

Where do children die from asthma? National data from 2003 to 2015

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Clinical Implications

- Although out-of-hospital pediatric asthma deaths have decreased, most deaths still occur outpatient, with a higher proportion in non-Hispanic black children compared with non-Hispanic white and Hispanic children. Ensuring that all children have access to timely asthma care may prevent deaths.

TO THE EDITOR

Despite significant improvements in asthma treatments, pediatric asthma deaths still occur, with disproportionate impacts in different racial/ethnic populations in the United States. Since the 1980s, black children have had higher asthma hospitalization and mortality rates compared with white children.^{1,2} Underlying causes of racial/ethnic disparities in asthma outcomes are complex and include access to care, quality of care, socioeconomic, environmental, and genetic factors.³ Although previous studies have investigated racial/ethnic disparities in asthma mortality,^{1,2} to our knowledge, other studies have not specifically investigated where children die from asthma along the continuum of medical care—in the out-of-hospital, outpatient, or inpatient setting and whether the location of death varies by race/ethnicity.

We investigate the location of death because where children die may suggest differential access to quality comprehensive care and can guide future efforts. Out-of-hospital deaths suggest focusing on patient education regarding when to seek care and access to care. Outpatient deaths suggest focusing on improving acute care and appropriate assessment of clinical severity. Inpatient deaths suggest focusing on improving inpatient and pediatric intensive care.

We used the National Center for Health Statistics Mortality Multiple Cause-of-Death public data collected from US death certificates from 2003 to 2015. We focused on individuals younger than 19 years of age, with asthma as the underlying cause of death based on the International Classification of Death codes J45 and J46. We categorized deaths as out-of-hospital (home or dead on arrival), outpatient (outpatient or admitted to emergency department), or inpatient. We excluded patients younger than 2 years of age given the ambiguity in asthma classification at this age ($n = 284$, 10%). We examined racial/ethnic groups: non-Hispanic white, non-Hispanic black, and Hispanic.

Mortality rates were calculated using bridged-race population estimates from the US Census intercensal (2003-2009) and postcensal estimates (2010-2015).⁴ Linear regressions were performed using STATA 14.1 (College Park, Tex); P values were

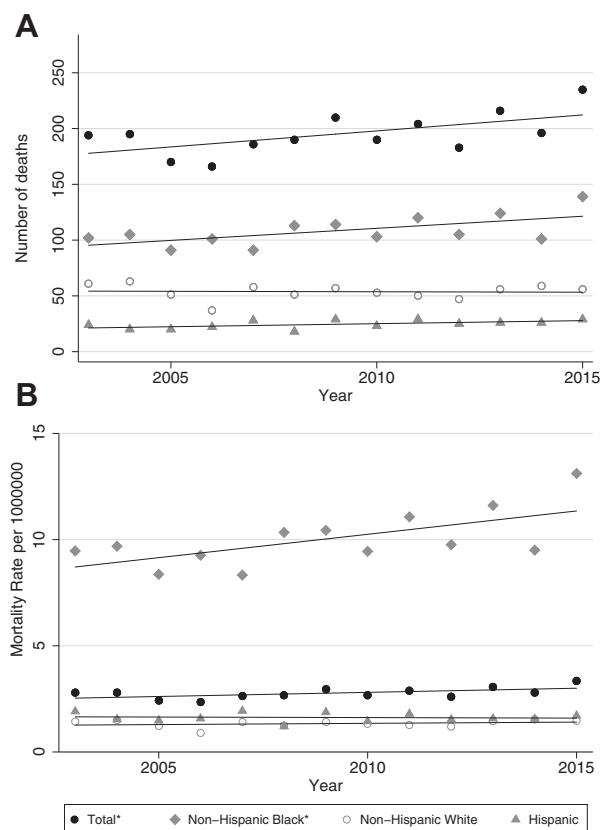


FIGURE 1. A, Pediatric asthma deaths in the United States, ages 3 to 19. B, Pediatric asthma mortality rates in the United States, ages 3 to 19; * $P < .05$.

obtained for the test of slope of the linear fit being significantly different than 0 over the time period. We examined the proportion of deaths for age groups, sex, and race/ethnicity by location and the proportion of deaths for each location. We compared differences in proportions using the Marascuilo procedure.⁵ Two-tailed $P < .05$ was considered statistically significant.

On average, 195 pediatric asthma deaths occurred annually, with a total of 2,535 deaths over the 13-year period (Figure 1, A). The average annual asthma mortality rate for these children was 2.8 deaths per million, with a significant increase over time (Figure 1, B). Children aged 10-14 years, compared with other age groups, had the highest average annual mortality rate (3.1 deaths per million). Boys, compared with girls, had a higher annual average mortality rate (2.9 and 1.8 deaths per million, respectively). Non-Hispanic black children had an average annual mortality rate (10 deaths per million) 6 times higher than Hispanic children (1.62 deaths per million) and 7 times higher than non-Hispanic white children (1.33 deaths per million).

Most pediatric asthma deaths occurred in the outpatient setting (1,293 deaths, 51%), compared with the out-of-hospital (340 deaths, 13%) or inpatient (813 deaths, 32%) setting. In all

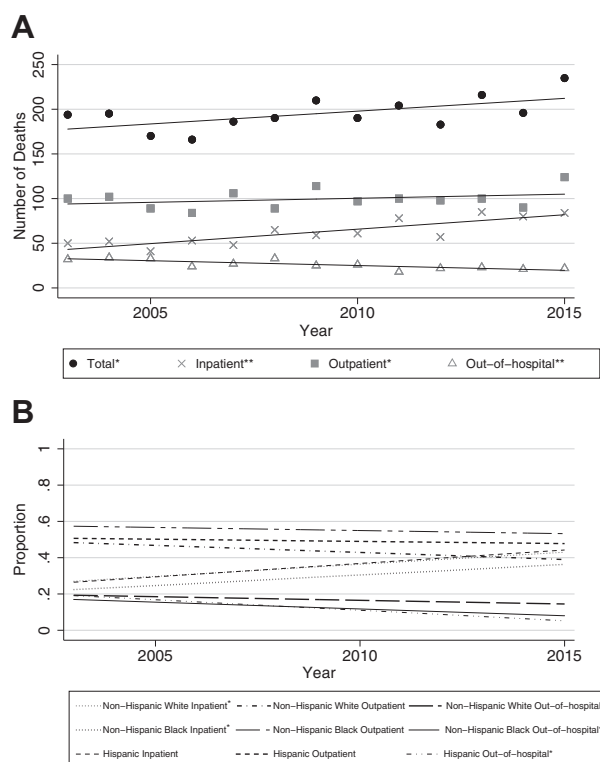


FIGURE 2. A, Pediatric asthma deaths in the United States by location, ages 3 to 19. B, Proportion of pediatric asthma deaths in the United States stratified by location and race/ethnicity, ages 3 to 19; * $P < .05$, ** $P < .01$.

locations—out-of-hospital, outpatient, and inpatient settings—the highest proportion of deaths occurred among non-Hispanic black (52%, 61%, 53%) compared with both Hispanic (11%, 13%, 15%) and non-Hispanic white (37%, 25%, 32%; $P < .01$) children.

Over the study period, there was a significant decrease in out-of-hospital deaths, which corresponded to a significant increase in inpatient deaths (Figure 2, A). For non-Hispanic white, non-Hispanic black, and Hispanic children, the proportion of out-of-hospital deaths decreased over time (from 19%, 16%, and 18% in 2003-2006 to 15%, 10%, and 8% in 2011-2015, respectively), which corresponded to an increase in the proportion of inpatient deaths over time (from 29%, 26%, and 27% in 2003-2006 to 40%, 34%, and 39% in 2011-2015, respectively; Figure 2, B).

In summary, we observed an increase in the pediatric asthma mortality rate from 2003 to 2015, with the majority of deaths occurring outpatient and a decrease in out-of-hospital deaths over time. We observed a persistent racial/ethnic disparity in asthma mortality rates and a higher proportion of deaths occurring in non-Hispanic black children compared with their counterparts across all locations of death.

Despite an increase in the use of inhaled corticosteroids in the last decade, the pediatric mortality rate has increased. Most deaths occurred in the outpatient setting, suggesting that care was sought and children received some medical interventions before death. Efforts may need to continue

focusing on acute asthma care such as appropriate assessment of clinical severity.⁶ In addition, previous studies show that 80% to 92% of fatal asthma cases are characterized by a clinical deterioration of poorly controlled asthma over several days.^{7,8} Most fatal asthma cases are preventable as early management with medications reduces asthma mortality.⁹ However, a comprehensive review of pediatric asthma deaths showed that 43% were caused by inadequate use of corticosteroids or overuse of bronchodilators, and 20% were attributed to prescriber practices.⁸ Thus, future interventions may still need to focus on educating providers and patients on appropriate asthma therapy.

We found a proportional decrease in out-of-hospital deaths over time with a corresponding increase in inpatient deaths, suggesting that access to timely care may have improved for all children. However, given that the majority of deaths across all settings occurred in non-Hispanic black children, future efforts still need to focus on reducing this racial/ethnic disparity.

The limitations of our data include the lack of detailed clinical information, coding errors, and misclassification. However, these data are the most comprehensive national data on deaths available and have been previously shown to be accurate.⁸

Providers need to be aware that the majority of pediatric asthma deaths occur in the outpatient setting and that a racial/ethnic disparity in pediatric asthma mortality still persists. In addition to ensuring that all asthmatic children are using appropriate controller therapy, providers need to ensure that all asthmatic children have access to timely effective exacerbation care to prevent progression to fatal asthma.

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