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Short Communication

# Communication channels for air quality alerts in the United States

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ABSTRACT

Short-term exposure to air pollution can result in acute health effects, particularly for individuals with respiratory and cardiovascular disease. Air quality alert programs that notify the public about high air pollution days are critical for susceptible populations. We assessed how U.S. adults receive air quality alerts and whether it varies by demographic or health characteristics. We analyzed data from the summer 2014 wave of ConsumerStyles, a nationally representative survey of U.S. adults ($n$ = 4269). We calculated the weighted proportion of individuals who received air quality alerts from seven communication channels, combining all individuals and stratifying by demographics. To assess whether the reach of communication channels varied by respiratory and cardiovascular disease status, we computed weighted prevalence ratios adjusted for sex, age, race, and education. Forty-eight percent of U.S. adults had heard about air quality alerts. Within every demographic category, television was the most common communication channel (76% among individuals aware of air quality alerts). Other common communication modes were radio (30%), newspaper (24%), and internet (20%). Less common communication modes were friend or family member, mobile phone or device app, and electronic highway sign. The reach of communication channels varied by demographic factors, such as age, but not by respiratory or cardiovascular disease status. Television is the most common communication channel for receiving air quality alerts. Expanding use of other communication channels might increase awareness of air quality alerts. These results can help decision-makers target communication channels that reach susceptible populations and will achieve the greatest impact.

## 1. Introduction

Short-term exposure to air pollution can result in acute health effects such as cardiovascular and respiratory morbidity (World Health Organization, 2018). These effects can be immediate and are particularly dangerous for susceptible individuals such as those with respiratory and cardiovascular disease. It is recommended that individuals sensitive to air pollution minimize exposure on days with poor air quality. In the United States, air quality alert programs use information from the U.S. Environmental Protection Agency's (EPA) Air Quality Index (U.S. Environmental Protection Agency, 2018) to notify the public about days with high air pollution. Individuals can use this information to protect their health.

Despite the critical information air quality alerts provide, a recent analysis by Mirabelli and colleagues found that only 49% of U.S. adults were aware of air quality alerts (Mirabelli et al., 2018). It is currently unknown which communication channels are most effective in relaying alerts to the population. If information were available about which communication channels are optimal for disseminating air quality alerts, particularly to susceptible groups, it could be used to increase the reach of these important public health messages. To fill this gap, we analyzed nationally representative data to assess how U.S. adults receive air quality alerts and whether it varies by demographic or health characteristics.

## 2. Methods

We analyzed data from the summer 2014 wave of the cross-sectional ConsumerStyles survey conducted by Porter Novelli Public Services. The survey was conducted among a random sample of 4269 adults who

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**Table 1**
Percentage of U.S. adults in 2014 who received air quality alerts from radio, television, newspaper and internet, stratified by demographic and health characteristics.

| | Number of respondents[a] | Communication channel | | | |
|---|---|---|---|---|---|
| | | Weighted percentage (95% CI) | | | |
| | | Radio | Television | Newspaper | Internet |
| Individual Characteristics | | | | | |
| Sex | | | | | |
| Male | 1202 | 32.0 (28.9, 35.1) | 76.3 (73.4, 79.2) | 24.4 (21.6, 27.2) | 20.7 (17.9, 23.5) |
| Female | 1105 | 27.8 (24.7, 30.8) | 75.7 (72.6, 78.7) | 23.3 (20.4, 26.1) | 18.5 (15.8, 21.2) |
| Education | | | | | |
| High school or less | 678 | 24.1 (20.4, 27.9) | 83.7 (80.2, 87.1) | 19.0 (15.6, 22.4) | 10.5 (7.7, 13.2) |
| Some college | 708 | 32.5 (28.5, 36.5) | 74.9 (71.0, 78.7) | 23.7 (20.1, 27.2) | 20.7 (17.1, 24.3) |
| Bachelor's degree or higher | 921 | 33.3 (29.8, 36.9) | 69.6 (66.0, 73.2) | 28.6 (25.2, 32.0) | 27.4 (23.8, 30.9) |
| Race/ethnicity | | | | | |
| White, non-Hispanic | 1840 | 30.6 (28.2, 33.0) | 75.1 (72.7, 77.4) | 24.7 (22.5, 26.8) | 19.2 (17.1, 21.3) |
| Black, non-Hispanic | 168 | 27.6 (20.2, 35.1) | 90.9 (86.4, 95.4) | 21.0 (14.5, 27.4) | 15.1 (9.5, 20.7) |
| Other, non-Hispanic | 121 | 36.7 (25.1, 48.3) | 71.3 (60.5, 82.0) | 27.9 (16.9, 39.0) | 32.8 (21.2, 44.3) |
| Hispanic | 178 | 23.8 (17.0, 30.6) | 73.6 (66.2, 81.0) | 18.5 (11.9, 25.1) | 17.6 (11.5, 23.8) |
| Age, in years | | | | | |
| 18–29 | 148 | 25.7 (18.0, 33.3) | 60.1 (51.6, 68.5) | 13.3 (7.3, 19.3) | 26.8 (19.2, 34.4) |
| 30–44 | 440 | 25.0 (20.3, 29.7) | 65.5 (60.2, 70.7) | 13.5 (9.6, 17.4) | 28.7 (23.7, 33.7) |
| 45–59 | 844 | 34.0 (30.3, 37.7) | 80.5 (77.6, 83.4) | 21.5 (18.3, 24.7) | 16.3 (13.6, 19.0) |
| 60–74 | 708 | 31.4 (27.6, 35.2) | 84.9 (82.1, 87.7) | 34.3 (30.4, 38.2) | 14.9 (12.2, 17.6) |
| 75–92 | 167 | 31.4 (23.8, 38.9) | 87.9 (82.6, 93.2) | 49.5 (41.4, 57.6) | 7.7 (3.7, 11.6) |
| Smoking status | | | | | |
| Current smoker | 296 | 26.0 (19.7, 32.3) | 80.9 (75.9, 85.9) | 15.6 (10.6, 20.7) | 11.9 (7.7, 16.0) |
| Former smoker | 762 | 29.7 (25.9, 33.4) | 81.6 (78.3, 84.8) | 28.7 (25.1, 32.3) | 17.5 (14.5, 20.6) |
| Lifetime non-smoker[b] | 1249 | 31.1 (28.1, 34.0) | 71.7 (68.6, 74.8) | 23.2 (20.5, 25.9) | 22.6 (19.8, 25.5) |
| Health characteristics | | | | | |
| Respiratory disease (asthma, COPD[c]) | | | | | |
| Yes | 243 | 31.4 (24.6, 38.2) | 79.9 (74.2, 85.7) | 25.1 (18.7, 31.4) | 15.2 (9.8, 20.5) |
| No | 2064 | 29.8 (27.5, 32.1) | 75.5 (73.3, 77.8) | 23.7 (21.6, 25.8) | 20.1 (18.0, 22.2) |
| Heart disease | | | | | |
| Yes | 110 | 25.8 (17.2, 34.4) | 87.0 (79.8, 94.2) | 31.9 (22.1, 41.7) | 13.1 (6.5, 19.7) |
| No | 2197 | 30.1 (27.9, 32.4) | 75.5 (73.3, 77.7) | 23.5 (21.5, 25.6) | 19.9 (17.9, 21.9) |
| Household characteristics | | | | | |
| Household income | | | | | |
| < $25,000 | 279 | 22.8 (17.3, 28.2) | 82.2 (76.7, 87.7) | 25.8 (19.8, 31.8) | 12.7 (8.6, 16.9) |
| $25,000 to < $50,000 | 527 | 26.3 (21.9, 30.6) | 77.7 (73.3, 82.0) | 20.8 (16.8, 24.8) | 15.2 (11.5, 18.8) |
| $50,000 to < $75,000 | 455 | 30.6 (25.4, 35.7) | 76.3 (71.8, 80.9) | 20.9 (16.8, 25.1) | 18.0 (13.9, 22.0) |
| $75,000+ | 1046 | 33.2 (29.9, 36.5) | 73.4 (70.1, 76.6) | 25.8 (22.8, 28.8) | 24.1 (21.0, 27.3) |
| Census region | | | | | |
| Northeast | 374 | 32.8 (27.3, 38.3) | 81.1 (76.4, 85.8) | 22.0 (17.1, 26.9) | 16.8 (12.4, 21.2) |
| Midwest | 549 | 28.5 (24.1, 32.9) | 74.5 (70.1, 78.8) | 22.2 (18.3, 26.2) | 16.6 (13.1, 20.2) |
| South | 779 | 25.3 (21.8, 28.8) | 77.1 (73.5, 80.6) | 21.1 (18.0, 24.2) | 18.7 (15.5, 21.9) |
| West | 605 | 34.8 (30.3, 39.3) | 72.7 (68.3, 77.0) | 29.4 (25.1, 33.7) | 24.5 (20.3, 28.8) |

Percentages are weighted to the 2014 U.S. Current Population Survey.
[a] Unweighted sample size.
[b] Includes individuals with unknown smoking status.
[c] COPD = Chronic obstructive pulmonary disease.

responded to the spring wave of ConsumerStyles. ConsumerStyles surveys are conducted among a random sample from KnowledgePanel®, an internet panel of approximately 55,000 adults. Probability-based sampling is used to be representative of the U.S. adult population and reaches individuals regardless of internet or landline phone access. Data were weighted based on sex, age, household income, race/ethnicity, household size, education, metro status, census region, and internet access prior to joining the panel to match proportions from the 2014 U.S. Current Population Survey. Additional details about the survey sampling and implementation are available elsewhere (Denny et al., 2016; Holman et al., 2015; Moore et al., 2016).

Respondents were asked "Have you ever heard or read about the Air Quality Index or air quality alerts where you live?" If respondents answered yes, they were then asked "Where did you hear or read about air quality alerts?" Possible answers were radio, television, newspaper, internet, mobile phone or device app, electronic highway sign, friend or family member, and other. Respondents could select all answers that applied to them. Information on individual- and household-level demographic variables and respiratory and cardiovascular disease currently and in the past year were available for survey respondents.

We examined the percent of respondents, and corresponding population estimate of U.S. adults, who received air quality alerts from each communication channel and whether this differed by demographic or health characteristics. We also calculated prevalence ratios using predicted marginal probabilities from logistic regression models (Bieler et al., 2010) to examine whether communication channel reach varied by respiratory or cardiovascular disease status when adjusting for sex, age, race, and education. Analyses were conducted in SAS 9.4 (SAS Institute, Inc., Cary, North Carolina) and SAS-callable SUDAAN (RTI International, Research Triangle Park, North Carolina) and accounted for sample weighting.

## 3. Results

Of the 4269 U.S. adults who responded to the summer 2014 wave of the ConsumerStyles survey, 2307 reported they had heard or read about the Air Quality Index or air quality alerts and provided information about how they received air quality alerts. Our analyses were restricted

to this sample, which corresponds to 48% of the U.S. population. Among these respondents, 66% attended some college or had a bachelor's degree or higher, 73% were of white race and non-Hispanic ethnicity, and age ranged from 18 to 92 years (Table 1). At the time of the interview or in the past year, 10% reported respiratory disease (i.e. asthma or chronic obstructive pulmonary disease [COPD]) and 4% reported heart disease (i.e. atrial fibrillation, congestive heart failure, angina, heart attack).

Television was the most common communication channel for receiving air quality alerts. It reached 76.0% of individuals who had received air quality alerts (95% confidence interval [CI] 73.9%, 87.1%). Other common communication channels were radio (29.9% [95% CI 27.8%, 32.1%]), newspaper (23.9% [21.9%, 25.9%]), and internet (19.6% [17.7%, 21.6%]). Mobile phone or device app, electronic highway sign, and friend or family member each reached less than 6%. Among individuals who received air quality alerts, 45% received them from more than one communication channel. When examining differences by demographic and health characteristics, television was the most widely used communication channel in all groups (Table 1). The most prominent demographic trends in communication channel reach were by age. For example, receiving air quality alerts from newspaper was most common among individuals over the age of 59 years while receiving them from the internet was most common under the age of 45 years (Table 1).

When examining differences by disease status, percent of individuals receiving alerts from radio, television, newspaper, and internet did not vary markedly by respiratory or heart disease status (Table 1). Prevalence ratios indicated no association between respiratory or heart disease status and communication channel used for air quality alerts when adjusting for sex, age, race, and education. Associations (PR [95% CI]) between respiratory disease and receiving alerts were: radio 1.07 (0.85, 1.35), television 1.02 (0.93, 1.11), newspaper 0.97 (0.75, 1.25), internet 0.86 (0.61, 1.22); associations with heart disease were: radio 0.76 (0.52, 1.10), television 1.04 (0.92, 1.18), newspaper 0.86 (0.60, 1.22), internet 0.93 (0.56, 1.53).

## 4. Discussion

Television reached the largest percentage of U.S. adults aware of air quality alerts. This finding was consistent across all demographic groups examined; the reach of other communication channels such as newspaper and internet varied by factors such as age. We identified no consistent differences in communication channels used for air quality alerts between people with and without respiratory and heart disease. Demographic factors, rather than disease status, might be better suited to target air quality alerts to specific groups. For example, television and newspaper are the most high-impact routes for relaying alerts to individuals over the age of 59 years. Knowledge about communication channels used by younger ages is important as this group ages into a more susceptible population.

This analysis used population weighted data representative of U.S. adults. Data were self-reported and relied on respondents' recall of how they received air quality alerts. In order for air quality alerts to protect population health, individuals must act on the information they receive, for example by postponing outdoor activities until air quality improves. Our analysis did not assess behavior modification following alerts. Previous publications have found that changing behavior due to air quality alerts or poor air quality depends on clinical, demographic, and psychosocial factors (D'Antoni et al., 2017; Wells et al., 2012; Wen et al., 2009). Both the reach of air quality alerts and the use of alerts to change behavior determine the impact of air quality alert programs. We did not compare characteristics of individuals aware and not aware of air quality alerts because this comparison was previously published using ConsumerStyles data (Mirabelli et al., 2018). Individuals with respiratory and cardiovascular disease are not the only groups particularly susceptible to the health effects of air pollution. We were unable to examine differences in use of communication channels to receive air quality alerts in other high risk groups, such as pregnant women and individuals who work outside, due to lack of communication channel data on these groups.

The results from this analysis can be used to help decision-makers target communication channels that reach susceptible populations and will achieve the greatest impact. Communication channels identified as reaching a smaller percentage of the population, such as mobile phone or device apps, represent an opportunity to increase the reach of air quality alerts. Reception of air quality alerts via mobile phone or device app was extremely low, despite the availability of such alerts via U.S. EPA's “AIRNow” application among others. Knowledge about communication channels for air quality alerts can help increase the reach, and subsequent impact, of air quality alert programs.

## Conflicts of interest

None.

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