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'Home is where the health is': Housing quality and adult health outcomes in the survey of income and program participation

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Abstract

Nearly a quarter of the homes in the United States were considered unhealthy or inadequate, but whether these housing characteristics have direct effects on health or whether they are driven by other contextual housing and neighborhood characteristics remains unclear. The purpose of this study was to quantify the independent associations between poor housing quality and adult health outcomes, adjusting for socioeconomic factors (e.g. income to poverty ratio, food insecurity) and other contextual housing characteristics (e.g. rental status, number of people per household, unsafe neighborhood). Using in-person household interview data from wave 1 of the 2014 Survey of Income and Program Participation (SIPP), a secondary analysis was performed using a series of logistic regression models. The 2014 SIPP sample is a multistage stratified sample of 53,070 housing units designed to represent the civilian, noninstitutionalized population of the United States (N = 55,281 adults ages 18 and older). Our results indicate that each additional poor housing characteristic was associated with poorer health status (OR: 1.17, CI [1.11, 1.23]), higher medical utilization (OR: 1.11 CI: [1.06, 1.16]), and a higher likelihood of hospitalization (OR: 1.07, CI [1.02, 1.12]). Non-housing-related government assistance, food security, and safe neighborhoods only partially explained associations between housing quality and health outcomes. Evaluating current local, state, and federal policy on housing quality standards may help determine

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if these standards decrease the number of Americans residing in inadequate homes or result in improvements in health and reductions in healthcare costs. Simply put, the home is where [we suggest] the health is.

Keywords

House quality; Utilization; Health status; Home; Neighborhood

1. Introduction

A 2017 Report to Congress revealed that 8.3 million very low-income rental households in the United States had *worst case needs* (defined as renters with very low incomes who do not receive government housing assistance and paid more than one-half of their income for rent, lived in severely inadequate conditions, or both) (United States Department of Housing and Urban Development, 2017). National estimates of poor housing quality have been higher in studies that include home owners and other income brackets. For example, a 2011 study found that 23.4 million of 110 million housing units were considered *unhealthy* residences based on the presence of rodents, leaks, peeling paint, or faulty smoke alarms (Raymond et al., 2011), while, 5.8 million residences were considered *inadequate* based on moderate or severe deficiencies in plumbing, heating, electricity, and upkeep (Raymond et al., 2011). However, national estimates are even higher when examining only those who reside in metropolitan areas. According to the 2018 State of Healthy Housing report, nearly 40% of metropolitan homes had at least one significant health or safety hazard. The occupants of these unhealthy or inadequate residences were disproportionately people with lower educational attainment, people in poverty, and people of color (Raymond et al., 2011).

Homelessness, poor housing and disadvantaged neighborhood conditions (e.g. blight, high violence, low-income) have all been linked to poorer health and higher healthcare utilization (Bonnefoy, 2007; Krieger and Higgins, 2002; Office of the Surgeon General, 2009). Sub-standard housing specifically has been associated with infectious disease (Krieger and Higgins, 2002), chronic disease such as asthma (Bonnefoy, 2007), and poor mental health (Pevalin et al., 2017). The chronic exposures to hazards such as lead, mold, allergens, or poor sanitation can impact health and functioning (National Research Council US Committee on Measuring Lead in Critical Populations., 1993; Mudarri and Fisk, 2007), while inadequate structural characteristics can impact personal safety through an increased risk for injury. However, debate exists on the pathways that drive the associations between housing and health, as contemporaneous adversities such as food insecurity, poverty, and unsafe neighborhoods are also independently tied to poor health (Bennett et al., 2007; Comission on Social Determinants of Health (CSDH), 2008). Additionally, other factors including rental status, labor force status, and receipt of government assistance (housing and non-housing related) may buffer or exacerbate the relationship between housing and health. For example, people in tight financial positions may be faced with choosing to spend limited funds on healthcare or various home and housing needs; participation in government programs may free up income for families allowing them to focus some of their funds on

healthcare. Additionally, people who rent their home may have limited agency for housing maintenance or improvement.

In order to inform the policy discussion on housing quality, we examined how poor housing quality was associated with general health status and healthcare utilization (e.g. number of medical visits and hospitalizations) among adults by adjusting for other demographic, socioeconomic, and contextual housing covariates using a large nationally-representative survey with detailed questions on government assistance programs and eligibility, as well as health status indicators, housing, and neighborhood characteristics. Understanding *how* housing and neighborhood characteristics are associated with poorer health and higher healthcare use may help inform public and private investment in health promotion, lower health costs, and alleviate racial, income, and educational disparities in health across the lifespan (Williams and Rucker, 2000).

2. Methods

This analysis uses Wave 1 of the 2014 Survey of Income and Program Participation (SIPP) to estimate logistic regression models predicting the association between housing quality and health outcomes. The SIPP is a nationally representative longitudinal survey administered by the U.S. Census Bureau that collects monthly information on economic well-being, family dynamics, household composition, neighborhood characteristics, and eligibility and participation in government assistance programs essential to answer our questions of interest. The 2014 SIPP sample is a multistage stratified sample of 53,070 housing units from 820 sample areas designed to produce accurate estimates from low income households and represent the civilian, noninstitutionalized population of the United States. These data were collected between February and June of 2014 via household interviews. Data were collected using interviews with each adult in the household. The Census Bureau used weighting adjustments to account for over-sampling, and imputation to adjust for non-response or missing data. For more detailed information on the survey methodology, refer to the 2014 SIPP Source and Accuracy statement (US Census Bureau, 2017).

We limit this analysis to adults age 18 and older in order to capture the differences between considerations such as housing tenure and labor force participation. Further, children under 15 in the SIPP are *proxy-reported* by a household representative whereas the adult sample is *self-reported* when possible. Children under certain ages also have different medical well-visit recommendations compared to adult recommendations (e.g. children under 2 years of age are recommended to visit the doctor every 1–2 months) (Hagan et al., 2017).

3. Measures

Brief descriptions of each dependent, predictor, and covariate indicator are provided below, and complete details on the measures and construction of all variables are available in Supplementary Table 1.

3.1. Dependent variables

Health status was measured by the response to the survey item, "What is [respondent]'s health-status?" Possible responses ranged from 1 ("excellent") to 5 ("poor"). As in other studies using this indicator for adults (Hart et al., 2017; Sentell et al., 2014; Zhao et al., 2018), this 5-point Likert scale of reported health status was dichotomized to represent either good/very good/excellent or poor/fair health, to accommodate the high degree of skewness in distribution. Number of nights spent in the hospital in the preceding year was recoded to indicate any hospitalization versus no hospitalizations. Results presented contain the full analytic sample. We conducted post-hoc sensitivity analyses that excluded women who most recently gave birth and results were similar. Number of medical visits (other than hospital stays) in the preceding year was categorized into "0″ for no medical visits, "1″ for 1–2 medical visits per year (reference group), and "2″ for > 2 medical visits for the year.

3.2. Primary predictor of interest

Housing quality was represented by the number of poor housing characteristics reported. The household respondent was asked if any of the following four conditions were present in their residence during 2013: "… holes in the walls or ceiling, or cracks wider than the edge of a dime?"; "… holes in the floor big enough to catch your foot on?"; "… problems with pests such as rats, mice, roaches, or other insects?", and "… a toilet, hot water heater, or other plumbing that didn't work?" Similar to previous health literature, a response of "yes" to any of the aforementioned problems was coded as 1 and responses were summed together to create an index, for which higher values indicated poorer housing quality (Coley et al., 2014; Gielen et al., 2012; Jones-Rounds et al., 2014).

3.3. Other covariates

Demographic characteristics studied included sex, race, ethnicity, age, education, and disability status.

Socioeconomic characteristics studied included the federal income-to-poverty ratio, level of food insecurity, health insurance coverage, labor force status, and receipt of non-housing-related government assistance.

Contextual housing characteristics included: home rental status, household size, receipt of government housing assistance, neighborhood safety, and metropolitan status. Rental status was dichotomous and coded as 0 ("owned") if the living quarters were owned or bought by someone in the household compared to 1 ("rented" or "occupied without payment of rent"). Household size can serve as an indicator of cramped and crowded conditions that may give rise to poor hygiene and increased risk of disease transmission. Receipt of government housing assistance was coded as 1 ("receipt of rent, housing voucher, or energy assistance") or 0 ("no receipt of government housing assistance"). Similar to recent literature, perception of unsafe neighborhood was dichotomized as 1 ("very unsafe, somewhat unsafe, or somewhat safe") and 0 ("very safe") (Datar et al., 2013; Lenhart et al., 2017).

4. Statistical analyses

Nested logistic regression models were estimated to predict associations between housing quality and each health outcome variable. Odds ratios and 95% Wald confidence intervals are reported. Separate logistic regression models were used for the possible outcomes of number of medical visits. Model 1 estimated the bivariate relationship between poor housing quality and the outcome of interest. Models 2–4 additively controlled for demographic, socioeconomic, and other contextual housing characteristics available in SIPP that are known to impact the relationship between housing and health. Additional analyses (results not presented) examined each of our fully-saturated models, stratified by the number of poor housing characteristics, to assess how other factors contribute to health outcomes in the presence of different levels of housing quality. The models were developed a priori and were guided by the theoretical underpinnings of social determinants of health frameworks (Solar and Irwin, 2010) and clinical implications.

Our comparison group for health status was "good, very good, or excellent health" and our comparison group for number of nights in the hospital was "no hospitalizations". Results are presented separately for no medical visits versus moderate use (1–2 visits), and for high use (3 or more visits) versus moderate use (1–2 visits). Our comparison group was moderate use, as the majority of adults in the sample who reported "excellent health status" reported a mean of 1–2 medical visits per year.

We used SIPP weights in all analyses to adjust for oversampling (Williams and Rucker, 2000). Percentages were weighted to be representative of non-institutionalized U.S. adults. Variance estimates accounted for the complex clustered design of the SIPP study using replicate weights and Fay's BRR method. Multicollinearity was assessed prior to multivariable modeling and it was determined that tolerance and variance inflation factors were within normal limits.

5. Results

5.1. Study sample

The 2014 wave 1 SIPP data included 55,281 adults age 18 years and older. All adults are included in the analysis; due to imputation procedures there were no cases missing data on any variables of interest (Bureau USC, 2017).

5.2. Descriptive statistics

Table 1 presents descriptive statistics for the sample. Younger adults (18–44 years) comprised 46.7% of the analytic sample, while middle-aged adults (45–64 years) and older adults (> 64 years of age) comprised 34.5% and 18.8% of the sample, respectively. The majority of the sample identified as non-Hispanic (84.9%) and White (79.1%). Approximately 20.2% of the sample identified as having at least one disability, and 12.5% reported having attained less than a high-school diploma. More than a tenth of the sample (11.2%) reported receiving non-housing-related government assistance, while 3.7% of the sample reported receiving some type of housing assistance. About one third of the sample,

or 33.6%, did not own their home. An estimated 32.2% of adults were reported living in a less than safe neighborhood by the referent adult.

Overall, 16.3% of the adults reported having poor or fair health. Almost a third (30.9%) of adults reported having a moderate number of medical visits (1–2 visits per year), and 10.7% had at least one hospitalization. More than a tenth (11.3%) of adults reported having one poor housing characteristic – the most common of which was pests(46.7% of adults with one housing problem), while 3.8% reported two poor housing characteristics – the most common of which was pests and cracks (40.2% of adults with two housing problems), 1.2% reported three poor housing characteristics, and 0.4% reported having all four poor housing characteristics (cracks in ceiling, holes in floor, pest problems, or plumbing problems).

6. Multivariable logistic regression results

6.1. Health status

Table 2 summarizes the results of the models that examined the association between poor housing quality and poor health status. Results of the baseline model indicated that each additional poor housing characteristic was associated with greater odds of having fair or poor health (odds ratio [OR] = 1.50, 95% confidence interval [CI] = 1.44,1.56). The effect of poor housing quality remained significant after adding demographic characteristics, including whether the respondent reported having a disability. Although the magnitude of the effect of poor housing quality on health status decreased with the inclusion of socioeconomic and housing characteristics, the association remained statistically significant across all models (Model 4 (fully adjusted model): OR = 1.17, CI = 1.11, 1.23). Contemporaneous adversities partially explained the relationship between poor housing quality on poor health status but the main effect remained significant. Results from the stratified model (available upon request) indicate that food insecurity increased the odds of fair or poor health for people with zero to three housing quality issues, while receipt of non-housing government assistance increased the odds for people with zero to two housing quality issues, and residing in a non-metro area increased the odds for people with one, two, or four housing quality issues.

6.2. Hospitalization

Table 3 summarizes the results of the models that examined the associations of poor housing quality with hospitalization. As with health status, the results of the baseline logistic regression model indicated that each additional poor housing characteristic was associated with greater odds of hospitalization (OR = 1.22, 95%, CI = 1.16,1.27). This effect remained significant with the inclusion of demographic, socioeconomic, and housing characteristics (Model 4 (fully adjusted model): OR = 1.07, CI = 1.02, 1.12). Each additional person residing in the household, non-metropolitan status, rental status, and receipt of non-housing government assistance were also associated with a greater odds of being hospitalized. Contemporaneous adversities partially explained the relationship between poor housing quality on hospitalizations but the main effect of housing quality remained statistically significant. Results from the stratified models (available upon request) demonstrated that food insecurity, receipt of non-housing government assistance, and receipt of housing

assistance all increased the odds of high medical use but the effects varied by the number of poor housing characteristics reported.

6.3. Number of medical visits

Supplementary Table 2 and Table 4 examine the associations of poor housing quality with 1) no medical visits compared to moderate use (1–2 medical visits/services) and 2) high medical use (3 or more medical visits/services) compared to moderate use, respectively. The relationship between poor housing quality and no medical visits was not significant in the full model, therefore the discussion of the results will focus on high medical use.

In Table 4, the baseline model suggested that each additional poor housing characteristic was also associated with greater odds of having high medical use in comparison to moderate use (Model 1: OR: 1.18, 95% CI = 1.14, 1.23). Socioeconomic and other contextual housing characteristics partially explained the relationship between poor housing quality on high medical use, however the effect of poor housing quality remained significant across each nested model (Model 4 (fully adjusted model): OR = 1.10, 95% CI = 1.05, 1.15). Results from the stratified model (available upon request) indicate that food insecurity, receipt of non-housing government assistance, and residing in an unsafe neighborhood all increased the odds of high medical use but the effects varied by the number of poor housing characteristics reported.

7. Discussion

Each *additional* poor housing characteristic (cracks in the ceiling, holes in the floor, pests, or plumbing problems) was associated with poorer health status, high medical use, and higher likelihood of hospitalization even after controlling for other factors known to affect health and medical usage, such as disability status and neighborhood safety. Our study provides evidence to support that the negative associations between poor housing quality and health that are not fully explained by socioeconomic assistance, neighborhood safety, and rental status. Socioeconomic characteristics and other possible buffers, such as non-housing-related government assistance, only partially explained the relationship between poor housing and health. They also represent additional factors that in most cases exacerbate the relationship. Contextual housing characteristics such as household size, rental status, neighborhood safety, and housing-related government assistance had very little effect on the relationships among poor housing and each of our health outcomes.

Consistent with other literature linking poor housing to poor health (Jacobs et al., 2009; Krieger and Higgins, 2002), our results could be used to inform interventions to improve housing and housing quality standards that may lead to corresponding improvements in health and decreases in healthcare costs. While this paper does not explore which poor housing characteristics have the strongest associations with health outcomes nor the direction of the association, it does provide evidence that the number of poor housing characteristics a residence has is associated with a higher likelihood of poor health. The National Center for Healthy Housing and the American Public Health Association (2014) have developed healthy housing standards to address the relationship between housing and health (National Center for Healthy Housing & American Public Health Association., 2014);

however, these recommendations only serve as a guide for property owners, elected officials, and code agency staff.

Global initiatives toward the improvement of housing quality standards and recommendations have also surfaced. In 2018, the World Health Organization (WHO) published housing and health guidelines, and recommended raising and better reinforcing housing quality standards as key steps to improving houses and health (World Health Organization, 2018). Since the average person roughly spends about 60–70% of their day within a home-residence (and infants and elderly spend more time in home) (Klepeis et al., 2001), the value of improving the home may be of importance to public health policymakers, providers, and health care systems. While several housing quality standards currently exist, a relatively small percentage of our population is covered under enforceable federal housing quality regulations. In the U.S., only 3% of the general population is protected by legislation on federal housing quality standards as only those who reside in government housing are legally covered (U.S. Department of Housing and Urban Development, 2001).

Our results showing that *each additional* poor housing characteristic was associated with a higher likelihood of being hospitalized and having a high number of medical visits after controlling for socioeconomic and other contextual housing characteristics. Identification of these associations could be used to support research to determine if investment in housing improvement initiatives could lead to reduced utilization and corresponding cost savings in our healthcare system. While housing-related government assistance has previously been associated with less crowding and less neighborhood poverty (Lindberg et al., 2010), additional post-hoc sensitivity analyses (available upon request) revealed that, among adults that could qualify for housing assistance (N = 36,008 with an income to poverty ratio of 2 or less), receipt of housing assistance was positively associated with more poor housing characteristics compared to not receiving housing assistance when controlling for race and ethnicity.

To better understand housing issues at the local level, health providers and Community Health Needs Assessments (Billioux et al., 2017) conducted by local hospitals may consider expanding current social determinants of health questions to include screening for housing quality, given the association with negative health outcomes. Relatedly, housing resources linked to screening like rent support, eviction prevention, and increased affordable housing could be expanded to also include opportunities for improving the quality of new and existing affordable housing. Research has suggested that improvements in housing (DiGuiseppi et al., 2010; Jacobs et al., 2010; Krieger et al., 2010; Sandel et al., 2010; Thomson et al., 2009) and neighborhoods (Branas et al., 2018) have had positive effects on health and safety. Because our results underscore the interconnectedness of housing and health, health care systems could also dedicate efforts to better integrate social and health service information exchanges to increase referrals and connectivity among community organizations, health care delivery organizations, and families (McKethan et al., 2019). Health-care systems may also start to consider integrating medical-legal partnerships dedicated to housing improvement, as more research has highlighted the positive impact and efficacy on patient health outcomes (Martinez et al., 2017). Web-based referral systems,

such as the Breathe Easy at Home initiative, in which healthcare providers are able to refer patients with asthma to housing officials for inspections (City of Boston, 2018; State of Rhode Island Department of Health, 2019), are innovative strategies community or health care systems could employ.

Our findings provide a piece of support for the holistic notion that the treatment of a patient should be considered within context of their social milieu and environment. The relationship between health and physical home environment could be considered within a social context-centered care model as an area for intervention to further improve patient health.

8. Limitations

First, the data used for this study's analyses were cross-sectional, and therefore causality and the direction of the relationships cannot be inferred from the study's results. Relatedly, despite the range of demographic, socioeconomic and geographic measures available in the SIPP, this study's analyses were not exhaustive, especially with regard to having only four poor housing characteristics variables. Studies designed to address temporal concerns and to rule out alternative explanation for these findings are needed to document the potential impact that improving housing quality has on health and healthcare use. In addition, we were unable to adjust for length of time at current residence or household churning which are two important considerations future research could examine. Second, the data are subject to error arising from a variety of sources including sampling error and non-sampling error. In addition, multiple imputation methods were conducted on the SIPP and therefore, these estimates may be more conservative. Multiple imputation ensures that the error associated with the missing data is built into the model, and thus, the standard errors are larger due to reflect the additional amount of uncertainty. Third, all measures were self-reported and subject to recall bias. Future research could incorporate more objective measures such as health care records of medical usage as well as objective measures of housing quality. Despite these limitations, our data suggests that contemporaneous adversities only partially explain the association between poor housing and poor health, and these results may be used to support the investigation of initiatives on improving housing quality standards and better screening related to housing quality to determine if these measures improve population health.

9. Conclusion

Early recognition of housing quality issues in addition to housing insecurity and related interventions in vulnerable families can support holistic approaches to care. Our results suggest that poor housing quality is associated with negative health outcomes even after controlling for contemporaneous adversities and socioeconomic factors. Evaluating current local, state, and federal policy on housing quality standards may help determine if these standards decrease the number of Americans residing in inadequate homes or result in improvements in health and reductions in healthcare costs. Simply put, the *home is where* [we suggest] *the health is*.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding source

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Table 1

Weighted percentages and means of adults in the United States in wave 1 of the SIPP analytic sample, for those aged 18 years and older.

Source: 2014 Survey of Income and Program Participation, wave 1, public use file.

	Age group 18 years of age N = 55,281
	% or mean (std error)
Outcome variable of interest	
Poor or fair health status	16.3% (0.002)
Any hospitalization, 2013	10.7% (0.002)
No medical utilization, 2013	23.4% (0.003)
Moderate utilization (1–2 medical visits, reference group), 2013	30.9% (0.003)
High utilization (> 2 medical visits), 2013	45.6% (0.003)
Housing quality current characteristics	
No poor housing characteristics (reference group)	83.3% (0.003)
1 poor housing characteristic	11.3% (0.002)
2 poor housing characteristics	3.8% (0.001)
3 poor housing characteristics	1.2% (0.001)
4 poor housing characteristics	0.4% (0.0004)
Demographic characteristics	
Race	
Black/African American	12.3% (0.002)
Asian	5.5% (0.002)
American Indian/Pacific islander	1.4% (0.001)
Multi-racial	1.7% (0.001)
White (reference group)	79.1% (0.003)
Hispanic	15.1% (0.003)
Male	48.2% (0.002)
Age	
Young adulthood (18–44, reference group)	46.7% (0.003)
Middle adulthood (45–64)	34.5% (0.002)
Older adulthood (> 64)	18.8% (0.002)
Disability status	20.2% (0.002)
Education	
Less than high school	12.5% (0.002)
High school graduate or equivalent	29.1% (0.002)
Associate's degree or some college	29.1% (0.002)
Bachelor's degree or higher (reference group)	29.4% (0.003)
Socioeconomic characteristics	
Income to poverty ratio (past year)	4.4 (0.03)
In labor force in December 2013	65.4% (0.002)
Food insecurity (range l:Low - 3:High)	1.2 (0.004)
Health insurance coverage (past year)	84.9%% (0.002)

	Age group 18 years of age *N* = 55,281
	% or mean (std error)
Non-housing gov't assistance (past year)	11.2% (0.002)
Other housing contextual characteristics[1]	
Rental status (current)	33.6% (0.003)
Household size during month of interview	2.9 (0.02)
Gov't housing assistance (past year)	6.9% (0.002)
Unsafe neighborhood (past year)	32.2% (0.003)
Non-metropolitan status (current)	13.7% (0.01)

Table 2

Logistic regression odds ratio estimates and 95% Confidence limits of models predicting self-reported poor or fair health status of adults ages 18 and older in the United States (N = 55,281).

Source: 2014 Survey of Income and Program Participation, wave 1, public use file.

	Model 1	Model 2	Model 3	Model 4
Current housing characteristics				
Poor housing quality, 0–4	1.50 [1.44, 1.56]	1.34 [1.27, 1.40]	1.19 [1.13, 1.26]	1.17 [1.11, 1.23]
Demographic characteristics				
Race				
Black/AA		1.59 [1.45, 1.74]	1.34 [1.22, 1.48]	1.28 [1.16, 1.42]
Asian		1.38 [1.16, 1.63]	1.34 [1.13, 1.59]	1.31 [1.10, 1.56]
American Indian/Pacific islander		1.27 [1.03, 1.56]	1.08 [0.86, 1.35]	1.07 [0.86, 1.33]
Multi-racial		1.12 [0.89, 1.41]	0.98 [0.78, 1.23]	0.97 [0.78, 1.22]
White (reference group)				
Hispanic		1.18 [1.07, 1.29]	1.11 [1.01, 1.22]	1.08 [0.98, 1.19]
Male		0.89 [0.84, 0.95]	1.02 [0.96, 1.08]	1.02 [0.96, 1.08]
Age				
Young adulthood (18–44, ref)				
Middle adulthood (45–64)		2.58 [2.39, 2.78]	3.00 [2.77, 3.25]	3.05 [2.80, 3.32]
Older adulthood (> 64)		2.52 [2.31, 2.76]	2.49 [2.26, 2.74]	2.56 [2.31, 2.84]
Disability status		8.66 [8.13, 9.23]	6.54 [6.13, 6.98]	6.49 [6.08, 6.92]
Education				
Less than high school		3.12 [2.79, 3.50]	1.97 [1.74, 2.23]	1.90 [1.68, 2.15]
High school graduate or equivalent		2.21 [2.02, 2.41]	1.66 [1.51, 1.82]	1.62 [1.48, 1.78]
Associate's degree or some college		1.64 [1.50, 1.78]	1.35 [1.23, 1.48]	1.32 [1.21, 1.45]
Bachelor's degree or higher (reference)				
Socioeconomic characteristics				
Income to poverty ratio (past year)			0.96 [0.95, 0.97]	0.96 [0.95, 0.97]
In labor force in December 2013			0.51 [0.48, 0.54]	0.51 [0.48, 0.54]
Food insecurity (past year)			1.40 [1.33, 1.47]	1.36 [1.29, 1.44]
Health insurance coverage (past year)			0.88 [0.81, 0.97]	0.89 [0.81, 0.97]

	Model 1	Model 2	Model 3	Model 4
Receipt of non-housing gov't assistance (past year)			1.73 [1.57, 1.90]	1.66 [1.51, 1.83]
Housing characteristics				
Rental property (current)				1.05 [0.98, 1.14]
Household size during month of interview				1.01 [0.98, 1.03]
Gov't housing assistance (past year)				1.19 [1.06, 1.34]
Unsafe neighborhood (past year)				1.29 [1.20, 1.38]
Non-metropolitan status (current)				1.13 [1.05, 1.23]

Poor housing quality was measured as a count variable from 0 to 4, with 0 indicating no house problems up to 4 house problems (cracks in ceiling, holes in floor, pest and plumbing problems).

Table 3

Logistic regression odds ratio estimates and 95% Confidence limits of models predicting hospitalizations of adults in the United States (N = 55,281).

Source: 2014 Survey of Income and Program Participation, wave 1, public use file. Poor housing quality was measured as a count variable from 0 to 4, with 0 indicating no house problems up to 4 house problems (cracks in ceiling, holes in floor, pest and plumbing problems).

	Model 1	Model 2	Model 3	Model 4
Current housing characteristics				
Poor housing quality, 0–4	1.22 [1.16, 1.27]	1.13 [1.08, 1.19]	1.07 [1.02, 1.13]	1.07 [1.02, 1.12]
Demographic characteristics				
Race				
Black/AA		1.14 [1.05, 1.24]	1.03 [0.95, 1.13]	1.01 [0.92, 1.11]
Asian		0.72 [0.60, 0.86]	0.70 [0.58, 0.84]	0.68 [0.57, 0.82]
American Indian/Pacific islander		1.12 [0.86, 1.45]	1.07 [0.81, 1.38]	1.01 [0.77, 1.32]
Multi-racial		0.98 [0.79, 1.23]	0.90 [0.72, 1.13]	0.89 [0.71, 1.11]
White (reference group)				
Hispanic		0.90 [0.81, 0.99]	0.93 [0.84, 1.03]	0.90 [0.81, 1.00]
Male		0.68 [0.64, 0.72]	0.76 [0.71, 0.80]	0.76 [0.71, 0.80]
Age				
Young adulthood (18–44, ref)				
Middle adulthood (45–64)		1.10 [1.02, 1.19]	1.13 [1.04, 1.22]	1.17 [1.08, 1.27]
Older adulthood (> 64)		2.01 [1.84, 2.18]	1.76 [1.60, 1.94]	1.89 [1.71, 2.08]
Disability status		3.13 [2.94, 3.34]	2.50 [2.33, 2.67]	2.50 [2.33, 2.67]
Education				
Less than high school		1.32 [1.18, 1.49]	1.09 [0.96, 1.23]	1.05 [0.92, 1.18]
High school graduate or equivalent		1.16 [1.06, 1.27]	1.05 [0.95, 1.16]	1.03 [0.93, 1.14]
Associate's degree or some college		1.10 [1.00, 1.20]	1.03 [0.93, 1.13]	1.02 [0.92, 1.12]
Bachelor's degree or higher (reference)				
Socioeconomic characteristics				
Income to poverty ratio (past year)			1.00 [0.99, 1.01]	1.01 [1.00, 1.01]
In labor force in December 2013			0.62 [0.58, 0.67]	0.63 [0.58, 0.67]
Food insecurity (past year)			1.20 [1.14, 1.26]	1.18 [1.12, 1.24]
Health insurance coverage (past year)			1.63 [1.47, 1.81]	1.46 [1.31, 1.62]

	Model 1	Model 2	Model 3	Model 4
Receipt of non-housing gov't assistance (past year)			1.78 [1.62, 1.97]	1.70 [1.54, 1.88]
Housing characteristics				
Rental property (current)				1.13 [1.04, 1.22]
Household size during month of interview				1.03 [1.01, 1.05]
Gov't housing assistance (past year)				1.16 [1.03, 1.29]
Unsafe neighborhood (past year)				1.00 [0.93, 1.08]
Non-metropolitan status (current)				1.10 [1.02, 1.19]

Models 1–4 Multinomial logistic regression odds ratio estimates and 95% Confidence limits of models predicting high medical utilization compared to moderate medical utilization in adults in the United States (N = 55,281).

Source: 2014 Survey of Income and Program Participation, wave 1, public use file. Poor housing quality was measured as a count variable from 0 to 4, with 0 indicating no house problems up to 4 house problems (cracks in ceiling, holes in floor, pest and plumbing problems).

	Model 1	Model 2	Model 3	Model 4
Current housing characteristics				
Poor housing quality, 0–4	1.18 [1.14, 1.23]	1.14 [1.09, 1.18]	1.11 [1.06, 1.16]	1.11 [1.06, 1.16]
Demographic characteristics				
Race				
Black/AA		0.98 [0.91, 1.06]	0.95 [0.87, 1.03]	0.95 [0.87, 1.03]
Asian		0.83 [0.73, 0.95]	0.83 [0.73, 0.95]	0.83 [0.73, 0.95]
American Indian/Pacific Islander		1.07 [0.85, 1.35]	1.08 [0.85, 1.36]	1.08 [0.86, 1.36]
Multi-racial		1.05 [0.87, 1.26]	1.02 [0.84, 1.23]	1.02 [0.84, 1.23]
White (reference group)				
Hispanic		0.84 [0.78, 0.91]	0.87 [0.80, 0.94]	0.87 [0.80, 0.94]
Male		0.66 [0.63, 0.69]	0.69 [0.66, 0.72]	0.69 [0.66, 0.72]
Age				
Young adulthood (18–44, ref)				
Middle adulthood (45–64)		1.42 [1.34, 1.50]	1.44 [1.36, 1.52]	1.44 [1.37, 1.53]
Older adulthood (> 64)		2.14 [1.99, 2.31]	1.97 [1.82, 2.13]	1.97 [1.82, 2.13]
Disability status		2.96 [2.77, 3.15]	2.69 [2.51, 2.88]	2.69 [2.51, 2.88]
Education				
Less than high school		1.01 [0.92, 1.11]	0.97 [0.88, 1.06]	0.96 [0.88, 1.06]
High school graduate or equivalent		0.94 [0.88, 1.00]	0.93 [0.87, 1.00]	0.93 [0.87, 0.99]
Associate's degree or some college		0.99 [0.93, 1.05]	0.98 [0.92, 1.05]	0.98 [0.92, 1.05]
Bachelor's degree or higher (reference)				
Socioeconomic characteristics				
Income to poverty ratio (past year)			1.01 [1.00, 1.01]	1.01 [1.00, 1.01]
In labor force in December 2013			0.83 [0.79, 0.88]	0.83 [0.79, 0.87]
Food insecurity			1.16 [1.11, 1.22]	1.16 [1.11, 1.21]

	Model 1	Model 2	Model 3	Model 4
Health insurance coverage (past year)			1.68 [1.54, 1.82]	1.68 [1.55, 1.83]
Receipt of non-housing gov't assistance (past year)			1.36 [1.26, 1.46]	1.36 [1.26, 1.47]
Housing characteristics				
Rental property (current)				0.97 [0.92, 1.03]
Household size during month of interview				0.99 [0.97, 1.00]
Gov't housing assistance (past year)				1.00 [0.89, 1.12]
Unsafe neighborhood (past year)				1.11 [1.05, 1.18]
Non-metropolitan status (current)				1.01 [0.94, 1.09]