Task 4: Analysis of Survey Data on Ozone Alert Days

Final Report

Prepared for

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EPA Contract Number 68-D-99-024

RTI Project Number 7647.004.399

September 2003

RTI INTERNATIONAL

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SECTION 1

INTRODUCTION

The Air Quality Index (AQI) and the associated ozone alert system is one of a number of programs that provide information to the public about an environmental threat. This information can help the public in two general ways. People can use this information to decide whether and how much they need to protect themselves by limiting their own exposure. In addition, the information could encourage people to take whatever steps they can to reduce the level of the environmental threat for others. For example, in the case of ozone pollution people could limit time outdoors to reduce their own exposure and limit the amount they drive during the day to reduce the overall level of ozone pollution in the region.

There is some empirical evidence to support the notion that individuals may take defensive actions to avoid harmful pollutants. Bresnahan, Dickie and Gerking (1997) find adults with smog-related health symptoms reduced time spent outdoors when ozone concentrations were high. Addition behavioral changes such as limiting or changing planned leisure activities and increased use of home air conditioning were also taken. In addition to health status, the authors find higher levels of education correlated with averting behaviors on days of poor air quality. Neidell (2002), using a data set that combines individual child asthma-related hospitalization data with zip code level population demographics, finds a negative, significant relationship between health advisories (proxies for avoidance behavior) and hospitalizations. Families of high socio-economic status display particularly strong patterns of avoidance behavior.

More generally, there is evidence that the public may respond to safety messages that affect a variety of health risks. In a controlled evaluation of how variation information materials communicating the risks from radon influenced people's perceptions of those risks, Smith et al. (1990) find that risk communication policies can be effective in modifying risk perceptions. Defining education and behavioral change is key in measuring the effectiveness of risk communication materials. In a follow up study, Smith et al. (1995) present results that track risk perceptions and mitigation decisions of a panel study. They find that presenting risk information that emphasizes radon threshold for action increases the likelihood of mitigating actions being taken.

In this study, we will use survey data to examine awareness of the ozone alert program and the factors that influence an individual's choice to limit time outdoors and the amount they drive on high ozone days. The data come from a national survey conducted by RTI and Knowledge Networks (KN) in August 2000. As part of the survey, respondents were asked a series of questions related to ozone alert days. This data will be combined with county-level variables to estimate a series of regressions accounting for possible sample selection bias to help explain awareness of ozone alerts and reported changes in behavior.

SECTION 2

HEALTH AND AGING SURVEY

The ozone questions were a module in RTI's Survey of Health and Aging. Conducted in August 2000, the panel was based on a sample of adults, aged 18 and older, selected from a nationally representative Web-enabled panel and surveyed via interactive TV.

2.1 Background on the Knowledge Networks Panel

The basis for the Web-enabled panel was a probability-based RDD sample drawn from all 10-digit telephone numbers in the United States. The survey employed a stratified random design that incorporates the known probabilities of selection associated with geographical location, the number of phone lines and people in each household, and whether or not the phone number was listed.

Prior to telephone contact, a pre-notification letter was sent to each household whose randomly sampled telephone number could be matched to a mailing address. For selected telephone numbers to which an address could not be matched, attempts were made to contact the household over the phone, obtain an address, and send a letter. Following the pre-notification, selected households were contacted via telephone to recruit participants and obtain information about the households.

Households that agreed to participate in the panel were then sent equipment to enable them to hook up the Web-enabled panel. Every participating household received free hardware, free Web access, free e-mail accounts for each resident over the age of 13, ongoing technical support, and an incentive program to encourage continued participation. These households then completed an initial "demographic characteristic" survey via the Web.

2.2 The Survey of Health and Aging

One respondent was randomly selected from each sampled household, and a request was sent to the individual to ask them to respond to the Health and Aging Survey. An initial subsample of 7,493 persons aged 18 years and older was selected. This subsample was subsequently augmented to include another 1000 persons as part of the nonresponse follow-up activities, for a total of 8,493 sample members.

Data collection began on August 3, 2000, and continued through September 13, 2000. Telephone follow-up of nonrespondents was conducted for a subsample of 1000 initial nonrespondents in the panel between August 31 and September 13, 2000.

The survey questions were programmed for administration on interactive TV. To initiate the survey, e-mail messages were sent to the selected adult panel members. The e-mail message informed the recipient that could complete the survey. Clicking on a button within the e-mail started the multimedia questionnaire, which took fifteen minutes to complete. Self-administration allowed respondents to complete the surveys at their convenience, in the comfort and privacy of home. Because every household has the same standardized hardware, survey consistency was assured. Two e-mail reminders were sent to sampled individuals to encourage their participation.

Telephone follow-up reminders were conducted with a random sample of 1,000 nonrespondents to the initial panel request.

Of the 7,493 panel members initially selected from the web-enabled panel, 5,868 (78.3 percent) completed the survey via interactive TV. That is, nearly 80 percent of respondents with working Web-enabled panel systems who were asked to participate in the Health and Aging Survey completed the survey.

In addition, telephone data collection was attempted with a stratified random sample of 1,000 adults in households who had either declined to participate in the panel or who had not installed their Web-enabled panel box. Altogether, telephone data collection was conducted with three subsamples of nonrespondents:

- Persons who declined to participate in the panel (n=500);
- Persons who agreed to participate in the panel but did not install their Web-enabled panel box (n=500); and
- Panel members who did not respond to the survey (n=1,000).

Fifteen telephone call-backs, on different days of the week and at different times of the day were placed to “ring-no-answer” telephone numbers prior to close out. Respondents who declined to participate in the panel or who had not installed their Web-enabled panel box were asked to complete the survey by telephone.

These methods of data collection yielded data from 6,306 eligible respondents. Of these respondents:

- 5,868—respondents completed the survey via interactive TV;
- 238—respondents completed the survey via interactive TV following a telephone reminder to complete the survey;
- 129—respondents, randomly selected from among households who initially agreed to participate in the survey panel but had not installed their Web-enabled panel box, subsequently completed this survey via telephone; and
- 71—respondents, randomly selected from among households who initially declined to participate in the initial Web-enabled panel, subsequently completed this survey via telephone.

Weights were assigned to all respondents (initial and follow-up) to reflect their overall probability of being selected for the survey.

2.3 Overall Response Rate

The overall weighted survey response rate[1] was between 43.3 percent and 52.2 percent. The 43.3 percent response rate is a conservative estimate because it assumes that the pending cases (i.e., all "ring no answer" telephone numbers after 15 callback attempts) were distributed in proportion to the number of bad numbers obtained, and that this proportion of telephone numbers was not included in the denominator. The 52.2 percent response rate is a liberal estimate because it assumes that *all* pending cases were non-working numbers, and therefore all removed from the denominator. Given the fact that 15 callbacks were attempted, it is likely that most of the pending were ineligible households. Therefore, the higher response rate provides the most reasonable estimate of response rate.

2.4 Ozone Alert Questions

Out of the panel described above, 6,304 people responded to the ozone alert questions. We dropped 198 respondents from the data set because their county of residence

[1]The overall weighted response rate accounts for the selection probabilities that were used to select the follow-up samples.

could not be identified (those interviewed by telephone), leaving 6,106 observations for analysis. Each participant provided general demographics information including his/her age, race, level of education, employment status, and household income. Responses to questions on current health status and concerns about coping with serious illness in the future were also included in the data set. Political affiliation and expected voting behavior during the 2000 election were retained as well. Figure 2-1 contains the questions from the survey pertaining to ozone alerts.

Q14.	Ground-level ozone is an air pollution problem in many areas of the country. The government has developed a ranking system—Code Orange and Code Red—to alert people on days when ozone levels are high. Are you familiar with this ranking system?		
	1	(N=) Yes	Go to Q 15
	2	(N=) No	Go to Q18
If Q14=1			
Q15.	To your knowledge, have there been any high ozone alert days (Code Orange or Code Red) in the area where you live this summer?		
	1	Yes	Go to Q16
	2	No	Go to Q18
If Q15 = 1			
Q16.	How did you change your outdoor activities on high ozone alert days?		
	1	I stayed indoors all or most of those days	
	2	I limited my time outdoors on all or most of the high ozone alert days	
	3	I did not change my behavior on those days	
If Q15 = 1			
Q17.	How did you change your driving behavior on high ozone alert days?		
	1	I did not drive on those days	
	2	I reduced the amount of driving I did on high ozone alert days	
	3	I did not change my driving patterns on those days	

Figure 2-1. Ozone Alert Questions

SECTION 3

COUNTY LEVEL DATA

In addition to the survey data, we collected data for the counties in our sample on ozone pollution and on county level demographics.

3.1 County Demographic Data

County-level demographics data was obtained from the Bureau of Census, Census 2000 website (Department of Commerce, 2002). The detailed tables from *Summary File 3* provides county level observations on basic demographics including the share of population residing in urbanized areas, race, household size, employment, educational attainment, median income, and poverty status. Variables identifying the ability to speak English, mode of transportation to work, and the number of people who had moved to a new residence in the past five years were also included since they may reflect certain populations' awareness of, or responses to, the ozone alert system.

3.2 Determining the Count of "Purple," "Red," and "Orange" Ozone Days

According to the Environmental Protection Agency (EPA), AQI data for ozone exceedence days at the county level was not available. As a result, raw ozone data from the EPA's Air Quality System (AQS) was used (EPA, 2002). This data set contains hourly observations for several thousand monitor sites located across the country, predominately in areas with the potential to experience air quality problems. Observations from May 1, 2000, through July 31, 2000, were retained since they represent the period prior to administration of the survey. From the 24-daily observations, the highest daily eight-hour daily maximum concentration of ozone at each monitoring site was derived. The highest daily value across all sites in a county was retained and subsequently coded according to the AQI breakpoints (EPA, 1999). The total count of total "purple," "red," and "orange" days for each county during the summer of 2000 was then determined.

The count of ozone days are a conservative number since other criteria pollutants may have had a higher AQI value than ozone on a particular day, driving up the AQI. In most cases, however, ozone is the primary pollutant contributing to the AQI. In any event, ozone value that exceeds 100 on the AQI will always be reported to the public, to alert sensitive groups to potential health risks.

3.3 Historic Data on Ozone Levels

The American Lung Association (ALA) publishes an annual document *State of the Air* which reports on national air quality. This includes county level data on the total number of "orange," "red," and "purple" days experienced over the entire year. The 2001 version of the publication provides historical date on the total number of ozone days from 1997-99 (ALA, 2001). The daily color is calculated based upon the highest daily eight-hour daily maximum concentration of ozone for each ozone-monitoring site. The highest daily eight-hour daily maximum concentration in each county was then determined based on the EPA-defined ozone season (including the months of August and September).

3.4 Merging the Data

The survey and census data was merged with ozone data from 2000 and subsequent years by the fips code identifier. The 6,106 respondents were mapped to 1,042 different counties. Of those counties, 478 (46 percent) had complete or partial ozone data, the remainder did not. As stated previously, monitors are located predominately within metropolitan areas where the air quality is poorest and sensitive populations must be informed of potential health effects. We assumed that if air quality monitoring information was missing the counties did not have high ozone days or if they did that the residents were not informed through the ozone alert system.

3.5 Summary of Dataset

Table 3-1 contains summary statistics for the demographic characteristics of the respondents in our sample. Summary statistics for the county level data collected from the Census are in Table 3-2. Finally Table 3-3 contains the data on ozone alert days in the counties where our respondents live.

Table 3-1. Summary Statistics for KN Survey Respondents

Variable	Value
Age (mean in years)[a]	45
Male [b]	49%
Median HH Income ($1999)	$45,000
Educational Attainment [c]	
Less than high school degree	9%
High school degree	31%
Some college	34%
College degree	18%
Graduate degree	8%
Employment Status [d]	
Working full time	56%
Working part time	8%
With a job, on medical leave, vacation or strike	1%
Retired	16%
Homemaker	9%
In school (working, not working)	6%
Unemployed/looking for work	3%
Health Status [e]	
Health excellent	18%
Health very good	37%
Health good	32%
Health fair	10%
Health poor	3%
Household Income ($1999)[f]	
Income $0–$14,999	9%
Income $15,000–$24,999	10%
Income $25,000–$34,999	12%
Income $35,000–$49,999	25%
Income $50,000–$74,999	28%
Income $75,000–$124,999	12%
Income $125,000 and above	4%

(continued)

Table 3-1. Summary Statistics for KN Survey Respondents (continued)

Variable	Value
Marital Status [g]	
Married	63%
Widowed	5%
Divorced	10%
Separated	2%
Never married	19%
Race [h]	
White	81%
Black/African American	11%
American Indian/Alaskan Native	2%
Asian/Pacific Islander	3%
Other	4%

[a] 53 observations missing
[b] 38 observations missing
[c] 37 observations missing
[d] 49 observations missing
[e] 22 observations missing
[f] 957 observations missing
[g] 29 observations missing
[h] 338 observations missing

N = 6,106 respondents.
Percentage totals may not sum to 100 percent due to nonresponses and rounding.

Table 3-2. Summary Statistics for U.S. Counties (Census 2000)

Variable	Value
Age (years)	36
Median HH Income ($1999)	$39,007
County Population in Urban Area	51%
Educational Attainment	
No high school degree	19%
High school degree	32%
Some college	28%
College degree	13%
Graduate degree	7%
Employment Status	
Unemployed	6%
Language	
Households linguistically isolated	2%
Race	
White	84%
Black/African American	9%
American Indian/Alaska Native	1%
Asian	2%
Pacific Islander/Hawaiian Native	0.1%
Other	3%
Transportation	
Workers who commute alone	82%
Workers who use public transit	2%

Note: Percentage totals may not sum to 100 percent due to nonresponses and rounding.

Table 3-3. Ozone Data for Survey Counties

Number of Counties in Dataset	N = 1,042	Percent
Survey counties with ozone data for 2000 (May–July)	478	46.0%
Counties with 1+ orange day(s)	354	74.0%
Counties with 1+ red day(s)	84	17.6%
Counties with 1+ purple days(s)	9	1.9%
Total number of “color” days in those counties in 2000 (May–July)		
Total number of orange days	1,506	
Total number of red days	171	
Total number of purple days	12	
Survey counties with ozone data for 1997–1999	438	42.0%
Counties with 1+ orange day(s)	408	93.0%
Counties with 1+ red day(s)	250	57.0%
Counties with 1+ purple days(s)	55	13.0%
Total number of “color” days in those counties 1997–1999		
Total number of orange days	10,746	
Average annual number of orange days	3,582	
Total number of red days	1,401	
Average annual number of red days	467	
Total number of purple days	212	
Average annual number of purple days	71	

SECTION 4

ANALYSIS AND RESULTS

The ozone alert system provides information to individuals about possible threats to their health. This information can be used for two purposes. On days with high ozone levels, individuals may take actions to mitigate the impact of ozone on their health. Limiting time outdoors is one of the most effective methods of reducing exposure to high ozone. In addition, individuals could also take action to reduce the actual level of ozone pollution, for example by driving less. However, for the ozone alert system to be effective, people must be familiar with it.

Table 4-1 presents the responses to ozone questions (Questions 14-17 in Figure 2-1) from the Health and Aging Survey. Overall, 33 percent of the sample had heard of the alert system. Thirty-four percent of the counties represented in the survey experienced at least one day of code orange (or worse) air quality in 2000, covering 71 percent of the respondents. Thirty-seven percent of respondents in counties with orange (or worse) air quality were aware of the ozone alert system, compared with 23 percent of respondents in counties that did not experience a code orange (or worse) day. Of those who resided in counties that had experienced a code orange day, 54 percent correctly reported that their county had experienced a code orange day during that summer. On ozone alert days, 57 percent reported spending less time outdoors, 56 percent reported driving less and 48 percent reported engaging in both activities. Forty-four percent of respondents reported making neither behavioral adjustment.

Table 4-1. Ozone Survey Response Data

	N	Percent
Generally aware of ozone alert system[a]	2,008	33%
Aware of ozone alert system in moderate ozone areas[b]	1,595	37%
Correctly reported moderate to high ozone alert in their city[c]	854	54%
Adjusted outdoor activities on moderate ozone alert days[d]	422	57%
Adjusted driving behavior on moderate ozone alert days[d]	441	56%

[a] Aware of alert system, regardless of whether respondent's county experienced high ozone day in summer 2000.

[b] Those respondents who were aware of ozone alert system in counties that experienced 'orange' ozone day in summer 2000.

[c] Those respondents who were aware of alert system and correctly stated that alert had been issued for orange or worse ozone days in summer 2000.

[d] Those respondents who adjusted behavior in counties that had experienced moderate or worse ozone days in summer 2000.

The survey questions generated binary data on awareness and behavioral changes of respondents. Consequently, our analysis was limited to discrete choice models. A probit regression model was selected to predict an individual's choice. The dependent variable in each model was evaluated against independent variables that included demographic and county characteristics, as well as environmental factors. Table 4-2 provides the names and descriptions of the variables used in the analysis. The error term was adjusted for correlation between observations in the same MSA (Municipal Statistical Area) or county (if the county did not belong to an MSA) in which the respondent resided, in order to control for MSA/county-specific effects (using the "cluster" command in STATA).

The first model estimated respondents' general awareness of the ozone alert system (survey Question 14). Generally, those with more education, higher incomes and better health were more likely to be aware of the alert system (see Table 4-3). Awareness is positively associated with age, suggesting that awareness increases as respondents become older. Males were less likely to be aware of the alert system, relative to females. Black/African-American and white respondents were more likely to be aware of the system, relative to Asian respondents. Those reporting their current health status to be excellent or very good were more likely to be aware of the system, relative to those reporting poorer

Table 4-2. Model Variable Names and Descriptions

Variable Name	Description
age	Age of survey respondent
male	Gender
black	Race is black / African-American
white	Race is white
other	Race is other
college	Highest level of education was some college
bach_grad	Highest level of education was bachelor's or graduate degree
fulltime	Employed full time
parttime	Employed part time
workother	Retired / homemaker / student / employed but on medical leave, vacation or strike
mid_income	Household pre-tax income $35,000 - $74,999 ($1999)
high_income	Household pre-tax income $75,000 or greater ($1999)
healthbest	Current health status describes as excellent or very good
orange2000	MSA or county (not in MSA) had at least one orange alert day in 2000
red2000	MSA or county (not in MSA) had at least one red alert day in 2000
purple2000	MSA or county (not in MSA) had at least one purple alert day in 2000
orange9799	MSA or county (not in MSA) had at least one orange alert day 1997-1999
red9799	MSA or county (not in MSA) had at least one red alert day 1997-1999
purple9799	MSA or county (not in MSA) had at least one purple alert day 1997-1999

health status. This results may be due to health status being positively, albeit weakly, correlated with education and household income, both of which have strong associations with awareness.

Respondents with at least some college education were more likely to be aware of the system than those with a high school degree or less. This result conforms with findings of previous studies that suggest a positive relationship between education and awareness of a variety of environment-related health risks. Those who were employed full time or are students, homemakers or retired persons are more likely to be aware of the system than those who are unemployed. These individuals may be better informed through greater access to

Table 4-3. Regression Results of Awareness of Ozone Alert System (Question 14)

Variable Name	Coefficient (Standard Error)
age	0.003**
	(0.001)
male	–0.07**
	(0.03)
black	0.18**
	(0.09)
white	0.15**
	(0.06)
other	–0.09
	(0.13)
healthbest	0.07*
	(0.04)
college	0.08**
	(0.04)
bach_grad	0.11**
	(0.04)
fulltime	0.15*
	(0.09)
parttime	0.07
	(0.10)
workother	0.17*
	(0.09)
mid_income	0.09**
	(0.04)
high_income	0.04
	(0.05)
orange2000	0.15*
	(0.09)
red9799	0.23**
	(0.09)
purple9799	0.25**
	(0.11)
_cons	–1.33
	(0.11)
Log pseudo-likelihood	–3,660.6
Pseudo R^2	0.03

* significant at p-value = 0.10
** significant at p-value = 0.05

N = 5,958 respondents.

information, relative to the unemployed. Respondents working part time were not found to be statistically more or less aware of the alert system, relative to the unemployed. In addition, those with household incomes between $35,000 and $75,000 were more likely to be aware of the system, relative to those with incomes below $35,000. This result agrees with empirical evidence which suggests that, similar to higher levels of education, higher income is typically associated with greater awareness. However, the coefficient on household income above $75,000 was not statistically significant, although it was of the expected sign. This finding may be due to the relative small size of the sample (only 15 percent of households in the entire survey had income above $75,000).

Recent and historic environmental conditions may also have impacts on respondents' awareness of the system. We expect that the occurrence of moderate or high ozone days would have a positive relationship with awareness, since these conditions trigger the issuance of warnings. This expectation is supported by our results, which indicated that the occurrence of a moderate ozone day in the respondent's county during the summer of 2000 was positively associated with awareness. In addition, the occurrence of historically high ozone days (1997-1999) was also positively related to awareness.

The second model estimated whether respondents correctly reported the occurrence of moderate or worse ozone days in their city during the summer of 2000 (survey Question 15). Gender, race, education, income and historic environmental conditions were significant predictors of correct response (see Table 4-4). Males were more likely to respond correctly on whether moderate or worse days had occurred in their city, relative to female respondents. Although age was a significant predictor of awareness, it was not found to be a significant predictor of a correct response. White respondents were less likely to respond correctly, relative to Asians. Black and other race categories were not statistically significant. Those with some college education were less likely to respond correctly, relative to those with lower levels of education. Further analysis would be needed to gain insight into this counter-intuitive result. Potentially, less educated individuals reside in areas with higher levels of pollution and are thus more frequently exposed to ozone alerts and other environment-related health messages. Employment status was not a significant predictor in this model. Consistent with the result above, those with household incomes between $35,000 and $75,000 were more likely to be aware of the system, relative to those with incomes below $35,000. This result agrees with empirical evidence which suggests that, similar to higher levels of education, higher income is typically associated with greater awareness. However,

Table 4-4. Respondents Who Correctly Reported Existence of Ozone Alert System (Question 15)

Variable Name	Coefficient (Standard Error)
age	0.000 (0.003)
male	0.29** (0.10)
black	0.18 (0.36)
white	-0.52* (0.27)
other	-0.31 (0.50)
college	-0.23* (0.12)
bach_grad	-0.19 (0.16)
fulltime	0.29 (0.29)
parttime	0.31 (0.43)
workother	0.18 (0.62)
mid_income	0.18* (0.11)
high_income	-0.03 (0.17)
healthbest	0.14 (0.11)
orange9799	3.53** (0.349)
_cons	-1.87 (0.43)
Log pseduo-likelihood	-192.5
Pseudo R^2	0.49

* significant at p-value = 0.10
** significant at p-value = 0.05

N = 969 respondents.

the coefficient on household income above $75,000 was not statistically significant. Current health status was also not found to be statistically significant.

Historic environmental conditions may also have impacts on correctly reporting on the alert system. We expect that the occurrence of moderate or worse ozone days in previous years would have a positive relationship with awareness, since such conditions trigger the issuance of warnings. This expectation is supported by our results, which indicated that the occurrence of a moderate ozone day in the respondent's area between 1997 and 1999 was positively related to awareness.

The third model estimated behavioral changes, specifically whether the respondent stayed indoors more or did not go outside on moderate or high ozone days (survey Question 16). Factors affecting the likelihood of taking averting behavior include age, gender, current health status, and extremely unhealthy environmental conditions (see Table 4-5). Consistent with the first model, age is positively associated with taking averting behavior. This may reflect the heightened sensitivity of older persons to unhealthy environmental conditions, relative to general population. Males were less likely to adjust their behavior on moderate or high ozone alert days, relative to females. Whites were less likely than Asians to stay indoors more on high ozone days, while black and other race respondents were not found to have statistically different behaviors, relative to Asian respondents. Neither high level of education, nor work status were found to have a statistically significant effect on averting behavior. Respondents from high income households (over $75,000) were less likely to take averting actions, relative to low income households. Intuitively, one would expect wealthier households would have access to information that would encourage them to stay indoors more, in order to protect their health. However, there are several potential explanations for this result. For example, high income households may travel to shopping malls, museums or other facilities on bad ozone days, as a substitute for time typically spent at the home when environmental conditions are better. Or, it is possible that those in wealthier households may have employment schedules or other obligations that do not allow flexibility in terms of mode of transportation.

Respondents who reported to be in excellent or very good health were less likely to take averting actions on moderate to high ozone days, relative to respondents of reporting fair or poor health status. Ozone poses less of the threat to those in good health, reducing the benefits to healthy people of staying indoors. Combining information from this response and

Table 4-5. Likelihood of Modifying Outdoor Activity (Question 16)

Variable Name	Coefficient (Standard Error)
age	0.005 (0.003)
male	–0.47** (0.09)
black	0.18 (0.20)
white	–0.38** (0.15)
other	0.29 (0.26)
college	0.05 (0.10)
bach_grad	–0.07 (0.11)
fulltime	–0.40 (0.32)
parttime	–0.37 (0.34)
workother	–0.03 (0.31)
mid_income	–0.04 (0.10)
high_income	–0.28** (0.13)
healthbest	–0.18* (0.10)
purple2000	0.59** (0.09)
_cons	0.85 (0.39)
Log pseduo-likelihood	–597.2
Pseudo R^2	0.10

* significant at p-value = 0.10
** significant at p-value = 0.05

N = 965 respondents.

the result of Question 14 suggests that those in poor health may adjust their behavior on the basis of conditions that typically co-occur with high ozone, such extreme temperatures or smog, rather than as a result of alert system warnings specifically.

The occurrence of high ozone days had a strong positive association with averting behavior, while moderate alert days were not found to have a statistically significant effect on averting behavior, suggesting it is when environment-related health risks are at their highest that individuals will take averting actions, such as remaining indoors or reducing the time spent outdoors. Historic incidence of moderate and high alert days also did not have a statistically significant effect on respondents' behaviors.

The fourth model also estimates behavioral changes, specifically whether the respondent drove less or not at all during moderate or high ozone days (survey Question 17). Thus, we are interested in determining not only whether people take actions to protect themselves, but also whether they take measures to reduce the level of environmental threats for others. Factors that affect the likelihood of taking averting behavior include gender, current health status, race, and environmental conditions (see Table 4-6). Consistent with results of the previous model, males were less likely to take averting action on ozone days, relative to females. Although the coefficient on age remained consistent with earlier results, it was not a statistically significant determinant in this model. Whites were less likely than Asians to stay indoors more on high ozone days; black and other race respondents were not found to be statistically significant. High levels of education and work status also were not statistically significant determinants of averting behavior. Similar to the previous result, respondents from high income households were less likely to change their behavior, relative to low income households. As discussed previously, wealthier households may decide to substitute for time spent at home on unhealthy air days by traveling to shops or museums, or they may be more restricted in alternative modes of transportation to work or other activities.

Respondents who reported to be in excellent or very good health were less likely to drive less or not at all on moderate to high ozone days, relative to respondents in good, fair or poor health. Since healthier people may be less likely to feel the adverse effects of poor environmental conditions, they may have less reason to adjust their behavior in response to these conditions or be less likely to adjust their behavior to protect the health of others. Respondents with poor health may drive less on high ozone days since they are staying indoors more.

Table 4-6. Likelihood of Modifying Driving Behavior (Question 17)

Variable Name	Coefficient (Standard Error)
age	0.002 (0.003)
male	–0.47** (0.11)
black	0.06 (0.22)
white	–0.49** (0.19)
other	0.51 (0.36)
college	0.05 (0.11)
bach_grad	–0.03 (0.121)
fulltime	–0.24 (0.35)
parttime	–0.06 (0.36)
workother	0.27 (0.35)
mid_income	0.03 (0.10)
high_income	–0.38** (0.15)
healthbest	–0.25** (0.11)
purple2000	0.60** (0.17)
_cons	0.87 (0.38)
Log pseudo-likelihood	–474.6
Pseudo-R^2	0.12

* significant at p-value = 0.10
** significant at p-value = 0.05

N = 783 respondents.

Recent environmental conditions also had effects on averting actions taken by respondents. The occurrence of high ozone day was positively related to driving less or not at all, while the occurrence of moderate ozone days was not found to have a statistically significant effect on averting behavior. This result suggests that it is when environment-related health risks are highest that individuals may take averting actions, such as driving less or not at all, to protect personal health and reduce the health threats to others. Historic incidence high ozone days did not have a statistically significant effect on respondents' behaviors.

Consistent across most models, age and gender are statistically significant predictors of awareness and the likelihood of taking averting behavior. Race and work status do not appear to be major predictors of averting behavior. Higher incomes are positively associated with awareness, but appear to have a negative effect on averting behavior. Health status is significant across the models, positively relating to awareness, but negatively relating to behavioral change on moderate or high ozone days. While recent and historic occurrence of poor environmental quality are key predictors of awareness, it is only the occurrence of high ozone days during the summer of 2000 that is a statistically significant predictor of averting behavior.

These results suggest improving awareness of the alert system and its implications for health effects, should be directed towards the less educated and lower income households who current report relatively lower levels of general awareness. In addition, education of higher income households about the benefits to themselves, and their communities, of taking averting behaviors such as driving less on days with poor air quality may be considered.

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