2008

Racial/Ethnic Differences in Exposure to Environmental Volatile Organic Compounds in the U.S. General Population: The National Health and Nutrition Examination Survey 1999–2000

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ABSTRACT

Background : Exposure to volatile organic compounds (VOCs) has been associated with many health disorders. A better understanding of unequal health risk from exposure to environmental VOCs is critical to the elimination of health disparities.

Objective : The goal of this study was to investigate racial/ethnic differentials in exposure to airborne VOCs within a national sample of the U.S. population and assessed socio-demographic determinants that may contribute to these racial differences.

Methods: We used data from a stratified sample of 576 participants (aged 20–59 years) who provided personal air samples for VOC measurements in the National Health and Nutrition Examination Survey (NHANES) in 1999–2000. We used Analysis of Variance (ANOVA) and multiple regression models for statistical analyses.

Results: Compared to the exposure of the majority populations in the United States, a disproportionate burden of exposure to airborne VOCs fell on minority populations: The levels of total VOC exposure were 52% and 37% higher in Mexican Americans and non-Hispanic blacks, respectively, than in non-Hispanic whites after adjusting for socioeconomic and other covariates (p< 0.001). Socio-demographic and lifestyle factors, including education, tobacco exposure, presence or absence of a window for ventilation inside the home, and gasoline use/storage, also affected levels of personal exposure to VOCs.

Discussion and Conclusion: This research study demonstrates that race/ethnicity is associated with VOC exposure independent of socioeconomic and other demographic factors. To help promote public health for communities and individuals, further efforts should be made to investigate underlying causes of racial/ethnic disparities in exposure to environmental VOCs.

INTRODUCTION

- Volatile organic compounds (VOCs), such as benzene, are a group of ubiquitous environmental chemicals generated from petroleum products, anthropogenic activities (i.e., cigarette smoking and automobile exhaust), and industrial sources.
- Exposure to VOCs is associated with a series of health disorders including leukemia and asthma in both the workplace and the environment. However, limited studies have examined racial/ethnic differences in exposure to environmental VOCs. There is a need for better understanding of environmental health disparities.

OBJECTIVES

- To investigate if there is racial/ethnic differentials in exposure to airborne VOCs within a national sample of the U.S. population
- To assess socio-demographic determinants that may contribute to racial differences in exposure to airborne VOCs.

METHODS

- 576 persons aged 20-59 years with valid measurement of airborne VOCs from the National Health and Nutrition Examination Survey (NHANES, 1999-2000) database.
- Major variables: Socio-demographic and lifestyle characteristics were obtained from questionnaire. VOC exposure levels were measured in personal samples for benzene, chloroform, 1,4-dichlorobenzene, ethylbenzene, tetrachloroethene, m-/p-xylene, and o-xylene. We estimated the concentration of total VOCs by summing the levels of individual VOCs.
- Analysis of variance and Cochran-Mantel-Haenszel chi-square were used for comparisons among racial/ethnic groups. Multiple regression analyses were used to investigate the combined effect of variables on VOC exposure. SAS 9.12 and SUDAAN 9.01 were used for statistical analyses.

RESULTS

Table 1. Demographic characteristics of participants by race/ethnicity

	Mexican American	non-Hispanic black	non-Hispanic white	*p*[b]
Sample size (*n*)	182	126	268	N/A
Age in years (percent in category, 95% CI)				0.20
20-29	38.6 (31.1-46.8)	26.0 (19.5-33.6)	23.8 (16.5-33.1)	
30-39	27.5 (20.0-36.5)	33.5 (23.8-44.8)	28.3 (22.5-34.8)	
40-49	22.2 (15.2-31.2)	23.6 (17.5-31.1)	28.0 (21.5-35.6)	
50-59	11.7 (8.86-15.3)	16.9 (10.2-26.8)	19.9 (16.0-24.5)	
Gender (percent in category, 95% CI)				0.56
Male	48.8 (40.0-57.7)	54.4 (46.0-62.6)	49.9 (43.4-56.4)	
Female	51.2 (42.3-60.0)	45.6 (37.4-54.0)	50.1 (43.6-56.6)	
Education (percent in category, 95% CI)				< 0.001
More than high school	21.6 (13.9-32.1)	48.6 (39.5-57.9)	59.1 (49.1-68.4)	
High school or less[c]	78.4 (67.9-86.1)	51.4 (42.1-60.5)	40.9 (31.6-50.9)	
Tobacco exposure (percent in category, 95% CI)				0.02
Active smokers	22.3 (15.8-30.5)	33.0 (21.2-47.5)	35.4 (28.1-43.6)	
Exposed to ETS	36.1 (25.6-48.0)	40.9 (31.8-50.7)	30.9 (25.2-37.2)	
Nonexposed	41.6 (30.9-53.3)	26.1 (17.2-37.4)	33.7 (26.3-41.9)	
Use gasoline (percent in category, 95% CI)[d]				0.81
Yes	47.4 (40.4-54.6)	48.4 (39.9-57.0)	50.9 (42.7-59.0)	
No	52.6 (45.5-59.6)	51.6 (43.0-60.2)	49.1 (41.0-57.3)	
Any windows open in the home (percent in category, 95% CI)				0.65
Yes	62.9 (46.3-77.0)	54.8 (38.2-70.4)	57.7 (44.3-70.1)	
No	37.1 (23.0-53.8)	45.2 (29.6-61.8)	42.3 (29.9-55.6)	

Figure 1. Geometric mean (SE) of total VOC concentration (μg/m3) by race/ethnicity and socio-demographic status

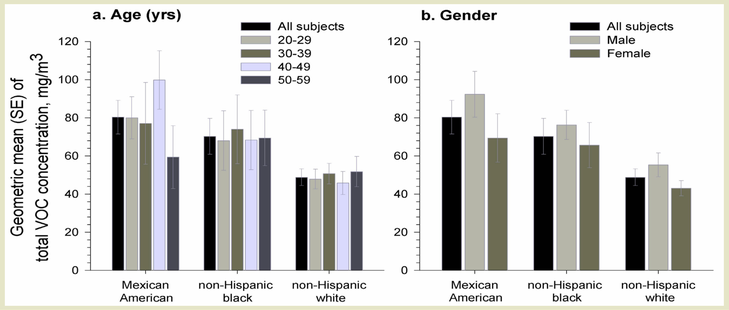

Figure 1 (continued)

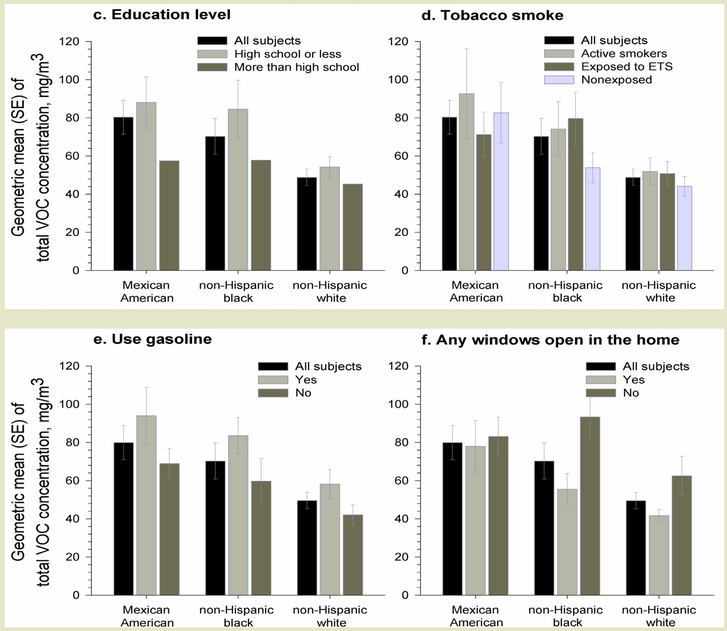

Table 2. Multiple regression for personal exposure to total airborne VOCs (μg/m3, log-transformed)

Note: For a given predictor, the regression coefficient (β) is the multiplier that depicts fold increases (or decreases) in total VOCs, compared with a reference group. For example, the predicted level of total VOCs in air would be 1.52 (i.e., e0.417) times greater in for Mexican Americans than in for non-Hispanic whites (reference group) after adjusting for other covariates.

Variables	β (SE)	*p* value
Race/ethnicity		< 0.001
Mexican American	0.417 (0.119)	
non-Hispanic black	0.316 (0.116)	
non-Hispanic white	Reference	
Age (years)	0.005 (0.002)	0.02
Any windows open at home (yes)	-0.415 (0.107)	< 0.001
Gender (male)	0.169 (0.089)	0.06
Tobacco exposure		0.10
Active smokers	0.011 (0.091)	
Exposed to ETS	0.166 (0.090)	
Nonexposed	Reference	
Use gasoline (yes)	0.256 (0.163)	0.12
Education (high school or less)	0.269 (0.115)	0.02
Model R^2	0.11	

DISCUSSION and CONCLUSION

- The current study found that race/ethnicity is associated with VOC exposure in that levels of total VOC exposure were higher for Mexican Americans and non-Hispanic blacks compared to non-Hispanic whites, both with or without adjusting for other socio-demographic variables.
- Given increasing evidence that many health disorders were associated with VOC exposure, especially for vulnerable subpopulations (i.e., children), further efforts are needed to investigate underlying causes of racial/ethnic disparities in exposure to environmental VOCs.