Original article

Profile of COVID-19 patients with renal and neurological dysfunctions

Perfil dos pacientes com COVID-19 e disfunções renais e neurológicas

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ABSTRACT | OBJECTIVE: To analyze the clinical and sociodemographic profile of patients with a confirmed diagnosis of COVID-19, as well as associated renal and neurological dysfunctions. **METHODS:** This is a descriptive, cross-sectional study with a quantitative approach, based on convenience sampling. Data collection was performed through the analysis of 271 physical and digital medical records of patients admitted to hospitals in the northern region of Minas Gerais, Brazil, between March and November 2020, using sociodemographic and clinical variables. Data were analyzed descriptively using the Statistical Package for the Social Sciences (SPSS), Windows version 27.0. **RESULTS:** A predominance of male patients (54.2%) and individuals identified as mixed race ("pardo") (57.8%) was observed. Most patients were over 60 years of age (53.1%). Among patients infected with COVID-19, 21.0% presented neurological complications and 12.5% developed acute kidney injury. A total of 61 deaths (22.5%) were recorded, with the highest frequency among intubated patients (72.1%). Renal and neurological complications were mainly concentrated among patients over 60 years of age, accounting for 25.0% and 35.0%, respectively. **CONCLUSIONS:** The findings of this study highlight the occurrence of renal dysfunction and neurological complications primarily among hospitalized patients with COVID-19, especially those over 60 years old.

KEYWORDS: COVID-19. Nervous System Diseases. Acute Kidney Injury. SARS-CoV-2.

RESUMO | OBJETIVO: Analisar o perfil clínico e sociodemográfico de pacientes com diagnóstico confirmado de COVID-19 e suas disfunções renais e neurológicas. **MÉTODOS:** Trata-se de um estudo descritivo com delineamento transversal de abordagem quantitativa, com amostragem de conveniência, realizado por meio da análise de 271 prontuários físicos/digitais de pacientes internados nos hospitais da região no norte de Minas Gerais no período de março a novembro de 2020, utilizando as variáveis sociodemográficas e clínicas. Os dados foram analisados de forma descritiva no software Statistical Package for the Social Sciences (SPSS) versão Windows 27.0. **RESULTADOS:** Observou-se predomínio do sexo masculino (54,2%) e de indivíduos pardos (57,8%). A maioria dos pacientes tinha idade superior a 60 anos (53,1%). Entre os pacientes infectados por COVID-19, 21,0% apresentaram complicações neurológicas e 12,5% desenvolveram injúria renal aguda. Houve registro de 61 (22,5%) óbitos, sendo o maior registro entre os pacientes intubados (72,1%). As complicações renais e neurológicas se concentraram principalmente entre os pacientes com mais de 60 anos, 25,0% e 35,0%, respectivamente. **CONCLUSÕES:** Os resultados deste estudo evidenciam a ocorrência de disfunções renais e complicações neurológicas principalmente entre pacientes hospitalizados com COVID-19, sobretudo naqueles com idade superior a 60 anos.

PALAVRAS-CHAVE: COVID-19. Doenças do Sistema Nervoso. Injúria Renal Aguda. SARS-CoV-2.

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1. Introduction

SARS-CoV-2 (Severe Acute Respiratory Syndrome-Coronavirus-2), the etiological agent of COVID-19, is responsible for an acute respiratory infection transmitted through direct contact, respiratory droplets, and aerosols[1,2]. The infection can range from asymptomatic to severe forms, with symptoms such as fever, cough, fatigue, headache, and diarrhea, and may progress to hospitalization, intubation, or death[2]. According to World Health Organization (WHO), as of August 2024, more than 775 million cases and 7 million deaths have been reported worldwide. In Brazil, approximately 38.8 million cases and 712 thousand deaths have been recorded[3].

The severe form of COVID-19 can cause serious complications in affected individuals, leading to acute cardiac problems, liver and kidney injuries, cardiac arrhythmias, rhabdomyolysis, coagulopathies, and shock[2]. In addition, viral spread in organs is rapid, leading to hematological, immunological, and biochemical alterations[2,4]. According to the Ministry of Health, some populations are more susceptible to developing the severe form of the disease, such as: pregnant women; postpartum women; adults over 60 years of age; patients with tuberculosis; cardiovascular diseases; nephropathies; hepatopathies; neurological and developmental disorders; immunosuppression; smoking; and obesity[5].

Regarding kidney complications, a retrospective case study conducted in China in 2020 reported an incidence of Acute Kidney Injury (AKI) in 13.1% of patients affected by COVID-19, raising concern in the scientific community about renal involvement associated with the disease. Based on evidence correlating AKI with SARS-CoV-2 infection, researchers formulated hypotheses to justify such an association. One of them is that AKI induced by SARS-CoV-2 infection is multifactorial, associated with direct viral injury to the renal parenchyma and the hyperinflammatory response linked to COVID-19[6].

In this regard, there is an association between immunological hyperactivity and the cytokine storm with AKI, which may lead to increased need for intensive care and mechanical ventilation, as well as being associated with higher mortality and worse prognosis of COVID-19[7]. Understanding this relationship is essential for the development of more effective clinical strategies for monitoring, treatment, and prevention, as well as for guiding the proper allocation of health resources and the preparation of care protocols better adapted to these patients. In this way, a comprehensive and preventive approach is promoted, especially relevant in pandemic and health crisis scenarios[5].

Studies on COVID-19 have also evidenced several other neurological manifestations associated with SARS-CoV-2 infection, in which the virus can affect the central and peripheral nervous system by penetrating the brain, especially through the olfactory bulb[8,9]. Complications include dizziness, ataxia, anosmia, ageusia, and musculoskeletal changes. Research conducted in Wuhan indicated that more than 45% of patients presented neurological symptoms, with encephalopathy (42%) and Stroke (62%) being the most prevalent complications, surpassing inflammatory syndromes such as encephalitis and Guillain-Barré. Headache (80%) and memory loss (80%) were identified as late neurological manifestations, along with psychopathological symptoms such as depression, anxiety, and post-traumatic stress disorder[9].

In COVID-19, the prognosis is unpredictable, since each patient may present a clinical picture with varying intensity and/or severity[4]. Acute kidney injury and neurological manifestations in hospitalized patients are directly associated with higher mortality and worse prognosis[10]. In this context, knowledge of risk factors and previous comorbidities in the patient's history becomes extremely important, especially regarding the presence of chronic diseases and lifestyle habits, in addition to early diagnosis of renal and neurological complications, in order to establish the best therapeutic approach and increase the patient's chances of survival[4].

Thus, when considering the impact caused by Coronavirus on the global population during the pandemic, COVID-19 brought with it a series of medical and scientific challenges, revealing the complexity of SARS-CoV-2 in the human body[5]. Among the most affected systems, the renal and neurological systems have been the focus of studies due to the wide variety of clinical manifestations observed in patients with the disease and the severity of its progression, with the possibility of irreversible complications[8]. Therefore, the objective of this study was to analyze the clinical and sociodemographic profile of patients with confirmed diagnosis of COVID-19 and renal and neurological dysfunctions.

2. Method

This is a descriptive study with a cross-sectional design and a quantitative approach, carried out through the analysis of physical/digital medical records of hospitalized patients in large public/private hospitals diagnosed with COVID-19.

The four hospitals analyzed present broad institutional capacity, although with structural variations. The first corresponds to a university hospital focused on teaching, research, and extension, with 100% of care provided to the public through the Sistema Único de Saúde — SUS (Unified Health System) and with 172 beds, including intensive care units (adult, neonatal, and pediatric). The second was a philanthropic hospital that serves both SUS and private health plans, as well as the private sector, with approximately 392 beds allocated to SUS and a significant number of Intensive Care Unit (ICU) beds. The third, also philanthropic and private nonprofit, has approximately 214 beds distributed across various specialties, with more than 80% of care directed to SUS. Finally, the fourth hospital, a philanthropic and charitable civil entity, has about 180 beds among public, health plan, and private patients, already operating with an adult ICU[6].

For this research, four hospitals were selected, which were reference centers for COVID-19 care, both at the municipal level and as referral centers for neighboring municipalities in the region. It is noteworthy that a municipal laboratory was accredited as the sole laboratory for COVID-19 testing for patients from different municipalities referred to Montes Claros.

The municipality is the main urban center of northern Minas Gerais and, for this reason, has characteristics of a regional capital. Its sphere of influence covers the entire northern region of Minas and part of southern Bahia. In 2020, its population was 409,341 inhabitants, ranking as the sixth most populous municipality in Minas Gerais and the 60th in Brazil, according to 2019 data from the Instituto Brasileiro de Geografia e Estatística – IBGE (Brazilian Institute of Geography and Statistics)[3].

The case series of this study consisted of 271 patient records. Inclusion in the study considered all patient records with a diagnosis confirmed by RT-PCR (Real-Time Polymerase Chain Reaction), with hospital admission between March and November 2020, and with available records (physical or digital) containing complete clinical information. Records that were incomplete, illegible, or that did not allow the extraction of essential data for analysis were excluded.

Both physical records (on paper), which required manual reading and careful systematization of information, and electronic records, accessed through the digital systems of hospital units, were used. To enable data collection, a digital spreadsheet was created for the database, in which clinical, laboratory, and epidemiological data extracted from hospital records were entered.

The following variables were collected: age, sex, self-reported race/skin color, presence of comorbidities, clinical manifestations, laboratory values (including serum creatinine levels), occurrence of neurological and renal complications, need for intubation, and clinical outcome (discharge or death). The laboratory tests included in the database referred to those performed on the date of hospital admission and after seven days of hospitalization—or on the date of discharge, if it occurred before this period. This strategy made it possible to assess, through creatinine levels, whether kidney injury was present at admission or acquired during hospitalization for COVID-19. The following reference ranges were adopted for serum creatinine: Men: 0.7 to 1.3 mg/dL; Women: 0.6 to 1.2 mg/dL. Urea data were not analyzed due to incomplete records.

In this study, patients were evaluated for the presence of kidney and neurological diseases. In the case of kidney disease, individuals were classified into three distinct groups, according to creatinine reference values and the presence of previous morbidities: patients with acute kidney injury (developed within the first seven days of hospitalization, after assessment of creatinine tests); patients with chronic kidney disease (hospitalized with a known diagnosis); patients with acute kidney injury undergoing dialysis therapy, according to laboratory test data from the date of admission, compared with tests after seven days of hospitalization or discharge before this seven-day period, as well as evaluation of pre-existing morbidities.

The structure and content of the database were previously evaluated by specialists in public health and clinical epidemiology, ensuring methodological consistency and suitability for the study objectives. The information obtained through the collection instrument was selected, transcribed into a computerized database, and analyzed using SPSS software, version 27. A descriptive analysis of sociodemographic, clinical, and laboratory characteristics of the patients included was carried out, covering the entire study period.

The research project was submitted to the Research Ethics Committee and approved under opinion number: 3.978.838, in accordance with Resolution n° 466/2012 of the National Health Council (CNS), in line with CNS Resolution 510/16.

3. Results

The sociodemographic profile of this study revealed a predominance of hospitalization in male patients (54.2%). Regarding race/skin color, there was a predominance of mixed-race individuals (57.8%), followed by white patients (14.4%), with elderly individuals over 60 years old prevailing (53.1%). The mean age found was 56.3 years, with a standard deviation of approximately 25.5 years, ranging from a minimum age of 0 years (infants) to a maximum of 101 years.

As shown in table 1, 12.5% of patients developed acute kidney injury. It is important to note that 6.3% of patients already had chronic kidney disease at the time of hospital admission. Interestingly, neurological conditions were detected in 21.0% of the patients evaluated. Furthermore, table 1 shows that among the neurological conditions observed, Stroke was the most prevalent manifestation (7.0%), followed by Alzheimer's disease (3.3%) and epilepsy (2.9%).

Table 1. Patients with COVID-19 affected by kidney and neurological disease, Montes Claros, Brazil, 2020 (*N*=271)

Variable	*n* (%)
Acute Kidney Injury	
Yes	34 (12.5%)
No	203 (74.9%)
No information	34 (12.5%)
Chronic Kidney Disease	
Yes	17 (6.3%)
No	233 (86.0%)
No information	21 (7.7%)
Acute Kidney Injury requiring dialysis	
Yes	5 (1.8%)
No	247 (91.1%)
No information	19 (7.0%)
Neurological disease	
Yes	57 (21.0%)
No	214 (79.0%)
Specified neurological disease (*n*=57)	
Psychiatric	4 (1.4%)
Alzheimer's disease	9 (3.3%)
Stroke	19 (7.0%)
Epilepsy	6 (2.9%)
Others	19 (7.0%)
No information	214 (78.0%)

Source: the authors (2020).

Regarding kidney assessment, table 2 presents the results of creatinine measurements categorized by sex. The assessment of creatinine levels in COVID-19 patients revealed that 8.1% of women and 14.4% of men had values above the reference limits in tests performed after seven days of hospitalization.

Table 2. Evaluation of creatinine values by sex of COVID-19 patients in the city of Montes Claros, Brazil, 2020 (*N*= 271)

Variable	Total (*N*%)	Male (*N*%)	Female (*N*%)
Creatinine			
Normal	148 (54.6%)	78 (28.8%)	70 (25.8%)
Low	22 (8.1%)	9 (3.3%)	13 (4.8%)
High	61 (22.5%)	39 (14.4%)	22 (8.1%)
No information	40 (14.7%)	21 (7.7%)	19 (7.0%)

Source: the authors (2020).
Normal reference values from the Ministry of Health: Men: 0.7 to 1.3 mg/dL; Women: 0.6 to 1.2 mg/dL, with values above reference considered high and below reference considered low.

As shown in table 3, most patients did not develop sepsis (82.3%). A total of 61 deaths were confirmed, representing 22.5% of the study population. Analysis of death cases showed that 72.1% of patients required mechanical ventilation, compared to 37.8% who did not undergo this treatment.

Table 3. Clinical outcome of COVID-19 patients Montes Claros, Brazil, 2020 (*N*= 271)

Variables	*N* (%)
Sepsis	
Yes	37 (13.7%)
No	223 (82.3%)
No information	11 (4.1%)
Confirmed deaths	61 (22.5%)
Death with mechanical ventilation	44 (72.1%)
Death without mechanical ventilation	17 (27.9%)

Source: the authors (2020).

To better understand the profile of patients who died and required mechanical ventilation, according to age group, table 4 shows a higher proportion among children aged 0–15 years (65.4%).

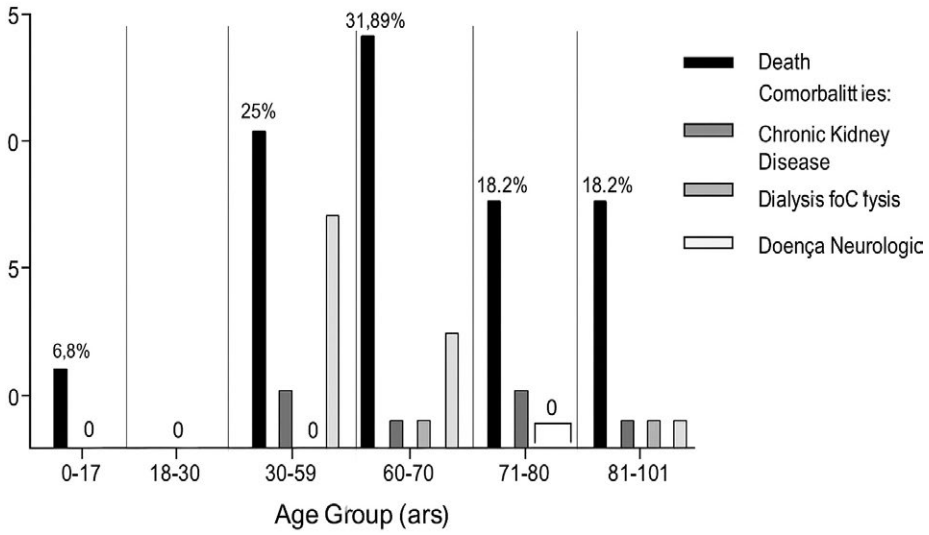
Table 4. Deaths by age group among patients undergoing mechanical ventilation. Montes Claros, Brazil, 2020 (*N*= 44)

Age Group / Mechanical Ventilation	Death *n* (%)
0 – 7 years	10 (24.5%)
8 – 15 years	18 (40.9%)
16 – 30 years	15 (34.1%)
31 – 60 years	-
61 – 90 years	1 (0.5%)

Source: the authors (2020).

The assessment of patients' neurological or kidney conditions, segregated by age group in relation to death, is shown in figure 1. Deaths were observed in all age groups, except for 18–30 years, in which no cases were recorded. The highest proportion of deaths occurred among those aged 60–70 years (31.8%), followed by the age groups 31–59 years (25%) and 71–80 years (18.2%).

Figure 1. Assessment of deaths by age group among hospitalized COVID-19 patients, from March to November 2020, undergoing mechanical ventilation with renal and/or neurological disease. Montes Claros, Brazil, 2020



Source: the authors (2020).

Through figure 1, it was also observed that chronic kidney disease and neurological complications associated with COVID-19 were more prevalent in the 60–70 and 71–80 age groups. Although younger patients (31–59 years) also experienced a considerable proportion of deaths (25%), some already on dialysis, this suggests that the presence of chronic comorbidities, even in working-age adults, increases the risk of mortality.

4. Discussion

In this study, a higher frequency of COVID-19 was observed in men, mixed-race individuals, and elderly patients over 60 years old, highlighting groups susceptible to disease worsening. Overall, rates of illness and death from COVID-19 among Black populations have been two to three times higher than among White populations. The higher prevalence of chronic diseases in Black/mixed-race populations, as well as barriers to access to adequate healthcare services, underscores structural inequalities that hinder the full realization of the principles of universality and equity of the Brazilian Unified Health System (SUS)[11].

Inequalities in SARS-CoV-2 infection are not limited to social or ethnic-racial factors but also involve sex-related differences, as observed in this study. A rationale for this finding has been provided by studies evaluating immune competence in relation to genetic and hormonal factors, supporting the observation that men exhibit a more intense inflammatory response, resulting in a higher risk of complications[12,13]. Additionally, the higher prevalence of comorbidities in this group, such as cardiovascular diseases, obesity, and hypertension, may contribute to the adverse outcomes observed in men with COVID-19[13]. However, it should be noted that this is a complex issue, and the incidence of COVID-19 is influenced by multiple variables, both endogenous and intrinsic as well as exogenous and extrinsic[13].

Aging is recognized as a risk factor for various pathological conditions, and the elderly population is often exposed to an increased risk of COVID-19–related complications resulting from the interaction between immunosenescence and the presence of comorbidities, which together exacerbate disease severity[1]. In the present study, the age group with the highest disease prevalence among the analyzed patients was those aged over 60 years, corroborating the scientific literature, which highlights that the clinical and epidemiological profile of COVID-19 predominantly affects adults and older individuals. In addition to age, the high prevalence of comorbidities is widely recognized as a risk factor for clinical complications and more severe COVID-19 outcomes[14,15]. The probability of death is approximately twice as high in patients with any comorbidity compared to those without, which is consistent with our findings showing a higher incidence of mortality among patients aged ≥60 years with associated comorbidities[15].

Beyond age and comorbidity-related determinants, complications arising during the clinical course of COVID-19 constitute critical outcomes that can influence the survival of hospitalized patients. Among these complications, acute kidney injury (AKI) has received particular attention in the literature due to its high frequency and significant impact on the clinical severity of SARS-CoV-2 infection[6]. In this study, AKI occurred in 12.5% of patients during hospitalization. There is an association between SARS-CoV-2 infection and the development of acute kidney injury, which includes the virus's direct cytopathic effect on renal cells and the systemic inflammatory response characteristic of COVID-19[6]. In this context, immune dysregulation, marked by excessive production of pro-inflammatory cytokines, may exacerbate renal dysfunction, particularly in patients with severe disease progressing to acute respiratory distress syndrome[12].

Early detection of AKI through creatinine level analysis allows timely interventions, which may help preserve renal function and promote better clinical outcomes[12]. Our data indicated that both men and women exhibited elevated serum creatinine levels; however, although hospitalization rates were higher among men in our study, women experienced worse prognoses regarding renal complications. In this perspective, elevated creatinine levels may reflect inflammatory complications associated with severe renal injury such as AKI[12]. Thus, the importance of evaluating renal function biomarkers is emphasized, given that renal complications in COVID-19 have reached high levels[6].

The study revealed a higher prevalence of renal disease among individuals aged 60–80 years, demonstrating that older adults have an increased propensity for renal complications, particularly in acute illnesses such as COVID-19[17]. This pattern may be explained both by the presence of comorbidities and physiological changes associated with aging[17]. Among COVID-19–related complications, neurological manifestations were also notable, observed in approximately one-third of patients in the current study, primarily in severe cases, and potentially occurring at different stages of the disease or even after recovery[18,19].

Several pathophysiological hypotheses have been proposed to understand the mechanisms of nervous system involvement by SARS-CoV-2. The literature indicates that neurological injury may also result from hypoxia due to reduced oxygen levels in blood vessels caused by impaired gas exchange in COVID-19. This condition leads to increased anaerobic metabolism with acid accumulation, resulting in cerebral vasodilation, cerebral edema, cytokine release, and vascular permeability impairment. In advanced stages, increased intracranial pressure may occur[20].

Furthermore, vascular impairment caused by SARS-CoV-2 can be explained by infection and dysfunction of endothelial cells, which lead to the release of tissue factors activating the thrombotic pathway, resulting in microangiopathy, and/or by activation of an inflammatory pathway that causes vasculitis or destabilization of pre-existing atherosclerotic plaques[21,22]. Although studies linking COVID-19 and neurological diseases are limited, the literature suggests probable correlations between viral infection and nervous system dysfunction[22]. These findings underline the importance of careful monitoring of patients with a neurological history.

Regarding the number of confirmed deaths in the present study associated with COVID-19, most occurred in patients undergoing mechanical ventilation (72.1%), highlighting the severity of the disease in the most critical cases. This profile aligns with previous studies showing high mortality among COVID-19 patients on mechanical ventilation, associated with complications such as sepsis and respiratory failure[6,27].

Analysis of deaths by age group among patients on mechanical ventilation revealed heterogeneous mortality patterns in the present study. Mortality was observed in children aged 0–15 years and in elderly patients aged 61–90 years. These findings corroborate international data indicating that age extremes, especially the elderly and infants, exhibit higher vulnerability to severe COVID-19 outcomes, possibly due to less efficient immune responses or comorbidities[27]. The discrepancy in mortality rates reinforces the need for differentiated monitoring and intervention strategies according to age group, particularly in critically ill patients receiving mechanical ventilation[27].

The evidence presented in this study may also have direct implications for the organization and responsiveness of healthcare services[21]. The high demand for hospitalizations, combined with the clinical complexity of severe COVID-19 cases, requires a robust healthcare infrastructure with qualified human resources, well-established protocols, and the availability of health supplies and technologies[22].

Thus, this study is distinguished by its detailed characterization of multiple clinical complications of COVID-19, considering both pre-existing and hospital-acquired conditions[23]. However, one of the main limitations is the reliance on clinical records of hospitalized COVID-19 patients, which may be incomplete or vary in information quality, leading to data gaps. Additionally, the retrospective nature of the analysis may introduce selection bias, as patient inclusion depends on the availability of records. Finally, the sample may not be representative of the general COVID-19 patient population, limiting the generalizability of results, and the absence of a control group hinders more rigorous evaluation of associations between COVID-19, renal dysfunction, and neurological diseases, as discussed in the literature[22,23].

5. Conclusion

The results of this study allowed the clinical and sociodemographic profile of hospitalized COVID-19 patients in the northern region of Minas Gerais to be outlined, highlighting a predominance of male patients, mixed-race individuals, and elderly patients over 60 years, reinforcing the vulnerability of social groups more exposed to severe disease outcomes. An increase in serum creatinine levels was also observed, particularly in women, suggesting possible impairment of renal function that warrants continuous monitoring in the context of infection. Furthermore, mechanical ventilation was associated with a substantial number of deaths.

Another relevant finding was the higher frequency of renal and neurological complications in elderly patients, indicating the need for more specific and intensive care strategies for this group. In this regard, it is suggested that future analytical and multicenter studies investigate the associations between clinical and sociodemographic factors and outcomes in COVID-19 patients, as well as longitudinal research exploring the progression of renal and neurological dysfunctions in the post-COVID period. Investigations addressing the impact of social and racial inequalities on clinical outcomes are also essential to support public policies aimed at reducing vulnerabilities and promoting equity in access to healthcare.

Authors' contributions

The authors declare having made substantial contributions to the work in terms of the conception or design of the study; the acquisition, analysis, or interpretation of data for the work; and the drafting or critical revision of relevant intellectual content. All authors approved the final version to be published and agreed to take public responsibility for all aspects of the study.

Competing interests

No financial, legal, or political conflicts involving third parties (government, companies, private foundations, etc.) were declared for any aspect of the submitted work (including, but not limited to, grants and funding, participation on advisory boards, study design, manuscript preparation, statistical analysis, etc.).

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