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Different types of housing and respiratory health outcomes

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ABSTRACT

Evidence has shown that housing conditions may substantially influence the health of residents. Different types of housing have different structures and construction materials, which may affect indoor environment and housing conditions. This study aimed to investigate whether people living in different types of housing have different respiratory health outcomes. The data from the 1999–2006 National Health and Nutrition Examination Survey were used for the analyses. The types of housing included houses, townhouses, apartments, and mobile homes. Respiratory symptoms included wheezing, coughing, sputum, and dyspnea; respiratory diseases included asthma, chronic bronchitis, emphysema, and chronic obstructive pulmonary disease (COPD). Multiple logistic regression was used to calculate odds ratio (OR) and 95% confidence interval (CI) after adjustment for potential confounding factors. A total of 11,785 participants aged 40 years and older were included in the analyses. Compared with those living in single family houses, participants living in mobile homes were more likely to have respiratory conditions, the OR (95% CI) was 1.38 (1.13–1.69) for wheezing, and 1.49 (1.25–1.78) for dyspnea; whereas participants living in apartments were less likely to have respiratory conditions, the OR (95% CI) was 0.58 (0.36–0.91) for chronic bronchitis, and 0.69 (0.49–0.97) for COPD. Compared with living in single family houses, living in mobile home was associated with worse, whereas living in apartments was associated with better, respiratory health outcomes. Further research is needed to better understand the underlying mechanisms and prevent adverse respiratory effects associated with living in mobile homes.

1. Introduction

There is growing recognition that the built environment may profoundly influence the physical and mental health of inhabitants (Perdue et al., 2003; Sallis et al., 2012; Srinivasan et al., 2003). Built environment encompasses all buildings and spaces created or modified by humans (Srinivasan et al., 2003), but family housing may be particularly important because people spend the majority of their time at home (Hancock, 2002; Klepeis et al., 2001). In recent two decades, accumulating evidence has shown that housing quality and conditions may affect the health of residents (Hood, 2005; Jacobs, 2011; Krieger and Higgins, 2002; Matte and Jacobs, 2000). For example, substandard housing may increase exposures to biological (e.g., molds, mites, roaches), chemical (e.g., lead, carbon monoxide, volatile organic compounds), and physical (e.g., extreme temperature, fine particles, radon) hazards (Bonnefoy, 2007; Jacobs, 2011), leading to a wide range of adverse health outcomes, especially respiratory diseases (Bonnefoy, 2007; Hood, 2005; Jacobs, 2011; Krieger and Higgins, 2002; Matte and Jacobs, 2000). Whereas housing interventions to improve housing conditions such as elimination of moisture intrusion, integrated pest management, and active radon mitigation can effectively reduce respiratory conditions (Krieger et al., 2010; Sandel et al., 2010). These studies provide convincing evidence that housing is related to health through housing quality and conditions.

According to the 2011 American Housing Survey (US Census Bureau, 2013), there are approximately 132 million homes in the US, about 63% are detached single-family homes, 30% are attached family homes including duplexes and apartments, and 7% are manufactured homes or trailers (mobile homes). Different types of housing have different structures and construction materials, which may substantially affect housing conditions and indoor environment. People living in different types of housing may thus be exposed to different levels of indoor pollutants, leading to different health outcomes. Based on the hypothesis, we conducted this study to investigate whether people living in different types of housing have different respiratory health outcomes, using a nationally representative sample of US adults from the 1999–2006 National Health and Nutrition Examination Survey (NHANES).

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2. Methods

2.1. Study population

The NHANES is a series of cross-sectional surveys conducted by the US National Center for Health Statistics. During each survey, a nationally representative sample of the civilian noninstitutionalized population is selected using a complex multistage sampling design to estimate the health and nutritional status of the US population (Johnson et al., 2013; Zipf et al., 2013). The survey consists of a household interview and a medical examination. In the household interview, various health-related questionnaires such as medical conditions are administered by a trained interviewer. Detailed information on the study population and the survey design is available elsewhere (Johnson et al., 2013; Zipf et al., 2013).

There are four two-year cycles of NHANES (1999–2000, 2001–2002, 2003–2004, and 2005–2006) that comprise information on types of housing in the questionnaire of housing characteristics. We aggregated these data to create a combined dataset (NHANES 1999–2006). Because chronic respiratory diseases such as emphysema and chronic bronchitis are relatively rare among people <40 years old, the self-reported diagnoses of these diseases may not be accurate among these participants. Further, young people are generally more likely to change residences, their current residences might not be related to their respiratory conditions. Additionally, in NHANES, some respiratory symptoms data such as dyspnea were collected only for people aged 40 years and older. Therefore, this study was restricted to participants aged 40 years and older who participated in the medical examination. For these participants, the overall response rate during NHANES 1999–2006 was 68% (Centers for Disease Control and Prevention, n.d.). The NHANES 1999–2006 was reviewed and approved by the NCHS Institutional Review Board; informed consent was obtained from all participants.

2.2. Types of housing

According to the questionnaire of housing characteristics during NHANES 1999–2006, the types of housing for participants' current homes at the time of interview were defined as follows:

House: A one family house detached from any other house.

Apartment: An apartment.

Townhouse: A one family house attached to one or more houses.

Mobile home: A mobile home or trailer.

2.3. Respiratory health outcomes

2.3.1. Respiratory symptoms: the presence of a respiratory symptom was defined by answering 'yes' to the corresponding question

Wheezing: 'In the past 12 months, have you had wheezing or whistling in your chest?'.

Coughing: 'Do you usually cough on most days for 3 consecutive months or more during the year?'.

Sputum: 'Do you bring up phlegm on most days for 3 consecutive months or more during the year?'.

Dyspnea: 'Have you had shortness of breath either when hurrying on the level or walking up a slight hill?'. The question was regarding a person's current general situation at the time of interview.

2.3.2. Respiratory diseases: respiratory diseases were defined as self-reported diagnosis by a doctor or other health professionals, unless otherwise specified

Asthma: was defined by answering 'yes' to the following two questions: (1) 'Has a doctor or other health professional ever told you that you have asthma?'; (2) 'Do you still have asthma?'.

Chronic bronchitis: was defined by answering 'yes' to the following two questions: (1) 'Has a doctor or other health professional ever told you that you have chronic bronchitis?'; (2) 'Do you still have chronic bronchitis?'.

Emphysema: was defined by answering 'yes' to the question 'Has a doctor or other health professional ever told you that you had emphysema?'.

Chronic obstructive pulmonary disease (**COPD**): was defined by having chronic bronchitis, emphysema, or both.

2.4. Potential confounding factors

Based on the questionnaire design and the frequency distribution, potential confounding factors were categorized as follows:

Age (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): the participants were divided into quartiles based on their age: 40–49, 50–61, 62–72, or 73–85 years.

Sex (Global Initiative for Chronic Obstructive Lung Disease, 2017; Han et al., 2007): men, women.

Race/ethnicity (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): non-Hispanic white, non-Hispanic black, Mexican American, or other.

Body mass index (**BMI**) (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): BMI was calculated by a person's weight in kilograms divided by the square of height in meters. Based on BMI, the participants were divided into four groups: <18.5 kg/m^2 (underweight), 18.5–24 kg/m^2 (normal), 25–29 kg/m^2 (overweight), ≥30 kg/m^2 (obese). Also, an "unknown" group was included to retain those with missing data on BMI.

Educational attainment (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): less than high school, high school (including general equivalency diploma), and more than high school.

Family income-to-poverty ratio (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): the ratio of annual household income to the family's corresponding poverty threshold published by the US Census Bureau in a given calendar year (US Census Bureau, n.d.). The ratio takes into account annual family income, family size, and the minimum income needed to support the family in a specific year. The participants were divided into tertiles based on their income-to-poverty ratios, representing low (≤1.56), medium (1.57–3.57), and high (≥3.58) family income levels, respectively. Also, an "unknown" group was included to retain the participants with missing data on family income-to-poverty ratio.

Leisure time physical activity (Bousquet and Khaltaev, 2007): on the basis of self-reported frequency and duration of participation in various moderate and vigorous physical activities during the past 30 days, the weekly total number of minutes spent in moderate (weekly frequency multiplied by the average duration of activity) and vigorous (weekly frequency multiplied by the average duration of activity multiplied by 2) physical activity was calculated for each participant. Ideal, intermediate and poor levels of physical activity were defined as ≥150, 1–149, and 0 min of physical activity each week, respectively (Caleyachetty et al., 2015; Ford et al., 2012).

Cigarette smoking status (Bousquet and Khaltaev, 2007; Global Initiative for Chronic Obstructive Lung Disease, 2017): current smokers (had smoked ≥100 cigarettes in lifetime and still smoked at the time of interview), former smokers (had smoked ≥100