Data Shop

Data Shop, a department of Cityscape, presents short articles or notes on the uses of data in housing and urban research. Through this department, the Office of Policy Development and Research introduces readers to new and overlooked data sources and to improved techniques in using well-known data. The emphasis is on sources and methods that analysts can use in their own work. Researchers often run into knotty data problems involving data interpretation or manipulation that must be solved before a project can proceed, but they seldom get to focus in detail on the solutions to such problems. If you have an idea for an applied, data-centric note of no more than 3,000 words, please send a one-paragraph abstract to david.a.vandenbroucke@hud.gov for consideration.

Musty Smells, Mold, and Moisture in the U.S. Housing Stock: Results from Two National Surveys

Veronica Eva Helms Garrison
Jacqueline Bachand
U.S. Department of Housing and Urban Development, Office of Policy Development and Research

Peter J. Ashley
U.S. Department of Housing and Urban Development, Office of Lead Hazard Control and Healthy Homes

The views expressed in this article are those of the author and do not represent the official positions or policies of the Office of Policy Development and Research, the U.S. Department of Housing and Urban Development, or the U.S. Government.

Abstract

A large body of public health research concludes that the presence of musty smells, mold, or moisture within the home is associated with the development and exacerbation of asthma and other respiratory ailments in children and adults. Despite this strong relationship, national data describing the scope and breadth of these home hazards in the U.S. occupied-housing stock are limited. Having this information publicly available is important for administrators and policymakers interested in remediating unhealthy housing and preventing asthma exacerbation attributable to poor housing conditions.

Abstract (continued)

In the proposed article, the authors introduce readers to two nationally representative housing surveys managed by the U.S. Department of Housing and Urban Development (HUD) that can be used to examine the national prevalence of significant home health hazards: the 2015 American Housing Survey (AHS) and the American Healthy Homes Survey II (AHHS II). Both surveys can be used to describe housing quality aspects within the U.S. housing stock. Additionally, the authors describe and compare the national prevalence of musty smells, mold, and moisture in both surveys. Prevalence rates are compared and discussed to help AHS and AHHS II data users better understand how self-reported housing quality metrics differ from more objective housing quality measures observed by a trained technician. Lastly, important data use implications are discussed.

Introduction

The purpose of this article is twofold. First, the article introduces readers to two national housing surveys HUD manages: the 2015 American Housing Survey (AHS) and the American Healthy Homes Survey II (AHHS II). Both AHS and AHHS II can be used to examine the national prevalence of significant home health hazards among occupied, U.S. housing units. Although AHS and AHHS II both seek to capture information about U.S. housing quality, the data collection efforts greatly differ. The AHS relies on respondents' self-reported questionnaires on aspects of housing quality. In comparison, the AHHS II uses self-reported questionnaires, field technician observations, and the collection and analysis of environmental samples to detect the presence of specific hazards.

Second, the article examines the relationship between (1) housing age and (2) musty smells, mold, and moisture in both surveys, using data analyses to form understudied associations. This relationship was selected for analysis because these home hazards have been associated with the development and exacerbation of respiratory ailments. Additionally, little is known about the relationship between housing age and musty smells, mold, and moisture in the U.S. housing stock. In this article, key survey differences and findings across the two data sources are examined. Results are highlighted and compared for both surveys. Critical implications regarding the interpretation of home hazard findings, given differing survey metrics and implementation procedures, are discussed.

Background

Prior public health research concludes that musty smells, mold, and moisture within the home environment are associated with the exacerbation of asthma and other respiratory conditions in children and adults, with more limited evidence of the association of asthma development among children (Fisk, Lei-Gomez, and Mendell, 2007). An update of a 2000 Institute of Medicine review concluded that there is sufficient evidence for a causal association between exposure to dampness and dampness-related agents and asthma exacerbation in children (Kanchongkittiphon

et al., 2015). One study suggests that 21 percent of current asthma cases in the United States are attributable to mold and moisture in the home (Mudarri and Fisk, 2007). In a recent editorial on exposure assessment for dampness and mold in epidemiological studies, the authors concluded that nonbiological assessments of dampness and mold (that is, moldy odor, mold growth, water damage, or moisture) consistently resulted in stronger associations with health effects compared with the use of microbiological sampling (for example, mold in the air or dust) (Mendell and Adams, 2019).

Despite this important relationship, national data describing the scope and breadth of musty smells, mold, and moisture in the U.S. occupied-housing stock are limited. Although several international studies have found a strong relationship between housing age and these specific home hazards in their housing stock, this relationship remains relatively unknown in the U.S. housing stock. For example, one New Zealand study found that 35.1 percent of respondents reported mold, and mold was independently associated with older housing (Howden-Chapman et al., 2005). Having this information available for the U.S. housing stock is especially crucial for policymakers interested in remediating unhealthy housing and preventing asthma exacerbation attributable to poor housing conditions. State and local housing remediation program administrators can easily identify neighborhoods with large shares of older housing; therefore, understanding the relationship between housing age and home moisture has important policy and practice implications. Additionally, there is some evidence that physical remediation efforts that address the root causes of moisture sources significantly reduce symptom days and healthcare use for children with asthma who live in homes that have documented mold problems (Kercsmar et al., 2006).

Data Sources

The AHS and the AHHS II are two surveys on the U.S. housing stock. Although both surveys have similar purposes, data users should note several key differences. More information about each survey is provided below.

2015 American Housing Survey

The AHS is the nation's largest and most comprehensive housing survey. The AHS is jointly administered by HUD and the U.S. Census Bureau (Census); Census conducts the survey, which is sponsored by HUD ("About: American Housing Survey," n.d.). Since 1973, the AHS has provided timely information about the size, composition, cost, and quality of the U.S. housing stock. Conducted biennially in odd-numbered years, the AHS is a longitudinal survey with redrawn samples in 1985 and 2015. The primary unit of analysis in the AHS is occupied and vacant residential housing units. Census interviewers conduct in-person visits and call occupied households to collect information. When a unit is unoccupied, information is obtained from landlords, real estate agents, or knowledgeable neighbors ("Methodology: American Housing Survey," n.d.).

Geographically, the AHS covers all 50 states and the District of Columbia. Housing units are selected to be nationally representative; every AHS housing unit represents between 450 and 4,000 housing units. Every cycle, the AHS includes a national sample of approximately 85,000

housing units, including 50,000 nationally representative units, 30,000 units from 15 preselected metropolitan areas, and 5,000 HUD-assisted housing units.

Topical modules are sometimes included in the AHS to capture detailed information about important or emerging topics. Example analyses in this article use the Healthy Homes (HH) topical module from the 2015 AHS. The HH module was included in the 2011 and 2015 AHSs; the next iteration will occur in 2021. Developed in consultation with HUD's Office of Lead Hazard Control and Healthy Homes (OLHCHH), the National Center for Healthy Housing, and the Centers for Disease Control and Prevention, the HH module collects data on potential health and safety hazards in the home. It includes questions on second-hand smoke, important asthma triggers (for example, pests and mold), key injury hazards, radon exposure, and related topics.

American Healthy Homes Survey II

In cooperation with the Environmental Protection Agency (EPA), HUD implemented the AHHS II, a survey that estimates the national prevalence of lead-based paint hazards and other common contaminants (for example, formaldehyde, mold, and pesticide residues) in residential housing units in the U.S. occupied-housing stock. In addition to updating previous estimates of lead in paint, dust, soil, mold, and pesticide levels, AHHS II survey results will also be used to quantify the first national estimates of lead in water and formaldehyde in air. During AHHS II implementation, trained teams administered a survey questionnaire and collected environmental samples at each participating home. Collected samples were analyzed for lead, mold, formaldehyde, and pesticides using standardized laboratory and quality control procedures (Quan Tech, Sept. 2020).

The AHHS II study design employs a three-stage cluster sample of residential housing. QuanTech, a survey research firm under contract with HUD's OLHCHH, conducted sampling between May 2018 and May 2019 (QuanTech, Sept. 2020). Among a sample of approximately 2,200 random housing units drawn, approximately 700 residents of eligible units completed the survey. About one-half of recruited households were ineligible (10 percent), unreachable (10 percent), or refused to participate (23 percent). The AHHS II was conducted in 78 primary sampling units (PSUs) in 37 states. Each PSU is a county or group of counties selected randomly and range from heavily populated urban counties to very rural areas.

Once PSUs were identified, a two-person team of an interviewer and a certified lead inspector/risk assessor (technician) was dispatched to each locality. The interviewer arrived first and was responsible for recruitment. The resident of every selected unit was mailed an advance letter explaining the survey and announcing the interviewer's intended visit. Once homes were identified for participation, both the interviewer and the technician would conduct home visits. Upon arrival, the interviewer was responsible for administering the questionnaire, a household inventory of rooms, observations of housing conditions, and the receipt of a tap water sample collected by the resident. The technician was responsible for taking air samples, conducting wipe samples, testing painted surfaces for lead, and testing visible water service lines for lead. Participants could request final reports on any safety hazards found in the home.

The AHHS II is the third survey among a series of three HUD-sponsored national residential environmental health surveys. In 1998–2001, HUD sponsored the National Survey of Lead and Allergens in Housing in collaboration with the National Institute of Environmental Health Sciences (Clickner et al., 2001; NIEHS, n.d.). The survey was the first national survey to measure the prevalence of lead in dust, soil, and paint in the nation's housing stock. In 2005–2006, HUD oversaw the first iteration of the AHHS (AHHS I); field data and environmental samples were collected from 1,131 randomly selected homes (Dewalt et al., 2015). Findings from these surveys have proven useful for tracking national progress in reducing the number of U.S. housing units with lead-based paint and other home health hazards.

Example analyses displayed in this article use data from the AHHS II. Those data are expected to be publicly available by early 2021. In addition to data on lead hazards, this data source can be used to assess the prevalence of other home hazards, including the presence of musty smells, mold, and moisture.

Survey Differences

Although the AHS and the AHHS II are both nationally representative surveys that can quantify the prevalence of certain home hazards, there are several key differences across the two surveys that might contribute to differing findings. Data users should consider key survey differences when planning home hazard analyses (exhibit 1).

Exhibit 1

Survey Differences and Use Consideration for the American Housing Survey (AHS) and the American Healthy Homes Survey (AHHS II) (1 of 2)

Topic	2015 AHS	AHHS II	Use Considerations
Survey Content	Covers a broad range of housing topics, including some home hazards	Primary focus is housing-related hazards	AHS allows users to examine basic information about home hazards alongside other housing characteristics. AHS regularly sponsors a healthy homes topical module. AHHS II can provide very detailed information about specific home hazards and will be repeated less frequently.
Findings Audience	Wide range of stakeholders	Environmental health scientists	AHS covers a broad range of topics, which often does not allow for a deep dive into specific subtopics. Some AHHS II data collection methods are highly technical (for example, DNA-based analyses) and designed for interpretation by environmental health scientists.
Approximate Sample Size	85,000 housing units	700 housing units	Given the large sample size, prevalence estimates using AHS will have a relatively small standard error even when subsetting the data by select characteristics.
Unit of Analysis	Household (housing unit)-level and limited person-level information	Household (housing unit)-level information	Although both surveys allow for housing unit-level analyses, AHS allows users to identify key characteristics for the head of household. AHHS does not identify a head of household.

Exhibit 1

Survey Differences and Use Consideration for the American Housing Survey (AHS) and the American Healthy Homes Survey (AHHS II) (2 of 2)

Topic	2015 AHS	AHHS II	Use Considerations
Data Collection	Census interviewers conduct in-person visits or telephone calls; takes approximately 1 hour to complete	Two-person teams (interviewer and field technician); completion time ranges from 2.0 to 3.5 hours	Although lengthy, AHHS II data collection process is multidimensional and highly detailed, which allows users to gain a deep, unparalleled understanding of the prevalence of home hazards in the U.S housing stock. This information is not collected in any other national survey.
Survey Responses	All responses are self-reported	Includes self-reported questionnaire responses and observations from trained field technicians	For AHHS II, trained and certified inspectors and risk assessors record observations regarding several home health hazards. AHS relies fully on respondent self-reporting, introducing several types of potential bias, including self-report bias, selective recall bias, and social desirability bias.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Data Analysis Example

To highlight key differences across the 2015 AHS and the AHHS II, the prevalence of musty smells, mold, and moisture was examined in the occupied U.S. housing stock. Additionally, the relationship between (1) housing age and (2) musty smells, mold, and moisture was examined. This relationship was selected as a data analysis example because these home hazards have important implications for the public health community. Additionally, little is known about the prevalence of these conditions or the relationship between housing age and musty smells, mold, and moisture in the U.S. housing stock. In this section, the procedures used to analyze the AHS and the AHHS II are briefly explained. Then, key findings are highlighted.

Variable Availability and Metric Definitions

Before conducting analyses, the researchers examined available survey questions and corresponding variables pertaining to musty smells, mold, and moisture in both the AHS and the AHHS II. As mentioned previously, the AHS solely focuses on self-response, whereas the AHHS II collects information via self-response questionnaires and observations recorded by a trained field technician. Exhibit 2 highlights key survey questions pertinent to musty smells, mold, and moisture in both surveys.

Exhibit 2

Survey Question(s) Regarding Musty Smells, Mold, and Moisture in the 2015 American Housing Survey (AHS) and the American Healthy Homes Survey II (AHHS II)

Topic	Survey Name (Response Type)		
	2015 AHS (Respondent Self-Report)	AHHS II (Respondent Self-Report)	AHHS II (Trained Technician Observation)
Musty Smells	In the last 12 months, how often have you noticed any musty smells inside your home? *(Daily/Weekly/ Monthly/A few times/Never)*	Does your home frequently have a mildew odor or musty smell? *(Yes/No)*	Does this room have a musty smell? *(Yes/No)*
Mold	In the last 12 months, was there mold covering an area greater than or equal to the size of an 8-1/2" x 11" piece of paper in your unit? *(Yes/No)*	N/A	Does this room have any visible mold growth? *(Yes/No)*
Moisture and Leaks	(1) Did water leak in from the outside within the past 12 months? *(Yes/No)* and (2) Did any inside water leaks happen within the past 12 months? *(Yes/No)*	(1) Have there ever been water problems or dampness in your home from broken pipes, persistent leaks, heavy rain, or floods? *(Yes/No)* (2) How recently have there been water problems or dampness in your home? *(Right now/Not now but in the last 3 months/3 to 12 months ago/More than a year ago)*	N/A

NA = not applicable.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Based on question availability, topics were defined as follows:

- **Musty Smells.** In the AHS, musty smells were considered "frequent" if respondents reported noticing musty smells daily, weekly, or monthly during the prior 12 months. In the AHHS II, musty smells were coded based on "yes/no" questions regarding frequent or current musty smells noticed by household respondents and field technicians.

- **Mold.** In the AHS, housing units were considered to have mold if respondents reported noticing mold covering an area greater than or equal to 8-1/2" x 11"(dimensions of a standard sheet of paper) in any housing unit location during the prior 12 months. This "yes/no" question seeks to identify homes with large areas of mold growth. In the AHHS II, units were considered to have mold if the field technician noted "any visible mold growth" in kitchens, common living areas, bedrooms, or basements. The AHHS II questionnaire did not ask households to self-report the presence of mold.

- **Moisture and Leaks.** The presence of moisture or leaks was defined using two questions in the AHS and the AHHS II. AHS respondents were considered to have moisture in their home if they reported inside water leaks or leaks from the outside during the prior 12 months. In the AHHS II, respondents were considered to have moisture in their units if they reported

water problems or dampness in their home from broken pipes, persistent leaks, heavy rain, or floods during the prior 12 months.

Analytic Procedures

All statistical analyses were performed using SAS software.[1] Survey analysis procedures were used to analyze complex survey design data. Such procedures account for multistage design, stratifications, variance estimation, and proper weighting (SAS Institute, n.d.). Standard error (SE) estimates were produced for all weighted prevalence estimates. For analyses using the AHS, the household-level public use file (PUF) was used (U.S. Census Bureau, 2015). Because the HH module questions were asked to only approximately one-half of respondents, proper weights were applied. The AHHS II file was received directly from HUD's contractor, QuanTech.

Select Findings

The following section provides uncontrolled, weighted tabulations regarding the prevalence of musty smells, mold, and moisture in the occupied U.S. housing stock. Tabulations include estimates from both the AHS and the AHHS II. It is important to note that, although many variables are based on similar concepts, survey questions are not consistent across data sources.

Musty Smells, Mold, and Moisture

When examining the prevalence of musty smells in the U.S. housing stock, rates differ by survey (exhibit 3). According to the 2015 AHS, an estimated 5.85 percent (SE: 0.17) of respondents reported frequent musty smells in their home. Prevalence rates were much higher among AHHS II respondents, with 13.4 percent (SE: 1.33) self-reporting frequent musty smells. Additionally, AHHS II technicians observed musty smells in 12.7 percent (SE: 1.94) of surveyed units.

Prevalence rates pertaining to visible mold in the U.S. housing stock were similar by survey. According to the 2015 AHS, an estimated 3.77 percent (SE: 0.14) of residents in occupied units reported a large area (8-1/2"x11" or larger) of mold inside the home. Similarly, AHHS II technicians observed visible mold (any size) in 2.76 percent (SE: 0.58) of housing units.

The prevalence of moisture and leaks was also similar in both surveys despite differences in survey questions. According to the 2015 AHS, 16.7 percent (SE: 0.26) of residents in occupied units reported indoor or outdoor leaks during the prior 12 months. Similarly, the AHHS II household questionnaire found that approximately 21.0 percent (SE: 1.93) of respondents self-reported dampness in their home from broken pipes, persistent leaks, heavy rain, or floods during the prior 12 months.

[1] SAS Institute Inc., Cary, North Carolina, USA: Version 9.4.

Exhibit 3

Prevalence of Musty Smells, Mold, and Moisture in the U.S. Occupied Housing Stock, 2015 American Housing Survey (AHS) and American Healthy Homes Survey II (AHHS II)

Outcome	2015 AHS		AHHS II			
	Respondent Self-Report		Respondent Self-Report		Technician Observation	
	%	SE	%	SE	%	SE
Musty Smells	5.85	0.17	13.4	1.33	12.7	1.94
Mold	3.77	0.14	N/A	N/A	2.76	0.58
Moisture and Leaks	16.7	0.26	21.0	1.93	N/A	N/A

N/A = not applicable. SE = standard error.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Housing Age and Musty Smells, Mold, and Moisture

To determine if housing age is associated with the prevalence of musty smells, mold, and moisture, cross-tabulations were conducted. Due to sample size issues in the AHHS II, housing age was collapsed into three categories (pre-1950, 1950–1979, and 1980+). Chi-square testing was conducted to determine if each hazard was significantly and independently associated with housing age. Despite collapsing housing age into three categories, standard error estimates were relatively high for the AHHS II due to limited sample size.

When examining the relationship between housing age and musty smells, both AHS and AHHS II estimates suggest that older housing units report higher rates of musty smells (exhibit 4). All three variables examining this topic yielded significant results.

Exhibit 4

Prevalence of Musty Smells in the U.S. Occupied Housing Stock, 2015 American Housing Survey (AHS) and American Healthy Homes Survey II (AHHS II)

Year Housing Unit Built	2015 AHS			AHHS II					
	Respondent Self-Report			Respondent Self-Report			Technician Observation		
	%	SE	p-value*	%	SE	p-value*	%	SE	p-value*
Pre-1950	6.26	0.39		20.5	3.57		21.3	4.05	
1950–1979	6.43	0.28	0.0018	16.1	2.19	0.0021	16.4	2.68	<.0001
1980+	5.18	0.24		8.60	1.83		6.48	1.90	

**Based on chi-square testing*

SE = standard error.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Analyses examining the relationship between mold and housing age yielded similar results in both the AHS and the AHHS II (exhibit 5). Prevalence rates of mold appear to be higher among pre-1950 housing units. Depending on which data source is examined, pre-1950 units have rates approximately two to five times higher than housing units built in 1980 or later.

Exhibit 5

Prevalence of Mold in the U.S. Occupied Housing Stock, 2015 American Housing Survey (AHS) and American Healthy Homes Survey II (AHHS II)

Year Housing Unit Built	2015 AHS			AHHS II					
	Respondent Self-Report			Respondent Self-Report			Technician Observation		
	%	SE	p-value*	%	SE	p-value*	%	SE	p-value*
Pre-1950	4.95	0.36					5.95	2.32	
1950–1979	4.60	0.24	<.0001	N/A			3.71	0.97	0.0003
1980+	2.57	0.17					0.77	0.27	

**Based on chi-square testing*

N/A = not applicable. SE = standard error.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Lastly, the relationship between moisture and housing age was examined (exhibit 6). Although both surveys revealed a significant relationship, the directionality is less clear for the AHHS II data. In the AHS, there is a clear relationship between housing age and the reported presence of home moisture; however, in the AHHS II, the highest rate of moisture occurred in the middle category (units built between 1950 and 1979). This rate could be attributed, however, to the fact that confidence intervals overlap across categories. For both surveys, the newest housing (1980+) had the lowest prevalence of recent moisture problems.

Exhibit 6

Prevalence of Moisture in the U.S. Occupied Housing Stock, 2015 American Housing Survey (AHS) and American Healthy Homes Survey II (AHHS II)

Year Housing Unit Built	2015 AHS			AHHS II					
	Respondent Self-Report			Respondent Self-Report			Technician Observation		
	%	SE	p-value*	%	SE	p-value*	%	SE	p-value*
Pre-1950	22.4	0.69		24.8	3.64				
1950–1979	17.2	0.43	<.0001	26.3	2.65	0.0003	N/A		
1980+	13.9	0.37		15.4	2.17				

**Based on chi-square testing*

N/A = not applicable. SE = standard error.

Sources: U.S. Census Bureau, 2015 American Housing Survey; HUD, American Healthy Homes Survey II

Data Implications

The data analysis example highlighted above shows that both the AHS and the AHHS II can be used to produce prevalence estimates regarding home health hazards in the occupied U.S. housing stock. Although estimates regarding musty smells differed across the surveys, prevalence estimates regarding the presence of mold and moisture were similar in both surveys despite survey differences.

Results suggest three critical implications regarding the interpretation of home hazard outcomes given differing survey metrics and implementation procedures used in the AHS and the AHHS II.

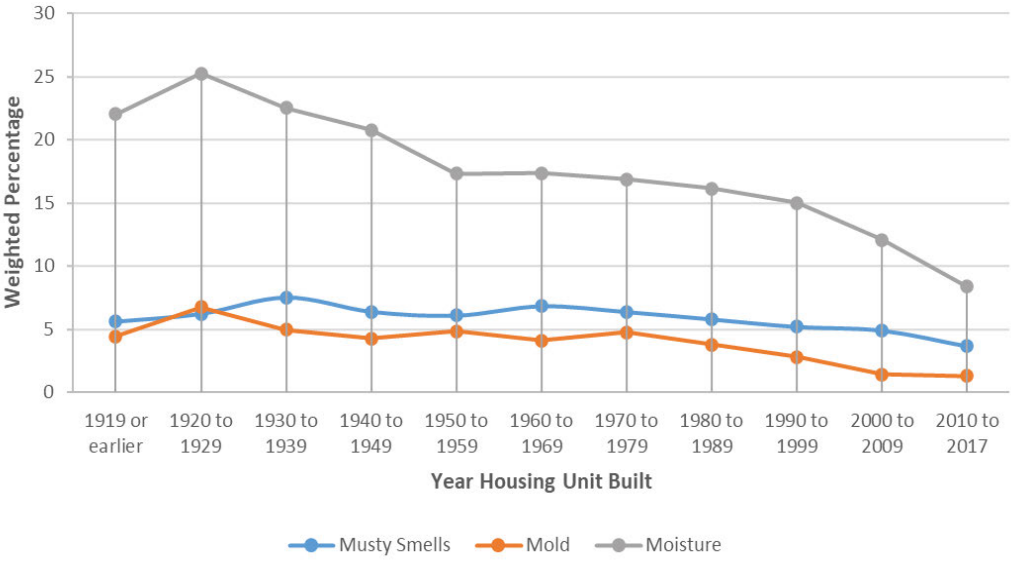
First, data users should consider their analytic purpose. Although the AHS can be used to broadly examine and estimate the prevalence of some home hazards, the AHHS II should be used for detailed analyses regarding specific hazards (for example, lead dust hazards). Most AHHS II data collection efforts for specific hazards represent the gold standard. If users plan to subset analyses by specific sociodemographic characteristics (for example, race and ethnicity), however, careful consideration should be given to potential sample size limitations.

Second, it is important for users to carefully review the survey questions and data collection efforts used to capture information about specific home hazards. For example, consider the "musty smells" topic. Researchers interested in this topic have several options. Although all questions capture the same construct, there are slight nuances that should be considered. The AHS asks respondents a Likert-scale question: *In the last 12 months, how often have you noticed any musty smells inside your home?* Response options include daily, weekly, monthly, a few times, and never. Conversely, the AHHS II asks respondents a "yes/no" question: *Does your home frequently have a mildew odor or musty smell?* Both self-report questions are similar, but different question wording may affect responses. The AHHS II also asks trained field technicians to complete the following question: *Does this room have a musty smell?* Again, options are yes/no. Because technicians are formally trained, users may want to bypass using self-reported metrics and use field observations. Data users should carefully consider question nuances when planning analyses.

Third, although AHHS II captures detailed information about specific hazards, including field technician observations, the low sample size makes multivariate analyses difficult. For example, in the analyses highlighted in this article, housing age had to be collapsed into three categories. Conversely, the large AHS sample size allows users to examine 11 categories of housing age (exhibit 7). From these analyses, the relationship between housing age and musty smells ($p=0.0255$), mold ($p<0.0001$), and moisture ($p<0.0001$) appears significant. This finding further underscores that research questions and output purpose should guide whether the AHS or the AHHS II is used for analyses.

Exhibit 7

Prevalence of Musty Smells, Mold, and Moisture by Housing Age, 2015 American Housing Survey



Source: U.S. Census Bureau, 2015 American Housing Survey

Conclusion

This article introduces readers to the use of the 2015 AHS and the AHHS II to determine the prevalence of certain home hazards in the U.S. housing stock. The presence of musty smells, mold, and moisture was examined in each survey as a data analysis example. Despite differing survey implementation strategies and survey questions, the results of both surveys were similar. Nonetheless, the results suggest several important considerations for data users interested in using these surveys for national population estimates regarding home hazards.

Acknowledgments

The authors would like to acknowledge Eugene Pinzer from the U.S. Department of Housing and Urban Development, Office of Lead Hazard Control and Healthy Homes for his thoughtful feedback and comments about the American Healthy Homes Survey. The authors are also grateful to Dr. David Cox and Jonathan Bielli from QuanTech for their support in obtaining a pre-public release dataset from the American Healthy Homes Survey II.

Authors

Veronica Eva Helms Garrison is a Social Science Analyst at the U.S. Department of Housing and Urban Development, Office of Policy Development and Research.

Jacqueline Bachand is a Social Science Analyst at the U.S. Department of Housing and Urban Development, Office of Policy Development and Research.

Peter J. Ashley is the Director of the Policy and Standards Division at the U.S. Department of Housing and Urban Development, Office of Lead Hazard Control and Healthy Homes.

References

Clickner, Robert P., David A Marker, Susan M. Viet, John Rogers, and Pamela Broene. 2001. *National Survey of Lead and Allergens in Housing, Volume I*. Analysis of Lead Hazards. Washington, DC: Westat, U.S. Department of Housing and Urban Renewal.

Dewalt, Gary F., David C. Cox, Robert O'Haver, Brendon Salatino, Duncan Holmes, Peter J. Ashley, Eugene A. Pinzer, Warren Friedman, David Marker, Susan M. Viet, and Alexa Fraser. 2015. "Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing," *Journal of Environmental Health* 78 (5): 22–29.

Fisk, William J., Quanhong Lei-Gomez, and Mark J. Mendell. 2007. "Meta-Analyses of the Associations of Respiratory Health Effects with Dampness and Mold in Homes," *Indoor Air* 17: 284–96.

Howden-Chapman, Philippa, Kay Saville-Smith, Julian Crane, and Nick Wilson. 2005. "Risk Factors for Mold in Housing: A National Survey," *Indoor Air* 15 (6): 469.

Kanchongkittiphon, Watcharoot, Mark J. Mendell, Jonathan M. Gaffin, Grace Wang, and Wanda Phipatankul. 2015. "Indoor Environmental Exposures and Exacerbation of Asthma: An Update to the 2000 Review by the Institute of Medicine," *Environmental Health Perspectives* 125: 6–20.

Kercsmar, Carolyn M., Dorr G. Dearborn, Mark Schluchter, Lintong Xue, H. Lester Kirchner, John Sobolewski, Stuart J. Greenberg, Stephen J. Vesper, and Terry Allan. 2006. "Reduction in Asthma Morbidity in Children as a Result of Home Remediation Aimed at Moisture Sources," *Environmental Health Perspectives* 114 (10): 1574–1580.

Mendell, Mark J., and Rachel L. Adams. 2019. "The Challenge for Microbial Measurements in Buildings," *Indoor Air* 29 (4): 523–526.

Mudarri, David, and William J. Fisk. 2007. "Public Health and Economic Impact of Dampness and Mold," *Indoor Air* 17 (3): 226–35.

National Institute of Environmental Health Sciences (NIEHS). N.d. Rockville, MD: "National Survey of Lead & Allergens in Housing (NSLAH)." https://www.niehs.nih.gov/research/clinical/studies/nslah/index.cfm.

QuanTech. QuanTech Website. Accessed September 2020. https://www.quantech.com/.

_____"Lead Based Paint and Healthy Homes." Accessed September 2020. https://www.quantech.com/lead-healthy-homes.

SAS Institute. N.d. "SAS/STAT® 14.3 User's Guide: Introduction to Survey Sampling and Analysis Procedures." https://support.sas.com/documentation/onlinedoc/stat/143/introsamp.pdf.

U.S. Census Bureau. 2015. "AHS 2015 National Public Use File (PUF)." Washington, DC: U.S. Census Bureau. https://www.census.gov/programs-surveys/ahs/data/2015/ahs-2015-public-use-file--puf-/ahs-2015-national-public-use-file--puf-.html.

———. N.d. "About: American Housing Survey." Washington, DC: U.S. Census Bureau. https://www.census.gov/programs-surveys/ahs/about.html.

———. N.d. "Methodology: American Housing Survey." Washington, DC: U.S. Census Bureau. https://www.census.gov/programs-surveys/ahs/about/methodology.html.