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Linkage of 1999–2012 National Health Interview Survey and National Health and Nutrition Examination Survey Data to U.S. Department of Housing and Urban Development Administrative Records

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

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Programs and Collection Procedures

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

Hyattsville, Maryland
October 2017
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Abstract

Background

The National Center for Health Statistics (NCHS) provides statistical information to guide actions and policy to improve the health of the American people. NCHS has developed a data linkage program that links its cross-sectional health survey data to information from vital and administrative data sources. Through a collaborative interagency agreement between NCHS and the U.S. Department of Housing and Urban Development (HUD), participants in two national health surveys administered by NCHS were linked to administrative data from HUD.

Methods

This report describes and evaluates the data linkage of 1999–2012 National Health Interview Survey (NHIS) and National Health and Nutrition Examination Survey (NHANES) to administrative records from HUD through 2014. A brief overview of the data sources, methods used for linkage, details of the resulting linked data files, and analytic considerations are provided.

Conclusions

The NCHS–HUD linkage demonstrates the feasibility of linking population health survey data to administrative records from federal programs and enhances two NCHS population health surveys, NHANES and NHIS, by allowing examination of the relationship between housing and health.

Keywords: record linkage • linked data • HUD • housing • NHIS • NHANES

Linkage of 1999–2012 National Health Interview Survey and National Health and Nutrition Examination Survey Data to U.S. Department of Housing and Urban Development Administrative Records

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Introduction

The National Center for Health Statistics (NCHS) is the nation's principal agency providing health statistics to identify and address health issues. To maximize the scientific value of NCHS population-based surveys, the agency has developed a data linkage program that links health survey data to vital and administrative data sources. Linked data files enable researchers to use longitudinal data from administrative databases or mortality data in combination with cross-sectional data to examine and provide more insight on factors that influence disability, health care utilization, morbidity, and mortality among different U.S. subpopulations.

Two NCHS national health surveys—the National Health Interview Survey (NHIS) and the National Health and Nutrition Examination Survey (NHANES)—monitor the health and well-being of the civilian noninstitutionalized population of the United States. Through a collaborative interagency agreement between NCHS and the U.S. Department of Housing and Urban Development (HUD), participant records from these two NCHS surveys were linked to administrative data from HUD's largest federal housing assistance programs, which include Housing Choice Vouchers (HCVs), multifamily (MF), and public housing (PH) programs. The HUD administrative files contain housing, income, and household characteristics as well as program participation data for HCV, MF, and PH program recipients in all 50 states and the District of Columbia.

This report summarizes the data sources and linkage methods used to create the linked NCHS–HUD data files. It provides linkage rates for the 1999–2012 NHIS–HUD and NHANES–HUD linked files and the percentage distribution of selected characteristics among linked survey participants. Appendix I contains a summary of the HUD programs included in linked data sets. Appendix II summarizes the contents of the linked NCHS–HUD data files. Appendix III provides details about the files and a description of some key

variables for researchers to consider when using the linked NCHS–HUD data. Appendix IV describes an evaluation comparing characteristics among linked 2012 NHIS–HUD and 2009–2012 NHANES–HUD participants to those of HCV, MF, and PH program recipients, using HUD administrative data from the same time period.

Data Sources

NHIS

NHIS is a cross-sectional household interview survey designed to monitor the health of the civilian noninstitutionalized U.S. population through the collection and analysis of data on a broad range of health topics (1). NCHS has conducted NHIS continuously since 1957, and the content of the survey is periodically updated. The sampling plan follows a multistage area probability design that permits the representative sampling of households and noninstitutional group quarters (e.g., college dormitories). The sampling plan is redesigned after every decennial census. The NHIS 1995–2005 survey design oversampled black as well as Hispanic persons; the 2006–2012 design oversampled black, Hispanic, and Asian persons (2).

Demographic and basic health information are collected on everyone in the household. For the years of data used for linkage, the Core questions have remained largely unchanged. This allows for trend analyses and for data from more than 1 year to be pooled to increase sample size for analytic purposes. For 1999–2012 NHIS, the Core section contains four major components: Household, Family, Sample Adult, and Sample Child. The Household component collects limited demographic information on all of the individuals in a particular household. The Family component verifies and collects additional demographic information on each member from each family in the household and collects data on topics including health status and limitations, injuries, health care access and utilization, health insurance, and income and assets.

From each family, one sample adult (not necessarily the head of household) and one sample child (if any children under age 18 years are present) are randomly selected, and detailed survey data are collected on specific health topics using the Sample Adult Core and the Sample Child Core questionnaires. Data for the Sample Child questionnaire is obtained from a knowledgeable adult in the household, usually a parent.

Data are collected through a personal household interview conducted by interviewers employed and trained by the U.S. Census Bureau according to procedures specified by NCHS. A computer-assisted personal interviewing (CAPI) mode using a laptop computer has been used since 1997. For more information on NHIS, visit: https://www.cdc.gov/nchs/nhis.htm.

NHANES

NHANES utilizes interviews, laboratory tests, and physical examinations to assess the health and nutritional status of civilian noninstitutionalized adults and children in the United States (3). The survey currently includes a nationally representative sample of about 5,000 persons in about 15 counties across the country each year. Oversampled subgroups for 1999–2006 included non-Hispanic black as well as Mexican-American persons; low-income persons of non-Hispanic white and other race and ethnicity (beginning in 2000); adolescents aged 12–19; and non-Hispanic white and other persons aged 70 and over. Oversampled subgroups for 2007–2010 included all Hispanic as well as non-Hispanic black persons; low-income persons of non-Hispanic white and other race and ethnicity; and non-Hispanic white and other persons aged 80 and over (4,5). Beginning with the NHANES 2011–2012 cycle, non-Hispanic Asian persons were also oversampled in addition to the ongoing oversample of subgroups from 2007–2010 (6).

Health interviews are conducted in participants' homes. Physical examinations and health measurements are performed in a specially designed and equipped mobile examination center (MEC), which travels to locations throughout the country. The study team consists of a physician, medical and health technicians, and dietary and health interviewers.

The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests. Survey findings are used to determine the prevalence of major diseases and risk factors for diseases. NHANES findings are also the basis for national standards for such measurements as height and weight and for national growth charts. Data are also collected on chronic and previously undiagnosed conditions.

More information on NHANES is available from: https://www.cdc.gov/nchs/nhanes.htm.

HUD Administrative Data

HUD's largest housing assistance programs, which include Housing Choice Vouchers (HCVs), multifamily (MF) programs, and public housing (PH) programs, are included in the linked NCHS–HUD data. MF programs provide affordable housing through contracts with private owners of apartment buildings. HCV and PH programs are managed by local public housing agencies (PHAs), which oversee data collection and manage housing assistance program implementation. Buildings of PH programs are owned by PHAs. The HCV program gives tenants a voucher that covers part of their rent in a private-market unit. Administrative data for HUD-assisted households are submitted by housing providers. Additional information about these programs is provided in Appendix I and the Analytic Guidelines (7).

Public and Indian Housing Information Center

Local PHAs collect and electronically submit information to the Public and Indian Housing Information Center (PIC) for households receiving HCVs or PH assistance. Each occasion that data are entered into the system is referred to as a transaction. The administrative purpose of the periodic transactions is to ensure that tenant rent contributions, which are based on income, are determined accurately. Information collected on the administrative forms include: dates of enrollment and participation, program recertification, family characteristics, detailed income and asset information for all household members, and an estimate of the family's anticipated income for the next 12 months, including sources of that income. More information about recertification for HCV and PH programs is available from the Analytic Guidelines (7).

Tenant Rental Assistance Certification System

Owner/agents and contract administrators of MF units collect and electronically submit information to HUD through the Tenant Rental Assistance Certification System (TRACS). As with PIC, TRACS collects dates of enrollment and participation, program recertification, detailed income and asset information for all household members, and an estimate of the family's anticipated income for the next 12 months, including sources of that income. Also like PIC, each occasion that data are entered into the system is referred to as a transaction. More information about TRACS and recertification for MF programs is available from the Analytic Guidelines (7).

HUD transaction dates included in NCHS–HUD administrative period

For the linkage described in this report, HUD programming staff created an extract of HUD transactions for recipients of HCV, MF, and PH programs based on PIC and TRACS, referred to as the Transaction File. HUD administrative records included in the Transaction File were restricted to MF program transactions occurring June 30, 1996–December 31, 2014, and HCV and PH program transactions occurring December 1, 1999–December 31, 2014. These program transaction periods are referred to as the linked NCHS–HUD administrative period.

Data Linkage Approval, Eligibility, and Process

Linkage Approval and Eligibility

All NCHS data linkage activities are reviewed and approved by the NCHS Research Ethics Review Board (ERB). The NCHS Research ERB, which functions similar to an Institutional Review Board (IRB), is an appointed ethics review committee that ensures research involving human participants and the welfare of study participants conform to federal regulations. The NCHS–HUD linkage was reviewed and approved by the NCHS Research ERB.

Survey data and HUD administrative records were linked only for NCHS–HUD linkage-eligible survey participants. NCHS determined eligibility for this linkage based on whether the survey participant provided certain data elements necessary for linkage, including Social Security number (SSN), sex, month of birth, year of birth, first name, and last name; did not refuse data linkage; and did not refuse to respond to questions about receiving rental assistance (NHIS only). The question about receiving rental assistance was asked only of families reporting that they lived in a rental property. Very few families living in a rental property refused to answer the question about receiving rental assistance (less than 1% in each of the 1999–2012 NHIS survey years). NCHS–HUD linkage eligibility is distinct from HUD program eligibility; the latter defines whether a person meets eligibility criteria to receive HUD housing assistance through HCVs and related programs, MF programs, or PH programs. More information about HUD eligibility criteria is available from the HUD website: https://www.huduser.gov/portal/home.html.

The process for determining linkage eligibility and collecting personally identifiable information (PII) varied by NCHS survey and year (cycle). For NHANES, PII was consistently collected during the time frame used for linkage, but the process for obtaining consent for record linkage varied across the survey cycles. For 1999–2008 NHANES participants, refusal to provide an SSN was considered an implicit refusal for record linkage. For 2009–2012 NHANES, participants were explicitly asked for consent to be included in record linkage activities during the informed consent process prior to interview. Participants who provided an affirmative response to the linkage question were considered linkage-eligible, conditional on having sufficient PII.

For NHIS, changes over time in the process for collecting PII and the addition of a question to obtain explicit consent for linkage meant that the criteria for linkage eligibility varied by survey year. For 1999–2006, the full nine-digit SSN (SSN9) was requested. For 1999–2001, SSN9 was requested for all NHIS participants. For 2002–2003, SSN9 was requested for only the family respondent. For 2004–2006, SSN9 was requested for the NHIS family respondent, sample adult, and sample child. For these years, if participants refused to provide SSNs, they were implicitly considered to have refused record linkage. During that time period, the refusal rate for providing SSN increased, which reduced the number of NHIS participants eligible for record linkage (8). In an attempt to counter the decline in linkage eligibility rates, research was conducted at NCHS to assess the accuracy of National Death Index matches using partial SSN and other PII. The research assessed algorithms using the last four and last six digits of SSNs. The results provided sufficient evidence to support changes in how NHIS collected SSNs for linkage (9). Beginning in 2007, NHIS attempted to decrease linkage refusal rates by adding a short introduction before asking

for SSN during the interview, requesting only the last four SSN digits (SSN4) instead of all nine and asking participants for their explicit permission to link to administrative records if SSN4 had not been provided (8). Also at this time, the NCHS Research ERB determined that for NHIS 2007 forward, only primary respondents (sample adult and sample children) would be eligible for linkage to administrative records.

NCHS survey participants under age 18 at the time of the survey are considered linkage-eligible if the above-mentioned linkage eligibility criteria are met and consent is provided by their parent or guardian at the time of the survey. Once the child participant becomes an adult, however, they do not have the opportunity to provide or deny consent for linking their survey data to administrative data based on their experience as an adult. In accordance with NCHS Research ERB guidelines, the linked NCHS–HUD data of child participants are available only for records that occurred prior to the survey participant's 18th birthday. For example, a 15-year-old linkage-eligible survey participant of NHIS 2005 can be linked to HUD administrative records. Linked data containing HUD administrative data for 2007 and earlier years could be accessed by a researcher and included in analyses because the child survey participant would have been under age 18 during this time. However, NCHS is not authorized to provide researchers access to HUD administrative records for that child survey participant from 2008 through 2012 because the child survey participant would have been aged 18 or older.

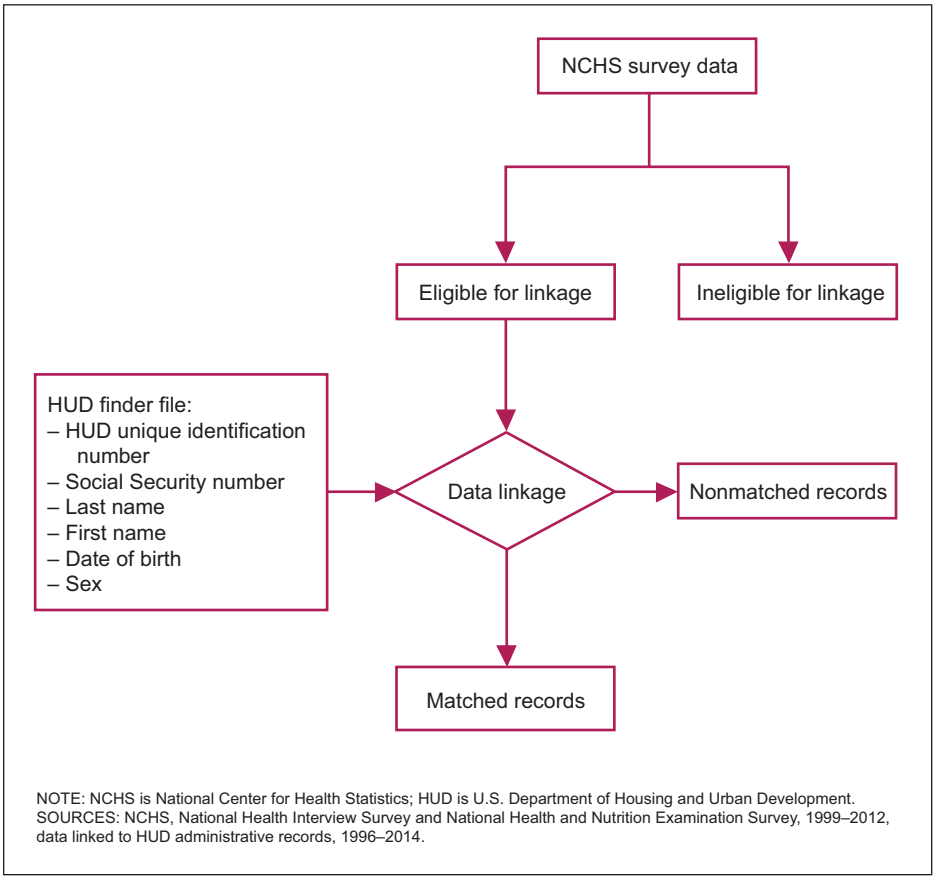
Table 1 presents the total number of 1999–2012 NHIS participants for each survey year and age group (0–17 years, 18–39, 40–64, and 65 and over), the number who were eligible for linkage, the percentage eligible out of the total sample, the number who were linked, and the percentage who were linked out of those eligible for linkage. Data are presented for all NHIS participants, both sample adults and sample children. Table 2 shows similar results for 1999–2012 NHANES participants. Data are presented for all NHANES participants and for those who were examined in the MEC.

Linkage Process

Figure 1 presents the overall process for linking NCHS survey data to HUD administrative data. HUD provided a data file, referred to as the HUD finder file, containing PII (e.g., SSN, first and last name, sex, date of birth, a unique HUD-created identification [ID], and a sequence number to identify specific transactions) of individual HCV, MF, or PH program recipients. NCHS staff verified that the SSNs on the HUD files were valid before linking to a file of 1999–2012 NHIS and NHANES linkage-eligible survey participants. For example, if an SSN contained fewer than nine digits; nonnumeric values; the first three digits "000," "666," or in the 900 series; the second group of two digits as "00"; or the third group of four digits as "0000," it was not considered valid. For survey participants who did not provide a valid SSN yet did not refuse to provide their SSN, SSN9 was extracted from their Medicare Health Insurance Claim (HIC) number, if provided. SSN9 was extracted from the Medicare HIC number only if the survey participant was identified as the primary claimant for Medicare benefits.

The linkage was predominantly deterministic or rules-based, meaning that a set of criteria had to be met for a pair of records to be linked. Two approaches were used to link NCHS survey data to HUD administrative records. The first approach was used for NCHS survey years when the SSN9 was collected from survey participants (1999–2006 NHIS and all NHANES cycles). This approach linked survey participants to HUD administrative records by matching on valid SSN9, year of birth, month of birth, and sex.

The second approach accommodated the NHIS survey years when SSN4 was collected. This approach matched on SSN4, year of birth, month of birth, sex, first name, last name, and day of



NOTE: NCHS is National Center for Health Statistics; HUD is U.S. Department of Housing and Urban Development.
SOURCES: NCHS, National Health Interview Survey and National Health and Nutrition Examination Survey, 1999–2012, data linked to HUD administrative records, 1996–2014.

Figure 1. Process used to link National Center for Health Statistics survey data to U.S. Department of Housing and Urban Development administrative data sources

birth, thus incorporating first and last names and day of birth into the matching criteria. Agreement on first name and last name was based on exact spelling matches or, because spelling variants of names are common, was based on the way a name sounds rather than how it is spelled. The sound-alike systems included both a variation of the New York State Identification Intelligence System (NYSIIS) and the Soundex algorithm (10). NYSIIS converts a name to a phonetic coding. For example, records with last names Smith and Smyth received equivalent NYSIIS codes, and both would be selected as a potential match for an NCHS submission with Smith (or Smyth) as a last name. Similarly, Soundex is a phonetic algorithm for indexing names by sound, as pronounced in English. The goal is for homophones to be encoded to the same representation so that they can agree despite minor differences in spelling. Specifically, the second approach linked survey participants to administrative records based on matching the last four digits of SSN, year of birth, month of birth, sex, and meeting at least one of the following conditions:

- Soundex of first names and last names agree and are not missing
- NYSIIS of first names and last names agree and are not missing
- Soundex of nonmissing first names agree and day of birth agree
- Soundex of nonmissing last names agree and day of birth agree
- NYSIIS of nonmissing first names agree and day of birth agree
- NYSIIS of nonmissing last names agree and day of birth agree
- Soundex first name agrees with Soundex last name and Soundex last name agrees with Soundex first name
- NYSIIS first name agrees with NYSIIS last name and NYSIIS last name agrees with NYSIIS first name

NCHS participants whose data fields matched the equivalent administrative fields using either of the two approaches were identified as linked records.

To increase the likelihood of finding a match, multiple or alternate submission records were used for each linkage-eligible NCHS survey participant based on variations of names. HUD records could be matched to any or all of the submission records created for a survey participant. For example, the name "Beth" may be a nickname for a formal name like "Elizabeth." In this situation, a record for "Beth" and a record for "Elizabeth" were created and submitted for linkage.

Once the linkage was performed and the best-matched record was selected, NCHS created an NCHS finder file containing the HUD-created ID and binary indicator flags for survey participants who were linked to the HUD administrative files for HCV, MF, or PH program recipients through 2014. This file was delivered to HUD, and HUD programming staff prepared and delivered to NCHS a single transactions-level file containing data summarized for the person's household as well as data summarized for the individual HUD housing assistance recipients who were linked to NCHS survey participants.

NCHS programming staff ensured that all linked survey participants identified in the linkage process were returned in the transaction file. NCHS staff edited the HUD Transaction File to resolve discrepancies with linked records so that the final transaction file met ERB guidelines. The final linked transaction file served as the basis for creating the linked files.

Linked NCHS–HUD Data

General Description of Linked Data Files

The linked NCHS survey data and HUD administrative data were used to produce 12 separate data files. Two public-use feasibility files, one for the 1999–2012 NHIS and one for the 1999–2012 NHANES, are available on the NCHS data linkage website: https://www.cdc.gov/nchs/data-linkage/index.htm. Ten restricted-use files, consisting of the transaction and concurrency files, seven separate episode files, and a weights file, are available only through the NCHS Research Data Center (RDC). Appendix Table I describes each of the files that compose the linked NCHS–HUD data. Data documentation, including the Analytic Guidelines (7) and Data Dictionary (11), feasibility files, and sample read-in software programs to import the feasibility files, can be found on the NCHS website: https://www.cdc.gov/nchs/data-linkage/hud.htm. Details about each of the linked files are provided in the following section.

NHIS–HUD and NHANES–HUD public-use feasibility files

NCHS created the 1999–2012 NHIS–HUD public-use feasibility file and the 1999–2012 NHANES–HUD feasibility file, which can be downloaded directly from the NCHS website and merged with public-use NHIS and NHANES data, respectively.

The feasibility files contain data on survey participants' linkage eligibility status for the NCHS–HUD linkage, final match status, and whether the survey participant ever participated in HCV, MF, or PH programs. A survey participant is classified as "ever receiving HUD housing assistance" if the survey participant was linkage-eligible and had at least one transaction in the HUD administrative database during the linked NCHS–HUD administrative time period. Also provided are three variables representing ever participation in HCV, MF, or PH programs during the linked NCHS–HUD administrative time period. Program participation is not mutually exclusive across the administrative period. For example, a person may receive assistance as an MF program recipient and then receive an HCV during the linked NCHS–HUD administrative period.

The feasibility files can be used to determine the maximum available sample size to assess the feasibility of conducting analyses using the linked NCHS–HUD data by allowing researchers who are developing NCHS RDC proposals to determine if sufficient numbers of individuals and sufficient degrees of freedom exist in the category of interest

among those that have been successfully linked to HUD administrative data. These publicly available files also make it possible to identify demographic and health status variables available in the corresponding survey public-use data through subdividing the survey sample, calculating estimates of numbers of people in categories of interest, and determining cell sizes by related categories.

Note that the feasibility files do not contain data pertaining to the timing of HUD assistance or details about the housing unit; instead, they contain record status variables and record counts to assist researchers who are considering whether to initiate an RDC proposal. Researchers should be aware that all NCHS surveys linked to the HUD administrative data have complex survey designs. Therefore, considerations of sample size and statistical power should take into account the survey design to produce statistically reliable analyses (2,6).

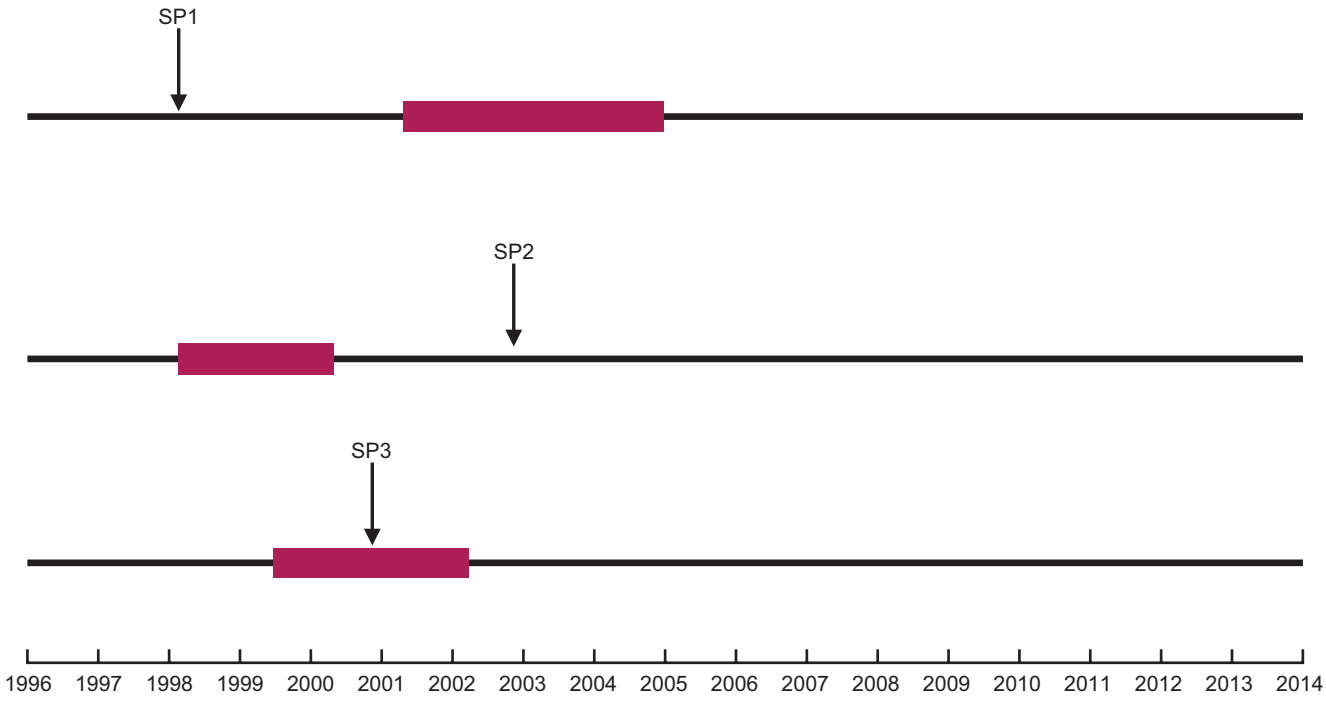
NCHS–HUD restricted-use transaction file

The transaction file contains a record for each HUD administrative transaction of the linked 1999–2012 NHIS–HUD and NHANES–HUD participants, and may contain more than one record per person. The transaction file contains detailed member and household attributes that are contained in HUD administrative systems. Transactions for child participants that occurred after the child's 18th birthday were removed during postprocessing, per ERB guidance.

NCHS–HUD restricted-use episode files

To facilitate analyses using the linked files, episode files were created with a single record per person containing the start and end dates for each period of continuous enrollment, or episode. An episode is a single continuous period of enrollment in a HUD program and is characterized by a start date and an end date. A graphical depiction of an episode is presented in Figure 2.

Seven episode files contain start and end dates for participation episodes. One file is for all HUD programs overall, and six additional files are for HUD subprograms based on the transaction data and assumptions about reasonable intervals between transactions (Appendix Table I). Most HUD housing assistance recipients are required to recertify each year, and consequently, a transaction is expected each year. However, some HUD programs have longer intervals between recertifications. The episode files are useful primarily for longitudinal analysis related to the duration and timing of housing assistance episodes, and conditions or outcomes that may have pre-existed or occurred after such episodes.



NOTES: The figure shows three possible scenarios related to the temporal alignment of the linked survey and housing assistance data for three hypothetical survey participants (SPs). In each timeline, the arrow represents the year of the National Center for Health Statistics (NCHS) survey, and the rectangular box represents the time period (episode) during which the SP received housing assistance from the U.S. Department of Housing and Urban Development (HUD). SP1 received HUD assistance after his or her interview, SP2 received HUD assistance before his or her interview, and SP3 received HUD assistance concurrent with his or her interview.
SOURCES: NCHS, National Health Interview Survey and National Health and Nutrition Examination Survey, 1999–2012, data linked to HUD administrative records, 1996–2014.

Figure 2. Temporal alignment of National Center for Health Statistics surveys linked to U.S. Department of Housing and Urban Development administrative data files

NCHS–HUD restricted-use concurrency file

The NCHS–HUD concurrency file is a restricted-use file that contains a single record for each linked participant and summarizes information based on timing of housing assistance relative to the date of the NCHS survey interview or examination. This file includes all linked survey participants, whether they were classified as concurrent or nonconcurrent. A linked survey participant is classified as concurrent if he or she was administered their NCHS survey interview or examination between the start and end dates of a HUD assistance episode. A graphical depiction of a survey participant who concurrently received HUD assistance at the time of the survey (SP3) is provided in Figure 2. A nonconcurrent participant would have partaken in the NCHS survey at some point outside of their HUD assistance episode (SP1 and SP2 in Figure 2).

The concurrency file enables researchers to determine whether linked survey participants concurrently received HUD housing assistance at the time of the NHIS or NHANES interview or NHANES examination. Several factors influence the temporal alignment of the survey and administrative data, including age of the survey participant, HUD program eligibility, discontinuous program coverage, and residential mobility of the survey participants. More information about the concurrency variables is provided in Appendix III.

For researchers interested in examining the timing of HUD assistance for nonconcurrent linked participants, the number of days between the interview date and the end date of their most recent HUD episode was calculated, as well as the number of days between the interview date and the start date of their next HUD episode. Although these variables cannot be accessed directly by the researcher, researchers can request their own categories in their RDC proposal, based on the number of days between the NCHS interview or examination and a HUD transaction. More information about these timing variables is provided in Appendix III.

Table 3 presents the number and percentage of NHIS and NHANES linked participants who received HUD housing assistance concurrently, within 1, 2, and 3 years of their survey interview. Data are presented by survey year and age at the time of interview (0–17 years, 18–39, 40–64, and 65 and over).

NCHS–HUD restricted-use sample weights file

The weights file contains a record for each 1999–2012 NHIS and NHANES participant who was linkage-eligible, and contains five sample weights (sample adult weight, sample child weight, and person weight for NHIS, and interview weight and MEC weight for NHANES) that correspond to the survey and are adjusted for linkage eligibility. All linkage-ineligible survey participants are given a weight of zero. The linkage eligibility-adjusted sample weights were derived using a model-based calibration approach.

The sample weights provided in the NCHS population health survey data files adjust for oversampling of specific subgroups and differential nonresponse. The sample weights are poststratified to annual population totals for specific population domains to provide nationally representative estimates (2,12–14). Previous research suggests that survey participants who provide sufficient PII for linkage are not a random sample of survey participants. For some characteristics, linkage-eligible survey participants may differ systematically from survey participants who are not linkage-eligible; failing to account for linkage eligibility when examining these differences may lead to biased results (15). Analyses using the linked NCHS–HUD data should include only linkage-eligible survey participants rather than the full survey sample, and NCHS recommends using sample weights that are adjusted for linkage eligibility.

To adjust for the potential bias that may result from differences between the linkage-eligible and linkage-ineligible populations, the linked NCHS–HUD data contain linkage-eligibility adjusted weights. A model-based calibration approach developed within the SUDAAN software package (Procedure WTADJUST or WTADJX) (16) was used to adjust the statistical weights for nonresponse with auxiliary information, specifically age, race and ethnicity, and sex. NCHS provides adjusted sample weights in a weights file based on this approach to account for differences in characteristics among linkage-eligible and linkage-ineligible survey participants. Because inferences may depend on the approach used to adjust sample weights—within SUDAAN's WTADJUST or using a different calibration approach—researchers are advised to seek assistance from a mathematical statistician for guidance on their particular project. Note that other approaches to calculating weights or handling possible linkage-eligibility bias with other statistical software packages can be used. More information about the eligibility-adjusted survey weights can be found in the Analytic Guidelines (7).

Access to Linked NCHS–HUD Data Files

Due to confidentiality requirements, NCHS restricts the availability of linked NCHS–HUD data files to researchers who have approved research proposals through NCHS RDC, with the exception of the NCHS–HUD feasibility files (available from: https://www.cdc.gov/nchs/data-linkage/hud-feasibility.htm). More information regarding RDC and instructions for submitting an RDC proposal are available from: https://www.cdc.gov/rdc/.

Analytic Considerations

This section highlights general considerations and guidelines for analysis when using the linked data files; more detailed information can be found in the Analytic Guidelines (7). These general considerations do not replace the guidance for analyzing data from NHIS and NHANES. NCHS encourages researchers who discover new analytic issues during the course of their analysis

of the linked data to report them to the NCHS Data Linkage Program via datalinkage@cdc.gov.

As part of a researcher's proposal to RDC, restricted variables from NCHS surveys and variables from the HUD files need to be specifically requested within the same proposal. For more information about restricted-use NCHS survey data, visit: https://www.cdc.gov/rdc/b1datatype/dt122.htm. In the proposal, the researcher provides a file containing variables from the public-use NCHS survey data to RDC for merging with the requested restricted variables from NCHS surveys and the linked NCHS–HUD file variables. An RDC staff member verifies the full list of variables (restricted and public-use) and consults with the data divisions at NCHS that are responsible for producing the files, as well as with the NCHS confidentiality office to ensure that no potential disclosure risk of survey participants exists. A description of selected variables that may be useful in analyses of the linked NCHS–HUD data files is included in Appendix III.

Sample Weights

All proposals to use the linked data should request the correct sample weight to be used. The weights file contains a single record for all survey participants of 1999–2012 NHIS and NHANES, as well as adjusted sample weights from NHIS (person weight, sample adult weight, and sample child weight) and NHANES (interview weight and MEC weight). See the Data Dictionary for more information about these variables (11).

Analyses Using Linked NCHS–HUD Data

NCHS recommends that researchers using the linked NCHS–HUD data combine survey years to increase sample size, if needed. Consult the analytic guidelines for NHANES (6,17) and NHIS (18,19) for instructions on combining years. Even though the survey periods for the linked 1999–2012 NHIS–HUD and NHANES–HUD data files overlap, data from the two surveys should be analyzed separately.

Careful consideration is needed when examining characteristics among NCHS–HUD linked participants and defining an analytic sample of linked participants. Although some characteristics (e.g., sex or race and ethnicity) are not likely to change over time or be associated with receipt of HUD housing assistance, other characteristics (e.g., type of health insurance coverage or poverty status) may differ because these characteristics are associated with receipt of HUD housing assistance. As a result, survey participants who were linked at any time during the administrative period and those who were receiving HUD housing assistance at the time of their survey interview or examination may differ for several characteristics.

When combining years of survey data, NCHS recommends that researchers assess the assumption of no trend in the estimates of the research variables of interest over the time periods being combined, including trends in the receipt of housing assistance, and changes in the quality of the HUD administrative data that may affect their study results.

Descriptive Analyses of Linked NHIS–HUD and NHANES–HUD Participants

The linked NCHS–HUD data allow for many different analyses, but note that the population of linked survey participants may differ from both their respective survey populations as well as the overall population of HUD housing assistance recipients. Survey participants who were linked to the HUD administrative data may not be representative of the larger survey populations and differ by certain characteristics, such as poverty status, that would make them more likely to receive HUD housing assistance. This section provides a brief descriptive analysis of the linked NHIS–HUD and NHANES–HUD participants and their similarities to and differences from their respective survey populations. A comparison between the population of linked survey participants and the overall population of HUD housing assistance recipients is presented in Appendix IV.

Descriptive statistics for 2008–2012 NHIS and 2009–2012 NHANES participants and linked survey participants from those same surveys are presented in Tables 4–7. Children (aged 0–17 years) and adults (aged 18 and over) are presented separately. Summary statistics for the linked NHIS–HUD data are presented in Tables 4 and 5; linked NHANES–HUD summary statistics are shown in Tables 6 and 7. The sample weights used in preparing the summary statistics are those in the weights file and are adjusted for linkage eligibility as described previously. Researchers should be aware that applying different analytic approaches (i.e., variable parameterization and alternative approaches to weight adjustment) may result in findings different from those presented below.

The following criteria were used to assess similarities and differences in the selected sociodemographic and health characteristics between linked participants and the survey population:

1. If the percentage for each category (e.g., male or female) of a characteristic (e.g., sex) is equal for both linked participants and the survey population, it is described as being the same.
2. If the relative difference between the linked sample and the survey population, defined as:

$$| X_{population} - X_{linked} | / X_{population}$$

is between 0.0 and 0.1 for all categories of the characteristic, the linked sample is described as being "consistent or similar" to the survey population with respect to that characteristic.
3. If the relative difference between the linked sample and the survey population for at least one category of the characteristic is 0.1 or greater, the linked sample is described as being "different (higher/more or lower/less)" than the survey population with respect to that characteristic.

Because the two populations (linked participants and the survey population) were not statistically independent and measures of correlation between the two populations were not readily available, comparisons were not statistically tested.

Descriptive statistics for 2008–2012 NHIS child participants and linked child survey participants are presented in Table 4. The percentages of the linked child survey participants that were male (49.6%) and female (50.4%) were similar to the percentages among the NHIS population aged 0–17 years (males 51.1%, females 48.9%). However, the distributions of age, race and ethnicity, poverty status, health status, and health insurance coverage differed between the two populations. Compared to the population of NHIS child participants, more of the linked child survey participants were aged 6–11 years (38.5% compared to 32.9%) and non-Hispanic black (47.7% compared to 15.3%), and had family incomes that were below the poverty threshold (59.2% compared to 21.5%). The percentage of children with fair or poor health was higher among the linked child survey participants (5.0%) than among NHIS child participants (1.9%), and more linked child survey participants had public insurance (67.7%) compared to NHIS child participants (26.6%).

Descriptive statistics for 2008–2012 NHIS adult participants and linked adult survey participants are presented in Table 5. The distributions of sex, age, race and ethnicity, poverty status, health status, and health insurance coverage among linked adult survey participants differed between the two populations. Compared to NHIS adult participants, more linked adult survey participants were female (69.5% compared to 51.7%), aged 18–39 (54.9% compared to 39.1%), and non-Hispanic black (37.1% compared to 11.9%), and had family incomes that were below the poverty threshold (48.0% compared to 12.8%), fair or poor health (29.1% compared to 12.7%), and public insurance (47.7% compared to 15.3%).

Descriptive statistics for 2009–2012 NHANES child participants and linked child survey participants are presented in Table 6. The percentages of linked child survey participants that were male (49.1%) and female (50.9%) were similar to the percentages among the NHANES population aged 0–17 years (males 50.7%, females 49.3%). However, the distributions of age, race and ethnicity, poverty status, health status, and health insurance coverage differed between the two populations. More of the linked child survey participants were aged 12–17 years (40.6% compared to 34.5%) and non-Hispanic black (45.8% compared to 14.2%), and had family incomes that were below the poverty threshold (61.0% compared to 23.5%). Compared to NHANES child participants, linked child survey participants had a higher percentage with fair or poor health (7.1% compared to 4.3%) and a lower percentage with no health insurance coverage (5.5% compared to 8.0%).

Descriptive statistics for 2009–2012 NHANES adult participants and linked adult survey participants aged 18 and over are presented in Table 7. The distributions of sex, age, race and ethnicity, poverty status, health status, and health insurance coverage differed between the two populations. Compared to NHANES adult participants, more linked adult survey participants were female (66.7% compared to 51.7%), aged 18–39 (52.8% compared to 38.7%), and non-Hispanic black (35.6% compared to 11.6%), and had family incomes that were below the poverty guideline (47.1% compared to 15.8%), had fair or poor health (33.5% compared to 17.2%), and were uninsured (26.1% compared to 20.3%).

These results may assist researchers in understanding how linked survey participants differ from the overall survey sample and demonstrate that inferences about research findings based on the linked sample may not be generalizable to the national population. Additionally, the linked data are not intended to reflect the entire population of HUD housing assistance recipients. The linked participants represent the survey participants that received federal housing assistance at some time point in the linked NCHS–HUD administrative period. This may not be the same as the entire population of HUD housing assistance recipients because of the sample design of the surveys, which include only the civilian noninstitutionalized U.S. population. In Appendix IV, characteristics of the linked sample and the entire HUD-assisted population are presented to illustrate similarities and differences between linked survey participants and the entire population receiving HUD assistance.

Conclusion

The linked NCHS–HUD data are the first NCHS linked data product combining health and housing assistance data and stem from an interagency collaboration between NCHS and HUD. These data provide information about health characteristics of persons who received HUD housing assistance during the 1999–2014 HUD administrative period, including those receiving HUD housing assistance at the time of their survey interview and/or examination. While the distribution of various characteristics (such as sex, or race and ethnicity) remained consistent between individuals who had been linked and the overall sample, several characteristics appear to differ (such as poverty status). These differences in characteristics, as well as changes in the data or receipt of assistance over time, may impact findings from analyses of the linked NCHS–HUD data.

The linkage of health data from NHIS and NHANES to housing assistance data from the HUD administrative records enhances the utility of these population health surveys as well as the HUD administrative data. The NCHS–HUD linkage provides a unique opportunity to examine the relationship between receipt of assisted housing and various health-related outcomes, such as access to health care and utilization of health services, general health status, health characteristics, and health behaviors.

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Table 1. Sample size and percentage of survey participants linked to HUD data, by survey year and age at interview: National Health Interview Survey, 1999–2012

Survey year and age (years) at NHIS interview	All NHIS participants					Sample Adult					Sample Child				
		Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD	
	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible
1999–2012															
Total	1,291,224	316,102	24.48	27,555	8.72	413,027	205,905	49.85	18,610	9.04	166,212	41,599	25.03	4,939	11.87
1999															
Total	97,059	36,822	37.94	2,673	7.26	30,801	17,115	55.57	1,411	8.24	12,910	3,698	28.64	344	9.30
0–17	27,271	7,050	25.85	698	9.90	...	...	...	...	...	12,910	3,698	28.64	344	9.30
18–39	30,183	11,709	38.79	905	7.73	12,544	6,716	53.54	603	8.98	...	...	...	...	...
40–64	28,605	12,387	43.30	671	5.42	12,255	6,750	55.08	465	6.89	...	...	...	...	...
65 and over	11,000	5,676	51.60	399	7.03	6,002	3,649	60.80	343	9.40	...	...	...	...	...
2000															
Total	100,618	35,318	35.10	2,815	7.97	32,374	16,605	51.29	1,433	8.63	13,376	3,504	26.2	393	11.22
0–17	28,495	6,755	23.71	829	12.27	...	...	...	...	...	13,376	3,504	26.2	393	11.22
18–39	31,153	11,263	36.15	892	7.92	13,283	6,512	49.03	609	9.35	...	...	...	...	...
40–64	29,764	11,903	39.99	680	5.71	12,911	6,609	51.19	479	7.25	...	...	...	...	...
65 and over	11,206	5,397	48.16	414	7.67	6,180	3,484	56.38	345	9.90	...	...	...	...	...
2001															
Total	100,760	35,397	35.13	2,701	7.63	33,326	16,997	51.00	1,384	8.14	13,579	3,551	26.15	406	11.43
0–17	28,572	6,763	23.67	807	11.93	...	...	...	...	...	13,579	3,551	26.15	406	11.43
18–39	30,941	11,131	35.97	912	8.19	13,555	6,590	48.62	612	9.29	...	...	...	...	...
40–64	30,230	12,191	40.33	612	5.02	13,619	6,939	50.95	461	6.64	...	...	...	...	...
65 and over	11,017	5,312	48.22	370	6.97	6,152	3,468	56.37	311	8.97	...	...	...	...	...
2002															
Total	93,386	16,681	17.86	1,385	8.30	31,044	11,353	36.57	1,119	9.86	12,524	...	...	...	...
0–17	26,191	...	...	...	...	...	...	...	...	...	12,524	...	...	...	...
18–39	28,298	6,148	21.73	600	9.76	12,467	4,219	33.84	455	10.78	...	...	...	...	...
40–64	28,312	7,134	25.20	472	6.62	12,717	4,629	36.40	373	8.06	...	...	...	...	...
65 and over	10,585	3,399	32.11	313	9.21	5,860	2,505	42.75	291	11.62	...	...	...	...	...
2003															
Total	92,148	14,805	16.07	1,305	8.81	30,852	10,223	33.14	1,062	10.39	12,249	...	...	...	...
0–17	25,537	...	...	...	...	...	...	...	...	...	12,249	...	...	...	...
18–39	27,809	5,383	19.36	568	10.55	12,154	3,782	31.12	446	11.79	...	...	...	...	...
40–64	28,529	6,416	22.49	474	7.39	12,939	4,204	32.49	384	9.13	...	...	...	...	...
65 and over	10,273	3,006	29.26	263	8.75	5,759	2,237	38.84	232	10.37	...	...	...	...	...
2004															
Total	94,460	21,744	23.02	1,790	8.23	31,326	13,428	42.87	1,170	8.71	12,424	3,170	25.52	384	12.11
0–17	26,161	3,175	12.14	384	12.09	...	...	...	...	...	12,424	3,170	25.52	384	12.11
18–39	28,015	6,896	24.62	648	9.40	12,052	5,080	42.15	517	10.18	...	...	...	...	...
40–64	29,526	7,984	27.04	463	5.80	13,255	5,503	41.52	384	6.98	...	...	...	...	...
65 and over	10,758	3,689	34.29	295	8.00	6,019	2,845	47.27	269	9.46	...	...	...	...	...

See footnotes at end of table.

Table 1. Sample size and percentage of survey participants linked to HUD data, by survey year and age at interview: National Health Interview Survey, 1999–2012—Con.

Survey year and age (years) at NHIS interview	All NHIS participants					Sample Adult					Sample Child				
		Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD	
	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible
2005															
Total	98,649	18,765	19.02	1,608	8.57	31,428	11,727	37.31	1,036	8.83	12,523	2,658	21.22	331	12.45
0–17	26,814	2,660	9.92	332	12.48	...	...	...	...	...	12,523	2,658	21.22	331	12.45
18–39	28,982	5,778	19.94	619	10.71	11,810	4,260	36.07	488	11.46	...	...	...	...	...
40–64	31,623	7,137	22.57	442	6.19	13,540	4,959	36.62	351	7.08	...	...	...	...	...
65 and over	11,230	3,190	28.41	215	6.74	6,078	2,508	41.26	197	7.85	...	...	...	...	...
2006															
Total	75,716	13,319	17.59	1,370	10.29	24,275	8,418	34.68	919	10.92	9,837	1,806	18.36	249	13.79
0–17	20,903	1,806	8.64	249	13.79	...	...	...	...	...	9,837	1,806	18.36	249	13.79
18–39	22,578	4,322	19.14	535	12.38	9,418	3,235	34.35	440	13.60	...	...	...	...	...
40–64	23,845	4,922	20.64	387	7.86	10,210	3,401	33.31	300	8.82	...	...	...	...	...
65 and over	8,390	2,269	27.04	199	8.77	4,647	1,782	38.35	179	10.04	...	...	...	...	...
2007															
Total	75,764	14,247	18.8	1,338	9.39	23,393	11,643	49.77	1,012	8.69	9,417	2,604	27.65	326	12.52
0–17	20,719	2,604	12.57	326	12.52	...	...	...	...	...	9,417	2,604	27.65	326	12.52
18–39	22,598	4,358	19.28	484	11.11	8,864	4,358	49.17	484	11.11	...	...	...	...	...
40–64	24,008	5,029	20.95	349	6.94	9,946	5,029	50.56	349	6.94	...	...	...	...	...
65 and over	8,439	2,256	26.73	179	7.93	4,583	2,256	49.23	179	7.93	...	...	...	...	...
2008															
Total	74,236	15,268	20.57	1,462	9.58	21,781	12,438	57.10	1,109	8.92	8,815	2,830	32.1	353	12.47
0–17	19,914	2,830	14.21	353	12.47	...	...	...	...	...	8,815	2,830	32.1	353	12.47
18–39	22,116	4,574	20.68	538	11.76	8,067	4,574	56.70	538	11.76	...	...	...	...	...
40–64	23,728	5,380	22.67	374	6.95	9,270	5,380	58.04	374	6.95	...	...	...	...	...
65 and over	8,478	2,484	29.3	197	7.93	4,444	2,484	55.90	197	7.93	...	...	...	...	...
2009															
Total	88,446	21,580	24.4	2,208	10.23	27,731	17,413	62.79	1,653	9.49	11,156	4,167	37.35	555	13.32
0–17	23,830	4,167	17.49	555	13.32	...	...	...	...	...	11,156	4,167	37.35	555	13.32
18–39	25,952	6,306	24.3	794	12.59	10,277	6,306	61.36	794	12.59	...	...	...	...	...
40–64	28,546	7,608	26.65	592	7.78	11,961	7,608	63.61	592	7.78	...	...	...	...	...
65 and over	10,118	3,499	34.58	267	7.63	5,493	3,499	63.70	267	7.63	...	...	...	...	...
2010															
Total	89,976	20,139	22.38	1,917	9.52	27,157	16,073	59.19	1,447	9.00	11,277	4,066	36.06	470	11.56
0–17	24,057	4,066	16.9	470	11.56	...	...	...	...	...	11,277	4,066	36.06	470	11.56
18–39	26,788	5,970	22.29	684	11.46	10,200	5,970	58.53	684	11.46	...	...	...	...	...
40–64	28,691	6,912	24.09	515	7.45	11,507	6,912	60.07	515	7.45	...	...	...	...	...
65 and over	10,440	3,191	30.57	248	7.77	5,450	3,191	58.55	248	7.77	...	...	...	...	...

See footnotes at end of table.

Table 1. Sample size and percentage of survey participants linked to HUD data, by survey year and age at interview: National Health Interview Survey, 1999–2012—Con.

Survey year and age (years) at NHIS interview	All NHIS participants					Sample Adult					Sample Child				
		Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD	
	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible
2011															
Total	101,875	25,786	25.31	2,378	9.22	33,014	21,055	63.78	1,820	8.64	12,850	4,731	36.82	558	11.79
0–17	26,802	4,731	17.65	558	11.79	...	...	...	...	...	12,850	4,731	36.82	558	11.79
18–39	29,970	7,704	25.71	901	11.70	12,191	7,704	63.19	901	11.70	...	...	...	...	...
40–64	32,586	8,870	27.22	608	6.85	13,921	8,870	63.72	608	6.85	...	...	...	...	...
65 and over	12,517	4,481	35.80	311	6.94	6,902	4,481	64.92	311	6.94	...	...	...	...	...
2012															
Total	108,131	26,231	24.26	2,605	9.93	34,525	21,417	62.03	2,035	9.50	13,275	4,814	36.26	570	11.84
0–17	28,016	4,814	17.18	570	11.84	...	...	...	...	...	13,275	4,814	36.26	570	11.84
18–39	31,184	7,555	24.23	972	12.87	12,434	7,555	60.76	972	12.87	...	...	...	...	...
40–64	35,361	9,218	26.07	700	7.59	14,709	9,218	62.67	700	7.59	...	...	...	...	...
65 and over	13,570	4,644	34.22	363	7.82	7,382	4,644	62.91	363	7.82	...	...	...	...	...

... Category not applicable.

NOTE: HUD is U.S. Department of Housing and Urban Development, and NHIS is National Health Interview Survey.

SOURCES: NCHS, 1999–2012 NHIS data linked to 1999–2014 HUD administrative records.

Table 2. Sample size and percentage of survey participants linked to HUD data, by survey year and age at interview: National Health and Nutrition Examination Survey, 1999–2012

Survey year and age (years) at NHANES interview	All NHANES participants					MEC participants				
		Eligible for linkage		Linked to HUD			Eligible for linkage		Linked to HUD	
	Total sample	*n*	Percent of total	*n*	Percent of eligible	Total sample	*n*	Percent of total	*n*	Percent of eligible
1999–2012										
Total	71,916	50,559	70.30	6,532	12.92	75,127	48,769	64.92	6,354	13.03
1999–2000										
Total	9,965	7,235	72.60	882	12.19	10,648	6,843	64.27	850	12.42
0–17	4,517	2,933	64.93	452	15.41	4,728	2,839	60.05	443	15.60
18–39	2,263	1,714	75.74	188	10.97	2,425	1,607	66.27	183	11.39
40–64	1,793	1,475	82.26	127	8.61	1,907	1,400	73.41	122	8.71
65 and over	1,392	1,113	79.96	115	10.33	1,588	997	62.78	102	10.23
2001–2002										
Total	11,039	8,715	78.95	1,199	13.76	11,601	8,346	71.94	1,160	13.90
0–17	5,046	3,709	73.50	711	19.17	5,207	3,626	69.64	700	19.31
18–39	2,507	2,002	79.86	266	13.29	2,606	1,929	74.02	261	13.53
40–64	2,023	1,753	86.65	108	6.16	2,104	1,691	80.37	104	6.15
65 and over	1,463	1,251	85.51	114	9.11	1,684	1,100	65.32	95	8.64
2003–2004										
Total	10,122	8,084	79.87	1,075	13.30	10,601	7,764	73.24	1,045	13.46
0–17	4,502	3,265	72.52	600	18.38	4,664	3,176	68.10	587	18.48
18–39	2,321	1,930	83.15	258	13.37	2,425	1,856	76.54	255	13.74
40–64	1,805	1,573	87.15	126	8.01	1,896	1,501	79.17	123	8.19
65 and over	1,494	1,316	88.09	91	6.91	1,616	1,231	76.18	80	6.50
2005–2006										
Total	10,348	7,298	70.53	911	12.48	10,746	7,073	65.82	888	12.55
0–17	4,785	3,079	64.35	522	16.95	4,954	3,001	60.58	510	16.99
18–39	2,507	1,816	72.44	211	11.62	2,614	1,748	66.87	205	11.73
40–64	1,867	1,448	77.56	111	7.67	1,925	1,413	73.40	109	7.71
65 and over	1,189	955	80.32	67	7.02	1,253	911	72.71	64	7.03
2007–2008										
Total	10,149	6,724	66.25	873	12.98	10,536	6,543	62.10	858	13.11
0–17	3,921	2,186	55.75	427	19.53	4,075	2,127	52.20	417	19.61
18–39	2,203	1,537	69.77	217	14.12	2,274	1,501	66.01	215	14.32
40–64	2,469	1,823	73.84	157	8.61	2,543	1,784	70.15	156	8.74
65 and over	1,556	1,178	75.71	72	6.11	1,644	1,131	68.80	70	6.19
2009–2010										
Total	10,537	6,607	62.70	754	11.41	10,821	6,482	59.90	738	11.39
0–17	4,010	2,084	51.97	299	14.35	4,127	2,041	49.45	293	14.36
18–39	2,392	1,587	66.35	219	13.80	2,450	1,560	63.67	217	13.91
40–64	2,612	1,808	69.22	153	8.46	2,658	1,783	67.08	149	8.36
65 and over	1,523	1,128	74.06	83	7.36	1,586	1,098	69.23	79	7.19
2011–2012										
Total	9,756	5,896	60.43	838	14.21	10,174	5,718	56.20	815	14.25
0–17	3,892	1,904	48.92	339	17.80	4,061	1,849	45.53	332	17.96
18–39	2,261	1,468	64.93	229	15.60	2,348	1,420	60.48	222	15.63
40–64	2,353	1,601	68.04	158	9.87	2,431	1,568	64.50	156	9.95
65 and over	1,250	923	73.84	112	12.13	1,334	881	66.04	105	11.92

NOTE: HUD is U.S. Department of Housing and Urban Development, NHANES is National Health and Nutrition Examination Survey, and MEC is mobile examination center.

SOURCES: NCHS, 1999–2012 NHANES data linked to 1996–2014 HUD administrative records.

Table 3. Linked NCHS–HUD file sample size and percentage of linked survey participants with concurrent HUD enrollment within 1, 2, and 3 years of survey interview, by survey and age at interview

Survey year and age (years) at NCHS interview	Linked respondents	Concurrently linked		Within 1 year of interview		Within 2 years of interview		Within 3 years of interview	
	n	*n*	Percent of all linked	*n*	Percent of all linked	*n*	Percent of all linked	*n*	Percent of all linked
NHIS									
1999–2012 total	27,555	11,060	40.1	16,076	58.3	18,666	67.7	20,394	74.0
1999 total	2,673	234	08.8	1,106	41.4	1,638	61.3	1,805	67.5
0–17	698	48	06.9	316	45.3	488	69.9	520	74.5
18–39	905	56	06.2	327	36.1	507	56.0	584	64.5
40–64	671	56	08.4	241	35.9	355	52.9	390	58.1
65 and over	399	74	18.6	222	55.6	288	72.2	311	77.9
2000 total	2,815	735	26.1	1,557	55.3	1,783	63.3	1,998	71.0
0–17	829	226	27.3	496	59.8	571	68.9	637	76.8
18–39	892	192	21.5	455	51.0	540	60.5	621	69.6
40–64	680	160	23.5	331	48.7	369	54.3	416	61.2
65 and over	414	157	37.9	275	66.4	303	73.2	324	78.3
2001 total	2,701	806	29.8	1,517	56.2	1,777	65.8	1,933	71.6
0–17	807	234	29.0	464	57.5	565	70.0	612	75.8
18–39	912	229	25.1	478	52.4	565	62.0	622	68.2
40–64	612	195	31.9	320	52.3	366	59.8	399	65.2
65 and over	370	148	40.0	255	68.9	281	76.0	300	81.1
2002 total	1,385	483	34.9	802	57.9	959	69.2	1,046	75.5
0–17	...	...	...	...	...	...	...	...	...
18–39	600	176	29.3	320	53.3	410	68.3	457	76.2
40–64	472	167	35.4	277	58.7	317	67.2	343	72.7
65 and over	313	140	44.7	205	65.5	232	74.1	246	78.6
2003 total	1,305	537	41.2	800	61.3	929	71.2	1,023	78.4
0–17	...	...	...	...	...	...	...	...	...
18–39	568	188	33.1	299	52.6	367	64.6	431	75.9
40–64	474	218	46.0	304	64.1	344	72.6	367	77.4
65 and over	263	131	49.8	197	74.9	218	82.9	225	85.6
2004 total	1,790	771	43.1	1,091	61.0	1,279	71.5	1,407	78.6
0–17	384	162	42.2	242	63.0	289	75.3	325	84.6
18–39	648	230	35.5	359	55.4	430	66.4	489	75.5
40–64	463	207	44.7	273	59.0	319	68.9	345	74.5
65 and over	295	172	58.3	217	73.6	241	81.7	248	84.1
2005 total	1,608	688	42.8	951	59.1	1,107	68.8	1,227	76.3
0–17	332	142	42.8	209	63.0	246	74.1	272	81.9
18–39	619	229	37.0	331	53.5	394	63.7	446	72.1
40–64	442	182	41.2	250	56.6	291	65.8	318	72.0
65 and over	215	135	62.8	161	74.9	176	81.9	191	88.8
2006 total	1,370	601	43.9	799	58.3	930	67.9	1,066	77.8
0–17	249	99	39.8	140	56.2	174	69.9	207	83.1
18–39	535	197	36.8	283	52.9	327	61.1	383	71.6
40–64	387	185	47.8	230	59.4	267	69.0	305	78.8
65 and over	199	120	60.3	146	73.4	162	81.4	171	85.9
2007 total	1,338	667	49.9	822	61.4	953	71.2	1,048	78.3
0–17	326	164	50.3	211	64.7	248	76.1	269	82.5
18–39	484	215	44.4	270	55.8	323	66.7	357	73.8
40–64	349	168	48.1	206	59.0	234	67.1	261	74.8
65 and over	179	120	67.0	135	75.4	148	82.7	161	89.9
2008 total	1,462	729	49.9	905	61.9	998	68.3	1,094	74.8
0–17	353	170	48.2	221	62.6	246	69.7	269	76.2
18–39	538	212	39.4	279	51.9	320	59.5	370	68.8
40–64	374	208	55.6	244	65.2	266	71.1	286	76.5
65 and over	197	139	70.6	161	81.7	166	84.3	169	85.8
2009 total	2,208	1,161	52.6	1,389	62.9	1,566	70.9	1,690	76.5
0–17	555	283	51.0	358	64.5	413	74.4	448	80.7
18–39	794	347	43.7	419	52.8	489	61.6	543	68.4
40–64	592	337	56.9	391	66.1	431	72.8	457	77.2
65 and over	267	194	72.7	221	82.8	233	87.3	242	90.6

See footnotes at end of table.

Table 3. Linked NCHS–HUD file sample size and percentage of linked survey participants with concurrent HUD enrollment within 1, 2, and 3 years of survey interview, by survey and age at interview—Con.

Survey year and age (years) at NCHS interview	Linked respondents	Concurrently linked		Within 1 year of interview		Within 2 years of interview		Within 3 years of interview	
	n	*n*	Percent of all linked	*n*	Percent of all linked	*n*	Percent of all linked	*n*	Percent of all linked
NHIS—Con.									
2010 total	1,917	974	50.8	1,198	62.5	1,337	69.7	1,447	75.5
0–17	470	215	45.7	283	60.2	329	70.0	365	77.7
18–39	684	274	40.1	366	53.5	421	61.6	458	67.0
40–64	515	294	57.1	343	66.6	370	71.8	395	76.7
65 and over	248	191	77.0	206	83.1	217	87.5	229	92.3
2011 total	2,378	1,231	51.8	1,481	62.3	1,623	68.3	1,731	72.8
0–17	558	266	47.7	351	62.9	394	70.6	423	75.8
18–39	901	384	42.6	469	52.1	521	57.8	562	62.4
40–64	608	349	57.4	404	66.5	437	71.9	466	76.6
65 and over	311	232	74.6	257	82.6	271	87.1	280	90.0
2012 total	2,605	1,443	55.4	1,658	63.7	1,787	68.6	1,879	72.1
0–17	570	319	56.0	387	67.9	415	72.8	433	76.0
18–39	972	419	43.1	501	51.5	558	57.4	595	61.2
40–64	700	415	59.3	455	65.0	486	69.4	519	74.1
65 and over	363	290	79.9	315	86.8	328	90.4	332	91.5
NHANES									
1999–2012 total	6,532	2,573	39.4	3,963	60.7	4,616	70.7	5,104	78.1
1999–2000 total	882	202	22.9	498	56.5	608	68.9	654	74.2
0–17	452	101	22.4	266	58.9	326	72.1	349	77.2
18–39	188	34	18.1	86	45.7	117	62.2	126	67.0
40–64	127	19	15.0	62	48.8	74	58.3	82	64.6
65 and over	115	48	41.7	84	73.0	91	79.1	97	84.4
2001–2002 total	1,199	343	28.6	702	58.6	848	70.7	935	78.0
0–17	711	219	30.8	452	63.6	534	75.1	587	82.6
18–39	266	60	22.6	127	47.7	169	63.5	192	72.2
40–64	108	27	25.0	54	50.0	66	61.1	72	66.7
65 and over	114	37	32.5	69	60.5	79	69.3	84	73.7
2003–2004 total	1,075	475	44.2	683	63.5	789	73.4	883	82.1
0–17	600	275	45.8	408	68.0	467	77.8	523	87.2
18–39	258	103	39.9	143	55.4	174	67.4	196	76.0
40–64	126	48	38.1	72	57.1	78	61.9	90	71.4
65 and over	91	49	53.9	60	65.9	70	76.9	74	81.3
2005–2006 total	911	369	40.5	558	61.3	667	73.2	730	80.1
0–17	522	217	41.6	335	64.2	407	78.0	445	85.3
18–39	211	69	32.7	114	54.0	139	65.9	152	72.0
40–64	111	50	45.1	64	57.7	70	63.1	78	70.3
65 and over	67	33	49.3	45	67.2	51	76.1	55	82.1
2007–2008 total	873	402	46.1	518	59.3	590	67.6	664	76.1
0–17	427	207	48.5	273	63.9	306	71.7	341	79.9
18–39	217	85	39.2	112	51.6	132	60.8	151	69.6
40–64	157	78	49.7	91	58.0	106	67.5	120	76.4
65 and over	72	32	44.4	42	58.3	46	63.9	52	72.2
2009–2010 total	754	346	45.9	459	60.9	512	67.9	574	76.1
0–17	299	148	49.5	201	67.2	228	76.3	257	86.0
18–39	219	59	26.9	93	42.5	112	51.1	129	58.9
40–64	153	79	51.6	97	63.4	103	67.3	116	75.8
65 and over	83	60	72.3	68	81.9	69	83.1	72	86.8
2011–2012 total	838	436	52.0	545	65.0	602	71.8	664	79.2
0–17	339	182	53.7	234	69.0	260	76.7	290	85.6
18–39	229	82	35.8	118	51.5	131	57.2	152	66.4
40–64	158	85	53.8	94	59.5	108	68.4	117	74.1
65 and over	112	87	77.7	99	88.4	103	92.0	105	93.8

… Category not applicable.

NOTE: NCHS is National Center for Health Statistics; HUD is U.S. Department of Housing and Urban Development; NHIS is National Health Interview Survey; and NHANES is National Health and Nutrition Examination Survey.

SOURCES: NCHS, 1999–2012 NHIS and NHANES data linked to 1996–2014 HUD administrative records.

Table 4. Unweighted sample size and weighted percent distribution of ever-linked 2008–2012 NHIS–HUD participants aged 0–17 years, by selected sociodemographic and health characteristics

Characteristic	All NHIS and HUD participants		Linked participants	
	n	Percent (weighted)	*n*	Percent (weighted)
Sex				
Male	62,663	51.1	1,245	49.6
Female	59,956	48.9	1,261	50.4
Age group (years)				
0–5	40,651	34.0	712	28.8
6–11	40,969	32.9	883	38.5
12–17	40,999	33.1	911	32.7
Race and Hispanic origin				
Hispanic	40,019	22.8	543	18.1
Non-Hispanic:				
White	52,740	56.1	638	31.1
Black	21,022	15.3	1,248	47.7
Other	8,838	5.8	77	*3.1
Poverty level[1]				
Below 100% of federal threshold	31,376	21.5	1,442	59.2
100%–200% or more of federal threshold	30,639	23.1	700	27.5
200% or more of federal threshold	60,604	55.5	364	13.3
Health status[2]				
Excellent/Very good	98,889	82.7	1,801	73.0
Good	20,975	15.3	578	22.0
Fair/Poor	2,673	1.9	127	*5.0
Health insurance				
No coverage	10,541	7.7	137	*5.3
Private insurance	59,576	54.8	341	14.4
Public Insurance	38,021	26.6	1,694	67.7
Other coverage	13,691	10.3	330	12.4

* Percentage estimate may be statistically unreliable because the absolute width of its Korn-Graubard confidence interval is between 5 and 30 percentage points, yet its relative width is larger than 130%.
[1]Based on published U.S. Census Bureau poverty thresholds.
[2]Self-reported.

NOTES: Missing responses are not presented. NHIS is National Health Interview Survey, and HUD is U.S. Department of Housing and Urban Development.

SOURCES: NCHS, 2008–2012 NHIS data linked to 1996–2014 HUD data.

Table 5. Unweighted sample size and weighted percent distribution of ever-linked 2008–2012 NHIS–HUD participants aged 18 and over, by selected sociodemographic and health characteristics

Characteristic	All NHIS and HUD participants		Linked participants	
	n	Percent (weighted)	*n*	Percent (weighted)
Sex				
Male	159,645	48.3	2,087	30.5
Female	178,897	51.7	5,977	69.5
Age group (years)				
18–39	134,928	39.1	3,889	54.9
40–64	148,491	43.9	2,789	32.3
65 and over	55,123	17.0	1,386	12.8
Race and Hispanic origin				
Hispanic	71,800	14.1	1,396	17.5
Non-Hispanic:				
White	190,468	68.4	2,949	41.1
Black	49,091	11.9	3,377	37.1
Other	27,183	5.7	342	4.3
Poverty level[1]				
Below 100% of federal threshold	50,690	12.8	4,386	48.0
100%–200% of federal threshold	69,661	18.8	2,356	30.5
200% of federal threshold or more	218,191	68.4	1,322	21.5
Health status[2]				
Excellent/Very good	197,900	60.3	2,909	40.0
Good	94,218	26.8	2,562	30.8
Fair/Poor	45,882	12.7	2,588	29.1
Health insurance				
No coverage	67,656	17.5	1,653	23.5
Private insurance	200,361	63.2	1,681	23.0
Public insurance	55,963	15.3	4,255	47.7
Other coverage	11,364	3.1	452	5.3

[1]Based on published U.S. Census Bureau poverty thresholds.
[2]Self-reported.

NOTES: Missing responses are not presented. NHIS is National Health Interview Survey, and HUD is U.S. Department of Housing and Urban Development.

SOURCES: NCHS, 2008–2012 NHIS data linked to 1996–2014 HUD data.

Table 6. Unweighted sample size and weighted percent distribution of ever-linked 2009–2012 NHANES–HUD participants aged 0–17 years, by selected sociodemographic and health characteristics

Characteristic	All NHANES and HUD participants		Linked participants	
	n	Percent weighted	*n*	Percent weighted
Sex				
Male	4,009	50.7	336	49.1
Female	3,893	49.3	302	50.9
Age group (years)				
0–5	3,318	32.9	201	25.1
6–11	2,585	32.5	233	34.3
12–17	1,999	34.5	204	40.6
Race and Hispanic origin				
Hispanic	2,354	18.9	112	16.9
Non-Hispanic:				
White	2,389	56.0	97	26.6
Black	1,894	14.2	359	45.8
Other	1,265	10.9	70	10.6
Family income to poverty guideline ratio[1]				
Less than 1	2,646	23.5	415	61.0
1 to 2	1,942	22.3	156	24.9
More than 2	2,668	47.6	50	11.1
Health status[2]				
Excellent/Very good	5,538	74.7	423	66.0
Good	1,925	21.0	163	26.9
Fair/Poor	438	4.3	52	7.1
Health insurance				
Has coverage	7,207	91.8	606	94.5
No coverage	678	8.0	32	5.5

[1]Calculated using U.S. Department of Health and Human Services poverty guidelines.
[2]Self-reported.

NOTES: Missing responses are not presented. NHANES is National Health and Nutrition Examination Survey, and HUD is U.S. Department of Housing and Urban Development.

SOURCES: NCHS, 2009–2012 NHANES data linked to 1996–2014 HUD data.

Table 7. Unweighted sample size and weighted percent distribution of ever-linked 2009–2012 NHANES–HUD participants aged 18 and over, by selected sociodemographic and health characteristics

Characteristic	All NHANES and HUD participants		Linked participants	
	n	Percent (weighted)	*n*	Percent (weighted)
Sex				
Male	6,072	48.3	339	33.3
Female	6,319	51.7	615	66.7
Age group (years)				
18–39	4,653	38.7	448	52.8
40–64	4,965	44.2	311	34.6
65 and over	2,773	17.1	195	12.6
Race and Hispanic origin				
Hispanic	2,830	13.1	173	21.3
Non-Hispanic:				
White	5,296	67.1	257	35.3
Black	2,733	11.6	446	35.6
Other	1,532	8.3	78	7.8
Family income to poverty guideline ratio				
Less than 1	2,823	15.8	506	47.1
1 to 2	2,984	18.9	284	32.0
More than 2	5,394	57.9	108	15.3
Health status[1]				
Excellent/Very good	4,855	47.6	267	30.1
Good	4,580	35.1	334	36.4
Fair/Poor	2,952	17.2	353	33.5
Health insurance				
Has coverage	9,326	79.6	721	73.8
No coverage	3,047	20.3	231	26.1

[1]Self-reported.

NOTES: Missing responses are not presented. NHANES is National Health and Nutrition Examination Survey, and HUD is U.S. Department of Housing and Urban Development.

SOURCES: NCHS, 2009–2012 NHANES data linked to 1996–2014 HUD data.

Appendix I. U.S. Department of Housing and Urban Development's Largest Housing Assistance Programs

This appendix describes basic characteristics of the U.S. Department of Housing and Urban Development's (HUD) largest housing assistance programs that are included in the linked National Center for Health Statistics (NCHS) survey and HUD files. More detailed information on these programs can be found in the Analytic Guidelines (7).

Housing Choice Vouchers and Related Programs

The Housing Choice Voucher (HCV) program is the federal government's largest housing assistance program, allowing low-income families, the elderly, and persons with disabilities to choose and lease safe and affordable housing. In the HCV program, housing assistance is tenant-based, meaning that participants find their own housing in the private market. Participants are free to choose any housing that meets program requirements and are not limited to units located in subsidized housing projects. For example, participants can choose single-family homes, townhouses, or apartments. When a public housing agency (PHA) issues a voucher to a family, the family is responsible for finding suitable housing, and the rental unit owner must agree to participate in the program. Selected units must meet minimal standards of health and safety as determined by the PHA. In the linked data, the HCV program also includes Homeownership Voucher, Project-Based Voucher, Section 8 Moderate Rehabilitation, and Section 8 Rental Certificate programs.

The Moving to Work (MTW) demonstration program was introduced to give PHAs flexibility with public housing (PH) and HCV programs. Participants in HCV programs may be served by either MTW or non-MTW PHAs, which have different mandates for data completeness and frequency of recertification. More information on the MTW demonstration project can be found in the Analytic Guidelines (7).

Multifamily Programs

The multifamily (MF) program category in the linked NCHS–HUD data encompasses a number of separate, distinct HUD programs, including: Section 221(d)(3) Below Market Interest Rate, Section 236 Multifamily Housing, Rental Assistance, Project-Based Section 8 (or PBS8) Voucher Assistance in Multifamily Housing, Section 202 Supportive Housing for the Elderly Program, Section 202/162—Project Assistance Contract, Section 811 Supportive Housing for Persons with Disabilities, and Rent Supplement. Because each of these programs lacked sufficient sample size on an individual basis in the linked file, they were combined into a single MF program category in the linked data files.

In all MF programs, subsidies are paid directly to private property owners who provide a certain percentage of their housing units at affordable rates for low-income persons who qualify. Ownership may be for-profit or nonprofit. HUD subsidies (i.e., rental subsidies, below-market interest financing, insured mortgages, and other forms of assistance) typically are linked with ongoing rental assistance for annual operating costs. MF program assistance is tied to the property, unlike tenant-based rental assistance programs (e.g., HCVs), and tenants cannot take their rental housing assistance subsidy elsewhere. Assistance always stays with the owner of the development during the duration of their assistance contract.

Public Housing

The PH program was established to provide safe rental housing for eligible low-income families, the elderly, and persons with disabilities. PH dwellings range from scattered-site single-family detached houses to high-rise apartment buildings. HUD provides capital subsidies and operating subsidies to local PHAs that manage public housing for eligible low-income residents. HUD also provides technical assistance to help PHAs plan, develop, and manage PH developments.

For PH residents, income must be verified at re-examination periods every 12–18 months. At re-examination, if the person's or family's income exceeds 80% of area median income, then PHA may reassess their eligibility for public housing. In PH programs, specific calculations are used to determine a tenant's monthly rent amount.

As with tenants in an HCV program, tenants participating in PH programs may be served by either MTW or non-MTW PHAs, which have different mandates for data completeness and frequency of recertification. More information on the MTW demonstration project can be found in the Analytic Guidelines (7).

Appendix II. Summary of Linked National Center for Health Statistics–U.S. Department of Housing and Urban Development Data

Table I. Linked NCHS–HUD data files: Name, population, and description

Data files	Universe	Description
Feasibility:		
1999–2012 NHIS–HUD	All 1999–2012 NHIS and NHANES participants	NCHS created two feasibility files for each linked survey file to aid researchers performing sample size and power calculations for potential analyses. The feasibility files contain linkage eligibility information and program participation indicators for each 1999–2012 NHIS and NHANES participant. See Analytic Guidelines for details on using these files to determine sample size.
1999–2012 NHANES–HUD		
Transaction	All 1999–2012 NHIS and NHANES participants linked to HUD administrative data	This file contains each transaction of the linked 1999–2012 NHIS–HUD and NHANES–HUD participants. As noted in Analytic Guidelines, transactions for children were removed if the transaction occurred after the child's 18th birthday.
Episode:		
Episode_dates	All 1999–2012 NHIS and NHANES participants linked to HUD administrative data	Seven episode files contain start and end dates for participation in HUD programs, based on transaction data and assumptions about reasonable intervals between transactions. Because most HUD recipients must recertify each year, a transaction is expected each year. However, certain HUD program categories (e.g., Moving to Work) have longer intervals between recertifications. See Analytic Guidelines for details on construction of the episode files.
Episode dates–MTW HCV	Linked participants with at least one Moving to Work Housing Choice Voucher transaction	
Episode dates–MTW PH	Linked participants with at least one Moving to Work public housing transaction	
Episode dates–Other MF	Linked participants with at least one Other multifamily transaction	
Episode dates–PBS8	Linked participants with at least one multifamily project-based Section 8 transaction	
Episode dates–PH	Linked participants with at least one public housing transaction	
Episode dates–HCV	Linked participants with at least one Housing Choice Voucher transaction	
Concurrency	All 1999–2012 NHIS and NHANES participants linked to HUD administrative data	This file contains variables related to the timing of HUD housing participation relative to NCHS survey participation, such as indicator variables for receipt of HUD housing assistance at the time of survey; type of HUD housing assistance received; and amount of time between last and next transaction. See Analytic Guidelines for details on using concurrency variables to identify participants receiving HUD housing assistance at interview.
Weights	All 1999–2012 NHIS and NHANES participants	Although NHIS and NHANES are designed to be nationally representative of the U.S. civilian noninstitutionalized population, not all NCHS survey participants are eligible for linkage. Specific weights have been calculated for analyses of these surveys when using linked data. One weights file contains a single record for all participants of 1999–2012 NHIS and NHANES, as well as various survey weights adjusted for linkage eligibility.

NOTES: NHIS is National Health Interview Survey, and NHANES is National Health and Nutrition Examination Survey. HUD is U.S. Department of Housing and Urban Development, and NCHS is National Center for Health Statistics. Analytic Guidelines is available from: https://www.cdc.gov/nchs/data/datalinkage/nchs_hud_analytic_considerations.pdf.

SOURCES: NCHS, 1999–2012 NHIS and NHANES data linked to 1996–2014 HUD data.

Appendix III. Data Variable Considerations

The following variables may be useful for researchers using the linked National Center for Health Statistics (NCHS) and U.S. Department of Housing and Urban Development (HUD) data because they provide information about whether the survey participant was linked to the HUD administrative data and the timing of receipt of HUD housing assistance relative to the survey interview and examination date:

- HUD_MATCH_STATUS—This variable can be used to identify participants who were eligible for linkage and who were linked to the HUD administrative data.
- Concurrency variables—These binary indicator variables indicate whether the survey participant received HUD housing assistance at the time of interview or examination. The 20 variables are characterized by HUD program category (Housing Choice Voucher [HCV], multifamily [MF], and public housing [PH]) and subprogram (non-Moving to Work [MTW] HCV, MTW HCV, non-MTW PH, MTW PH, Project-Based Section [PBS] 8, and non-PBS8 MF) at time of concurrency, and by concurrency at time of survey interview or examination (NHANES only):

Concurrency by Program (HCV, MF, PH)

Concurrency at survey interview

- CON_STATUS_INT: Lived in any type of HUD-assisted housing at time of interview
- CON_STATIN_HCV: Lived in HCV HUD-assisted housing at time of interview
- CON_STATIN_MF: Lived in MF HUD-assisted housing at time of interview
- CON_STATIN_PH: Lived in PH HUD-assisted housing at time of interview

Concurrency at examination (NHANES only)

- CON_STATUS_EXM: Lived in any type of HUD-assisted housing at time of examination
- CON_STATEX_HCV: Lived in HCV HUD-assisted housing at time of examination
- CON_STATEX_MF: Lived in MF HUD-assisted housing at time of examination
- CON_STATEX_PH: Lived in PH HUD-assisted housing at time of examination

Concurrency by Subprogram (non-MTW HCV, MTW HCV, non-MTW PH, MTW PH, PBS8 MF, non-PBS8 MF)

Concurrency at survey interview

- INT_HCV: Lived in non-MTW HCV HUD-assisted housing at time of interview
- INT_MTW_HCV: Lived in MTW–HCV HUD-assisted housing at time of interview
- INT_PH: Lived in non-MTW PH HUD-assisted housing at time of interview
- INT_MTW_PH: Lived in MTW–PH HUD-assisted housing at time of interview
- INT_PBS8: Lived in PBS8 MF HUD-assisted housing at time of interview
- INT_OTHER_MF: Lived in non-PBS8 MF HUD-assisted housing at time of interview

Concurrency at examination (NHANES only)

- EXM_HCV: Lived in non-MTW HCV HUD-assisted housing at time of examination
- EXM_MTW_HCV: Lived in MTW–HCV HUD-assisted housing at time of examination
- EXM_PH: Lived in non-MTW PH HUD-assisted housing at time of examination
- EXM_MTW_PH: Lived in MTW PH HUD-assisted housing at time of examination
- EXM_PBS8: Lived in PBS8 MF HUD-assisted housing at time of examination
- EXM_OTHER_MF: Lived in non-PBS8 MF HUD-assisted housing at time of examination

The following 16 variables are related to the timing of HUD assistance relative to the survey interview or examination for each HUD program category (HCV, MF, and PH). Although these variables cannot be directly accessed by researchers, researchers can develop their own categorical variables based on the following:

HUD Transactions Occurring After Survey

Number of days between interview and next HUD transaction

- TIME_A_INT: Number of days between interview and subsequent HUD transaction
- TIME_A_HCV_INT: Number of days between interview and subsequent HCV transaction
- TIME_A_MF_INT: Number of days between interview and subsequent MF transaction
- TIME_A_PH_INT: Number of days between interview and subsequent PH transaction

Number of days between examination and next HUD transaction (NHANES only)

- TIME_A_EXM: Number of days between examination and subsequent HUD transaction
- TIME_A_HCV_EXM: Number of days between examination and subsequent HCV transaction

- TIME_A_MF_EXM: Number of days between examination and subsequent MF transaction
- TIME_A_PH_EXM: Number of days between examination and subsequent PH transaction

HUD Transactions Occurring Before Survey

Number of days between interview and previous HUD transaction

- TIME_B_INT: Number of days between interview and previous HUD transaction
- TIME_B_HCV_INT: Number of days between interview and previous HCV transaction
- TIME_B_MF_INT: Number of days between interview and previous MF transaction
- TIME_B_PH_INT: Number of days between interview and previous PH transaction

Number of days between examination and previous HUD transaction (NHANES only)

- TIME_B_EXM: Number of days between examination and previous HUD transaction
- TIME_B_HCV_EXM: Number of days between examination and previous HCV transaction
- TIME_B_MF_EXM: Number of days between examination and previous MF transaction
- TIME_B_PH_EXM: Number of days between examination and previous PH transaction

Appendix IV. Evaluation of NCHS–HUD Data Linkage: Comparison With HUD Program Recipients

This analysis assesses whether similarities or differences occur between the linked National Center for Health Statistics (NCHS) survey participants and all recipients of U.S. Department of Housing and Urban Development (HUD)-assisted housing. The percent distribution of selected characteristics from all HUD housing assistance recipients are presented side by side with that from a sample of linked NCHS–HUD participants who received assistance during the same time period. This evaluation uses only 1 year of data (2012) from the National Health Interview Survey (NHIS) and two cycles (2009–2012) of the National Health and Nutrition Examination Survey (NHANES).

The NCHS–HUD linked samples from the 2012 NHIS and the 2009–2012 NHANES are included in this analysis; however, only variables derived from the HUD administrative data and not the NCHS survey data are described in the presentations, mainly because the HUD administrative data are the only data source available for both the NCHS–HUD linked sample and the population of HUD housing assistance recipients not included in the linked sample. Although some of these variables (e.g., sex, age, and total number of household members) are also collected in the NCHS survey, the mechanism for data collection differs between administrative and survey data. Analyses of these variables from the survey data may yield different results. This analysis is not intended to evaluate the HUD administrative data, but rather to present characteristics of both the NCHS–HUD linked sample and the population of HUD housing assistance recipients. The following variables are included in the analysis:

- HUD program category—Housing Choice Voucher (HCV), multifamily (MF), and public housing (PH)
- Sex (male and female)
- Age (0–17, 18–29, 30–44, 45–61, and 62 and over; age groups are based on categories used in HUD reports or publications)
- Indicator for households with at least one disabled person, based on HUD's operational definition of disability: https://portal.hud.gov/hudportal/HUD?src=/program_offices/fair_housing_equal_opp/disabilities/inhousing
- Indicator for households with at least one elderly person (HUD defines elderly as age 62 and over; therefore, for this comparison, age 62 was used as the threshold to define a household with an elderly person)
- Number of bedrooms in unit (0–1, 2, 3, and 4 or more)
- Total household members (1, 2, 3, 4, and 5 or more)

The following criteria are used to assess similarities and differences in the selected sociodemographic and household characteristics between the linked survey participants and all recipients of HUD-assisted housing:

1. If the percentage for each category (e.g., male and female) of a characteristic (e.g., sex) is equal in both populations, it is described as being the same.
2. If the relative difference between the two populations, defined as

$$| X_{\text{HUDpopulation}} - X_{\text{linked}} | / X_{\text{HUDpopulation}}$$

is between 0.0 and 0.1 for all categories of the characteristic, concurrent linked survey participants are described as "consistent or similar" to all recipients of HUD-assisted housing with respect to that characteristic.
3. If the relative difference between the two populations for at least one category of the characteristic is 0.1 or greater, concurrent linked survey participants are described as "different (higher/more or lower/less)" than all recipients of HUD-assisted housing with respect to that characteristic.

Because the two populations are not statistically independent and measures of correlation between the two populations were not readily available, comparisons were not statistically tested.

Evaluation of Linked 2012 NHIS–HUD Data: Methods

Recipients of HUD housing assistance during the 2012 calendar year were identified based on HUD administrative records with effective dates of Nov. 1, 2011, through Feb. 28, 2013. Only the most recent HUD transaction was retained so that each individual was counted only once. In this analysis, these HUD housing assistance recipients are referred to as the population of "all 2012 HUD-assisted tenants." Concurrent 2012 NHIS–HUD participants are, in theory, a subset of this population. Similarities and differences between the concurrent 2012 NHIS–HUD participants and all 2012 HUD-assisted tenants demonstrate ways in which the linked data may or may not be comparable to the population of HUD housing assistance recipients.

The NHIS sample adult and sample child weights were used in the analyses to account for unequal probabilities of selection and survey nonresponse, and were further adjusted for linkage eligibility via poststratification by age, race and ethnicity, and sex, using SUDAAN's procedure WTADJUST (16). Reweighting of the linked survey data ensures that population totals are maintained and helps account for potential linkage consent bias. The confidence intervals incorporate the complex sample design of NHIS.

Evaluation of Linked 2012 NHIS–HUD Data: Results

A total of 1,434 NHIS 2012 participants were concurrently linked to HUD administrative data. During the 2012 time frame, the HUD administrative

records contained data on 9,790,425 HUD recipients. Results are presented in Appendix Table II and Appendix Figures I–IV.

For both populations, the HCV program had the highest participation (53.7% among all 2012 HUD-assisted tenants and 49.7% among concurrent 2012 NHIS–HUD participants). The percentage of persons in MF units among all 2012 HUD-assisted tenants was lower (23.1%) than among concurrent 2012 NHIS–HUD participants (29.5%), and the percentage of all 2012 HUD-assisted tenants in PH units was higher (23.3%) than among concurrent 2012 NHIS–HUD participants (20.8%).

Concurrent 2012 NHIS–HUD participants were 63.8% female and 36.2% male, which was similar to the distribution by sex among all 2012 HUD-assisted tenants. The age distributions were similar between the two populations for most age groups. However, the percentage of adults aged 30–44 was lower among all 2012 HUD-assisted tenants (13.7%) than among concurrent 2012 NHIS–HUD participants (15.9%).

A higher percentage of all 2012 HUD-assisted tenants lived in households with a disabled person (26.2%) compared to concurrent 2012 NHIS–HUD participants (21.0%). Consistent with the population of all 2012 HUD-assisted tenants (18.6%), 18.3% of concurrent 2012 NHIS–HUD participants lived in a household with an elderly person. The distribution of unit size was consistent between the two populations. The distribution of total household members was similar between the two populations in all categories except for the 5 or more category; the population of all 2012 HUD-assisted tenants had more individuals living in households with 5 or more members (20.8%) than the population of concurrent 2012 NHIS–HUD participants (17.4%).

Evaluation of Linked 2009–2012 NHANES–HUD Data: Methods

Two NHANES cycles were pooled due to the small sample size of concurrently linked NHANES–HUD

Table II. Number and percent distribution of concurrently linked 2012 NHIS–HUD participants and 2012 HUD-assisted tenants, by HUD program and selected HUD-collected demographic characteristics

HUD program and demographic characteristics	2012 HUD-assisted tenants		2012 concurrently linked NHIS–HUD participants (*n* = 1,434)			
					95% CI	
	n	Percent	*n*	Percent (weighted)	Low	High
HUD housing category						
Housing Choice Voucher	5,252,249	53.7	635	49.7	44.4	55.1
Multifamily housing	2,256,365	23.1	441	29.5	23.8	35.9
Public housing	2,281,811	23.3	358	20.8	16.3	26.1
Sex						
Male	3,665,200	37.4	460	36.2	32.5	40.0
Female	6,124,452	62.6	973	63.8	60.0	67.5
Age group (years)						
0–17	3,931,683	40.2	318	37.2	33.9	40.6
18–29	1,443,686	14.8	217	16.0	13.5	18.7
30–44	1,341,524	13.7	270	15.9	13.8	18.4
45–61	1,474,394	15.1	269	15.0	12.3	18.1
62 and over	1,599,095	16.3	360	15.9	13.2	19.0
Households						
With disabled persons	2,567,030	26.2	333	21.0	17.7	27.7
With elderly persons	1,824,617	18.6	383	18.3	15.3	21.8
Unit size (number of bedrooms)						
0–1	2,104,962	21.5	486	20.3	17.2	23.8
2	2,936,021	30.0	488	32.8	28.7	37.2
3	3,543,478	36.2	359	34.7	30.4	39.3
4 or more	1,205,964	12.3	101	*12.2	9.1	16.3
Total household members						
1	2,221,424	22.7	551	23.1	19.8	26.7
2	1,834,022	18.7	307	20.0	17.3	23.0
3	1,978,692	20.2	264	21.5	18.0	25.5
4	1,721,379	17.6	165	17.9	14.6	21.9
5 or more	2,034,144	20.8	136	17.4	13.7	21.8

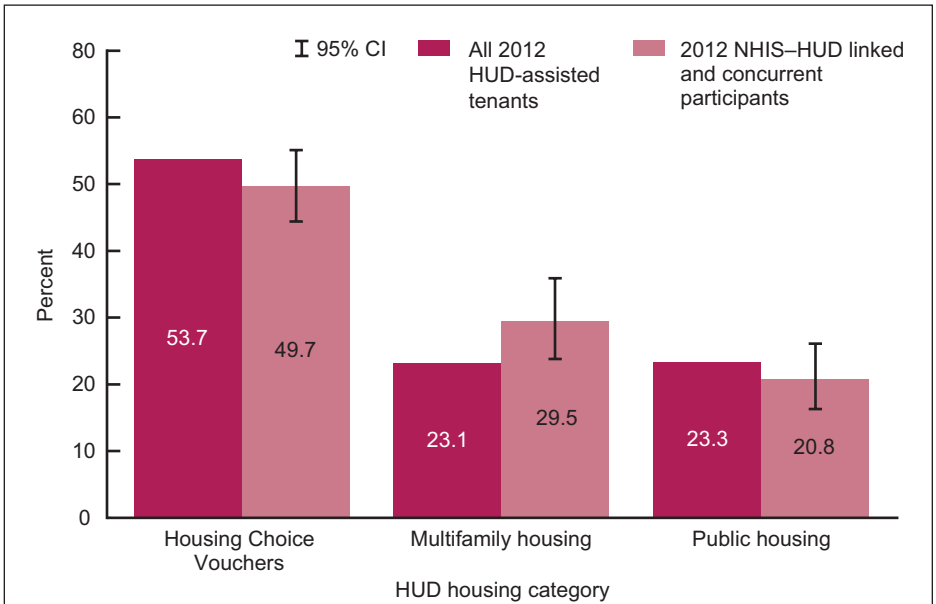
* Figure may be statistically unreliable because the absolute width of its Korn-Graubard confidence interval (CI) is between 5 and 30 percentage points, yet its relative width is larger than 130%.

NOTES: CIs for percentages are calculated using SUDAAN with the Korn-Graubard adjustment to the Clopper-Pearson method. NHIS is National Health Interview Survey, and HUD is U.S. Department of Housing and Urban Development.

SOURCES: NCHS, linked NHIS–HUD data sample, 2012; HUD administrative data, 2012.

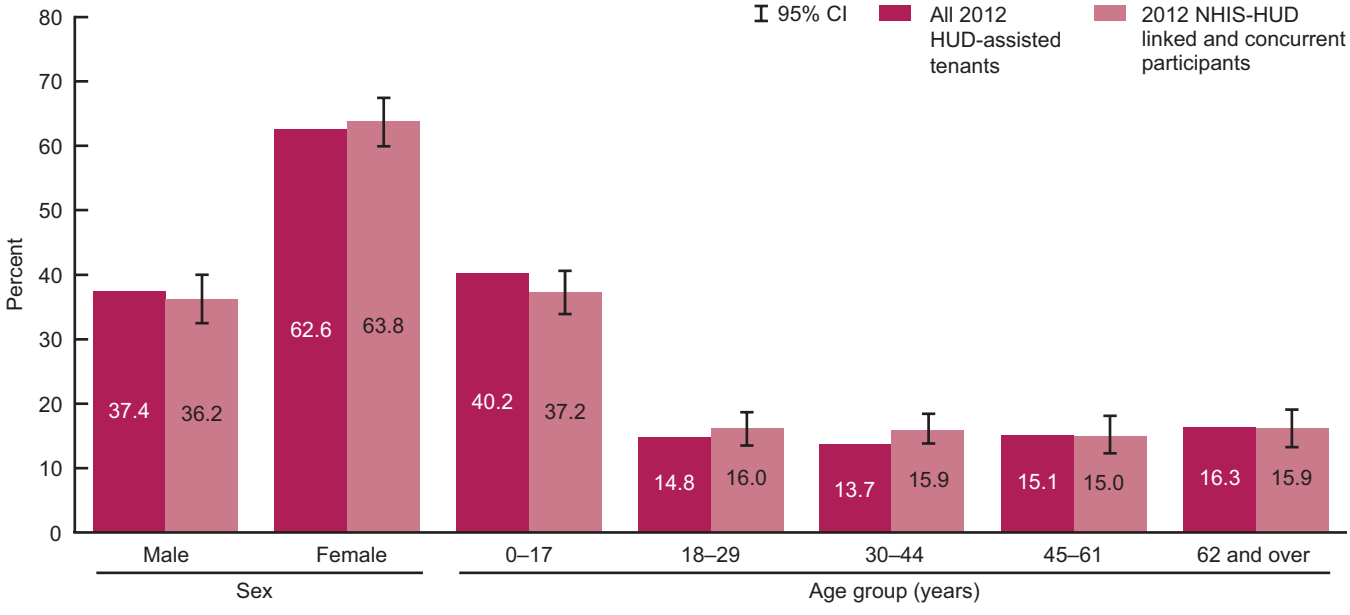
participants for a single cycle. Recipients of HUD housing assistance with effective dates from Nov. 1, 2008, through Feb. 28, 2013, were identified from the HUD administrative records and included in the analysis to conservatively capture all HUD housing assistance recipients from the 2009–2012 calendar years. If more than one record existed per individual, only the most recent record was retained, so that each person was counted once at most. In this analysis, these HUD housing assistance recipients are referred to as the population of "all 2009–2012 HUD-assisted tenants." Concurrent 2009–2012 NHANES–HUD participants are, in theory, a subset of this population. Similarities and differences between the concurrent 2009–2012 NHANES–HUD participants and all 2009–2012 HUD-assisted tenants demonstrate ways in which the linked data may or may not be comparable to the population of HUD housing assistance recipients.

The sample weights, accounting for unequal probabilities of selection and survey nonresponse, were further adjusted for linkage eligibility via poststratification by age, race and ethnicity, and sex using SUDAAN's WTADJUST (16). Reweighting of the linked survey data ensures that population totals are maintained and helps account for potential linkage consent bias. The confidence intervals reflect the complex design of NHANES.



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHIS is National Health Interview Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHIS–HUD data sample, 2012; HUD administrative data, 2012.

Figure I. All 2012 HUD-assisted tenants and concurrently linked 2012 NHIS–HUD participants, by HUD housing category



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHIS is National Health Interview Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHIS–HUD data sample, 2012; HUD administrative data, 2012.

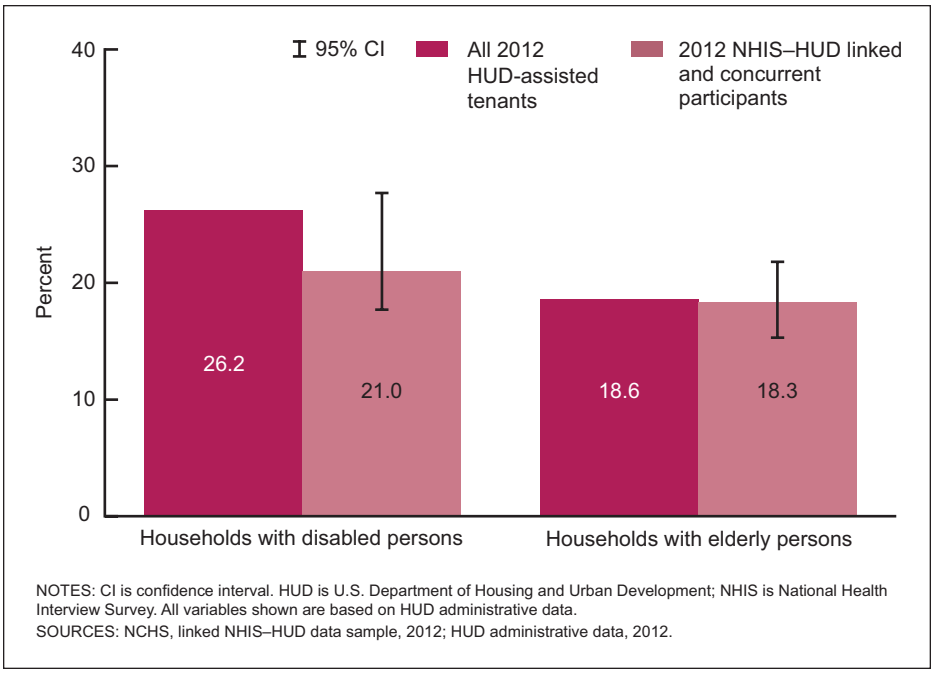
Figure II. All 2012 HUD-assisted tenants and concurrently linked 2012 NHIS–HUD participants, by sex and age group

Evaluation of Linked 2009–2012 NHANES–HUD Data: Results

A total of 782 NHANES 2009–2012 participants were concurrently linked to HUD administrative data. During the 2009–2012 time frame, the HUD administrative records contained data on 14,148,465 HUD recipients. Results are presented in Appendix Table III and Appendix Figures V–VIII.

In both populations, the HCV program was the most common housing assistance program. Compared to all 2009–2012 HUD-assisted tenants, concurrent 2009–2012 NHANES–HUD participants received more assistance through HCV programs (60.4% compared to 54.3%, respectively) and fewer received assistance through MF (17.6% compared to 20.9%) and PH programs (22.0% compared to 24.7%).

The percentages of concurrent 2009–2012 NHANES–HUD participants that were female (65.2%) and male (34.8%) were consistent with those of all 2009–2012 HUD-assisted tenants (females 61.6%, males 38.4%). For three of the five age categories, no differences were observed between the two populations. However, more concurrent 2009–2012 NHANES–HUD participants were aged 45–61 compared with all 2009–2012 HUD-assisted tenants (18.4% compared to 13.7%), and fewer were aged 18–29 (13.6% compared to 17.2%).



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHIS is National Health Interview Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHIS–HUD data sample, 2012; HUD administrative data, 2012.

Figure III. All 2012 HUD-assisted tenants and concurrently linked 2012 NHIS–HUD participants, by percentage of households with disabled or elderly persons

NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHIS is National Health Interview Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHIS–HUD data sample, 2012; HUD administrative data, 2012.

Figure IV. All 2012 HUD-assisted tenants and concurrently linked 2012 NHIS–HUD participants, by household characteristics

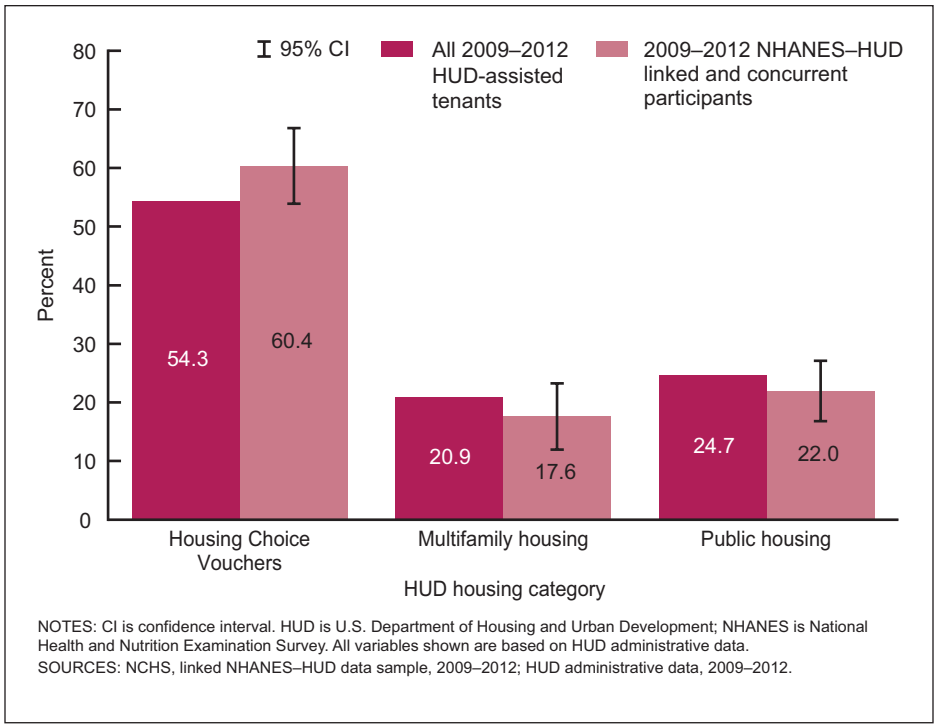
Table III. Number and percent distribution of concurrently linked 2009–2012 NHANES–HUD participants and 2009–2012 HUD-assisted tenants, by HUD program and selected HUD-collected demographic characteristics

HUD program and demographic characteristics	2009–2012 HUD-assisted tenants		2009–2012 concurrently linked NHANES–HUD participants (*n* = 782)			
					95% CI	
	n	Percent	*n*	Percent (weighted)	Low	High
HUD housing category						
Housing Choice Voucher	7,685,573	54.3	436	60.4	48.5	71.2
Multifamily housing	2,962,641	20.9	167	*17.6	11.9	25.2
Public housing	3,500,251	24.7	179	22.0	12.9	34.9
Sex						
Male	5,436,525	38.4	317	34.8	30.7	39.2
Female	8,710,946	61.6	465	65.2	60.9	69.4
Age group (years)						
0–17	5,683,455	40.2	332	37.3	31.5	43.4
18–29	2,431,653	17.2	79	13.6	10.5	17.4
30–44	1,897,090	13.4	79	13.8	11.7	16.2
45–61	1,935,830	13.7	111	18.4	15.3	21.9
62 and over	2,200,128	15.6	181	17.0	12.8	22.2
Households						
With disabled persons	3,588,153	25.4	151	23.2	17.1	30.6
With elderly persons	2,508,121	17.7	195	18.9	14.4	24.5
Unit size (number of bedrooms)						
0–1	2,974,052	21.0	182	20.4	14.8	27.6
2	4,142,288	29.3	189	23.8	18.6	29.9
3	5,246,890	37.1	320	45.3	40.2	50.5
4 or more	1,785,235	12.6	91	*10.5	6.9	15.6
Total household members						
1	3,166,498	22.4	201	23.8	18.2	29.3
2	2,443,175	17.3	122	14.6	11.8	18.0
3	2,897,762	20.5	158	21.7	17.2	27.1
4	2,577,165	18.2	132	19.3	14.9	24.5
5 or more	3,045,711	21.6	162	21.1	14.8	29.2

* Figure may be statistically unreliable because it is based on fewer than 8 degrees of freedom.

NOTES: Confidence intervals (CIs) for percentages are calculated using SUDAAN with the Korn-Graubard adjustment to the Clopper-Pearson method. NHANES is National Health and Nutrition Examination Survey, and HUD is U.S. Department of Housing and Urban Development.

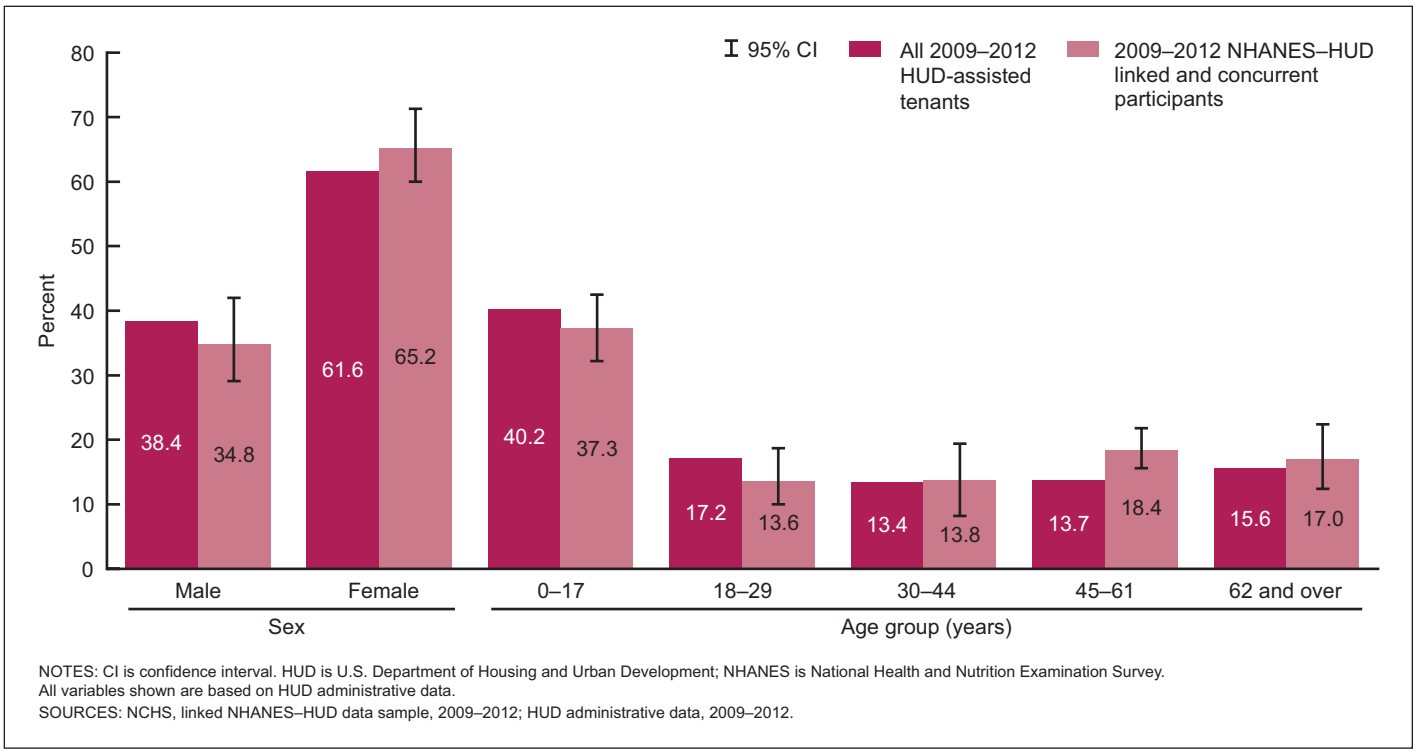
SOURCES: NCHS, linked NHANES–HUD data sample, 2009–2012; HUD administrative data, 2009–2012.



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHANES is National Health and Nutrition Examination Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHANES–HUD data sample, 2009–2012; HUD administrative data, 2009–2012.

Figure V. All 2009–2012 HUD-assisted tenants and concurrently linked 2009–2012 NHANES–HUD participants, by HUD housing category

Similar percentages of all 2009–2012 HUD-assisted tenants (25.4%) and concurrent 2009–2012 NHANES–HUD participants (23.2%) lived in a household containing a disabled person. Consistent with the population of all 2009–2012 HUD-assisted tenants (17.7%), 18.9% of concurrent 2009–2012 NHANES–HUD participants lived in a household containing an elderly person. The distribution of unit size differed between the two populations for all categories except the 0–1 number of bedrooms category. The distribution of total household members was similar between the two populations except for the category with a household size of two: The population of all 2009–2012 HUD-assisted tenants had more individuals living in households with a size of two (17.3%) than the population of concurrent 2009–2012 NHANES–HUD participants (14.6%).

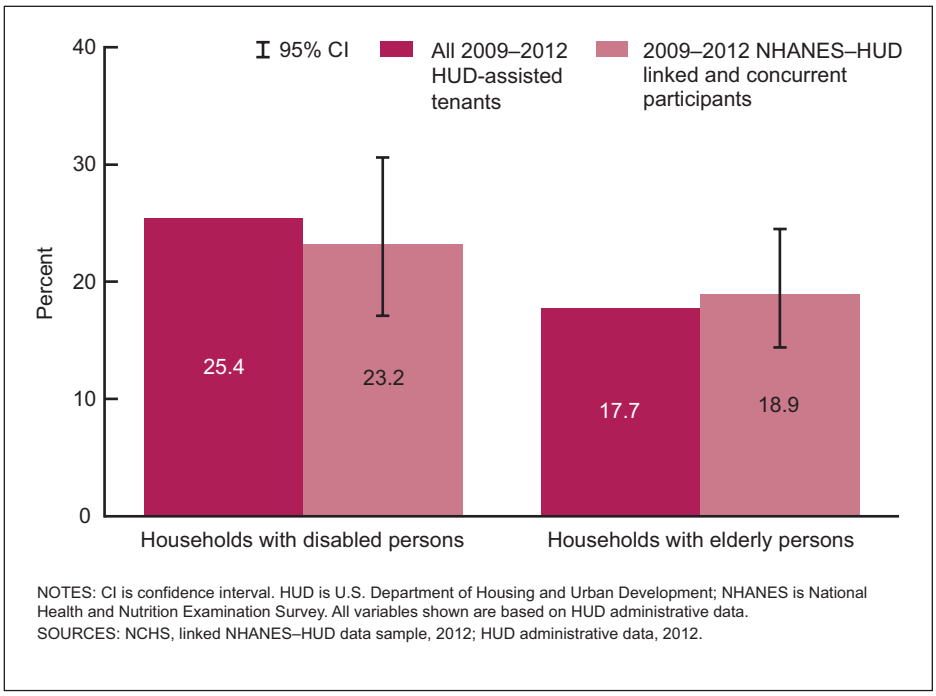


NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHANES is National Health and Nutrition Examination Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHANES–HUD data sample, 2009–2012; HUD administrative data, 2009–2012.

Figure VI. All 2009–2012 HUD-assisted tenants and concurrently linked 2009–2012 NHANES–HUD participants, by sex and age group

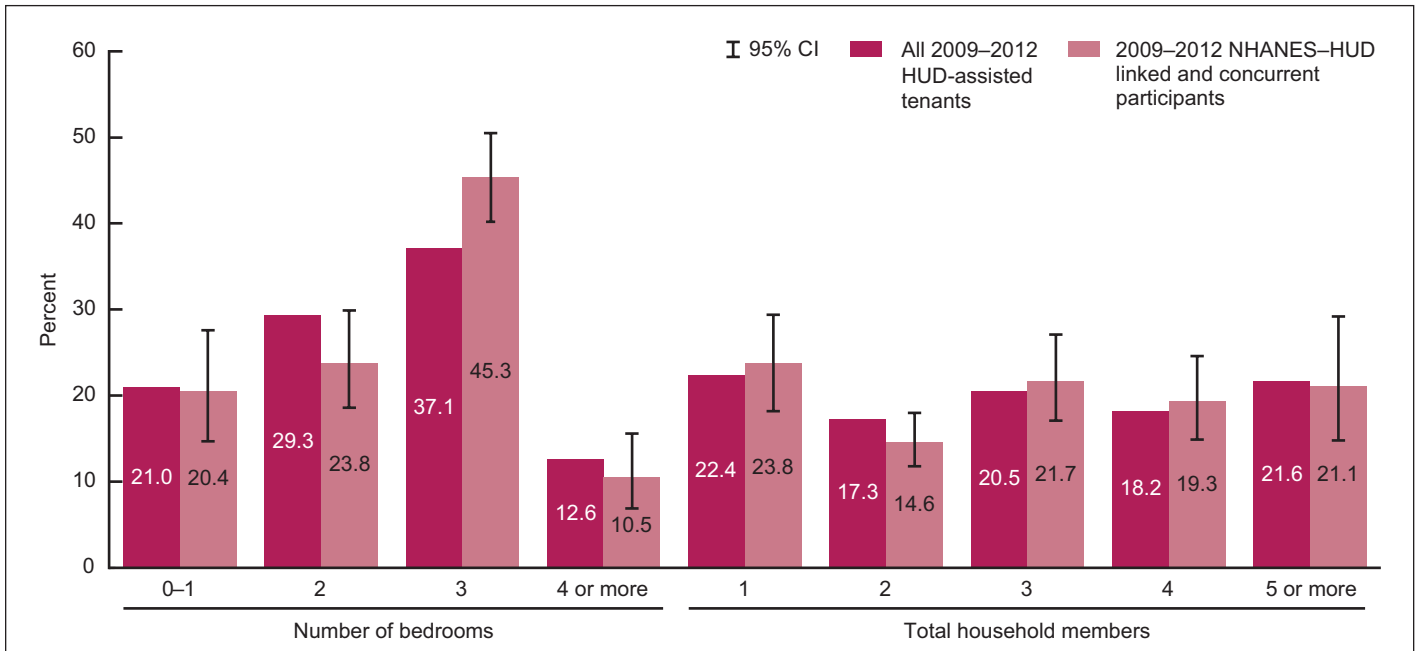
Conclusion

The linked NCHS–HUD data represent a sample of the civilian noninstitutionalized U.S. population living in HUD-assisted housing at some point in the administrative period and may or may not be comparable to the overall population of HUD assistance recipients. Among concurrent linked NHIS–HUD and NHANES–HUD participants, the percentages of males and females and the percentage of those living in a household with an elderly person were similar to the corresponding percentages among all HUD tenants. Differences between the two populations were observed by program category of HUD housing assistance received, age, household disability status, size of unit, and total number of household members. Differences in characteristics that were not measured here (e.g., income and health insurance coverage, among others) between concurrent linked survey participants and the population of HUD housing assistance recipients should also be taken into consideration. These differences may impact the generalizability of study results from analyses of the linked NCHS–HUD data to the overall population of HUD housing assistance recipients.



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHANES is National Health and Nutrition Examination Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHANES–HUD data sample, 2012; HUD administrative data, 2012.

Figure VII. All 2009–2012 HUD-assisted tenants and concurrently linked 2009–2012 NHANES–HUD participants, by percentage of households with disabled or elderly persons



NOTES: CI is confidence interval. HUD is U.S. Department of Housing and Urban Development; NHANES is National Health and Nutrition Examination Survey. All variables shown are based on HUD administrative data.
SOURCES: NCHS, linked NHANES–HUD data sample, 2009–2012; HUD administrative data, 2009–2012.

Figure VIII. All 2009–2012 HUD-assisted tenants and concurrently linked 2009–2012 NHANES–HUD participants, by household characteristics

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