

Inequalities in asthma mortality by ethnicity and race in the United States and Puerto Rico

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Clinical Implications

Asthma mortality rates among non-Hispanic White people, non-Hispanic Black individuals, and Puerto Rican residents have not been compared. Asthma mortality risk among non-Hispanic Black people was 2.8 times higher than among non-Hispanic White individuals, and Puerto Rican residents had 2.17 times higher asthma mortality compared with non-Hispanic White people. Black men younger than 35 years and women 65 years and older in Puerto Rico had the highest asthma mortality rates.

Non-Hispanic Black (NHB) individuals and Puerto Rican (PR) individuals are the groups with the highest asthma prevalence and morbidity in the United States.^{1,2} All-cause asthma mortality risk increases markedly within the first month after a severe asthma exacerbation requiring systemic steroids, emergency department visit, or hospitalization.³ Because PR and NHB individuals have higher emergency department and hospitalization rates than non-Hispanic White (NHW) individuals, we expect that PR and NHB individuals would have higher asthma mortality than NHW individuals. Pennington et al⁴ showed that NHB individuals had higher asthma mortality rates than NHW individuals and Hispanics in the United States, particularly among women.

The Hispanic ethnicity group comprises a heterogeneous group of persons from many counties with varying asthma prevalence.⁵ We hypothesize that asthma mortality rates among NHB individuals and residents in Puerto Rico will be comparable. We focus on Puerto Rico residents because PR individuals are the Hispanic group with the highest asthma burden and have a high use prevalence of Medicaid-based health care services.² The present study intends to compare asthma mortality rates among NHW, NHB, and PR individuals using the National Center for Health Statistics (NCHS) database and evaluate the effects of sex and age on asthma mortality because women and elderly individuals have higher mortality rates.

We conducted a retrospective analysis of asthma as the underlying cause of death. The data were obtained from online public files of the Division of Vital Statistics from the NCHS for 2011 to 2018. The demographic registry across the continental United States and Puerto Rico used the same reporting method.

The study's main outcome was asthma death defined by *International Classification of Diseases, 10th Revision* codes J45X and J46. The main exposure was race and Hispanic ethnicity defined by NCHS as NHB, NHW, and PR individuals. All Hispanic (Puerto Rican [56.4%], Mexican [0.2%], other/unknown Hispanics [43.5%]) residents of Puerto Rico were included as PR

individuals. Deaths from foreign residents and/or with missing data on age at death were excluded from analysis.

An epidemiological profile of asthma deaths was constructed. Age-specific mortality rates by race, ethnicity, sex, and the differences between age groups were estimated with 95% CI using Poisson regression models. The adjusted models included age in terciles, calendar year, and sex as confounding variables. The age-standardized asthma mortality (per 100,000) was estimated with 95% CI for each sex and ethnic group based on the US 2000 projected population⁶ and annual estimates of the resident population of the United States and Puerto Rico from the US Census Bureau.⁷ The age-standardized rate ratio (SRR) was estimated with 95% CI to assess the magnitude of the association between race and ethnicity, sex, and asthma mortality using the age at the time of death grouped as those younger than 35, 35 to 64, and 65 years or older.⁸ Computations were performed using Stata version 16 (StataCorp LLC, College Station, Tex).

Between 2011 and 2018, a total of 24,869 asthma deaths as underlying cause of death were reported; 62.0% were women, 30.7% were NHB, 66.7% were NHW, and 2.6% were PR individuals. The average age at death was 59.8 ± 23 years, varying by race (NHW individuals, 65 ± 21 years, NHB individuals, 47 ± 22 years, and PR individuals, 70 ± 17 years). Table I presents the age-standardized asthma mortality (per 100,000) according to sex, race, and ethnicity. Asthma mortality rate increased with age. NHB males younger than 35 years (0.21 PR vs 0.27 NHW vs 1.50 NHB), NHB women between the age of 35 and 64 years (1.74 PR vs 1.14 NHW vs 3.21 NHB), and PR women 65 years and older (9.31 PR vs 3.96 NHW vs 5.77 NHB) had the highest mortality rates when compared by sex and races/ethnicities.

Table II presents age-standardized asthma mortality's association to race and ethnicity and sex when age distribution is controlled. Overall, women had a 39% (SRR, 1.39; 95% CI, 1.35-1.43) higher risk of dying from asthma than did men. The asthma mortality risk among NHB individuals was 2.8 (SRR, 2.80; 95% CI, 2.72-2.87) times higher than that of NHW individuals, whereas PR residents had 2.17 (SRR, 2.17; 95% CI, 2.00-2.35) times higher mortality risk than NHW individuals.

Minorities carry the brunt of asthma mortality in the United States, confirming our hypothesis. The high asthma mortality risk among young NHB individuals has been previously reported but remains unexplained and warrants investigation. Among NHB individuals with asthma, the average age of death was more than a decade younger than that among NHW and PR individuals. PR individuals are the Hispanic population with the highest asthma prevalence, and it has remained elevated despite declining rates among NHB and NHW individuals in the United States.^{2,9} We demonstrated that asthma mortality rates among PR individuals doubled that from NHW individuals and approaches that of NHB individuals in the United States. The cause of the elevated mortality rate among PR individuals is not known. Multifactorial contributors to asthma mortality are unaddressed and include intrinsic asthma characteristics, health care utilization, and environmental and socioeconomic factors.

TABLE I. Age-specific asthma mortality as underlying cause of death (per 100,000) according to sex and ethnicity (N = 24,869)

Group	Sex	Age groups (y)	Counts	Mortality (per 100,000)	Crude RR (95% CI)	Adjusted RR (95% CI)
PR	Male	<35	13	0.21	1.00	1.00
		35-64	84	1.69	8.00 (4.46-14.35)	7.96 (4.44-14.27)*
		≥65	168	7.80	36.97 (21.03- 64.99)	36.47 (20.74-64.13)*
	Female	<35	13	0.21	1.00	1.00
		35-64	99	1.74	8.16 (4.57-14.54)	8.11 (4.55-14.46)*
		≥65	260	9.31	43.53 (24.94-75.98)	42.84 (24.54-74.78)*
	Overall	<35	26	0.21	1.00	1.00
		35-64	183	1.72	8.09 (5.36-12.20)	8.01 (5.31-12.07)†
		≥65	428	8.65	40.73 (27.41- 60.51)	39.78 (26.77-59.12)†
NHW	Male	<35	940	0.27	1.00	1.00
		35-64	2306	0.71	2.59 (2.40-2.79)	2.59 (2.40-2.79)*
		≥65	2347	1.78	6.52 (6.05-7.04)	6.53 (6.06-7.05)*
	Female	<35	731	0.22	1.00	1.00
		35-64	3796	1.14	5.16 (4.76-5.58)	5.15 (4.76-5.58)*
		≥65	6476	3.96	17.88 (16.56- 19.30)	17.95 (16.62-19.37)*
	Overall	<35	1671	0.25	1.00	1.00
		35-64	6102	0.93	3.74 (3.54-3.94)	3.70 (3.51-3.91)†
		≥65	8823	2.99	12.06 (11.44- 12.71)	11.68 (11.09-12.31)†
NHB	Male	<35	1373	1.50	1.00	1.00
		35-64	1713	2.98	1.99 (1.86-2.14)	1.99 (1.86-2.14)*
		≥65	497	3.69	2.47 (2.23-2.73)	2.48 (2.24-2.74)*
	Female	<35	775	0.85	1.00	1.00
		35-64	2115	3.21	3.79 (3.49-4.11)	3.79 (3.49-4.11)*
		≥65	1163	5.77	6.81 (6.22-7.45)	6.82 (6.22-7.47)*
	Overall	<35	2148	1.17	1.00	1.00
		35-64	3828	3.11	2.65 (2.51-2.79)	2.65 (2.51-2.79)†
		≥65	1660	4.94	4.21 (3.95-4.49)	4.24 (3.97-4.52)†

RR, Relative risk.

Generalized linear models with Poisson distribution were used to estimate crude and adjusted RR.

*Adjusted for calendar year.

†Adjusted for sex and calendar year.

TABLE II. Age-standardized asthma mortality as underlying cause of death (per 100,000) and its association to sex and ethnicity

Characteristic	Age-standardized mortality per 100,000*		
	Age-standardized mortality per 100,000*	SRR (95% CI)†	SRR (95% CI)†
Sex			
Male	0.92	1.00	0.72 (0.70-0.74)
Female	1.28	1.39 (1.35-1.43)	1.00
Ethnicity			
US NHW	0.86	1.00	0.36 (0.35-0.37)
US NHB	2.39	2.80 (2.72-2.87)	1.00
PR	1.86	2.17 (2.00-2.35)	0.78 (0.71-0.84)

*Direct method was used for age standardization using the Year 2000 Standard Population for the United States.

†In the sex comparison, reference group was men. In the ethnicity comparison, reference group was NHW.

The highest asthma mortality rates occurred among PR elderly women. Sex disparity worsened with increasing age, regardless of ethnic and racial group, suggesting a common contributor that must be evaluated.

The study has limitations, including biases in race, ethnicity, age, and diagnostic adjudication on death certificates such as the distinction of chronic obstructive pulmonary disease from asthma at older age. We did not consider PR

individuals residing in the United States, which may shed light on the role of the environment and acculturation. Nevertheless, this study evaluated a large data set that was collected uniformly. The consistent mortality rates increase the confidence in the results.

In conclusion, the study identifies a high asthma mortality rate among PR individuals and confirms increased asthma mortality rates among young NHB, women, and elderly individuals in the

United States. Understanding the factors that contribute to disparities is the first step to preventing unnecessary deaths.

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REFERENCES

1. El Burai Félix S, Bailey CM, Zahran HS. Asthma prevalence among Hispanic adults in Puerto Rico and Hispanic adults of Puerto Rican descent in the United States—results from two national surveys. *J Asthma* 2015;52:3-9.
2. Centers for Disease Control and Prevention. Most recent national asthma data. Accessed March 5, 2022. https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm
3. Engelkes M, de Ridder MA, Svensson E, Berencsi K, Prieto-Alhambra D, Lapi F, et al. Multinational cohort study of mortality in patients with asthma and severe asthma. *Respir Med* 2020;165:105919.
4. Pennington E, Yaqoob ZJ, Al-Kindi SG, Zein J. Trends in asthma mortality in the United States: 1999 to 2015. *Am J Respir Crit Care Med* 2019;199:1575-7.
5. Pino-Yanes M, Thakur N, Gignoux CR, Galanter JM, Roth LA, Eng C, et al. Genetic ancestry influences asthma susceptibility and lung function among Latinos. *J Allergy Clin Immunol* 2015;135:228-35.
6. Klein RJ, Schoenborn CA. Age adjustment using the 2000 projected US population. *CDC Statistical Notes* 2001;20:1-10.
7. Annual estimates of the resident population by sex, age, race alone or in combination, and Hispanic origin for the United States: April 1, 2010 to July 1, 2019 (NC-EST2019-ASR5H) and annual estimates of the resident population for selected age groups by sex for Puerto Rico Commonwealth: April 1, 2010 to July 1, 2019 (PRC-EST2019-AGESEX). U.S. Census Bureau, Population Division Release Date; 2020.
8. Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. *Stat Methods Med Res* 2006;15:547-69.
9. Akinbami LJ, Simon AE, Rossen LM. Changing trends in asthma prevalence among children. *Pediatrics* 2016;137:1-7.