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Gender, ethnicity and environmental risk perception revisited: the importance of residential location

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Abstract

Objectives—Studies in the U.S. have found that white men are less concerned about pollution than are women or people of other ethnicity. These studies have not assessed respondents' proximity to localized sources of pollution. Our objective was to assess lay perceptions of risk from air pollution in an ethnically diverse sample in which proximity to a major perceptible source of pollution is known.

Methods—Cross sectional interview study of combined area probability and convenience sample of individuals 40 and older in the Boston area, selected according to proximity to high traffic controlled access highways.

Results—Of 697 respondents 46% were white, 37% Asian (mostly Chinese), 6.3% African-American, 6.3% Latino, and 7.6% other ethnicity. While white respondents, and particularly white men, were less concerned about air pollution than others, this effect disappeared when controlling for distance from the highway. White men were slightly less supportive than others of government policy to control pollution

Conclusions—The "white male" effect may in part be accounted for by the greater likelihood of minority respondents to live near perceptible localized sources of pollution.

Keywords

Risk perception; air pollution; environmental justice

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1. INTRODUCTION

1.1 Expert evaluation of risk

Expert and lay approaches to evaluating environmental risks are very different; lay people generally have little or no access to expert risk assessment procedures. The formal discipline of risk assessment developed in the 1970s, in response to growing public concerns about chemical hazards in the human environment.(1, 2) The National Academy of Sciences (NAS) defines risk assessment as "the use of the factual base to define the health effects of exposure of individuals or populations to hazardous materials and situations."(3) (p. 3) The basic components of risk assessment as promulgated by the National Research Council in 1993 are now recognized as the standard in the field, including in federal policymaking.(4)

These include hazard identification -- the initial recognition that an agent may have adverse effects and should be studied. Lay people may not recognize some hazards at all which are considered significant by experts, or may have concerns that experts either have never formally assessed or believe to be low. The next component, dose-response assessment, demands complex inferences from data on laboratory animals and epidemiological studies, since intentional exposure of humans to environmental toxins is generally unethical. Exposure assessment means determining the actual or potential patterns of exposure to the hazard in the population, which depends on many complex factors. Finally, risk characterization depends on combining information from dose response and exposure assessment to calculate the actual or potential burden of harm from the agent. Such calculations depend on the outcomes which are examined, and how they are valued. While risk characterization may rely on a simple outcome such as mortality or cancer, comparison among risks and the value of interventions to ameliorate them requires that morbidity and mortality must be evaluated in common units, such as Health Adjusted Life Years. (5) There is intense debate about these measures on both technical and ethical grounds.(6)

Policymakers, then, will rely on expert calculations of the liability of a population to some exposure, a calculation of the dose-response relationship of the exposure to identified outcomes, translation of these outcomes into one or another version of HALYs, and finally a representation of the aggregate HALYs related to the exposure. These calculations incorporate numerous assumptions and uncertainties.

1.2 Lay perception of risk

These arcane procedures are generally not available to lay people, nor do they reflect how people ordinarily assess risk. Beginning in the late 1970s, social psychologists and people in related disciplines such as anthropology began the systematic study of lay perception of risk. Even when people are presented with expert calculations, other characteristics of risks tend to be more salient. Processing what authorities say requires learned techniques and cognitive effort. Direct experience involves associative and affective processes, which are readily available and require less effort.(7–12)

The major theories of lay perception of risk may be classified as cultural, and psychological. The most prominent cultural theory of risk is built on anthropologist Mary Douglas's two dimensional classification of cultural propensities, which she labels "grid" (similar to the

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concept labeled by others as “power distance”(13)) and “Group.”(14) Group refers to the degree to which people value solidarity and group interest as opposed to individual self-interest. Grid refers to the extent to which people endorse status differences, whether of gender, race, social class or position of authority, as opposed to favoring equality. These ideas were developed by Aaron Wildavsky into an account of how people form political opinions, given that they generally lack policy expertise.(14, 15)

Regarding environmental hazards, the argument is essentially that egalitarians and solidarists (low grid, high group) are supportive of policies that restrict individual actions that harm the common welfare; while individualists and hierarchists see regulation as infringing on liberties and undermining the authority of elites. (Some may see potential contradictions in both these stances but these dimensions refer to psychological proclivities, not coherent political ideologies.) Douglas embedded this theory into a highly controversial argument that lay people tend to overestimate environmental risks and inappropriately distrust the adequacy of regulatory authorities.(16) However, that is unrelated to the empirical question of its predictive power. The construct has been found to be predictive of people’s degree of concern about various environmental hazards, including air pollution.(17–20) However, this work is based on surveys of individuals within the United States. Whether it is correct in this context to speak of “cultural” as opposed to personality traits is not clear.

Psychological theories of risk approach the problem from a contrasting perspective, trying to identify the characteristics of risks that are associated with greater aversion among lay people. For example, risks are perceived as less acceptable when they are assumed involuntarily, are catastrophic (e.g. the death of a hundred people in a plane crash is less acceptable than thousands of widely scattered traffic fatalities), delayed in time, not well understood by science, and undetectable to those exposed.(7, 21)

In surveys of the U.S. population, it has often been found that white men tend to express less concern about air pollution than do women and members of racial and ethnic minority groups, a phenomenon termed the “White Male Effect.”(22–24) One study found this to be true of Taiwanese men as well.(25) These studies have found that this is associated with high grid-low group cultural orientation among these demographic sectors.

These studies did not, however, account for people’s actual exposure to air pollution, or proximity to perceptible sources or effects of pollution: they were based on samples from large geographic areas. Here, we present results from a survey of people in Boston and the nearby towns of Somerville and Malden, Massachusetts, in which their residential proximity to a major localized source of air pollution – Interstate highways 93 and 90 – is known. Our objective was to understand how cultural proclivities, ethnicity, and perception of risk from air pollution are related in this sample, and how these relationships may be affected by proximity to the highway.

1.3 Expert characterization of risk from near-highway pollution

The most recent Global Burden of Disease study ranks exposure to ambient fine particulate matter ninth out of all risk factors in global DALYs, ahead of several items of substantial

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public concern including physical inactivity, high serum cholesterol, intimate partner violence, and occupational injuries.(26) Highways are an important localized sources of ambient ultrafine particulate matter and other hazardous exposures. Residential proximity to major roadways and highways is associated with numerous adverse health outcomes, including cardiovascular and pulmonary diseases.(27–29) Several pollutants have been found to be elevated near heavy traffic, including ultrafine particles, oxides of nitrogen, carbon monoxide and black carbon. These pollutants have generally been found to decline with distance from the edge of highway, usually within 400 meters.(30) These pollutants are associated with adverse health effects in animal, controlled human exposure, and time series, although direct evidence for their health impact in near highway residents is still developing. (31, 32)

Hence expert characterization of the risk of living or spending prolonged time within 100–200 meters of a major highway is that it constitutes a substantial health hazard, with uncertainty about the causal factor(s).

2. METHODS

2.1 Data

This is an analysis of survey data from the Community Assessment of Freeway Exposure and Health (CAFEH), a community-based participatory research study. The study design and methods have been described in detail elsewhere.(32, 33) The analysis presented here includes survey data from the three near-highway areas in or near Boston, Massachusetts, each paired with urban background areas (>1 km from the highway). The study areas are located in Somerville, the Dorchester/South Boston and Chinatown neighborhoods of Boston, and Medford (the urban background comparison area for Chinatown). Recruitment proceeded in approximately one year periods. Random samples were generated for all addresses within the study areas. In each neighborhood we stratified recruitment for <100 m, 100–400 m and >1000 m from the edge of the nearest interstate highway (I-93 or I-90) We had complete sets of documents available in English, Spanish, Portuguese, Haitian Creole, Vietnamese and Chinese (Cantonese and Mandarin) and field interviewers fluent in these languages. To bolster numbers, we recruited additional convenience samples. The convenience samples consisted of residents in 4 elderly housing developments, 2 each in Somerville and Dorchester; and addresses in the same buildings, but apartments not on our random sample, in Chinatown. The study protocol and consent forms were approved by the Tufts Health Sciences IRB. Eligible respondents were community dwelling individuals 40 and older who were cognitively able to provide an interview.

For this sub-study, we included in the community survey items asking “How harmful to you believe that air pollution is in this neighborhood to you or to others who live here?” and a similar item asking about pollution specifically from the highway. We used a four-point ordinal response scale of “very harmful,” “somewhat harmful,” “slightly harmful,” and “not harmful at all.” We also asked “In your opinion, should the government do more to protect people in your neighborhood from air pollution, is the government regulating too much already, or is current policy about right?” a 3-point ordinal scale. To operationalize the grid/group construct we used items developed originally for use in the Nordic countries which

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are independent of any specific political proposals and have previously been associated with socio-demographic characteristics.(34) We also included items from the Multi-Dimensional Health Locus of Control Scale (MHLC),(35) and the Perceived Stress Scale.(36) Because of limited space on the questionnaire, we used a truncated version of the grid-group scale, excluding a “fatalism” sub-scale and using selected items from what were originally separate “hierarchy” and “egalitarianism” sub-scales. We also truncated the MHLC scale to 7 items from the original 18. We represented residential proximity to the highway as a 3-category ordinal variable consistent with the original stratification plan: < 100 meters, 100–400 meters, and the background areas.

We also tested the relationship between risk perception and other variables in the questionnaire, which produced some incidental findings which we will present. These did not affect our primary research question.

2.2 Analyses

We used principal components analysis with varimax rotation to decompose the MHLC, and grid-group scales. Because the dependent variables are ordinal, we used ordered logit models for both bivariate and multivariate analyses of association. In conducting the analyses and interpretation, the first author consulted with a group including both other academic investigators, and community residents who were participating in the CAFEH study, some of whom are co-authors of this report. The community residents had several suggestions about variables to include in the analysis, and contributed to the interpretation and discussion we present. Two are representatives of community based organizations in the study area, and the third is a retired United Way executive.

3. RESULTS

3.1 Respondents

From the original random sample of 1,847 addresses, 920 eligible respondents were identified, of whom 475 agreed to be interviewed for a response rate of 51.6%. An additional 222 respondents were in the convenience sample.

We acquired detailed information about ethnicity including specific national heritage. However, most of the specific ethnicity responses had low frequency, with the exception of non-Hispanic white, and Asian. Of the 234 respondents reporting Asian ethnicity, 196 were Chinese and 30 Vietnamese. Ethnicity was unevenly distributed by neighborhood, principally because of the concentration of Asian respondents in Chinatown. There were also differences in the distribution of ethnicity by distance from the nearest highway. (Table I) Because of the low frequency of most ethnicity categories, we present our main analyses distinguishing only between white non-Hispanic, and all others.

3.2 Factor analyses

We found two-factor solutions for both the short version of the MHLC and the grid/group scales. These are presented in Table II. (Items are presented in short form in the interest of space.) These do not factor entirely along the expected dimensions. For example, loadings

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for the assertion that “On the whole, government officials try to do what is best for the public” are similar for both factors in the grid/group scale. This item is supposed to be associated with high grid orientation. However, it is perhaps not surprising; in the contemporary political climate in the United States, distrust of government is associated with conservative rhetoric, i.e. government officials are not necessarily viewed as having legitimate high status by people who do view economic high status as legitimate. In a three factor solution, this item and “One of the problems with people today is that they challenge authority too often” both load strongly on the third factor, but no other variables do, which suggests that respondents are indeed viewing economic and political status separately. In the locus of control scale, Factor 1 can be interpreted as representing external locus of control, and factor 2 as representing internal locus of control. Table II about here

3.3 Associations with dependent variables

Degree of concern about pollution in the neighborhood generally, and pollution from the highway specifically, are highly correlated, with 77% of responses on the diagonal (gamma=.893, p<.0001). Because most previous research has not concerned near-highway pollution, but air pollution in general, in the interest of space we will present most findings about the first variable only. Table III shows bivariate associations with the independent variables of concern about air pollution generally, and support for government policy to control pollution. Most factor scores were not significant predictors, with the exception of the first factor for the grid/group scale, which we have labeled “conservatism.”

Consistent with previous studies, being white was associated with less concern about pollution and less support for government policy to control pollution risk. However, in contrast to previous findings, gender was not significantly associated with degree of concern about air pollution, although it is associated with support for government policy to ameliorate pollution. An association we had not anticipated is with the minutes per week respondents report spending in moderate physical activity. Because this item ranges from 0 to 1,000, we recoded it into hourly increments to make the coefficients more interpretable. The Perceived Stress Scale has a marginally significant association with concern about pollution. Age, and years of formal education have small negative associations with concern about pollution, while being in the convenience sample has a positive association. It is of interest that being a current smoker is not significantly associated with concern about pollution. We show this negative finding in the table.

There are also strong associations with being bothered by traffic sounds, and residential proximity to the highway. Since these are, not surprisingly, strongly associated with each other, they cannot be entered into multivariate models together.

In a multivariate ordinal regression including distance from the highway, we found that the association of ethnicity and gender with concern about pollution becomes non-significant. In a regression including all bivariate predictors, we found that the associations of gender and race/ethnicity with support for government policy to protect people from pollution remain significant. (See Table 4) The gender/ethnicity interaction is not significant, indicating that while there are effects of race/ethnicity and gender, they are independent. Parsimonious

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models showing the significant predictors of concern about air pollution, and support for government policy to control pollution, are also shown in Table IV. Table IV about here

4. DISCUSSION

Although our results were consistent with previous observations that white men express less concern about air pollution than others, we did not find a corresponding gender effect. On the other hand, we found a significant gender effect and a significant effect of white vs. non-white ethnicity with regard to support for government policy to control pollution. However, when we controlled for residential proximity to the highway, and other important predictors, the “white male” effect no longer exists with respect to concern about air pollution in the neighborhood.

These results suggest that previous findings of the white male effect should be viewed with caution. In our sample, racial and ethnic minority respondents are more likely to live in proximity to a localized source of pollution, in this case a major highway. There is a very large body of evidence showing that in the United States, non-white and low SES people are more likely to live in proximity to local sources of pollution,(37–41) including high traffic roadways.(42) It may be that direct experience of perceived exposure to environmental risk is more important than cultural or psychological proclivities in explaining ethnic disparities in risk perception. In addition, political controversy over localized sources of pollution may heighten its salience for people living nearby.

We also found that perceived psychosocial stress, and minutes per day spent in moderate physical activity, are both independently associated with increased concern about air pollution, apparently a novel finding. We can only speculate about the explanation for these observations. In the first case, it may be that people who are generally more anxious as a trait are inclined to report more concern about air pollution as they might about any hazard; or conversely that worries about air quality contribute to people’s overall perception of stress. The association with moderate physical activity could be related to overall greater health consciousness, or to spending more time out of doors. Or it may be that people who are less active are also in generally worse health and so have other concerns that supersede air pollution. These questions might merit further study.

All of these findings point to the broad conclusion that the study of perceived risk should be informed by people’s relevant individual circumstances, particularly their direct experience of exposure to observable sources or risks. It may be that demographic, cultural and psychological factors which have been invoked as explanations for variation in risk perception are correlated with such lived experience and so confound causal inference. A complication of this data is that non-white respondents are predominantly Asian, and Asians mostly live in Chinatown, which has a particular history of controversy over highway construction. In fact, the Chinatown neighborhood boundaries were defined on one side by the construction of I-93 in the 1950s. More recently the reconstruction of I-93 in the 1990s further altered the eastern edge of Chinatown and elicited substantial community reaction and protest.(43) It is also worth noting that the City of Somerville, location of another of our study areas, has a similar history of disruption by the construction of I-93 and more recent

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concerns, in this case about air pollution generated by the highway.(44) However, this history does not contradict, but reinforces the conclusion that people's specific, local circumstances should be accounted for in predicting risk perception.

This study has important limitations. The sample is from a single metropolitan area, with a distinctive political culture. The history of political controversy in Chinatown and the near-highway areas of Somerville over highway construction may make residents in the impacted areas unusually conscious of the highway as a risk. The sample is limited to people 40 and older so we cannot say whether similar findings would pertain to younger people. The mix of ethnicities is not balanced because of small numbers of people of ethnicities other than white non-Hispanic and Asian; results appear largely similar if Asian vs. White or Chinatown residence vs. all others are substituted for the white vs. non-white comparison (not shown). In either case, however, the conclusion remains that specific local experience, rather than cultural proclivities associated with race, may largely drive variation in risk perception.

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Table I

Simplified race/ethnicity categories by neighborhood and residential distance from a major highway

			Race/ethnicity					
Neighborhood			**White**	**Asian**	**Af_Am**	**Other**	**Latino**	**Total**
Chinatown[1]	Distance[2]	1.00	2	45	2	0	1	50
		2.00	1	112	2	2	1	118
		3.00	41	32	1	3	2	78
	Total		3	157	4	2	2	168
Dorchester/South Boston	Distance	1.00	36	9	1	3	2	51
		2.00	74	12	15	6	13	120
		3.00	25	18	14	11	2	70
	Total		135	39	30	20	17	241
	Total		41	31	1	3	2	78
Somerville	Distance	1.00	36	3	1	8	5	53
		2.00	59	3	7	16	7	92
		3.00	48	1	1	3	0	53
	Total		143	7	9	27	12	198
Total	Distance	1.00	74	57	4	11	8	154
		2.00	134	127	24	24	21	330
		3.00	114	51	16	17	4	202
	Total		322	235	44	52	33	686

[1] Includes comparison area in Malden

[2] 1= <100 m

2=100–400 m

3= >400 m (urban background)

Note: 18 respondents who did not state their race/ethnicity are omitted.

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Table II

Two factor solution for “grid/group” scale and Multidimensional Locus of Control Scale

Grid/group	Factor 1	Factor 2
Govt. should redistribute income	.757	.050
Govt. officials try to do what is best	.468	.401
People challenge authority too often	.143	.603
People should follow conscience even if illegal	.502	−.277
Private enterprise needs to be controlled	.681	.086
People should put families and communities ahead of own interests	.081	.399
People with money should be left to enjoy it	−.457	.595
If people are better off, it is because they have earned it	−.209	.748

MHLC	Factor 1	Factor 2
If I become sick, I have power to make self well	.457	−.096
Often I feel I have no control over whether I will get sick	−.038	.747
It seems my health is greatly influenced by accident	−.074	.694
I am directly responsible for my health	.656	−.091
Whatever goes wrong with my health is my own fault	.778	0.41
When I stay healthy, I am just plain lucky	.078	.633
When I feel ill, it is because I have not been taking care of myself properly	.713	.196

Note: Positive scores indicate disagreement

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Table III

Bivariate association of predictor variables with dependent variables

Independent Variable	Concern about pollution	Govt. should do more to control pollution
White vs. non-white	−.352 (p=.016)	−.714 (p<.021)
Male vs. female	−.123 (p=.441)	−.747 (p=.006)
Bothered by traffic sound 1 v. 4*	.0947 (p=<.0001)	.0975 (p<.0001)
Years of Education	−.058 (p=.00090	0.022 (p=.57)
Current smoker	−.339 (P=.124)	−0.198 (p=.56)
Minutes/wk moderate physical activity 5 vs. 1*	.1937 (P=.04)	−1.06 (p=.001)
Perceived stress scale	0.05 (P=.056)	0.048 (p=.28)
Factor score for first factor, grid/group (“conservatism”)	−0.148 (p=.056)	−.374 (p=.002)***
Convenience sample v. random	0.486 (p=.004)	0.578 (p=.067)
Age	−.003 (p=.7)	−006 (p=.586)
Proximity to highway (<100m v. background)	.902 (p<.0001)	0.74 (p=.034)

* Ranges from 0 to 1,000; recoded into hourly categories to make the coefficient more interpretable. The contrast shown is > 4 hours vs. 0.

Note: Scores have been reversed so that higher scores represent greater concern

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Table 4

Multivariate Ordinal regressions

Full Model		
	Concern about air pollution	**Support for government policy to address pollution**
	Coefficient (p value)	
White vs. non-white	−0.00991 (p=0.9585)	−0.8445 (p=0.0135)
male	−0.1113 (p=0.4968)	−0.6551 (p=0.0248)
Years of formal education	−0.0385 (p=0.0953)	0.0399 (p=0.343)
Current smoker	−0.5077 (p=0.0213)	−0.5824 (p=0.1558)
Moderate physical activity	0.04062 (p=0.0163)	0.1458 (p=0.0097)
Perceived stress scale	0.0406 (p=0.1266)	0.0359 (p=0.4619)
Factor score for “conservatism”	−0.0122 (p=0.6384)	−0.0539 (p=0.2158)
Random 0 vs 1	0.4571 (p=0.0088)	0.5464 (p=0.1101)
Age in years	−0.00046 (p=0.9446)	−0.00411 (p=0.7344)
< 100 meters from highway vs. background	0.9958 (p=<.0001)	0.7795 (p=0.0401)
100–400 meters vs. background	0.6126 (p=0.0017)	0.8869 (p=0.0089)

Parismonious model			
d1_smoking	−0.5285 (p=0.0104)	w_nw 1 vs 0	−0.7736 (p=0.0057)
Random 0 vs 1	0.4678 (p=0.0056)	male 1 vs 0	−0.5795 (p=0.0337)
distcat 1 vs 3	1.1401 (p=<.0001)	modphysact (60 mins)	0.1584 (p=0.0036)
distcat 2 vs 3	0.7525 (p=<.0001)	distcat 1 vs 3	0.7438 (p=0.0421)
modphysact (60 mins)	0.03906 (p=0.0168)	distcat 2 vs 3	0.771 (p=0.0119)