classification of Diseases (ICD-10), as well as selected subgroups (Serviço Regional de Estatística dos Açores, 2021). After retrieving the list of deaths by underlying cause from the INE database, the major groups were then mapped to ICD-10 codes (WHO, 2024).

In the first step of analysis, the mean annual number of deaths (total and by underlying cause) was calculated for two distinct periods: the pandemic period (2020–2021) and the pre-pandemic period (2015–2019). The difference in the mean number of deaths between these two periods was then determined for each major group of underlying causes according to ICD-10.

For the four major groups with the highest excess mortality between the pandemic and pre-pandemic periods, the mortality rate by underlying cause was calculated by gender and age group. The mortality rate was expressed as the number of deaths per 100,000 population. To assess differences between the pandemic and prepandemic periods for each underlying cause of death, standardized mortality ratios (SMRs) and corresponding 95% confidence intervals (95%CI) were calculated. The number of deaths observed during the pandemic period was calculated by dividing the number of deaths expected based on pre-pandemic mortality rates and then multiplying the result by 100. An SMR greater than 100 indicates an excess of deaths during the pandemic compared to expected values. SMRs were calculated by underlying cause, gender, and age group to identify the most vulnerable populations. Confidence intervals were estimated using Fisher's method, with calculations performed using WinPepi software, version 11.65.

Results

Comparing the mean number of deaths between the pandemic and pre-pandemic periods reveals an excess of 13,108 deaths during the pandemic. Among the major categories of causes of death, the four leading contributors to this excess were: *mental and behavioral disorders* (1,875 more deaths), *diseases of the circulatory system* (770 more deaths), *diseases of the genitourinary system* (615 more deaths), and *diseases of the nervous system and the sense organs* (412 more deaths), as shown in Table 1.



Table 1

ICD-10 Group	ICD10	Furopean shortlist	Mean numbe	Difference between pandemic	
	Code	of causes of death	Pre-pandemic 2015-2019	Pandemic 2020/2021	and pre-pandemic periods
		All causes of death	105806	118914	13108
V	F00-F99	Mental and behavioral disorders	4148	6023	1875
IX	I00-I99	Diseases of the circulatory system	31931	770	
XIV	N00-N99	Diseases of the genitourinary system	3169	3785	615
VI, VII, VIII	G00-H95	Diseases of the nervous system and the sense organs	3792	4204	412
XI	K00-K93	Diseases of the digestive system	4607	4985	378
II	C00-D48	Neoplasms	26925	27289	363
XII	L00-L99	Diseases of the skin and subcutaneous tissue	215	522	307
XVIII	R00-R99	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	6448	6745	297
XIX, XX	S00-T98; V01-Y99	External causes of morbidity and mortality	4778	4998	220
Ι	A00-B99	Certain infectious and parasitic diseases	1901	2010	109
III	D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	423	475	52
XIII	M00-M99	Diseases of the musculoskeletal system and connective tissue	464	474	10
XV	O00-O99	Pregnancy, childbirth and the puerperium	9	15	6
XVII	Q00-Q99	Congenital malformations, deformations and chromo- somal abnormalities	196	195	-1
XVI	P00-P96	Certain conditions originating in the perinatal period	148	115	-34
IV	E00-E90	Endocrine, nutritional and metabolic diseases	5164	5113	-52
Х	J00-J99	Diseases of the respiratory system	12259	10110	-2149

Number of deaths by underlying cause in pre-pandemic and pandemic periods

Table 2 presents the mortality rates for each of the four main underlying causes of death reported during the pandemic and pre-pandemic periods, as well as the difference in the mean number of deaths between these two periods. The results are disaggregated by gender and age group to highlight the most vulnerable populations. There was an excess of deaths across all underlying causes. However, for *diseases of the circulatory system*, the excess occurred only in the oldest age group. For the other causes, mortality increased across all age groups. A marked increase in deaths from *diseases of the nervous system and the sense organs* was seen in both younger men and older women during the pandemic period. Deaths due to *mental and behavioral disorders* also increased significantly across all age and gender groups, particularly among women.



Table 2

Difference between pre-pandemic and pandemic periods by underlying cause, age, and gender

Age group	Gender	Mental and behavioral disorders (IC- D10:F00-F99)		Diseases of the circulatory system (ICD10: I00-I99)		Diseases of the genitourinary system (ICD10: N00-N99)		Diseases of the nervous system and the sense organs (ICD10: G00-H95)					
		Difference no. of deaths	Pre-pandemic MR	Post-pandemic MR	Difference no. of deaths	Pre-pandemic MR	Post-pandemic MR	Difference no. of deaths	Pre-pandemic MR	Post-pandemic MR	Difference no. of deaths	Pre-pandemic MR	Post-pandemic MR
< 60	male	23	1.6	2.3	-71	36.2	34.8	6	1.2	1.4	18	5.4	5.9
	female	11	0.5	0.8	-33	12.0	11.4	2	0.7	0.7	-6	3.6	3.5
60-69	male	46	12.1	19.2	0	286.0	270.8	10	14.5	15.4	10	14.5	15.4
	female	26	6.2	9.7	-43	106.7	95.2	1	9.3	8.9	23	27.3	29.2
70-79	male	115	63.9	81.8	-213	789.9	654.0	64	62.1	68.9	45	108.0	105.6
	female	101	49.9	63.9	-137	479.6	418.3	53	44.2	50.1	56	73.8	78.0
> = 80	male	464	497.3	629.6	438	3347.8	3204.8	201	407.7	447.1	77	380.8	374.9
	female	1085	550.9	772.8	824	3276.7	3301.5	279	367.3	413.1	191	348.4	374.7

Note. MR = Mortality rate.

Figure 1 shows the SMRs and corresponding 95% CI by underlying cause, age, and gender.

A significantly higher-than-expected number of deaths was found for *mental and behavioral disorders* across all age and gender groups, most notably among younger women (SMR = 168%; 95%CI: 127-217) and older women (SMR = 140%; 95%CI: 137-144). For *diseases of the genitourinary system*, the number of deaths was also significantly higher than expected in the two oldest age groups of both genders, with SMRs ranging from 110% (95%CI: 105–114) in older men to 113% (95%CI: 104–

122) in women aged 70–79 and in women aged $80 \ge (95\%$ CI: 109-116). For *diseases of the circulatory system*, although there was an excess number of deaths in the older age groups, the differences between pandemic and pre-pandemic periods were not statistically significant in some groups, and in other groups, deaths were fewer than expected. For *diseases of the nervous system and the sense organs*, a significant increase in the number of deaths was observed during the pandemic period among younger men (SMR = 112%; 95%CI: 101-123) and older women (SMR = 108%; 95%CI: 104-112).



Figure 1

Standardized mortality ratio (SMR) and corresponding 95% confidence interval, by underlying cause, age and gender



Discussion

This study confirms the widely reported excess of deaths observed during the pandemic period. By analyzing deaths by underlying cause between 2015 and 2021, we identified *mental and behavioral disorders* as the leading contributor to this excess. Mortality from *mental and behavioral disorders* during the pandemic period was indeed higher than expected, highlighting the extreme vulnerability of individuals with these conditions, particularly younger women. The national study by Almeida et al. (2020) has shown that women are more likely to experience moderate to severe psychological distress, anxiety, depression, and post-traumatic stress disorder. The general population data also indicate a higher risk of depression (Pappa et al., 2020; Zenebe et al., 2021) and anxiety (Pappa et al., 2020) in women.

According to ICD-10, the category of *mental and behavioral disorders* encompasses a wide range of conditions, including mood disorders, anxiety and neurotic disorders, behavioral disorders due to psychoactive substance use, schizophrenia and psychotic disorders, personality disorders, and cognitive impairments (WHO, 2024). Individuals with these conditions are often dependent not only on healthcare services but also on other support systems to meet their basic needs. The COVID-19 pandemic was an unprecedented period that required a reorganization of healthcare services. Mental health services continued to be provided, but face-to-face consultations were replaced by telephone consultations (Serviço Nacional de Saúde & Coordenação Nacional dos Serviços de Saúde Mental, 2024).

Remote consultations for individuals with mental disorders were recommended by European psychiatric associations during the first phase of the pandemic to ensure the continuity of care, which is essential for these patients

(Kuzman et al., 2021). While many European countries, including Portugal, adopted this recommendation, technical limitations and or insufficient infrastructure may have hindered its implementation in other countries, potentially compromising the continuity of care for individuals with mental disorders (Kuzman et al., 2021). Despite efforts to provide continuous care to individuals with mental illness, these patients emerged as an especially vulnerable group during the pandemic for several reasons. First, these individuals were at greater risk of COVID-19 infection compared to the general population, even after adjusting for risk factors (Taquet et al., 2021), due to compromised immune systems and difficulty adopting protective behaviors (Chevance et al., 2020). Individuals with mental illness have a higher prevalence of cardiovascular disease and cardiovascular risk factors, namely arterial hypertension, metabolic syndrome, obesity and smoking (Chevance et al., 2020; Pahwa et al., 2023), with the aggravating factor that these comorbidities are underdiagnosed and undermedicated in mental patients (Chevance et al., 2020). These factors are associated with an increase in mortality following COVID-19 infection (Zhou et al., 2020). Young women with psychiatric disorders are particularly at risk for cardiovascular disease not only due to unhealthy lifestyles but also because of the side effects of psychiatric medications, which may reduce the cardiovascular protection typically seen in young women without mental illness (Pahwa et al., 2023). Third, the pandemic created new dynamics in healthcare services, with resources largely redirected toward the prevention and treatment of COVID-19, creating barriers to the care of individuals with chronic conditions (Outeirinho et al., 2023). Individuals with mental illness may have experienced additional difficulties accessing healthcare, making it harder to diagnose and monitor cardiovascular risk factors. Fourth, there was a deterioration in the health



status of young individuals with developmental disorders or autism spectrum disorders due to lockdown and social isolation measures (Chevance et al., 2020). O'Caoimh et al. (2020) described the increased risk of social isolation as a preventive measure against the spread of infection, which contributed, among other factors, to decreased satisfaction with care. Together, these factors help explain the extreme vulnerability of individuals diagnosed with mental and behavioral disorders, as reflected in the excess mortality during the pandemic found in this study. It remains unclear whether this excess mortality was a direct result of COVID-19 infection (due to an increased risk of infection) or an indirect consequence (due to the deterioration of the health status of these individuals). Nonetheless, it is essential to consider the increased mortality risk among individuals with mental and behavioral disorders in future scenarios similar to the COVID-19 pandemic.

According to our findings, individuals diagnosed with *diseases of the circulatory system* had a lower-than-expected mortality risk during the COVID-19 pandemic. Although the number of deaths in this group increased during the pandemic period, it remained below expected levels based on pre-pandemic mortality rates. Specifically, there was an increase in the absolute number of deaths attributed to diseases of the circulatory system in 2020, followed by a decrease in 2021 (INE, 2024). Early in the pandemic, individuals with chronic conditions such as hypertension and coronary artery disease were identified as being at high risk for COVID-19-related mortality (Zhou et al., 2020). In response, public health authorities issued several recommendations to protect individuals with cardiovascular diseases from infection. This group was, in fact, prioritized for vaccination (Serviço Nacional de Saúde [SNS], 2021). This public health intervention may help explain the lower-than-expected mortality observed among individuals with *diseases of the circulatory system*. Similarly to individuals with cardiovascular diseases, individuals with kidney failure were also prioritized for vaccination (SNS, 2021). However, unlike the previous group, our findings indicate higher-than-expected mortality during the pandemic among individuals diagnosed with diseases of the genitourinary system. This category includes kidney failure, which often requires hemodialysis. Patients undergoing hemodialysis not only face an increased risk of COVID-19 infection but are also more likely to develop severe illness (Ruan et al., 2024), resulting in an increased risk of death. Moreover, hemodialysis itself increases the risk of infection (Noordzij et al., 2023). Advanced age is a major factor in the severity of COVID-19, which helps explain the findings in this study indicating a higher mortality risk among individuals aged 70 or older with diseases of the genitourinary system. Viegas Madrid et al. (2023) reported a high incidence of genitourinary symptoms among hospitalized COVID-19 patients, with the frequency and distribution varying across different pandemic waves. Specific genitourinary conditions were associated with poorer outcomes and prognosis.

Variations in motor function (Romero et al., 2020) are variables related to health status. The frailty of the elderly, especially in the context of the pandemic, helps to explain the significant increase in deaths from "diseases of the nervous system and sensory organs". Keyhanian et al. (2020) noted that, in addition to the typical symptoms of COVID-19, patients may also experience a range of neurological manifestations affecting both the central and peripheral nervous systems.

In summary, it is not possible to determine whether the increased risk of mortality during the pandemic was a direct consequence of COVID-19 infection or an indirect result of its impact on healthcare services. Although analyzing mortality by underlying cause enables the identification of the disease or condition that triggered the sequence of events leading to death, it does not clarify whether COVID-19 infection was part of that sequence. Despite the limitations of this study, the findings highlight the existence of highly vulnerable population groups during the COVID-19 pandemic.

Conclusion

During the COVID-19 pandemic, individuals with mental and behavioral disorders, particularly younger women, as well as those with diseases of the genitourinary system and older individuals with cardiac conditions, emerged as especially vulnerable, showing an increased risk of death. Future research should adopt a broader approach to assessing the impact of COVID-19 on mortality, incorporating socioeconomic, clinical, and other relevant variables. The conditions imposed by the pandemic required rapid adaptation to a new reality, with potential consequences for the mental health of the general population, particularly among those who were already more vulnerable.

Author contributions

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