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Pulmonary embolism–related mortality during the COVID-19 pandemic: Data from the United States

1 | INTRODUCTION

The COVID-19 pandemic has resulted in excess deaths directly and indirectly due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its sequelae, and significant racial and ethnic disparities have been demonstrated in COVID-19–related and un–related excess deaths. Studies have also documented higher rates of thrombotic complications in individuals with SARS-CoV-2. Therefore, we hypothesized that pulmonary embolism (PE)-related mortality increased and that there were racial and ethnic disparities in PE mortality during the COVID-19 pandemic.

2 | METHODS

We used publicly available death certificate data from the Centers for Disease Control and Prevention (CDC) Wide-Ranging Online Data for Epidemiologic Research (WONDER). We queried for PE as an underlying or contributing cause of death (International Classification of Disease, 10th revision (ICD-10), code I26) from March 1, 2020 to December 31, 2020 and compared with the same months in 2019. For deaths occurring between March 1, 2020 and December 31, 2020, we identified those with COVID-19 (ICD-10 code U071) also listed as an underlying or contributing cause of death. We calculated age-adjusted mortality rates (AAMRs) using the standard US population age distribution for the year 2020. We examined PE-related AAMRs and PE and COVID-19 AAMRs, overall and by race and ethnicity categories, which represent social constructs and included American Indian/Alaska Native, Asian/Pacific Islander, Hispanic, non-Hispanic Black, and non-Hispanic White. We calculated expected deaths using 2019 mortality rates standardized to the 2020 population as previously described.

We then calculated excess deaths related to PE by subtracting expected deaths from observed deaths in 2020. As a sensitivity analysis, to ensure year alone did not account for rise in AAMR, we calculated AAMRs for the same months (March–December) for the years 2016, 2017, and 2018 overall and by race and ethnicity categories.

This study was determined to be exempt by the Institutional Review Board at Northwestern.

3 | RESULTS

Between March 1, 2020 and December 31, 2020, there were 40,233 deaths related to PE compared with 31,100 between March 1, 2019 and December 31, 2019. Among PE deaths in the 2020 study period, 5140 of those were also attributed to COVID-19. The overall PE AAMR was 12.21 deaths per 100,000 population (95% confidence interval [CI], 12.09–12.33). Non-Hispanic Black decedents had the highest overall PE AAMR (22.25 [95% CI, 21.74–22.76]) compared with non-Hispanic White decedents (11.96 [95% CI, 11.82–12.09]), Hispanic decedents (8.44 [95% CI, 8.13–8.75]), American Indian/Alaska Native decedents (11.77 [95% CI, 10.29–13.27]), and Asian and Pacific Islander decedents (3.90 [95% CI, 3.60–4.20]) (Figure 1).

The observed 2020 PE AAMR was higher than expected (12.21 [95% CI, 12.09–12.33] vs. 9.59 [95% CI, 9.48–9.69]) (Figure 2). Non-Hispanic Black decedents had the highest rate of excess deaths (2.47 [95% CI, 1.87–3.08]) compared with American Indian/Alaska Native decedents (2.21 [95% CI, 0.49–3.93]), Hispanic decedents (1.86 [95% CI, 1.55–2.16]), and non-Hispanic White decedents (0.22 [95% CI, 0.01–0.43]).

During the 2020 study period, AAMRs related to PE with COVID-19 were highest in American Indian/Alaska Native decedents (3.17 [95% CI, 2.43–3.91]), non-Hispanic Black decedents (3.11 [95% CI, 2.92–3.30]), and Hispanic decedents (2.31 [95% CI, 2.15–2.48]) compared with non-Hispanic White decedents (1.25 [95% CI, 1.21–1.30]) (Figure 1).

In the sensitivity analysis, similar PE AAMRs existed in the years 2016, 2017, and 2018 compared with the 2019 AAMR, both overall (9.2, 9.4, 9.4 deaths/100,000 population, respectively), and by race and ethnicity categories (Figure 3; Table S1).
In the United States, PE deaths increased significantly between March and December 2020 compared with the same months in 2019 (and earlier years). Racial and ethnic disparities in AAMR were widest for deaths due to PE and COVID-19, with an almost threefold higher rate among American Indian/Alaska Native and non-Hispanic Black decedents and an almost twofold higher rate for Hispanic compared with non-Hispanic White decedents. These data are consistent with previous studies showing racial disparities in PE mortality, and specifically in the COVID-19 pandemic, likely reflect structural and social determinants of health including occupational exposures. A substantial number of PE deaths occurred during the COVID-19 pandemic that were not directly related to COVID-19 infection, similar to patterns observed for other cardiovascular disease deaths. While unable to be ascertained from these data, the excess deaths across cardiovascular diseases suggest multifactorial drivers, including underrecognition.

**FIGURE 1** Age-adjusted mortality rates for pulmonary embolism (PE) as contributing cause of death 2020; stratified by presence of COVID-19 as contributing cause of death. AIAN, American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic Black; NHW, non-Hispanic White.

**FIGURE 2** Observed versus expected age-adjusted mortality rates attributed to pulmonary embolism 2020. AIAN, American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic Black; NHW, non-Hispanic White.

**FIGURE 3** Age-adjusted mortality rates for pulmonary embolism as contributing cause of death 2016–2020, overall and by race and ethnicity category.
of COVID-19 infection and avoidance or delays in health care due to overburdened health systems that disproportionately affected racial and ethnic minority groups. A limitation of this study is reliance on death certificate data. However, CDC WONDER represents the most comprehensive mortality surveillance reporting in the United States.

In conclusion, excess PE deaths occurred during the COVID-19 pandemic, and significant racial and ethnic disparities existed in PE AAMR. These data highlight the growing public health burden of PE in the context of the COVID-19 pandemic.

AUTHOR CONTRIBUTIONS
All authors contributed substantially to the study design, data analysis and interpretation, and writing of the manuscript.

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RELATIONSHIP DISCLOSURE
KAM, KH, XH, and SSK report no conflicts of interest to declare.

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SUPPORTING INFORMATION
Additional supporting information can be found online in the Supporting Information section at the end of this article.