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Linkage of the National Health Interview Survey to Air Quality Data



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics

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Centers for Disease Control and Prevention
National Center for Health Statistics

Hyattsville, Maryland
February 2008
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Contents

Abstract	1
Introduction	1
Background	1
Linkage of NHIS to Air Quality Data	2
Data Files Used for Linkage.....	2
Linkage Methods.....	4
Description of Linked Data Files	5
Methods	6
Results	6
Discussion	7
References	8

Text Tables

A. Median and interquartile range of the number of pollution monitors used in exposure estimation, by geographic linkage method and pollutant: National Health Interview Survey, 2005	7
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Detailed Tables

1. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM ₁₀ , by geographic linkage method and survey year: United States, 1987–2005.....	9
2. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for SO ₂ , by geographic linkage method and survey year: United States, 1987–2005.....	9
3. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for NO ₂ , by geographic linkage method and survey year: United States, 1987–2005.....	10
4. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for CO, by geographic linkage method and survey year: United States, 1987–2005.....	10
5. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM _{2.5} , by geographic linkage method and survey year: United States, 1999–2005.....	11
6. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for O ₃ , by geographic linkage method and survey year: United States, 1987–2005.....	11
7. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM ₁₀ , by geographic linkage method and respondent characteristic: United States, 2005	12
8. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for SO ₂ , by geographic linkage method and respondent characteristic: United States, 2005	13
9. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for NO ₂ , by geographic linkage method and respondent characteristic: United States, 2005	14
10. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for CO, by geographic linkage method and respondent characteristic: United States, 2005	15
11. Percentage and standard errors (SE) of NHIS respondents linked to annual EPA monitoring data for PM _{2.5} , by geographic linkage method and respondent characteristic: United States, 2005	16
12. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for O ₃ , by geographic linkage method and respondent characteristic: United States, 2005	17

13.	Median and interquartile range of PM ₁₀ exposure (µg/m ³) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005.	18
14.	Median and interquartile range of SO ₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005.	18
15.	Median and interquartile range of NO ₂ exposure(ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005.	19
16.	Median and interquartile range of CO exposure (ppm) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005.	19
17.	Median and interquartile range of PM _{2.5} exposure (µg/m ³) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1999–2005.	20
18.	Median and interquartile range of PM ₁₀ exposure (µg/m ³) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005	20
19.	Median and interquartile range of SO ₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005	21
20.	Median and interquartile range of NO ₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005	22
21.	Median and interquartile range of CO exposure (ppm) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005	23
22.	Median and interquartile range of PM _{2.5} exposure (µg/m ³) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005	24

Objective

This report describes the linkage between the National Health Interview Survey (NHIS) and air monitoring data from the U.S. Environmental Protection Agency (EPA). There have been few linkages of these data sources, partly because of restrictions on releasing geographic detail from NHIS on public-use files in order to protect participant confidentiality.

Methods

Pollution exposures for NHIS respondents were calculated by averaging the annual average exposure estimates from EPA air monitors both within 5, 10, 15, and 20 miles of the respondent's block-group location (which is available on restricted NHIS data files) and by county of residence. The 1987–2005 linked data files—referred to as NHIS-EPAAnnualAir—were used to describe the percentage of NHIS respondents linked and the median exposures by linkage method, survey year, and pollutant. Using the 2005 NHIS-EPAAnnualAir data file, the percentage linked and median exposure were described by respondent characteristics, linkage method, and pollutant.

Results

Many decisions were made to define pollution exposures for NHIS respondents, including monitor selection, location assignment for NHIS respondents, and geographic linkage criteria. Geographic linkage criteria for assigning area-level exposure estimates affected the percentage and composition of respondents included in the resulting linked sample. Median exposure estimates, however, were similar among geographic linkage methods.

Conclusion

NHIS-EPAAnnualAir data files for 1985 through 2005 are currently available to users in the NCHS Research Data Center.

Keywords: *National Health Interview Survey • air pollution • data linkage • GIS (geographic information system)*

Linkage of the National Health Interview Survey to Air Quality Data

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Introduction

The objective of this report is to describe the linkage of the National Health Interview Survey (NHIS) with air monitoring data obtained from the U.S. Environmental Protection Agency (EPA). This report is divided into several sections. The first two sections introduce and give background information concerning the linkage. The third section describes the methodological issues that arose during the linkage of the two national data systems, including characteristics of the input datasets, selection of monitors from the EPA data for inclusion, and the assignment of pollution exposures for each respondent. The fourth section describes the resulting linked data files, and the fifth section summarizes the report and presents conclusions. Because NHIS respondents do not necessarily live near air pollution monitors and air pollution monitors are not all located near NHIS respondents, the resulting linkage necessarily excludes some survey respondents and some air monitors. Consequently, both the characteristics of the sample and the

overall exposure estimates are affected by linkage decisions.

As the need to study the effects of environmental pollutants on human health increases, opportunities to combine existing data sources should be explored. Understanding the linkage issues will enhance the strengths and mitigate the limitations of analyses using the NHIS-EPAAnnualAir data files, and it may also improve future linked data files.

Background

To date, only a few research papers have used EPA air pollution monitoring data linked to NHIS to examine health outcomes; Ostro combined NHIS data from the late 1970s with corresponding estimates of air pollution to examine respiratory morbidity and work-loss days (1–5). Linkages between EPA data and the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) National Health and Nutrition Examination Surveys (NHANES) have also been used for analytic studies of cardiovascular (6)

Nataliya Kravets' work on this project was funded by the Office of the Assistant Secretary for Planning and Evaluation, ASPE, SP 05–039, Data Linkage for Environmental Health Policy. This report was edited by Demarius V. Miller and Megan M. Cox, CDC/CCHIS/NCHM/Division of Creative Services, Writer-Editor Services Branch, and typeset by Jacqueline M. Davis, CDC/CCHIS/NCHM/Division of Creative Services.

and pulmonary (7–8) outcomes. NCHS vital statistics data have been linked to county level air quality data to examine daily mortality (9–14) and perinatal outcomes (15–18).

In 1977, NCHS published “Statistics Needed for Determining the Effects of the Environment on Health,” which included many recommendations on how to use data efficiently to relate environmental factors to health effects (19). These recommendations included the extension and broadening of NCHS surveys to include measures of environmental exposures and the facilitation of epidemiological studies using available data. A subobjective was to facilitate and support the pooling and interpretation of data across institutions concerned with environmental health. Over the last 30 years, many biomonitoring measurements have been collected by NHANES programs and used for research and policy, and some studies linking ambient exposures to health have been conducted.

Linkages between NCHS surveys and EPA monitoring data, however, have been hindered by several factors, including limited geographic detail available on public-use files, noncompatible geographic units for linkage, and the lack of correspondence between respondent locations and monitor locations. Health data systems at NCHS are designed to provide national estimates for health outcomes, conditions, and risk factors. Disclosure of detailed information on individual records may lead to violations of data confidentiality; furthermore, the sample sizes for subnational geographic units are often too small to provide statistically reliable estimates. As a result, geographic information in the large national data systems is limited on public-use files and restricted on in-house files. Currently the public-use NHIS data files provide only one geographic identifier, REGION, which is coded into four categories: Northeast, Midwest, South, and West. Earlier years of NHIS released information on large Metropolitan Statistical Areas or large states (20).

Even with the more detailed geography on in-house NHIS data files, combining these files and EPA data systems is complicated by incompatible geographic units. Individual monitor measurements originate at a particular site and have been geocoded to latitude and longitude (21). NHIS, on the other hand, is limited by the availability and quality of geocodes. Although geocodes can be assigned at various geographic levels, more NHIS respondents can be coded to their U.S. Census Bureau block group of residence than to smaller units. Statistical approaches for analyzing misaligned data—that is, data with information for different levels of geography—have been described (22). One straightforward method is to aggregate estimates using geographic information common to both data sets. For example, county of residence for NHIS respondents and the average exposure for a county are easily combined.

Even with availability of location information and aligned estimates, survey data and monitoring data may not be collected at the same locations; that is, not all survey respondents reside near air pollution monitors, and not all pollution monitors are near survey respondents. This lack of overlap is not surprising because the data sources are collected for different purposes. Air monitors are used for regulatory purposes (23), whereas NHIS is designed to be a nationally representative sample of the U.S. civilian noninstitutionalized population (20). This lack of overlap means that health estimates from the resulting file no longer meet the NHIS feature of “nationally representative,” and exposure estimates are based on less coverage than those using the original collection of monitors.

Linkage of NHIS to Air Quality Data

Data Files Used for Linkage

The National Health Interview Survey

NHIS is a nationally representative sample of the civilian, noninstitutionalized population conducted continuously by NCHS (20). Data are collected through in-person interviews. The structure of the survey instrument has changed from 1987 to 2005. Since the major redesign of NHIS in 1997, questions from the Family Core Questionnaire are asked about each person in the family and compiled into the NHIS person file. In addition, a sample adult and a sample child from each family with children are randomly selected, and additional questions for this adult and child are asked. Information for the randomly selected adult and child from each family are contained in the separate sample adult and sample child files. Although respondent characteristics described in this report are from the person file, additional information from public-use files, including the sample adult and sample child files, can be combined with the linked data files for analytic studies.

Many households in NHIS are missing sufficient information for accurate coding at all levels of geography. Annually created in-house NHIS files, available under restricted conditions to NCHS staff and to other users of the Research Data Center (RDC) (24), include state and county codes. These codes have allowed researchers to link NHIS to contextual information from other sources, such as the Area Resource File (25). Special NHIS files geocoded to U.S. Census Bureau blocks and block groups have been created and are available only through the RDC for all users, including NCHS staff. Files with geocoded household location, used in the

assignment of block and block-group identifiers when available, are not currently retained by NCHS.

U.S. Census Bureau block groups, the primary geographic units used to link data files, are geographic subdivisions of census tracts; their primary purpose is to provide a geographic summary unit for census block data. A block group comprises a reasonably compact and contiguous cluster of census blocks. Each census tract contains a minimum of one block group and may have a maximum of nine block groups. Although the number of people in census block groups averages about 1,500, the minimum is about 600 people and the maximum is about 3,000 people (26). Because the geographic information available for block groups was different between the years prior to 1995 and the years starting with 1995, geographic internal points (unweighted coordinates at the center of the block group) of block groups were used for the 1987–1994 NHIS, and coordinates of the population-weighted centroids were used for the 1995–2005 NHIS; these locations are very close for most NHIS locations (see *Block-group centroid* under **Linkage Methods**).

EPA Annual Air Pollution Monitoring Data

The EPA has set national air quality standards for principal air pollutants, often referred to as criteria pollutants. These pollutants are ozone (O₃), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), particulate matter less than 10 microns in diameter (PM₁₀) and particulate matter less than 2.5 microns in diameter (PM_{2.5}), carbon monoxide (CO), and lead (Pb) (23). Each of these pollutants is monitored to summarize the current status of the air quality. The collection times, monitor locations, and the reported measures vary among pollutants because they are collected for regulatory rather than research purposes and because the properties of the pollutants differ.

The Air Quality System (AQS) database provides annual averages of air monitoring data, which are ambient concentrations of criteria and hazardous air pollutants at monitoring sites,

primarily in cities and towns (20). The AQS database is updated by the EPA daily, primarily by the staff of state and local environmental agencies that measure ambient concentrations of criteria air pollutants at several thousand monitoring sites throughout the United States. Each month, the EPA extracts a summary of the measurements recorded at each air monitoring station (the highest value in a year, the average, etc.) and updates AirData.

For the purposes of this project, monitor-specific annual averages were extracted from the AQS using the Annual Summary Web pages (21). Although the individual observations for each monitor are available, the annual arithmetic averages calculated by the EPA were used. For this initial linkage, using these averages was considered preferable to calculating these or other metrics directly from the raw data for several reasons: they were calculated using EPA methodology, are readily obtained, and are more easily replicated. However, even using the annual averages, several variables were downloaded from the system for each monitor (defined more fully in the EPA documentation [21]) to identify monitors for inclusion, including those listed below.

1. MONITORID—unique monitor identifier that comprises the following:
 - a. STATE—location of monitor.
 - b. COUNTY—location of monitor.
 - c. PARAMETERCD—identifier for the pollutant exposure collected at the monitor.
 - d. SITE ID—site identification is used to obtain information on the location of the pollution monitor.
 - e. POC—parameter occurrence code, which is used to distinguish monitors collecting information at the same site for the same pollutant.
2. PCNT_OBS—the percentage of data values collected relative to

that expected for a particular pollutant and monitor.

3. OBS_CNT—the number of observations.
4. EXCEPTIONAL DATA FLAG—indicates whether something has occurred locally that could have affected the annual average.
5. ARITH_MEAN—the annual average.
6. YR_WTD_ARITH_MEAN—the annual average based on combining four quarterly averages. This is available for PM₁₀ and PM_{2.5}.
7. INTERVAL_CODE—used to determine how frequently pollution measurements were obtained and how they were reported.

Using SITE ID, additional information about the monitoring sites (including location parameters) was extracted from the site information pages (21), including: LATITUDE, LONGITUDE, and DATUM CODE (indicating the geographic coordinate system used to code latitude and longitude).

For the purpose of this project, the following steps were performed:

1. The small number of monitors outside the 50 states and the District of Columbia were excluded.
2. The monitors were limited to those that collected data for Pb, total suspended particulates (TSP, a proxy sometimes used for PM₁₀), O₃, CO, SO₂, NO₂, PM₁₀, and PM_{2.5}.
3. Experimental monitors were excluded (POC > 4, a criterion for experimental monitors).
4. Multiple annual averages from some monitors were included in the AQS file because the monitors report different annual averages using different sets of the raw measurements for regulatory purposes. In the case of multiple monitor entries, the annual average that included all recorded measures (EXCEPTIONAL DATA FLAG

= 0, no events recorded, or 2, including all exceptional events) was retained. When exceptional events take place at a monitor's location, such as a forest fire, multiple ways of measuring pollution for regulatory purposes exist: including exceptional events, excluding them, including some types of events and excluding others, etc. Thus, this step also eliminated multiple records for the same monitor.

5. The annual averages were limited to those that were based on data collected under specified reporting intervals (as indicated by INTERVAL_CODE). Gaseous pollutants were typically reported hourly each day, whereas particulates were often reported as daily averages every 3 or 6 days. Specifications for selected pollutants were as follows:
 - a. For SO₂, 1-hour intervals were used. A very small number of monitors collected measurements at 5-minute intervals, and they were removed.
 - b. For NO₂, 1-hour intervals were used.
 - c. For CO, 1-hour intervals were used.
 - d. For O₃, daily maximums from 1-hour intervals and 8-hour running average intervals were used as separate variables.
 - e. For PM₁₀, 1-hour, 24-hour, and/or 24-hour block average (a daily average of 1-hour measurements) intervals were used interchangeably.
 - f. For PM_{2.5}, 1-hour, 24-hour, and/or 24-hour block average intervals were used interchangeably.
6. Monitors with missing annual arithmetic averages were excluded.
7. On the basis of PCNT_OBS and OBS_CNT, monitors with fewer than 75 percent of the expected number of observations were

excluded; after examining missing data patterns, monitors were excluded if either PCNT_OBS or OBS_CNT was missing.

8. Both PM₁₀ and PM_{2.5} may be measured under standard conditions (i.e., 25 °C, 1 atmosphere), prevailing local conditions, or both. This difference originates for political purposes and poses a comparability problem. For PM_{2.5}, only local data were used, which are much more prevalent than standard data. For PM₁₀, standard data was used in preference to local data if both were available at the same site, and when sites provided only local data, a county-specific correction (typically 5 percent or less) was used so that the value approximated standard conditions (personal communication with Abt Associates; available upon request).
9. After the preceding steps, if there were more than one monitor for a particular pollutant at a site, the annual average was retained for one monitor—most often the monitor with the highest percentage of observations collected (PCNT_OBS).

The annual exposure estimates for O₃ need to be further qualified. In cooler months, O₃ levels drop considerably. As a result, not all states require O₃ monitoring for the entire year, which leads to annual averages that are based on differing time periods; typically the monitoring season is May through September, but it varies (27). Although this system is adequate for regulatory purposes, its use could bias epidemiological associations and surveillance without additional purpose-specific qualifications.

Linkage Methods

Pollution exposure values were assigned to individual NHIS records by combining all annual averages for each pollutant from monitors within a specified distance and within the same

county of the respondent. Distances between NHIS participants and the air quality monitors were calculated using the latitude and longitude assigned to the block group of residence of NHIS participants and the latitude and longitude of the EPA monitors. Using these distances to identify nearby monitors, annual pollution estimates within 5, 10, 15, and 20 miles of the NHIS respondents' block group were calculated. Annual pollution estimates for each county were also calculated and assigned to NHIS participants by county of residence. As a result, pollution levels for a particular pollutant are assigned to NHIS participants in multiple ways in the NHIS-EPAAnnualAir data files.

Distance Calculations

Distance Formula—The Great Circle Distance Formula (28) was used in this research to calculate distances. Given that the calculation of the distance affects the identification of monitors near the block-group centroid, the choice of formula might influence distance-based exposure calculations. Although distance formulas are known to be approximations, for the relatively short distances needed for exposure assignment, the Great Circle Distance Formula likely provides reasonable measures for use in this research.

Geodetic datum—Another issue addressed when calculating distances was the unknown datum of the geographic coordinate system, that is, the system used to assign location. Latitude and longitude can be assigned to locations using a variety of systems that use different reference points and assume different conditions for Earth's surface and size (28). Importantly, the same latitude and longitude values can identify different points on Earth's surface if they are assigned using different geographic coordinate systems. However, if the geographic coordinate system is known for a particular location, coordinates can be transformed from one system to another. In the EPA monitor dataset, about 80 percent of the records were missing DATUM_CODE, which is used to identify the system used to assign latitude and longitude.

The remaining monitors had codes that indicated that the latitude and longitude coordinates had been recorded using one of three primary geodetic systems: North American Datum 1983, North American Datum 1927, or World Geodetic System of 1984. Although knowing how the coordinates were assigned to a location is essential for having accurate maps, what was not known during this research was whether there would be an effect of using coordinates derived from different geographic coordinate systems on distance calculations for the short distances (20 miles or less) needed for this exposure assessment. To examine this issue of geodetic datum, a sensitivity analysis was performed by reassigning the coordinate system of the block groups and recalculating distances. The results indicated that any potential miscalculation was likely to be negligible for the distance calculations needed for this project (details available upon request.)

Block-group centroid—This project next examined how distances that are based on block-group centroids approximate distances that are based on residence. Using a subset of the 2004–2005 intermediate NHIS data file with known location information by residence (these files were in the process of being geocoded at the time of this analysis, but the residential information has subsequently been destroyed), the (unweighted) distribution of the distances between NHIS family locations and the block-group centroid were examined. This process was repeated to examine both the geographic internal point (the approximate location of the physical center of the block group) and the population-weighted centroid (the approximate location of the center weighted by population—in other words, the center where people live). About 95 percent of NHIS families were within 2 miles of the assigned block-group centroid, whether the centroid was defined by the population-weighted centroid or the geographic internal point. The distribution of distances for the population-weighted centroid was shifted to the left, indicating shorter distances. Exceptionally large differences between

the population-weighted centroid and the geographic internal point were identified in Alaska and Hawaii, suggesting that block-group assignment is a better indicator of residential location for respondents in the 48 contiguous states.

For these data files, the population-weighted centroid of the block group and the geographic internal point were available for the 1995–2005 NHIS. Because the U.S. Census Bureau definitions were different for earlier years, only the geographic internal point was available prior to 1995. Exposure assignments using either centroid are likely to be similar. Nevertheless, the population-weighted centroid of the block group was used as the location for the 1995–2005 NHIS and the geographic internal point for earlier years.

Exposure Assignment

Using the distances between the latitude and longitude of the block group of residence of the NHIS participant and the latitude and longitude of the air quality monitor, pollution exposures for each participant were estimated by averaging all annual averages from monitors located within 5, 10, 15, and 20 miles from the block-group centroid. Unweighted and distance-weighted averages were calculated (distance-weighted averages were calculated using the inverse of the squared distance between the centroid and the monitor as a weight).

In addition to the distance-based pollution exposures, county-specific annual exposure averages were calculated by averaging the annual averages for each monitor in each county and were assigned to individual NHIS records by county of residence. Although the monitor information on the EPA website (21) is coded to the most recent set of county Federal Information Processing Standards (more commonly known as FIPS) codes (currently 2000) regardless of the year the monitoring data were collected, NHIS data files are not automatically updated. For the years in this report, FIPS county identifiers for the EPA monitor information were recoded to be compatible with NHIS.

Exposure Variables

Monitor-specific arithmetic annual average exposures were collected for the following: PM₁₀ (µg/m³), overall and quarterly weighted; PM_{2.5} (µg/m³), overall and quarterly weighted; CO (ppm); SO₂ (ppm); NO₂ (ppm); O₃ (ppm), overall and average of running 8 hour measurements; Pb (ppm); and TSP (µg/m³).

For each respondent, the following variables were created from the annual monitor averages for each pollutant above:

1. Average of annual exposures of monitors within the county.
2. Number of monitors used to calculate exposure within the county.
3. Average of annual exposures of monitors within 5, 10, 15, and 20 miles of the respondent's block group (four variables).
4. Average of annual exposures of monitors within 5, 10, 15, and 20 miles of the respondent's block group, inverse distance weighted (four variables).
5. Number of monitors within 5, 10, 15, and 20 miles of the respondent's block group (four variables).
6. Distance to nearest monitor.
7. Annual exposure at nearest monitor.

Currently, the 1985–2005 NHIS-EPAAnnualAir data files are available as statistical analysis software (also known as SAS) data files for external users in the RDC; 1985 and 1986 data years have exposure information for fewer respondents and are not described in this report.

Description of Linked Data Files

To evaluate the linked files, the NHIS-EPAAnnualAir data files are described in terms of the percentage of NHIS respondents linked to six of the linked pollutants using different alternatives for exposure

assignment: PM₁₀ (quarterly weighted), PM_{2.5} (quarterly weighted), CO, SO₂, O₃, and NO₂. The median and the interquartile range of pollution exposure are shown for all pollutants except O₃, because of its different monitoring schedule (27).

Methods

Percentage Linked

The percentage of NHIS respondents linked to each pollutant was calculated for selected geographic linkage methods (5 mile, 10 mile, 20 mile, and county) by survey year using the 1987–2005 NHIS-EPAAnnualAir data files. Using the 2005 NHIS-EPAAnnualAir data file, percentages were estimated for each geographic linkage method by NHIS subgroups, defined by poverty status (29), Hispanic origin and race, age, health status, region, and urbanization level of the county of residence (30).

Because many percentages are not independent, the respondents, for example, with a 5-mile exposure estimate are included among those with a 20-mile exposure estimate, and many respondents with an exposure estimate for PM₁₀ are likely included among those with an exposure estimate for NO₂; statements that refer to lower or higher percentages across geographic linkage methods or across pollutants are not based on statistical tests. Conversely, percentages between survey years or respondent characteristics are assumed independent, and tests of differences were based on approximate *z* statistics using the standard errors of each percentage to estimate the standard error of the difference (31); statements that refer to lower or higher percentages are based on a critical value of 1.96 for a two-sided *z* test at the 0.05 level with no adjustment for multiple comparisons. Lack of comment does not mean that percentages were compared and deemed not statistically significant.

Exposure Estimates

The median (50th percentile) and the interquartile range (25th and 75th percentiles) of the estimated annual

average pollution exposures were estimated for selected geographic linkage methods (5 mile, 20 mile, and county) by survey year using the 1987–2005 NHIS-EPAAnnualAir data files. These percentiles were also estimated for the geographic linkage methods by NHIS subgroups described above using the 2005 NHIS-EPAAnnualAir data files.

For these percentile calculations, the exposure variables calculated without inverse-distance weighting were used. That is, this research utilized the 20-mile exposure variables that were calculated by combining annual averages from all monitors within 20 miles, without regard to distance from the respondent's block group of residence. Differences in exposure estimates between the 5-mile and 20-mile variables are greater than the corresponding differences between the 5-mile and 20-mile inverse-distance weighted variables.

Sets (median and interquartile range) based on fewer than 100 total respondents or fewer than 25 respondents above the 75th percentile or below the 25th percentile are not shown. Statements that refer to lower, higher, or similar medians are not based on statistical tests; statistical methods for percentiles of geographically clustered exposures within complex surveys are not fully developed.

Because of the clustering inherent in complex survey designs, standard errors were calculated in SUDAAN (32). All estimates were weighted by NHIS survey weights to approximate the relative distributions and exposures in the population represented by the linked sample. Because of the varying percentages of linked records by pollutant and geographic linkage methods, the appropriateness of statistical methods that use the NHIS design (e.g., weights, strata, primary sampling units) for these linked data files has not been confirmed.

Results

Percentage of NHIS Respondents Linked to Air Quality data

For each pollutant, Tables 1–5 show the number and survey-weighted percentage of NHIS respondents linked by survey year as well as varying distances between the block group and the monitors. Using 2005 data as an example, the percentage linked for exposures defined by a 5-mile radius ranged from 17 percent for SO₂ to 36 percent for PM_{2.5}, and the percentage linked for a 20-mile exposure radius increased to a range of 55 percent for NO₂ to 80 percent for PM_{2.5}. The percentage of respondents linked to pollution exposure varied by pollutant, geographic linkage method, and survey year. For each pollutant and each survey year, a large percentage of NHIS respondents were not assigned an exposure estimate and could not be included in association studies of health and air pollution. This limitation is particularly pronounced for exposures defined by the 5-mile radius, where (with the exception of PM_{2.5} and PM₁₀ for the mid-1990s NHIS) fewer than 30 percent of respondents are linked. Although PM_{2.5} estimates are unavailable for earlier years, in recent years, more NHIS respondents had exposure data for PM_{2.5} than for other pollutants.

Using the 2005 NHIS-EPAAnnualAir file, Tables 6–10 show the number and survey-weighted percentage of NHIS respondents linked by varying distances from the block group to the monitor for different respondent characteristics. Generally, a higher percentage of poor respondents (compared with near-poor and nonpoor respondents—particularly for 5-mile exposures), non-Hispanic black respondents (compared with non-Hispanic white respondents), Hispanic respondents (compared with non-Hispanic respondents), and, to a lesser degree, younger respondents (compared with older respondents) are linked to pollution exposure information, although these relationships were not observed,

nor statistically significant, for all pollutants and all linkage methods. Associations between linkage and health status were weak. More respondents in the large central cities and in the West were linked compared with those in other areas. With some exceptions, within a particular subgroup, patterns were generally similar by geographic linkage method even if the percentages differed.

Percentages and standard errors calculated without survey weights were generally similar to those presented (not shown). Differences between the survey-weighted and unweighted estimates were generally larger for 5-mile linkages compared with linkages for greater radii, and they were also larger for population subgroups (particularly those in less urban areas) with lower linkage percentages. Most relative differences were lower than 10 percent (not shown).

Exposure Estimates

Tables 11–15 summarize the survey-weighted median and interquartile range of the exposures by survey year and the varying distances between the respondent's block group of residence and the exposure monitors. Pollution levels have generally decreased over time. Median pollution levels appear similar by geographic linkage method; slightly lower values were reported for NO₂ and SO₂ for larger geographic areas. PM_{2.5} estimates appear higher for 5-mile exposure estimates than for other geographic linkage methods.

Tables 16–20 summarize the survey-weighted median and interquartile range of the exposure estimates by selected respondent characteristics and by varying distances between the respondent's block group of residence and the exposure monitors using the 2005 EPA Annual Air file. Generally, median exposures were similar for poor respondents compared with near-poor and nonpoor respondents, although there were exceptions. Geographic differences (e.g., by region and urbanization level of the county) were larger than differences for other respondent characteristics. Median

exposures among respondents in the West were highest for some pollutants (e.g., CO) but lowest for others (e.g., PM_{2.5}).

The median numbers of monitors used to estimate exposures in 2005 are given in Table A. Relatively few monitors are used in the estimation of exposures for most respondents, particularly for the 5-mile and 10-mile exposure measures. On the other hand, for the 20-mile and county level exposures measures, the 75th percentiles of the number of monitors used for estimation are four or higher for nearly all of the pollutants examined. The estimates presented in this report are, for the most part, within 5 percent of those calculated using the inverse distance-weighted exposure variables, the variables assigned by combining annual monitor-specific averages weighted by their distance from the block-group center. Differences were larger for the 20-mile exposures compared with the 5-mile exposures, which is likely due to the relatively few monitors used in the estimation of 5-mile exposure for most respondents (Table A).

Discussion

Numerous decisions are needed to link national surveys to EPA's air monitoring data, including the selection of monitors, the calculation of distances, the assignment of geographic location for survey respondents, and the geographic area over which to estimate exposure. What is important to note is that the number of available survey respondents for analysis of exposure-health relationships with linked data

depends on the geographic area over which exposures are calculated—the larger the area, the more respondents are included. When more precise exposure estimates are needed, the number of respondents will decrease and the demographic composition of the sample will change. Depending on the study, differences in the sample could affect resulting associations (33). Nevertheless, the availability of these linked data files provides an opportunity to investigate nationwide, if not nationally representative, associations between air quality and health. Among other benefits, these investigations will likely lead to improvements in future linkage methodology between these data sources.

The best analytic methods for these data are unknown. Two statistical issues are particularly important. First, the combination of these data sources leads to a linked file that is a subset of the nationally representative survey; what is unknown is whether the survey weights are appropriate for use with the subsetted data or whether the resulting file should be analyzed unweighted and considered a clustered convenience sample. Second, because block-group centroids are used for assigning exposure, all respondents within a block group are assigned the same exposure value (or no exposure value.) The effect of the additional clustering on standard errors of summary statistics for these exposure measures (e.g., means and percentiles) within the NHIS clustered complex survey design is unknown. Statistical survey research is needed to understand the use of survey weights and design-based methods for these linked data files.

Table A. Median and interquartile range of the number of pollution monitors used in exposure estimation, by geographic linkage method and pollutant: National Health Interview Survey, 2005

Pollutant	5-mile	10-mile	20-mile	County
Carbon monoxide	1(1,1)	2(1,3)	2(1,5)	2(1,4)
Sulfur Dioxide	1(1,1)	1(1,2)	2(1,4)	1(1,3)
Nitrogen Dioxide	1(1,1)	1(1,2)	2(1,5)	2(1,4)
PM ₁₀	1(1,2)	1(1,3)	3(1,5)	1(1,6)
PM _{2.5}	1(1,2)	2(1,3)	3(2,6)	2(1,4)

NOTES: Percentiles calculated using survey weights. PM₁₀ is particulate matter less than 10 microns in diameter; PM_{2.5} is particulate matter less than 2.5 microns in diameter.

NHIS is a large household survey that collects information on many health indicators potentially associated with air quality, including asthma, cardiovascular health, and activity limitations. The data contain respondents of many racial and ethnic backgrounds with varying levels of socioeconomic status. Trends for many health indicators are available for many years. Although the cross-sectional design of the survey and the inability to determine clearly the time of exposure may limit the understanding of many of these relationships, the breadth and size of the linked data files suggest opportunity.

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Table 1. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM₁₀, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1987	122,859	17,590	13.9	0.8	34,836	27.4	1.1	51,966	41.7	1.3	39,747	31.7	1.3
1988	122,310	24,682	19.3	0.8	45,481	36.6	1.2	69,297	56.4	1.3	54,040	43.5	1.5
1989	116,929	34,806	29.1	1.0	58,665	49.7	1.3	77,505	66.5	1.4	65,550	55.5	1.3
1990	119,631	39,358	32.3	0.9	64,712	54.1	1.2	83,662	70.5	1.3	71,815	60.0	1.4
1991	120,032	40,724	33.3	0.9	66,619	55.1	1.1	86,068	71.8	1.2	74,605	62.0	1.3
1992	120,700	42,620	34.6	1.0	68,582	56.4	1.3	87,179	72.3	1.4	76,928	63.5	1.5
1993	109,671	39,514	35.3	1.0	64,271	58.2	1.3	80,922	73.8	1.4	71,551	65.0	1.6
1994	116,179	43,094	36.6	1.0	68,852	59.2	1.3	86,337	74.8	1.3	75,958	65.4	1.5
1995	102,467	41,382	38.5	0.8	65,247	61.3	0.9	80,728	77.7	0.9	70,061	66.2	1.0
1996	63,402	24,158	35.5	1.0	39,523	59.8	1.2	49,171	76.0	1.1	41,985	63.6	1.3
1997	103,477	38,866	35.3	0.7	63,776	58.8	0.8	80,334	76.1	0.9	68,768	63.5	1.0
1998	98,785	34,885	32.7	0.7	57,925	55.4	0.8	74,069	73.1	0.9	62,321	59.8	1.0
1999	97,059	30,815	28.8	0.7	52,740	51.0	0.8	70,100	69.8	0.9	56,657	54.5	1.0
2000	100,618	31,362	27.8	0.7	55,442	51.0	0.8	72,837	69.9	0.9	57,577	53.1	0.9
2001	100,760	31,195	27.3	0.7	53,909	49.2	0.9	72,017	68.4	1.0	58,271	52.7	1.0
2002	93,386	28,610	27.0	0.8	50,601	49.5	0.9	67,098	68.8	1.0	54,904	54.0	1.0
2003	92,148	27,509	26.0	0.8	48,458	47.5	0.9	64,282	66.3	0.9	51,755	50.9	0.9
2004	94,460	27,286	25.2	0.7	48,276	46.4	0.8	65,609	66.5	0.9	52,922	50.9	0.9
2005	98,649	25,705	22.9	0.6	47,797	43.8	0.8	65,967	63.6	0.9	52,100	48.2	0.9

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. PM₁₀ is particulate matter less than 10 microns in diameter.

Table 2. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for SO₂, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1987	122,859	34,219	27.0	0.7	55,161	44.2	0.9	72,516	58.8	1.2	59,848	48.3	1.2
1988	122,310	31,935	25.4	0.8	55,425	44.8	1.1	75,635	61.7	1.3	62,362	50.5	1.4
1989	116,929	29,577	24.4	0.8	51,150	43.1	1.1	70,303	60.3	1.3	56,955	48.2	1.5
1990	119,631	30,321	24.5	0.7	51,644	42.8	1.0	71,407	60.0	1.2	59,224	49.3	1.4
1991	120,032	30,400	24.7	0.8	51,710	42.7	1.1	73,012	61.0	1.3	60,389	50.2	1.4
1992	120,700	29,554	23.7	0.9	50,442	41.3	1.2	72,077	59.8	1.4	59,193	48.8	1.4
1993	109,671	26,804	23.8	0.9	46,616	42.3	1.2	64,796	59.2	1.4	54,836	50.0	1.4
1994	116,179	26,934	22.5	0.8	48,252	41.0	1.0	68,098	58.6	1.4	55,198	47.3	1.4
1995	102,467	25,750	23.3	0.7	45,136	42.3	0.9	63,738	61.1	1.0	54,092	50.4	1.0
1996	63,402	14,539	21.2	0.8	26,654	40.6	1.0	39,297	60.7	1.3	34,030	50.9	1.2
1997	103,477	23,094	20.8	0.6	43,264	40.1	0.8	63,326	60.1	1.0	52,280	47.7	0.9
1998	98,785	21,350	19.9	0.6	40,749	39.4	0.8	60,461	60.0	1.0	50,620	48.5	1.0
1999	97,059	20,431	19.6	0.6	38,666	38.2	0.8	58,312	58.8	1.0	49,275	47.9	0.9
2000	100,618	20,544	18.5	0.6	40,869	38.5	0.8	61,726	59.7	0.9	49,829	46.6	0.9
2001	100,760	19,969	18.0	0.6	40,510	38.0	0.8	60,255	58.0	0.9	48,649	45.2	0.9
2002	93,386	18,969	18.6	0.6	37,596	38.2	0.9	56,367	58.9	1.0	46,207	46.5	0.9
2003	92,148	17,589	17.3	0.6	35,595	36.7	0.8	53,598	56.6	1.0	42,754	43.1	0.9
2004	94,460	17,585	16.9	0.6	35,245	35.5	0.8	54,241	56.7	0.9	42,579	42.8	0.9
2005	98,649	18,565	17.1	0.5	38,377	37.1	0.8	57,984	57.7	0.9	46,727	44.6	0.9

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. SO₂ is sulfur dioxide.

Table 3. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for NO₂, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1987	122,859	22,773	18.2	0.7	41,323	32.9	0.9	57,105	46.3	1.1	42,130	33.9	1.0
1988	122,310	21,271	16.8	0.7	40,457	32.6	1.0	57,170	46.9	1.2	42,144	34.2	1.1
1989	116,929	21,247	17.5	0.7	38,401	32.4	1.1	54,546	46.8	1.4	40,930	34.7	1.3
1990	119,631	24,117	19.7	0.8	44,041	36.5	1.1	59,782	50.3	1.3	45,548	37.9	1.3
1991	120,032	24,842	20.3	0.7	44,884	37.1	1.0	61,598	51.5	1.3	47,648	39.7	1.2
1992	120,700	23,099	18.5	0.7	42,246	34.7	1.0	59,731	49.8	1.2	45,571	37.7	1.1
1993	109,671	22,171	19.5	0.8	39,951	36.3	1.0	56,059	51.5	1.2	42,505	38.8	1.2
1994	116,179	24,209	20.3	0.8	43,518	37.3	1.1	61,157	53.0	1.3	48,719	42.1	1.3
1995	102,467	23,843	20.4	0.6	41,626	37.3	0.7	57,568	53.9	0.8	47,109	42.5	0.8
1996	63,402	13,194	18.1	0.7	24,984	35.8	1.0	35,281	53.0	1.1	27,638	40.1	1.0
1997	103,477	24,012	19.6	0.5	43,289	37.2	0.7	59,423	53.7	0.8	48,613	42.4	0.7
1998	98,785	22,549	19.1	0.5	41,155	36.7	0.7	57,217	53.8	0.8	46,544	42.2	0.7
1999	97,059	22,844	19.7	0.5	41,128	37.5	0.7	56,552	54.4	0.8	46,802	43.5	0.8
2000	100,618	24,259	19.8	0.6	43,782	38.4	0.7	59,820	55.3	0.8	49,992	44.5	0.8
2001	100,760	23,422	19.0	0.5	43,639	38.0	0.7	59,089	54.4	0.8	49,395	43.6	0.8
2002	93,386	22,182	19.8	0.5	40,594	38.5	0.7	55,574	55.7	0.8	45,777	43.9	0.8
2003	92,148	20,756	18.7	0.5	38,376	36.9	0.7	53,447	54.6	0.8	43,965	42.8	0.8
2004	94,460	21,193	18.8	0.5	39,808	37.4	0.7	55,621	55.4	0.8	45,263	42.9	0.7
2005	98,649	22,162	19.0	0.5	41,948	37.8	0.7	57,472	55.0	0.7	48,087	43.9	0.7

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. NO₂ is nitrogen dioxide.

Table 4. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for CO, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1987	122,859	37,412	29.3	0.8	58,935	47.3	1.0	75,065	61.0	1.2	62,776	50.7	1.1
1988	122,310	36,530	28.7	0.7	58,871	47.6	0.9	75,122	61.5	1.2	64,402	52.3	1.1
1989	116,929	34,863	28.8	0.8	55,740	47.3	1.0	71,967	61.8	1.3	61,139	52.2	1.3
1990	119,631	34,987	28.5	0.8	56,329	47.0	1.1	72,494	61.2	1.3	60,289	50.5	1.3
1991	120,032	35,621	29.1	0.7	56,896	47.2	1.0	73,375	61.5	1.3	61,429	51.3	1.2
1992	120,700	35,160	28.5	0.8	56,505	46.7	1.1	72,724	60.5	1.3	61,127	50.7	1.2
1993	109,671	32,449	28.8	1.0	52,161	47.4	1.3	67,162	61.4	1.5	56,425	51.4	1.5
1994	116,179	33,531	28.4	1.0	54,364	46.7	1.3	70,923	61.4	1.5	58,054	50.1	1.5
1995	102,467	31,857	28.3	0.7	52,155	48.0	0.8	67,546	64.0	0.9	56,419	51.8	0.9
1996	63,402	19,151	27.2	0.9	31,839	47.1	1.1	41,732	63.7	1.1	34,683	51.2	1.2
1997	103,477	31,998	27.4	0.6	52,722	47.0	0.8	67,998	63.2	0.9	56,629	50.5	0.8
1998	98,785	29,651	26.4	0.7	49,101	45.6	0.8	64,046	61.9	0.8	53,447	49.7	0.8
1999	97,059	27,892	25.3	0.6	47,152	44.4	0.7	62,732	61.9	0.8	53,212	50.2	0.8
2000	100,618	30,222	26.0	0.7	50,133	45.3	0.7	65,991	62.6	0.8	55,890	50.7	0.7
2001	100,760	28,397	24.3	0.6	49,310	44.4	0.7	64,952	61.3	0.8	55,138	49.8	0.7
2002	93,386	26,213	24.2	0.6	45,170	43.9	0.8	60,279	61.4	0.8	50,579	49.5	0.7
2003	92,148	25,051	22.9	0.6	42,782	41.7	0.8	57,325	58.9	0.8	48,254	47.4	0.8
2004	94,460	24,945	22.5	0.6	43,453	41.9	0.7	59,389	60.2	0.8	49,586	48.2	0.7
2005	98,649	26,179	22.8	0.6	46,116	42.4	0.7	62,283	60.4	0.8	53,040	49.4	0.7

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. CO is carbon monoxide.

Table 5. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM_{2.5}, by geographic linkage method and survey year: United States, 1999–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1999	97,059	24,719	24.4	0.7	46,422	46.4	0.9	64,152	65.8	0.9	51,032	51.1	1.0
2000	100,618	39,621	36.3	0.8	64,383	61.1	0.9	81,201	79.6	0.9	73,311	69.8	1.0
2001	100,760	40,826	37.3	0.8	65,063	61.7	0.9	81,784	80.0	0.9	73,612	70.4	1.0
2002	93,386	38,806	38.5	0.8	61,695	63.2	0.9	76,916	81.0	0.9	70,005	71.9	1.0
2003	92,148	37,431	37.5	0.8	59,919	62.0	0.9	75,527	80.8	0.9	68,382	71.4	1.0
2004	94,460	37,315	36.8	0.8	60,572	61.7	0.9	77,144	80.9	0.8	69,907	71.4	1.0
2005	98,649	38,324	36.1	0.7	63,263	61.7	0.9	80,109	80.3	0.8	72,822	71.4	1.0

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. PM_{2.5} is particulate matter less than 2.5 microns in diameter.

Table 6. Number, percentage, and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for O₃, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Number of survey respondents	Geographic linkage method											
		5-mile			10-mile			20-mile			County		
		Number	Percent	SE	Number	Percent	SE	Number	Percent	SE	Number	Percent	SE
1987	122,859	39,048	31.3	0.8	66,615	53.9	0.9	86,308	70.3	1.2	74,879	61.1	1.2
1988	122,310	37,244	29.9	0.8	65,615	53.5	1.0	85,507	70.3	1.2	75,358	61.8	1.3
1989	116,929	36,902	31.1	0.8	63,954	54.7	1.2	82,267	70.9	1.4	72,996	62.6	1.4
1990	119,631	38,592	32.0	0.8	66,391	55.7	1.2	85,104	72.0	1.2	74,047	62.6	1.4
1991	120,032	38,668	31.9	0.8	66,333	55.1	1.1	85,561	71.7	1.2	74,886	62.9	1.3
1992	120,700	37,241	30.3	0.8	65,660	54.1	1.2	85,675	71.3	1.4	74,309	61.8	1.4
1993	109,671	35,333	31.7	0.8	61,498	56.1	1.2	78,672	72.4	1.3	70,333	64.7	1.4
1994	116,179	37,241	31.6	0.8	64,626	55.5	1.2	82,852	71.7	1.4	74,976	64.8	1.4
1995	102,467	35,714	31.9	0.7	61,023	57.2	0.9	77,550	74.5	1.0	70,363	66.4	1.0
1996	63,402	21,226	30.0	0.9	36,561	54.9	1.2	47,906	74.5	1.3	43,330	65.9	1.3
1997	103,477	35,836	31.0	0.7	62,269	56.8	0.9	80,250	75.9	1.0	71,121	65.9	1.0
1998	98,785	34,085	30.8	0.7	59,521	56.9	0.9	76,502	75.7	1.0	67,725	65.6	1.0
1999	97,059	33,743	31.4	0.7	58,870	57.5	0.9	75,703	76.5	1.0	66,737	66.0	1.0
2000	100,618	35,996	31.8	0.7	62,771	58.9	0.8	80,325	78.3	0.9	70,321	67.2	1.0
2001	100,760	35,813	31.5	0.7	63,234	59.4	0.8	80,902	78.8	0.9	71,657	68.4	1.0
2002	93,386	32,755	31.3	0.7	58,768	59.6	0.8	75,170	78.7	0.9	67,034	69.0	0.9
2003	92,148	32,239	31.4	0.7	58,002	60.0	0.8	74,781	79.7	0.9	66,416	69.7	1.0
2004	94,460	32,937	31.5	0.7	59,937	60.5	0.8	77,347	81.0	0.8	68,867	70.8	1.0
2005	98,649	33,571	30.8	0.7	61,557	59.4	0.8	79,767	79.7	0.9	71,947	70.9	1.0

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. O₃ is ozone.

Table 7. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for PM₁₀, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	22.9	0.6	63.6	0.9	48.2	0.9
Poverty status							
Below poverty threshold	15,540	30.9	1.2	63.8	1.4	52.4	1.3
At or above poverty threshold	83,109	21.7	0.6	63.6	0.9	47.6	0.9
Hispanic origin and race							
Hispanic or Latino	23,642	37.6	1.2	82.7	1.1	72.9	1.2
Mexican	16,006	41.7	1.6	83.2	1.5	79.5	1.6
Not Hispanic or Latino	75,007	20.4	0.6	60.3	1.0	44.0	0.9
White only	56,483	17.6	0.7	56.2	1.1	40.0	1.0
Black or African American only	13,216	31.4	1.2	75.1	1.7	57.5	1.5
Age							
Less than 25 years	37,137	24.2	0.7	64.4	0.9	49.6	0.9
25–64 years	50,282	22.3	0.6	64.0	0.9	48.1	0.9
65 years and over	11,230	21.6	0.9	59.4	1.3	45.0	1.2
Health status							
Poor or fair	9,658	24.1	0.9	59.7	1.3	46.6	1.3
Excellent, very good, or good	88,701	22.8	0.6	64.0	0.9	48.4	0.9
Region							
Northeast	17,086	12.4	1.1	54.8	1.8	22.2	1.6
Midwest	21,678	20.3	1.4	54.1	1.7	41.0	1.7
South	35,291	18.8	0.9	60.3	1.8	44.5	1.5
West	24,594	41.7	1.8	87.4	1.6	85.2	1.9
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	39.0	1.1	96.0	0.3	87.1	0.6
Large fringe metropolitan	22,759	13.6	0.8	66.9	1.2	29.0	1.2
Medium metropolitan	20,165	30.0	1.6	65.7	2.4	58.4	2.5
Small metropolitan	8,868	13.2	3.3	29.6	4.7	22.2	5.1
Other counties	14,658	5.1	1.4	17.7	2.8	10.9	2.8

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. PM₁₀ is particulate matter less than 10 microns in diameter. NCHS is the National Center for Health Statistics.

Table 8. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for SO₂, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	17.1	0.5	57.7	0.9	44.6	0.9
Poverty status							
Below poverty threshold	15,540	23.6	1.0	56.0	1.4	45.9	1.4
At or above poverty threshold	83,109	16.1	0.6	57.9	0.9	44.4	0.9
Hispanic origin and race							
Hispanic or Latino	23,642	24.0	1.1	65.1	1.3	60.2	1.3
Mexican	16,006	19.4	1.1	57.4	1.7	56.5	1.7
Not Hispanic or Latino	75,007	15.9	0.6	56.4	1.0	42.0	0.9
White only	56,483	13.4	0.6	53.0	1.1	39.0	1.1
Black or African American only	13,216	28.0	1.3	70.9	1.6	52.4	1.7
Age							
Less than 25 years	37,137	17.4	0.6	58.1	1.0	45.1	0.9
25–64 years	50,282	16.9	0.6	58.1	0.9	44.5	0.9
65 years and over	11,230	16.8	0.7	54.6	1.3	43.5	1.3
Health status							
Poor or fair	9,658	17.6	0.7	53.6	1.3	42.0	1.2
Excellent, very good, or good	88,701	17.0	0.6	58.1	0.9	44.8	0.9
Region							
Northeast	17,086	33.0	1.5	82.0	1.6	60.4	2.1
Midwest	21,678	16.6	1.3	54.3	2.4	39.5	2.0
South	35,291	10.1	0.7	48.4	1.5	33.6	1.4
West	24,594	15.1	1.2	55.7	1.6	54.9	1.6
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	31.0	1.2	87.3	0.6	84.7	0.8
Large fringe metropolitan	22,759	15.6	0.9	73.3	1.1	37.9	1.2
Medium metropolitan	20,165	16.1	1.4	50.2	2.7	38.6	2.4
Small metropolitan	8,868	6.5	2.2	18.1	4.4	13.3	3.8
Other counties	14,658	1.9	0.9	13.4	2.7	9.8	2.7

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. SO₂ is sulfur dioxide. NCHS is the National Center for Health Statistics.

Table 9. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for NO₂, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	19.0	0.5	55.0	0.7	43.9	0.7
Poverty status							
Below poverty threshold	15,540	26.2	1.0	54.3	1.2	46.4	1.3
At or above poverty threshold	83,109	17.9	0.5	55.1	0.7	43.5	0.7
Hispanic origin and race							
Hispanic or Latino	23,642	36.6	1.3	76.1	1.3	71.2	1.4
Mexican	16,006	35.5	1.5	71.5	1.7	69.7	1.8
Not Hispanic or Latino	75,007	16.0	0.5	51.4	0.8	39.3	0.7
White only	56,483	13.0	0.5	47.1	0.9	35.1	0.8
Black or African American only	13,216	27.3	1.2	66.7	1.6	53.0	1.6
Age							
Less than 25 years	37,137	19.7	0.6	56.0	0.8	45.0	0.8
25–64 years	50,282	18.8	0.5	55.1	0.7	43.6	0.7
65 years and over	11,230	17.7	0.7	51.4	1.1	41.8	1.1
Health status							
Poor or fair	9,658	19.1	0.7	49.7	1.1	40.8	1.1
Excellent, very good, or good	88,701	19.0	0.5	55.5	0.7	44.2	0.7
Region							
Northeast	17,086	30.0	1.4	74.8	1.4	54.0	1.7
Midwest	21,678	10.4	0.9	40.1	1.5	26.4	1.2
South	35,291	12.4	0.7	48.5	1.3	37.2	1.3
West	24,594	29.9	1.4	65.2	1.2	66.0	1.2
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	38.8	1.1	90.3	0.6	86.1	0.7
Large fringe metropolitan	22,759	16.1	0.9	71.7	1.2	39.0	1.2
Medium metropolitan	20,165	16.3	1.4	44.4	2.5	39.3	2.3
Small metropolitan	8,868	2.8	1.2	9.0	2.7	9.6	3.0
Other counties	14,658	1.1	0.8	6.4	1.7	2.6	1.5

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. NO₂ is nitrogen dioxide. NCHS is the National Center for Health Statistics.

Table 10. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for CO, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	22.8	0.6	60.4	0.8	49.4	0.7
Poverty status							
Below poverty threshold	15,540	30.1	1.0	58.5	1.3	51.0	1.3
At or above poverty threshold	83,109	21.7	0.6	60.7	0.8	49.2	0.7
Hispanic origin and race							
Hispanic or Latino	23,642	40.0	1.3	78.3	1.5	73.4	1.7
Mexican	16,006	37.8	1.6	74.3	2.0	72.7	2.4
Not Hispanic or Latino	75,007	19.9	0.6	57.4	0.8	45.4	0.7
White only	56,483	16.4	0.6	53.4	0.9	41.1	0.8
Black or African American only	13,216	33.4	1.4	70.1	1.6	58.6	1.4
Age							
Less than 25 years	37,137	23.3	0.6	61.4	0.8	50.5	0.8
25–64 years	50,282	22.8	0.6	60.8	0.8	49.6	0.7
65 years and over	11,230	20.9	0.8	55.8	1.1	45.3	1.0
Health status							
Poor or fair	9,658	23.5	0.8	53.9	1.1	44.9	1.0
Excellent, very good, or good	88,701	22.7	0.6	61.1	0.8	49.9	0.7
Region							
Northeast	17,086	31.3	1.4	77.8	1.3	59.2	1.7
Midwest	21,678	16.5	1.1	49.8	1.7	37.4	1.5
South	35,291	12.7	0.7	46.2	1.3	33.4	1.0
West	24,594	39.2	1.7	80.8	1.7	81.0	1.5
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	46.0	1.2	97.8	0.3	97.8	0.4
Large fringe metropolitan	22,759	16.7	1.0	75.1	1.2	40.6	1.2
Medium metropolitan	20,165	23.2	1.5	55.9	2.6	48.0	2.4
Small metropolitan	8,868	4.5	2.1	11.5	3.5	7.9	3.1
Micropolitan	14,658	1.1	0.7	5.4	1.4	3.3	1.3

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. CO is carbon monoxide. NCHS is the National Center for Health Statistics.

Table 11. Percentage and standard error (SE) of NHIS respondents linked to annual EPA air monitoring data for PM_{2.5}, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	36.1	0.7	80.3	0.8	71.4	1.0
Poverty status							
Below poverty threshold	15,540	46.65	1.3	79.6	1.2	72.5	1.4
At or above poverty threshold	83,109	34.53	0.7	80.4	0.9	71.2	1.0
Hispanic origin and race							
Hispanic or Latino	23,642	48.68	1.4	88.2	1.1	86.1	1.2
Mexican	16,006	45.58	1.6	85.7	1.5	84.7	1.5
Not Hispanic or Latino	75,007	33.99	0.8	79.0	0.9	68.9	1.1
White only	56,483	29.92	0.8	76.3	1.1	65.1	1.2
Black or African American only	13,216	51.99	1.6	89.4	1.2	82.8	1.5
Age							
Less than 25 years	37,137	37.79	0.8	81.3	0.9	72.7	1.0
25–64 years	50,282	35.42	0.7	80.5	0.8	71.2	1.0
65 years and over	11,230	34.09	1.0	76.6	1.2	67.7	1.3
Health status							
Poor or fair	9,658	37.22	1.1	76.7	1.1	67.7	1.4
Excellent, very good, or good	88,701	36.00	0.7	80.7	0.9	71.7	1.0
Region							
Northeast	17,086	43.57	1.5	87.0	1.2	75.3	1.6
Midwest	21,678	35.38	1.5	73.1	2.2	64.0	2.3
South	35,291	29.42	1.4	77.8	1.5	65.1	1.9
West	24,594	41.56	1.5	86.7	1.4	86.6	1.1
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	55.66	1.1	97.6	0.3	99.7	0.1
Large fringe metropolitan	22,759	29.75	1.3	89.8	0.8	70.2	1.4
Medium metropolitan	20,165	40.77	1.8	89.7	1.3	80.5	2.3
Small metropolitan	8,868	28.95	3.7	59.1	5.8	47.8	5.8
Other counties	14,658	9.03	2.0	34.1	3.4	24.1	3.7

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. PM_{2.5} is particulate matter less than 2.5 microns in diameter. NCHS is the National Center for Health Statistics.

Table 12. Percentage and standard error (SE) of NHIS respondents linked to annual EPA monitoring data for O₃, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Number	Geographic linkage method					
		5-mile		20-mile		County	
		Percent	SE	Percent	SE	Percent	SE
Total	98,649	30.8	0.7	79.7	0.9	70.9	1.0
Poverty status							
Below poverty threshold	15,540	37.0	1.2	77.6	1.3	67.7	1.4
At or above poverty threshold	83,109	29.9	0.7	80.1	0.9	71.3	1.0
Hispanic origin and race							
Hispanic or Latino	23,642	46.2	1.3	88.9	1.2	84.3	1.3
Mexican	16,006	48.6	1.6	86.1	1.6	84.2	1.5
Not Hispanic or Latino	75,007	28.2	0.7	78.2	1.0	68.6	1.1
White only	56,483	25.4	0.7	76.0	1.1	66.9	1.2
Black or African American only	13,216	38.7	1.3	87.0	1.5	72.7	1.6
Age							
Less than 25 years	37,137	31.6	0.7	80.4	1.0	71.7	1.0
25–64 years	50,282	30.6	0.7	80.1	0.9	71.0	1.0
65 years and over	11,230	29.6	1.0	76.3	1.1	67.6	1.3
Health status							
Poor or fair	9,658	30.5	0.9	74.8	1.2	64.8	1.3
Excellent, very good, or good	88,701	30.8	0.7	80.2	0.9	71.5	1.0
Region							
Northeast	17,086	30.9	1.5	91.3	1.3	76.2	1.9
Midwest	21,678	28.8	1.3	76.3	2.1	65.0	2.3
South	35,291	23.5	1.0	74.9	1.6	63.0	1.9
West	24,594	45.0	1.7	81.6	1.6	85.9	1.4
2006 NCHS urban-rural classification							
Large central metropolitan	32,199	49.6	1.2	97.5	0.3	90.4	0.7
Large fringe metropolitan	22,759	27.4	1.1	94.0	0.6	79.9	1.2
Medium metropolitan	20,165	36.1	1.8	89.9	1.5	84.8	2.3
Small metropolitan	8,868	15.3	2.8	46.1	4.9	42.4	5.3
Other counties	14,658	4.7	1.2	31.8	3.6	19.8	3.6

NOTES: Percentages and standard errors calculated using survey weights. NHIS is the National Health Interview Survey. EPA is the U.S. Environmental Protection Agency. O₃ is ozone. NCHS is the National Center for Health Statistics.

Table 13. Median and interquartile range of PM₁₀ exposure (µg/m³) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Geographic linkage method											
	5-mile			10-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th	Median	25th	75th
1987	37.7	32.0	46.7	38.2	32.9	46.2	37.2	32.3	44.7	37.5	31.1	45.3
1988	35.9	30.8	40.6	35.6	30.7	41.3	35.9	31.3	40.6	36.3	29.7	41.2
1989	33.5	28.7	38.7	34.1	29.0	39.4	34.2	28.7	38.3	33.4	28.6	40.4
1990	30.6	25.9	35.1	30.7	26.1	35.3	30.5	26.3	34.8	30.9	25.7	36.4
1991	30.5	25.9	35.6	30.9	26.1	35.2	31.0	26.0	33.9	30.3	25.5	35.5
1992	27.6	23.4	31.6	28.1	24.0	31.6	27.3	23.6	30.7	27.2	23.0	32.0
1993	26.9	23.1	31.1	27.1	23.0	31.3	27.0	23.1	30.4	26.7	22.8	32.6
1994	27.1	22.7	32.7	27.3	22.9	32.7	27.4	22.7	32.0	26.5	21.9	33.8
1995	25.1	21.5	31.1	25.5	21.5	30.5	26.0	21.3	30.2	25.1	21.2	31.4
1996	24.6	20.8	30.0	24.7	20.8	30.1	24.5	20.8	29.4	24.3	20.4	30.1
1997	24.6	21.3	29.6	24.6	21.3	29.7	24.6	21.1	28.7	24.4	21.1	29.0
1998	25.3	22.2	29.6	25.6	22.2	29.6	25.8	22.4	28.5	25.1	21.3	29.8
1999	25.3	21.7	30.1	25.1	21.7	29.3	24.9	21.5	28.7	25.1	21.5	30.3
2000	24.9	21.4	29.6	25.1	21.7	29.6	25.1	21.6	28.6	24.7	21.0	29.6
2001	24.2	20.8	29.3	24.5	21.0	28.7	24.1	21.1	28.0	24.2	20.5	28.6
2002	23.8	20.2	29.1	23.6	20.4	28.3	23.2	20.4	26.9	23.4	19.9	28.8
2003	23.9	20.6	29.4	23.9	20.5	29.2	23.8	20.5	27.9	23.9	20.3	28.4
2004	22.5	19.4	26.7	22.6	19.5	27.3	22.3	19.5	25.7	22.7	19.5	27.0
2005	24.5	21.3	29.0	24.8	21.3	29.5	24.8	21.3	29.2	24.5	20.7	28.3

NOTES: Percentiles calculated using survey weights. PM₁₀ is particulate matter less than 10 microns in diameter. EPA is the U.S. Environmental Protection Agency.

Table 14. Median and interquartile range of SO₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Geographic linkage method											
	5-mile			10-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th	Median	25th	75th
1987	8.2	4.6	12.0	7.9	4.5	11.4	7.7	4.4	11.2	7.4	4.1	11.1
1988	8.1	4.6	12.2	7.7	4.4	11.4	7.4	4.4	11.2	7.2	4.3	10.3
1989	8.1	4.6	12.2	7.7	4.5	11.4	7.4	4.1	10.8	7.1	3.6	10.8
1990	7.6	4.0	10.9	7.4	4.0	10.4	7.0	3.7	9.8	6.5	3.3	9.7
1991	7.8	4.4	11.2	7.5	4.2	10.1	7.1	3.3	9.5	7.0	3.3	9.5
1992	7.0	3.9	9.6	6.6	4.1	9.2	6.5	3.4	9.0	6.1	3.4	8.7
1993	6.6	3.8	9.0	6.3	3.6	8.9	6.2	3.3	8.6	6.1	2.7	8.2
1994	6.5	3.9	9.1	6.2	3.8	8.6	6.0	3.5	8.4	5.9	3.0	7.9
1995	5.5	3.6	7.1	5.0	3.2	6.8	4.8	3.0	6.7	4.6	3.0	6.2
1996	5.4	3.4	7.3	5.1	3.2	7.1	4.8	2.9	6.9	4.8	2.5	6.5
1997	5.5	3.7	7.4	5.3	3.2	7.0	5.1	2.9	6.8	4.7	2.5	6.4
1998	5.4	3.3	7.2	5.1	3.0	6.8	4.8	2.8	6.7	4.4	2.6	6.4
1999	5.2	3.4	7.1	4.8	3.1	6.6	4.6	2.8	6.5	4.2	2.6	6.5
2000	4.9	2.8	6.5	4.6	2.6	6.3	4.3	2.4	6.1	3.9	2.3	6.0
2001	4.7	2.9	6.3	4.4	2.7	6.1	4.3	2.6	5.7	3.7	2.3	5.3
2002	4.2	2.6	5.7	4.0	2.3	5.5	4.0	2.2	5.3	3.6	2.2	4.9
2003	4.2	2.5	5.7	4.0	2.4	5.5	3.8	2.1	5.5	3.4	2.0	4.9
2004	4.4	2.8	5.6	4.0	2.6	5.3	3.8	2.5	5.1	3.5	2.4	4.8
2005	4.3	2.7	5.7	4.1	2.3	5.4	3.8	2.3	5.2	3.6	2.2	5.0

NOTES: Percentiles calculated using survey weights. SO₂ is sulfur dioxide. EPA is the U.S. Environmental Protection Agency.

Table 15. Median and interquartile range of NO₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Geographic linkage method											
	5-mile			10-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th	Median	25th	75th
1987	27.8	22.5	37.2	27.2	21.9	34.2	25.3	20.5	31.5	25.1	19.8	32.1
1988	27.1	22.5	35.5	26.4	21.3	33.1	25.1	20.3	31.3	24.7	19.8	30.3
1989	27.2	22.0	35.1	25.8	21.2	31.7	24.8	19.9	30.0	25.1	18.6	29.2
1990	25.5	20.2	33.6	24.6	19.2	30.0	22.9	18.1	28.1	22.6	17.9	27.8
1991	25.1	19.8	32.4	24.2	18.9	29.4	22.6	17.5	27.4	21.5	16.5	27.9
1992	24.4	20.1	29.6	23.5	18.6	28.3	21.9	17.8	26.6	22.3	16.4	26.4
1993	23.9	19.1	29.9	23.5	18.4	28.1	21.8	17.1	26.9	21.1	16.8	26.7
1994	24.8	20.3	31.8	23.8	19.1	29.9	22.4	17.5	27.9	22.4	16.6	28.6
1995	23.1	18.7	29.8	22.3	17.3	28.6	20.9	16.4	27.1	21.1	15.8	27.1
1996	22.5	18.1	29.3	21.9	17.7	28.6	20.4	16.3	26.7	20.5	16.3	26.7
1997	21.9	17.0	28.2	20.3	16.0	27.9	19.3	15.1	25.7	19.2	14.3	25.7
1998	22.8	17.7	29.3	21.4	16.5	27.1	19.8	15.8	25.0	18.7	14.6	25.2
1999	22.4	17.5	28.0	20.8	16.6	26.4	18.9	15.4	24.6	18.7	14.9	25.4
2000	21.3	16.6	27.1	19.6	15.4	25.1	18.4	14.6	24.0	18.0	13.3	24.0
2001	21.0	16.6	27.4	19.6	15.7	25.8	18.5	14.6	24.0	18.0	13.2	24.1
2002	19.7	15.9	25.5	18.7	14.6	24.8	17.5	13.7	23.5	17.3	12.8	22.4
2003	18.6	14.4	24.8	17.7	14.2	23.8	16.9	12.8	22.0	16.3	12.1	21.9
2004	17.4	13.9	23.2	16.6	13.0	22.2	15.7	12.4	20.8	15.3	12.0	20.4
2005	17.5	13.5	23.4	16.7	13.0	21.7	15.8	12.0	20.1	15.1	11.7	20.0

NOTES: Percentiles calculated using survey weights. NO₂ is nitrogen dioxide. EPA is the U.S. Environmental Protection Agency.

Table 16. Median and interquartile range of CO exposure (ppm) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1987–2005

Survey year	Geographic linkage method											
	5-mile			10-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th	Median	25th	75th
1987	1.28	0.96	1.75	1.27	0.97	1.73	1.24	0.97	1.70	1.21	0.96	1.68
1988	1.23	0.92	1.64	1.22	0.94	1.62	1.18	0.93	1.61	1.19	0.90	1.58
1989	1.29	0.94	1.77	1.26	0.93	1.72	1.21	0.93	1.66	1.24	0.90	1.63
1990	1.18	0.92	1.58	1.17	0.89	1.50	1.13	0.90	1.44	1.08	0.88	1.41
1991	1.14	0.85	1.57	1.12	0.83	1.49	1.08	0.84	1.45	1.08	0.80	1.39
1992	1.07	0.84	1.46	1.06	0.84	1.38	1.03	0.84	1.34	0.99	0.82	1.33
1993	1.03	0.78	1.39	1.03	0.78	1.29	0.95	0.80	1.29	0.99	0.78	1.27
1994	0.99	0.80	1.31	1.00	0.80	1.31	0.98	0.80	1.28	0.96	0.78	1.28
1995	0.90	0.73	1.18	0.90	0.74	1.17	0.88	0.75	1.13	0.87	0.72	1.14
1996	0.86	0.69	1.17	0.84	0.68	1.14	0.86	0.70	1.12	0.83	0.67	1.10
1997	0.78	0.61	1.05	0.79	0.61	1.03	0.77	0.62	1.00	0.75	0.60	0.98
1998	0.81	0.61	1.06	0.80	0.62	1.01	0.80	0.61	0.98	0.80	0.57	0.97
1999	0.79	0.63	1.06	0.78	0.63	1.05	0.76	0.63	1.03	0.75	0.60	1.04
2000	0.70	0.53	0.92	0.69	0.53	0.92	0.68	0.53	0.93	0.66	0.49	0.89
2001	0.68	0.50	0.88	0.66	0.50	0.87	0.64	0.50	0.87	0.62	0.48	0.84
2002	0.60	0.46	0.81	0.59	0.45	0.79	0.59	0.45	0.78	0.57	0.45	0.80
2003	0.61	0.48	0.83	0.60	0.47	0.79	0.58	0.46	0.78	0.58	0.45	0.77
2004	0.55	0.43	0.72	0.54	0.42	0.72	0.52	0.42	0.72	0.53	0.41	0.68
2005	0.50	0.41	0.65	0.50	0.40	0.64	0.50	0.39	0.63	0.50	0.39	0.60

NOTES: Percentiles calculated using survey weights. CO is carbon monoxide. EPA is the U.S. Environmental Protection Agency.

Table 17. Median and interquartile range of PM_{2.5} exposure (µg/m³) for respondents linked to annual EPA monitoring data, by geographic linkage method and survey year: United States, 1999–2005

Survey year	Geographic linkage method											
	5-mile			10-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th	Median	25th	75th
1999	14.4	11.9	16.9	14.5	11.8	16.8	14.3	11.9	16.6	14.2	11.6	17.1
2000	13.8	11.5	16.0	13.7	11.4	15.9	13.7	11.4	16.0	13.4	11.4	16.0
2001	13.5	11.2	15.6	13.3	11.1	15.5	13.3	11.1	15.3	13.0	10.7	15.7
2002	13.4	11.0	15.2	13.1	10.7	15.0	13.0	10.7	14.8	12.8	10.7	14.8
2003	12.9	10.8	14.8	12.7	10.7	14.6	12.7	10.5	14.6	12.5	10.4	14.6
2004	12.6	10.4	14.2	12.4	10.3	14.1	12.2	10.2	13.9	12.1	10.1	14.0
2005	13.6	10.9	15.5	13.4	10.8	15.5	13.4	10.6	15.5	13.2	10.6	15.4

NOTES: Percentiles calculated using survey weights. PM_{2.5} is particulate matter less than 2.5 microns in diameter. EPA is the U.S. Environmental Protection Agency.

Table 18. Median and interquartile range of PM₁₀ exposure (µg/m³) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Geographic linkage method									
	5-mile			20-mile			County			
	Median	25th	75th	Median	25th	75th	Median	25th	75th	
Total	24.5	21.3	29.0	24.8	21.3	29.2	24.5	20.7	28.3	
Poverty status										
Below poverty threshold	25.4	21.7	29.6	26.2	22.4	29.6	25.1	22.5	30.0	
At or above poverty threshold	24.4	21.2	28.8	24.6	21.0	28.8	24.4	20.7	28.3	
Hispanic origin and race										
Hispanic or Latino	26.7	21.5	30.9	26.9	21.7	30.5	26.3	22.7	30.3	
Mexican	27.7	22.0	33.2	27.5	22.8	32.0	28.1	23.1	30.3	
Not Hispanic or Latino	24.4	21.2	28.2	24.4	21.2	28.3	23.9	20.6	28.3	
White only	24.0	21.2	27.5	24.2	21.1	27.9	23.7	20.6	28.1	
Black or African American only	25.1	21.6	29.6	26.2	22.5	29.6	25.1	22.5	28.3	
Age										
Less than 25 years	24.7	21.3	29.5	24.8	21.5	29.4	24.5	21.0	28.5	
25–64 years	24.5	21.3	28.9	24.7	21.3	29.0	24.5	20.7	28.3	
65 years and over	24.5	21.2	28.3	24.5	20.8	28.8	24.5	20.4	28.3	
Health status										
Poor or fair	25.1	21.5	29.2	25.0	21.7	29.6	24.7	21.1	29.2	
Excellent, very good, or good	24.5	21.3	29.0	24.7	21.3	29.0	24.5	20.7	28.3	
Region										
Northeast	24.5	22.7	29.1	27.3	22.7	29.6	24.3	20.2	27.7	
Midwest	25.6	22.5	28.9	26.4	23.6	29.3	27.0	23.3	28.3	
South	22.7	19.2	26.3	23.6	19.9	26.3	23.6	20.4	25.5	
West	25.5	21.4	30.9	25.6	20.7	31.9	25.0	20.6	30.3	
2006 NCHS urban-rural classification										
Large central metropolitan	26.3	22.3	29.6	27.4	23.3	29.9	26.1	23.6	30.3	
Large fringe metropolitan	23.6	19.3	28.9	24.8	21.6	28.6	23.5	19.5	27.4	
Medium metropolitan	24.2	20.4	27.7	23.0	19.6	25.9	23.0	19.6	25.8	
Small metropolitan	22.2	20.7	24.8	22.2	20.2	24.3	22.2	14.8	24.5	
Other counties	22.2	19.4	24.9	22.2	19.4	24.9	22.0	19.4	24.9	

NOTES: Percentiles calculated using survey weights. PM₁₀ is particulate matter less than 10 microns in diameter. EPA is the U.S. Environmental Protection Agency. NCHS is the National Center for Health Statistics.

Table 19. Median and interquartile range of SO₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Geographic linkage method								
	5-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th
Total	4.3	2.7	5.7	3.8	2.3	5.2	3.6	2.2	5.0
Poverty status									
Below poverty threshold	4.4	2.9	5.7	3.9	2.3	5.3	3.5	2.3	5.0
At or above poverty threshold	4.3	2.7	5.7	3.8	2.3	5.2	3.6	2.2	5.0
Hispanic origin and race									
Hispanic or Latino	4.0	2.2	5.9	3.0	1.8	4.3	3.0	1.6	3.8
Mexican	2.5	2.1	4.5	2.9	2.0	3.5	3.0	1.7	3.5
Not Hispanic or Latino	4.4	3.0	5.7	4.1	2.4	5.3	3.8	2.4	5.1
White only	4.6	3.1	5.8	4.1	2.4	5.3	3.9	2.5	5.2
Black or African American only	4.4	3.1	5.1	4.1	2.9	5.4	3.8	2.4	4.9
Age									
Less than 25 years	4.3	2.7	5.6	3.8	2.3	5.2	3.6	2.2	5.0
25–64 years	4.3	2.7	5.7	3.7	2.3	5.2	3.6	2.2	5.0
65 years and over	4.5	2.9	5.9	4.1	2.4	5.4	3.8	2.3	5.1
Health status									
Poor or fair	4.4	2.5	5.7	3.7	2.2	5.2	3.6	2.2	4.9
Excellent, very good, or good	4.3	2.7	5.7	3.8	2.3	5.2	3.6	2.2	5.0
Region									
Northeast	5.9	4.6	7.6	5.4	4.4	7.6	5.2	4.3	6.5
Midwest	4.1	3.1	5.1	4.1	3.1	4.8	3.8	3.1	5.0
South	3.4	1.9	4.9	3.1	1.8	5.0	3.1	1.6	4.4
West	2.2	1.7	2.8	2.2	1.7	3.0	2.6	1.7	3.3
2006 NCHS urban-rural classification									
Large central metropolitan	4.2	2.5	5.7	3.5	2.1	4.7	3.4	2.5	4.5
Large fringe metropolitan	4.3	3.2	5.5	4.3	2.9	5.4	4.3	1.8	5.4
Medium metropolitan	4.6	2.6	5.9	4.1	2.3	5.3	4.3	1.7	5.2
Small metropolitan	4.6	3.3	7.3	4.1	3.3	6.2	4.6	3.3	7.3
Other counties	†	†	†	3.5	2.2	5.1	3.8	2.4	7.4

† Estimates for groups with fewer than 100 respondents or fewer than 25 respondents above the 75th percentile or below the 25th percentile are not shown.

NOTES: Percentiles calculated using survey weights. SO₂ is sulfur dioxide. EPA is the U.S. Environmental Protection Agency. NCHS is the National Center for Health Statistics.

Table 20. Median and interquartile range of NO₂ exposure (ppb) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Geographic linkage method								
	5-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th
Total	17.5	13.5	23.4	15.8	12.0	20.1	15.1	11.7	20.0
Poverty status									
Below poverty threshold	18.5	15.0	24.4	15.9	12.3	22.3	15.9	12.1	22.0
At or above poverty threshold	17.3	13.4	22.8	15.7	12.0	20.1	15.1	11.7	19.8
Hispanic origin and race									
Hispanic or Latino	19.9	14.9	27.4	16.5	12.3	23.9	15.8	11.7	23.0
Mexican	19.2	14.9	25.9	16.5	13.0	23.9	16.5	12.8	23.0
Not Hispanic or Latino	17.3	13.3	21.6	15.5	12.0	19.6	15.1	11.7	19.2
White only	16.4	12.6	20.0	15.3	11.9	19.2	15.0	11.4	18.6
Black or African American only	19.2	15.4	21.7	16.6	12.6	20.0	16.0	12.2	21.7
Age									
Less than 25 years	17.7	13.6	23.2	15.7	12.2	20.2	15.1	11.7	20.0
25–64 years	17.7	13.6	24.0	15.7	12.1	20.2	15.3	11.7	20.1
65 years and over	17.3	13.3	22.2	15.8	11.9	20.0	15.4	11.1	19.6
Health status									
Poor or fair	17.7	14.1	24.1	15.3	11.6	20.2	15.4	11.4	20.0
Excellent, very good, or good	17.6	13.5	23.4	15.8	12.1	20.1	15.1	11.7	20.0
Region									
Northeast	20.0	16.1	26.3	17.5	15.3	26.0	16.6	13.8	22.1
Midwest	17.8	15.1	20.5	17.0	12.8	19.6	18.3	13.0	23.9
South	14.1	10.1	17.7	12.0	9.1	14.5	12.0	8.6	14.5
West	18.5	14.5	24.5	17.4	13.6	23.8	18.5	14.1	22.3
2006 NCHS urban-rural classification									
Large central metropolitan	20.0	16.4	26.3	17.4	13.3	23.8	18.1	14.5	23.0
Large fringe metropolitan	16.9	12.1	20.4	17.0	12.6	20.0	13.3	9.1	17.7
Medium metropolitan	14.3	11.1	16.1	12.6	10.6	15.1	13.7	11.1	15.1
Small metropolitan	†	†	†	8.4	7.9	12.3	8.4	7.9	10.6
Other counties	†	†	†	9.6	6.8	12.8	†	†	†

† Estimates for groups with fewer than 100 respondents or fewer than 25 respondents above the 75th percentile or below the 25th percentile are not shown.

NOTES: Percentiles calculated using survey weights. NO₂ is nitrogen dioxide. EPA is the U.S. Environmental Protection Agency. NCHS is the National Center for Health Statistics.

Table 21. Median and interquartile range of CO exposure (ppm) for respondents linked to annual EPA monitoring data, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Geographic linkage method								
	5-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th
Total	0.50	0.41	0.65	0.50	0.39	0.63	0.50	0.39	0.60
Poverty status									
Below poverty threshold	0.50	0.40	0.65	0.49	0.39	0.64	0.50	0.39	0.60
At or above poverty threshold	0.50	0.41	0.65	0.50	0.39	0.63	0.49	0.39	0.60
Hispanic origin and race									
Hispanic or Latino	0.55	0.42	0.70	0.54	0.44	0.66	0.51	0.45	0.60
Mexican	0.55	0.42	0.71	0.54	0.40	0.65	0.49	0.42	0.60
Not Hispanic or Latino	0.49	0.40	0.63	0.49	0.38	0.61	0.49	0.38	0.60
White only	0.49	0.39	0.62	0.48	0.38	0.60	0.48	0.38	0.60
Black or African American only	0.49	0.41	0.65	0.50	0.40	0.59	0.50	0.38	0.59
Age									
Less than 25 years	0.50	0.41	0.65	0.50	0.39	0.63	0.49	0.38	0.60
25–64 years	0.50	0.41	0.65	0.50	0.39	0.63	0.50	0.39	0.60
65 years and over	0.51	0.41	0.65	0.50	0.39	0.64	0.49	0.39	0.60
Health status									
Poor or fair	0.50	0.41	0.64	0.49	0.39	0.64	0.49	0.38	0.60
Excellent, very good, or good	0.50	0.41	0.65	0.50	0.39	0.63	0.50	0.39	0.60
Region									
Northeast	0.52	0.38	0.62	0.48	0.36	0.69	0.49	0.33	0.57
Midwest	0.45	0.38	0.55	0.45	0.37	0.54	0.48	0.37	0.54
South	0.47	0.41	0.56	0.47	0.38	0.56	0.47	0.38	0.53
West	0.60	0.43	0.74	0.61	0.47	0.79	0.60	0.46	0.79
2006 NCHS urban-rural classification									
Large central metropolitan	0.55	0.43	0.71	0.54	0.40	0.68	0.53	0.41	0.61
Large fringe metropolitan	0.48	0.38	0.60	0.50	0.40	0.57	0.46	0.32	0.55
Medium metropolitan	0.44	0.39	0.59	0.45	0.38	0.55	0.45	0.39	0.52
Small metropolitan	†	†	†	0.45	0.38	0.81	†	†	†
Other counties	†	†	†	0.37	0.33	0.44	†	†	†

† Estimates for groups with fewer than 100 respondents or fewer than 25 respondents above the 75th percentile or below the 25th percentile are not shown.

NOTES: Percentiles calculated using survey weights. CO is carbon monoxide. EPA is the U.S. Environmental Protection Agency. NCHS is the National Center for Health Statistics.

Table 22. Median and interquartile range of PM_{2.5} (µg/m³) exposure among respondents linked to annual EPA air monitoring data, by geographic linkage method and respondent characteristic: United States, 2005

Characteristic	Geographic linkage method								
	5-mile			20-mile			County		
	Median	25th	75th	Median	25th	75th	Median	25th	75th
Total	13.6	10.9	15.5	13.4	10.6	15.5	13.2	10.6	15.4
Poverty status									
Below poverty threshold	13.9	11.3	15.8	13.7	10.8	15.7	13.5	11.1	15.4
At or above poverty threshold	13.5	10.7	15.5	13.4	10.6	15.4	13.2	10.6	15.4
Hispanic origin and race									
Hispanic or Latino	13.5	10.5	15.6	12.6	10.1	15.7	12.6	10.5	15.4
Mexican	13.2	10.5	16	12.3	10.1	16.1	12.5	10.5	15.4
Not Hispanic or Latino	13.6	11	15.5	13.5	10.8	15.5	13.3	10.8	15.4
White only	13.3	10.6	15.4	13.4	10.6	15.4	13.2	10.6	15.3
Black or African American only	14.4	12.8	15.8	14.2	12.5	15.8	14.2	12.5	15.7
Age									
Less than 25 years	13.5	10.9	15.5	13.4	10.6	15.5	13.2	10.6	15.4
25–64 years	13.6	10.9	15.5	13.4	10.6	15.5	13.2	10.6	15.4
65 years and over	13.5	10.7	15.6	13.4	10.6	15.4	13.1	10.6	15.4
Health status									
Poor or fair	13.7	11.4	15.7	13.5	10.9	15.6	13.3	11.0	15.4
Excellent, very good, or good	13.5	10.8	15.5	13.4	10.6	15.5	13.2	10.6	15.4
Region									
Northeast	13.6	12.4	14.9	13.6	11.7	14.7	13.6	11.7	14.4
Midwest	15.5	12.9	16.4	15.6	12.9	16.3	15.3	12.9	16.2
South	13.6	11.7	15.1	13.5	11.7	15.0	13.2	11.2	14.8
West	10.3	8.6	14.7	9.9	9.0	14.0	10.5	9.0	14.1
2006 NCHS urban-rural classification									
Large central metropolitan	14.4	11.8	16.0	13.7	10.6	16.1	13.3	11.0	15.6
Large fringe metropolitan	13.5	11.6	15.5	13.9	10.8	15.5	13.6	11.0	15.1
Medium metropolitan	12.8	10.3	15.0	13.0	10.4	14.8	12.6	10.3	14.7
Small metropolitan	11.7	8.2	13.9	12.7	9.6	14.1	12.1	8.1	14.1
Other counties	12.4	10.1	14.6	13.6	10.8	14.9	12.9	10.2	14.6

NOTES: Percentiles calculated using survey weights. PM_{2.5} is particulate matter less than 2.5 microns in diameter. EPA is the U.S. Environmental Protection Agency. NCHS is the National Center for Health Statistics.

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