Older adult falls in the community: Does unsafe home environment have a risk role through the mediating effect of functional limitations?

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Abstract

Background and Objectives: Fall incidents from unsafe home environment are frequent in older-adult homes but the literature is ambiguous whether it is the presence/absence, or the interplay of such conditions and physical functioning that is of salience. We therefore estimated whether unsafe home environment adversely associated with subsequent falls among older adults and what proportion of this association was mediated through limitations in daily and instrumental activities of daily living (ADL/IADL).

Research Design and Methods: Using a nationally representative sample of community-dwelling Medicare beneficiaries (≥65 years) in the 2018-2019 National Health and Aging Trends Study (NHATS; n=2,599), we conducted bivariate and multivariable analyses. We examined baseline conditions of home disorders, unsafe bathroom settings, unsafe house/building features, and house disrepairs in 2018 and their relation with subsequent falls in 2019, after controlling for covariates. To assess whether ADL/IADL limitations mediated this relationship, we employed the Karlson–Holm–Breen (KHB) methodology.

Results: In 2019, the self-reported prevalence of falls among older adults was estimated at 34.68%. While baseline home disorders had both a direct (adjusted Odds Ratio [aOR]: 1.14, 95% Confidence Interval [CI]:1.03,1.26) and an indirect effect through limitations in ADL and IADL (aOR: 1.01; 95%CI: 1.00,1.03), the relation between unsafe bathroom settings and subsequent falls was unclear. Unsafe house/building features and house disrepairs were not statistically significantly related either directly or indirectly with subsequent falls.

Discussion and Implications: Addressing home disorders through policy and housing assessments to highlight home environmental safety would be essential to address falls among older adults.

Keywords: home disorders, unsafe bathroom settings, activities of daily living (ADL), instrumental activities of daily living (IADL), NHATS

Background and Objectives

Falls remain a major source of death and disability among older adults in the US (Burns & Karara, 2018; Centers for Disease Control and Prevention [CDC], 2022;). With progressive aging of the US population, the economic and healthcare burdens of geriatric falls are on the rise (CDC, 2022; Haddad et al., 2019). Approximately one in four Americans 65 years and older fall each year (Bergen et al., 2016; Burns & Karara, 2018; Florence et al., 2018), and in 2020 nonfatal fall injuries resulted in about 3 million emergency department visits and hospitalizations and close to $70 billion in medical cost (CDC, 2021). In addition to fatal and non-fatal injuries, falls also lead to loss of independence among older adults and recurrent falls are one of the primary causes for placement of older adults in long-term care institutions (CDC, 2022; Spoelstra et al., 2012).

The etiology of older adult falls is multifactorial and the literature identifies a multitude of risk factors that include both intrinsic (personal) and extrinsic (environmental) conditions (Ambrose et al., 2013; Boelens et al., 2013; Ganz, & Latham; 2020; Kelekar et al., 2021; Lord et al., 2007; Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society [AGSBGS], 2011; Pynoos et al., 2010). In contrast to personal behavioral and health characteristics that predisposes older adults to a fall, extrinsic factors are situational risks in the form of unsafe environmental conditions, such as slippery surfaces, clutter, unsupportive bathroom features, or poor furniture layout, to name a few (Carter et al., 1997; Pynoos et al., 2010;). Instances of such unsafe environmental conditions are frequent in older adult homes and are of particular concern since a majority of the falls among older adults in the community occur within the home (Gell et al., 2020; Kelekar et al., 2021; Pynoos et al., 2010; Rosen et al. 2013; Stevens et al., 2001; 2014; Wyman et al., 2007). Falls resulting from unsafe home environment also limit the potential for aging in place, while most older Americans prefer to live

independently and age in the community (Binette, & Vasold, 2019; Gell et al., 2020; Rosenwohl-Mack et al., 2020).

The role of environmental factors in influencing individual health, wellbeing, and functioning of older adults has been highlighted by a rich tradition of theoretical considerations in environmental gerontology which are rooted in the seminal concept of person-environment fit (Lawton & Nahemow, 1973; Scheidt, & Windley, 2006; Wahl & Gitlin, 2007; Wahl et al., 2012). Lawton & Nahemow's (1973) person-environment fit, also referred to as the environmental-press model, postulates optimal outcomes when personal competencies match the demands or "press" of the environment. In parallel, Verbrugge & Jette's (1994) disablement process model conceptualizes environmental risk/protective factors, including the built environment (such as, access to buildings), that speed up or delay the disablement process. Empirical evidence is mostly supportive of this line of argument with findings demonstrating, for instance, the impact of the home environment on functional outcomes among older adults (Breysse et al., 2022; Gitlin, 2003; Szanton et al., 2019, 2016; Wahl et al., 2009). Together, the person-environment fit and the disablement process models highlight the interplay between the person (intrinsic) and the environment (extrinsic) in influencing functional capacities and, in turn, falls among older adults.

Accordingly, the home environment can be identified as an extrinsic facilitator (or barrier) to physical functioning of aging individuals indicating that an indirect pathway through this factor may link home environment to falls (Lord et al., 2006; Oswald & Wahl, 2007; Wahl et al., 2009). This indirect link between unsafe home environment and older adult falls through physical functioning is of significance since functional limitations and time spent at home are high in this demographic (Ankuda et al., 2021; Musich et al., 2015; Ornstein et al., 2015).

However, prior studies examining falls among older adults in the community have evaluated the role of unsafe home environment independent of its indirect role through functional outcomes of older adults (c.f. Lee, 2021; Okoye et al., 2021; Teno et al., 1990; Tinetti et al., 1998). Consequently, it is less than clear whether unsafe home environment influences older adult falls directly, indirectly through functional limitations, or both. Thus, the objective of our study is to reinspect the relation between unsafe home environment and falls among older adults after factoring in the potential indirect influence through functional outcomes. Based on the environmental-press (Lawton & Nahemow, 1973) and the disablement process (Verbrugge & Jette, 1994) models, we hypothesize that, in addition to a direct effect, unsafe home environment will also have an indirect impact on falls through outcomes in physical functioning of older adults.

To test the above hypothesis, we conduct a mediation analysis using data from a nationally representative large sample of US Medicare beneficiaries (≥65 years) living in the community and estimate: 1) whether unsafe home environment had an adverse impact on subsequent falls among older adults, and 2) what proportion of that influence was mediated through functional limitations. Results from our analysis will clarify the relationship between unsafe home environment and older adult falls. We interpret findings for their implications in extending health promotion and fall prevention strategies among the older adult population.

Research Design and Methods

Data: We used data from the National Health and Aging Trends Study (NHATS). The NHATS is designed to study population-level trends on Medicare beneficiaries 65 years and older (NHATS, n.d.). Survey weights in NHATS are added for each participant such that weighted

estimates are representative of Medicare beneficiaries aged 65 and older nationally (Kasper, & Freedman, 2021). A total of 4,977 respondents participated in the 2019 NHATS and these respondents were also interviewed in the previous round in 2018. Given our study focus on community-dwelling older adults, we excluded respondents residing in nursing homes, residential care settings, and the deceased, resulting in a final sample of 4,034 community-dwelling older adult respondents. Additionally, we excluded responses that were missing (-9), "don't know" (-8), or "refused" (-7) for all variables in our analytic models and the percent of missing observations (excluding income) were about 5% of the sample. Lastly, we excluded respondents who moved in 2019 (n=103) to ensure that the impact of baseline (2018) unsafe home environment could be estimated on subsequent fall incidents in 2019.

Outcome variable: NHATS respondents are asked: "*In the past month, have you fallen down?"* with those responding "no" asked a second question: "*In the last 12 months have you fallen down?*" We used these two questions in the 2019 NHATS to construct the binary outcome variable representing subsequent no [=0] versus one or more fall incidents [=1] in 2019.

Exposure variables: The exposure variable in our study was baseline (2018) unsafe home environment. Using a 16-item environmental checklist, NHATS interviewers record information on unsafe environmental conditions in and around participants' homes. Additionally, using a separate question-set, NHATS participants are asked about access to (such as ramps, stairs) and features (such as, bathroom settings, kitchen-bed-bath on the same/different floor) inside their homes. Using these interviewer-observed and self-reported information in NHATS, prior studies have identified separate and distinct aspects of unsafe home environment, which have been employed to study physical functioning and falls among older adults (Gell et al., 2020; Okoye et

al., 2021, 2023; Samuel et al., 2015). We adopted this prior conceptualization to categorize unsafe home environment into the following components.

Home disorders—This component is constructed by grouping 6-items from the NHATS environmental checklist and consisted of: *1) peeling or flaking paint, 2) evidence of pests (cockroaches, or rodents), 3) broken furniture or lamp, 4) flooring in need of repair (e.g., torn carpet, broken tiles, split wood), 5) other tripping hazards (e.g., pathways not clear, throw rugs not secured, electrical cords in path, 6) clutter in the interview room or other rooms of the house*. If these conditions were observed inside the respondent's home, we coded each of these items with a [1]; otherwise [0].

Unsafe bathroom settings—If the following bathroom features were self-reported as absent, we coded each of these items with a [1]; otherwise [0]: 1) *bath tub and shower stall, 2) grab bar in the shower/tub, 3) seat in the shower/tub, 4) raised toilet, and 5) grab bars around the toilet*.

Unsafe house/building features: If the following adverse house/building features were self-reported as present, we coded each of these items with a [1]; otherwise [0]: *1) Entrance has a stair but no ramp?, 2) kitchen, bed and bath not on the same floor?*

House disrepairs: Six items in the NHATS environmental checklist were grouped together to represent house disrepairs: *1) any broken or boarded up windows?, 2) a crumbling foundation or open holes?, 3) missing bricks, siding, or other outside materials,? 4) roof problems (e.g., missing material, sagging, or a hole in roof)?, 5) uneven walking surfaces or broken steps in the area leading to the home/building?, 6) sidewalks not continuous in both directions?* If these unsafe conditions were observed outside the respondent's home, we coded each of these items with a [1]; otherwise [0].

The composite home disorders (range: 0-4 or more), unsafe bathroom settings (range: 0-4), house disrepairs (range: 0-4 or more), and unsafe house/building features (range: 0-2) variables were continuous in nature with a larger value denoting a greater number of unsafe home environmental conditions.

Mediator Variables: Functional limitations represented by difficulties in activities of daily living (ADLs) and instrumental activities of daily living (IADLs) in the baseline year served as the two intermediate variables mediating the association between unsafe home environment and fall incidents. Each item representing difficulties in ADLs (*eating, bathing, dressing, toileting, mobility*) and IADLs (*doing laundry, preparing meals, shopping for groceries, taking medications, money management*) were coded with a [1] or [0] otherwise. The composite ADL/IADL difficulty scores were then used to create the two functional limitation variables, which were binary in nature ([0]=no difficulties, [1]=one or more difficulties).

Covariates: A robust body of research has identified numerous significant risk factors of older adult falls that can be grouped into intrinsic (personal) factors and extrinsic (environmental) conditions (Ambrose et al., 2013; Boelens et al., 2013; Ganz, & Latham; 2020; Kelekar et al., 2021; Lord et al., 2007; Pynoos et al., 2010). The major intrinsic risk factors comprise fall history and chronic diseases in addition to functional limitations (Deandrea et al., 2010; Paliwal et al., 2017; Sibley et al., 2014; Yamashita, et al., 2012). Additionally, the literature has highlighted variations in fall incidents among older adults by socio-demographic and neighborhood characteristics (Burns et al., 2016; Deandrea et al., 2010; Okoye et al., 2021, 2023; Yamashita, et al., 2012). Consistent with the literature, we therefore included the following baseline conditions as covariates.

***Fall History*:** Whether a respondent had fallen in the baseline year (2018) served as a measure of their subsequent risk of fall incidents in 2019.

Chronic conditions and sensory impairments: We controlled for the number of chronic health conditions (range: 0-8 or more) as well as vision (0/1) and hearing (0/1) impairments at baseline. Participants were asked about the presence/absence of the following chronic diseases in the baseline or in preceding years*: heart attack, heart disease, hypertension, arthritis, osteoporosis, diabetes, lung disease, stroke, dementia/Alzheimer, and cancer.* Participants were also asked about *depressive and anxiety disorder symptoms* using the 4-item Patient Health Questionnaire (PHQ)-4 and we coded the combined (range: 0-12) PHQ-4 score of 6 or higher to indicate depression and anxiety disorders (Wicke et al., 2022). We constructed body mass index (BMI: normal/non-normal) using height and weight questions in NHATS. Lastly, we also considered difficulty with vision *("…did you use vision aid such as magnifying glass to help see things close up?*") and hearing ("*…have you used a hearing aid or other hearing device?"*).

Socio-demographics: Socio-demographic characteristics included sex (male/ female), age groups (65-74,75–84, 85 and over), race/ethnicity (non-Hispanic (NH) White, NH Black, Hispanic, NH Other), marital status (married or living with a partner/separated, divorced, widowed, never married), and income ($0-14,999, $15,000-24,999, $25,000-34,999, $35,000-49,999 and more than $50,000).

Neighborhood characteristics included NHATS question components that included three items: *1) Litter, broken glass, or trash, on sidewalks and streets?, 2) Graffiti on building walls?, 3) Vacant or deserted houses or storefronts?*. For each of these items, if the

adverse component was present, we coded it with a [1]; otherwise [0] to construct a composite variable (range: 0-3) representing neighborhood characteristics.

Statistical Analysis: While unsafe home environment may precipitate into a fall, a fall may prompt environmental modifications (Leland et al., 2010). To circumvent this bidirectionality or the problem of endogeneity between our study exposure and outcome variables, we considered unsafe home environment in the baseline year (2018) and its relation with subsequent fall incidents in 2019. We first examined variations in older adult fall incidents reported for the year 2019 by baseline unsafe home environment (home disorders, unsafe bathroom settings, unsafe house/building features, house disrepairs) and by functional limitations (ADL/IADL difficulties) (Table 2). Next, we conducted multivariable logistic regression analysis to test the association between the outcome of subsequent fall/no fall incidents in 2019 and baseline unsafe home environment, after controlling for covariates.

Lastly, to conduct a mediation analysis, we applied the Karlson–Holm–Breen (KHB) methodology for the evaluation of mediating effects (Karlson & Holm, 2011; 2012). This methodology allows for the decomposition of total effects of an independent variable into direct and indirect components for both discrete and continuous outcome variables. Using this methodology, we estimated the total, direct, and indirect/mediated effects of baseline unsafe home environment (exposure) on subsequent fall incidents (outcome), after controlling for covariates. While the direct effect represents the impact of baseline unsafe home environment on subsequent fall incidents, the indirect or mediated effect represents the relation between baseline unsafe home environment and subsequent fall incidents through difficulties in ADLs and IADLs in the baseline year. The KHB output of mediation percentage is interpreted as the percentage of the association between the exposure and the outcome that is explained by the mediator

variables. All analyses were performed using Stata 15 and appropriate methodology for survey data analysis using 2018 survey weights. We present weighted estimates at the 5% level of significance ($p<0.05$) unless stated otherwise.

Results

Descriptive Statistics: Table-1 presents the socio-demographic profile, self-reported prevalence of subsequent fall incidents and baseline fall history, and unsafe home and health conditions of older adults (n=2,599). Majority of the older adults were 65-74 year-old (50.37%), NH White (80.58%), female (52.60%), separated/divorced/widowed/never married (55.95%), or had an income greater than or equal to $50,000 (48.56%). In 2019, the self-reported prevalence of fall incidents among older adults were estimated at 34.68%, while 30.07% of the older adults reported falling in the baseline year. Over a fourth (26.09%) of the older adults reported having one or more home features in disorder, while about one in ten (9.72%) reported not having one or more bathroom safety features. In comparison, an overwhelming majority (73.55%) reported one or more unsafe house/building features and 62.51% reported one or more conditions of house disrepairs. Finally, about one-third of the older adults (29.62%) reported having one or more difficulties in ADLs and 64.42% reported one or more difficulties in IADLs.

In Table 2, we present the self-reported prevalence of no fall incidents (n=1,696; 65.3%) versus one or more fall incidents (n=903; 34.7%) in 2019 by baseline unsafe home conditions (home disorders, unsafe bathroom settings, unsafe house/building features, house disrepairs) and functional limitations (ADL and IADL difficulties) of older adults. A larger percentage of those with one or more home disorders (39.3%) compared to those without (33.0%) reported falling in 2019. However, the reverse was true for unsafe bathroom settings—about 34% with one or more

unsafe bathroom settings fell in 2019 compared to 41% with no unsafe bathroom setting falling in 2019. The differences in the self-reported prevalence of no fall/fall incidents in 2019 among older adults with one or more conditions of unsafe house/building features or one or more conditions of house disrepairs versus those without were not statistically significant ($p>0.05$). Lastly, a higher percentage of older adults with ADL (47.3%) and IADL (38.3%) difficulties reported one or more fall incidents in 2019 compared to those without any functional difficulty falling in 2019 (ADL: 29.4% and IADL: 28.1%).

Multivariable regression results: Table 3 presents the adjusted odds ratio (aOR) from the multivariable logistic regression models with subsequent fall incidents (Column 1), and ADL (Column 2), and IADL (Column 3) difficulties as outcomes. As indicated in Table 3-Column 1, both baseline home disorders and functional limitations were statistically significantly associated with subsequent fall incidents in 2019, after adjusting for covariates. With each additional home disorder condition, the odds of subsequent fall incidents increased by 14% [aOR: 1.14, 95% CI: 1.03,1.26]. Similarly, baseline functional limitations were positively associated with a greater likelihood of subsequent fall incidents in 2019. With one or more baseline ADL [aOR: 1.38, 95% CI: 1.08,1.78] and IADL [aOR: 1.25, 95% CI: 1.00,1.56] difficulties, the odds of subsequent fall incidents among older adults increased respectively by 38% and 25%. But, baseline conditions of one or more unsafe bathroom settings, unsafe house/building features, or house disrepairs did not statistically significantly associate with subsequent fall incidents.

In Table 4, we present the results from the mediation analysis using the KHB methodology. Home disorders had a significant direct and indirect effect on subsequent fall incidents through functional limitations in ADLs and IADLs. Older adults reporting one or more baseline home disorders had higher odds of reporting subsequent fall incidents [aOR: 1.16, 95%

CI: 1.04,1.28]. The association of home disorders with subsequent fall incidents was mediated by difficulties in ADLs and IADLs [aOR: 1.01, 95% CI: 1.00,1.03], although the magnitude of this effect was modest. To further analyze this result, we re-ran the KHB analysis with three separate mediators—mobility difficulty, other ADL difficulties, and IADL difficulties. Results showed that the three mediators respectively accounted for 48.7% (mobility), 39.5% (other ADLs), and 11.8% (IADLs) of the indirect effect of home disorders on subsequent fall incidents through functional limitations.

With regard to unsafe bathroom settings, while this component had no significant direct impact on subsequent fall incidents, the mediating effect of this variable was however in the reverse direction [aOR: 0.97, 95% CI: 0.96,0.99]. In contrast, unsafe house/building features and house disrepairs had no statistically significant direct or indirect effects. The percent of mediated effects of home disorders and unsafe bathroom settings respectively were 9.3% and 52.6%.

Discussion and Implications

Motivated upon two gerontological theories, the environmental-press hypothesis and the disablement process model, we tested whether the relation between unsafe home environment and fall incidents is mediated by functional limitations of older adults (Lawton & Nahemow, 1973; Verbrugge & Jette, 1994). Based on the prior literature, we considered four components of unsafe home environment, home disorders, unsafe bathroom settings, unsafe house/building features, and house disrepairs. Results from the mediation analysis (Table 4) indicate statistically significant associations between two components of unsafe home environment—unsafe bathroom settings and house disorders—and subsequent falls among older adults.

Unsafe bathroom settings associated with a lower likelihood of subsequent fall incidents among older adults through functional limitations only but had no direct impact. While prior studies have not examined the mediating effect of functional limitations on the association between unsafe bathroom settings and falls among older adults, most have highlighted the protective role of bathroom modifications on older adult falls (Pynoos et al., 2010; Szanton et al., 2011; 2015). However, at least one prior study has reported lower odds of bathroom falls among older adults associated with exposure to one or more environmental hazards (Gill et al., 2000). Although speculative, it is nonetheless plausible that older adults with functional disabilities received caregiver's help particularly with dressing, bathing, toileting, which may have offset the likelihood of falls in unsafe bathroom settings. Irrespective, future research is needed to further unravel the link between unsafe bathroom settings and fall incidents through physical functioning of older adults.

Home disorders significantly and positively associated with subsequent fall incidents both directly and indirectly through functional difficulties of older adults. Given our study finding showing functional limitations as one pathway linking home disorders to older adult fall incidents, we highlight that interventions addressing home disorders can have an effect on ADL/IADLs and, in turn, on falls. This interpretation is compatible with prior empirical findings forwarding evidence that the home environment impacts functional outcomes among older adults (Breysse et al., 2022; Liu & Lapane, 2009; Szanton et al., 2019, 2016; Wahl et al., 2009; Wu et al., 2020). For instance, prior studies have shown long-term effectiveness of the Community Aging in Place–Advancing Better Living for Elders (CAPABLE) program in reducing clutter and improving ADL difficulties (Breysse et al., 2022; Szanton et al., 2016). The CAPABLE program includes three interventionists—an occupational therapist (OT), a registered nurse (RN),

and a handyman or home repair professional (HR). While an OT and an RN work with older adult participants to identify functional goals, the HR modifies the participants' homes to meet these goals. This person-directed approach to both the built environment and the individual is what guides CAPABLE and makes it unique (Szanton et al., 2014).

Additionally, we emphasize the need for regular home-disorder assessments in the post-intervention period with the broader aim of supporting ADL/IADLs, in addition to preventing falls (Horowitz et al., 2013; Tomita et al., 2014). While sustained effort to mitigate conditions of home disorders is challenging for older adults, the application of validated checklists, such as the Home Safety Self-Assessment Tool (HSSAT), should be helpful (Horowitz et al., 2013; Nikolaus & Bach, 2003; Stevens et al., 2001; Tomita et al., 2014). The HSSAT was developed specifically for older adults and informal caregivers and includes pictorial depictions of a comprehensive set of risks and mitigation strategies across all areas of the home, information on service providers and free services, and Americans With Disabilities Act of 1990 (ADA) installation guidelines (Horowitz et al., 2013; Tomita et al., 2014). Thus, the promotion of home improvement and assessment resources, such as the CAPABLE and HSSAT, should be prioritized for wider dissemination among older adults, family members, and informal caregivers via community centers, churches, or libraries.

Results from our analyses also showed a direct association between home disorders and subsequent older adult fall incidents, which was substantial. Thus, addressing home disorders for all older adults regardless of functional status should be useful. In connection, we recommend the provisioning of suitable provider resources and professional guidance. Currently, clinical screening and fall prevention tools are in place, such as the Centers for Medicare & Medicaid's (CMS) Health-related Social Needs Screening Tool to evaluate social determinants of health or

the Centers for Disease Control and Prevention's Stopping Elderly Accidents, Deaths & Injuries (CDC-STEADI)—"Check your risk for falling" scoring tool (Billioux et al., 2017; CDC, 2021; CMS, 2023a). However, these tools do not include questions about home disorders, such as clutter, broken furniture, uneven flooring that can be potential fall risks as indicated in our results.

Similarly, while the Medicare program requires and incentivizes providers to conduct individual fall-risk assessments as part of its initial Annual Wellness Visits and referrals to community-based fall prevention strategies in subsequent visits, it however does not require professional visits for home assessments (CMS, 2023b; Esch, 2023; Gell et al., 2020). Consequently, older adults are eligible for home assessments from professionals, such as occupational therapists, only if they are undergoing rehabilitation or receiving home health services (Tomita et al., 2014; Gell et al., 2020). Including environmental conditions of home disorders more consistently across health programs, and clinical home assessment and fall risk screening tools would facilitate all stakeholders to help older adults navigate available resources, professional guidance, and address home disorders (Kelekar et al., 2021).

Several limitations of our study must be noted. First, we conducted an observational analysis that relied on participants' self-reported information about falls using a one-year recall period. Other key information, such as bathroom settings, are also self-reported in NHATS, which may have resulted in under-/over-reporting of these data. Additionally, the NHATS survey does not include information about the location of falls. Therefore, we could not conduct a more refined analysis, such as estimate the link between bathroom falls and unsafe bathroom settings or the role of home disorders specific to indoor falls. Furthermore, variability across NHATS interviewers may exist regarding home disorder assessments, although all interviewers undergo

training on how to administer the survey and report home disorders. Finally, NHATS questionnaires on unsafe home environment leaves out information on some vital unsafe home environmental features, such as poor lighting. Despite these shortcomings, the primary contributions of our study have been to report findings from analyses using nationally representative data on Medicare beneficiaries (≥ 65 years) and to show that a part of the association between home disorders and older adult fall incidents is mediated through functional limitations in ADL/IADLs.

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Conflict of Interest: None

Data Availability: The source data files that support the findings of this study are available from the National Health and Aging Trends Study (NHATS) at https://nhats.org/researcher/data-access. Computed measures and data analyzed are available from the corresponding author upon reasonable request. Pre-registration requirement is not applicable.

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Tables

Table 1. Socio-demographics, falls, and home and health conditions of older adults (≥65 years), NHATS[a] 2018, 2019

Variable	n[b] (%)[c]
Socio-demographic Characteristics	
Age Groups	
65-74 years	812 (50.37)
75-84 years	1,256 (39.09)
85 and over	531 (10.54)
Race/ethnicity	
Non-Hispanic (NH) White	1,855 (80.58)
NH Black	498 (7.41)
NH Other	71 (4.18)
Hispanic	175 (7.83)
Sex	
Male	1,178 (47.40)
Female	1,421 (52.60)
Marital Status	
Married/living with a partner	1,313 (44.05)
Separated/divorced/widowed/never married	1,286 (55.95)
Income ($)	
0-14,999	415 (12.61)
15,000-24,999	401 (13.03)
25,000-34,999	324 (11.61)
35,000-49,999	379 (14.19)
≥50,000	1,080 (48.56)
Fall Prevalence and History	
Falls in 2019	
No falls	1,696 (65.32)
One or more falls	903 (34.68)
Falls in 2018	
No falls	1,780 (69.93)
One or more falls	819 (30.07)
Baseline (2018) home, house, and health conditions	
Unsafe Home Environment	
Home Disorders	
None present	1,864 (73.91)
One or more disorders present	735 (26.09)
Unsafe Bathroom Settings	
None present	2,295 (90.28)
One or more unsafe settings present	304 (9.72)
Unsafe House/Building Features	
None present	744 (26.45)
One or more conditions present	1,855 (73.55)

House Disrepairs	
None present	975 (37.49)
One or more conditions present	1,624 (62.51)
Neighborhood Characteristics	
Neighborhood Disorders	
None present	2,367 (91.95)
One or more disorders present	232 (8.05)
Functional Limitations	
ADL Difficulties[a]	
None present	1,638 (70.38)
One or more ADL difficulties present	961 (29.62)
IADL Difficulties[a]	
None present	871 (35.58)
One or more IADL difficulties present	1,728 (64.42)
Chronic Health and Vision/Hearing Impairments	
Number of Chronic conditions	
None present	58 (2.37)
One or more conditions present	2,541 (97.63)
Difficulty in vision	
No	1,853 (70.02)
Yes	746 (29.98)
Difficulty in hearing	
No	2,103 (82.67)
Yes	496 (17.33)

Notes:
[a] NHATS National Health and Aging Trends Study; ADL activities of daily living; IADL instrumental ADL; [b] n, unweighted observations; [c] % weighted percent

Table 2. Self-reported prevalence of falls by baseline home conditions (home disorders and unsafe bathroom settings) and functional limitations (ADL and IADL difficulties)[a] of older adults (n=2,599), NHATS 2018, 2019[a]

Variable	Falls in 2019		
	No falls (n=1,696; 65.3%)	One or more falls (n=903; 34.7%)	p-value[d]
	n[b] (%)[c]	n (%)	
Unsafe Home Environment			
Home disorders			
None present	1,232 (67.0)	632 (33.0)	<0.05
One or more disorders present	464 (60.7)	271 (39.3)	
Unsafe bathroom settings			
None present	181 (58.8)	123 (41.2)	<0.05
One or more unsafe settings present	1,515 (66.0)	780 (34.0)	
Unsafe House/Building Features			
None present	491 (64.9)	253 (35.1)	>0.05
One or more conditions present	1,205 (65.5)	650 (34.5)	
House Disrepairs			
None present	645 (65.3)	330 (34.7)	>0.05
One or more conditions present	1,051 (65.3)	573 (34.7)	
Functional Limitations			
ADL difficulties			
No difficulties	1,171 (70.6)	467 (29.4)	<0.01
One or more difficulties	525 (52.7)	436 (47.3)	
IADL difficulties			
No difficulties	628 (71.9)	243 (28.1)	<0.01
One or more difficulties	1,068 (61.7)	660 (38.3)	

Notes:
[a] NHATS National Health and Aging Trends Study; ADL activities of daily living; IADL instrumental ADL; [b] n, unweighted observations; [c] % weighted percent; [d] p-value based on Chi-square analysis

Table 3. Multivariable Regression: Falls and ADL/IADL difficulties among older adults, NHATS 2018, 2019[a]

Variable	Falls (2019)	ADL[a] difficulties	IADL[a] difficulties
	aOR[b] (95% CI[c])	aOR (95% CI)	aOR (95% CI)
Exposure: Baseline Unsafe home environment			
Home disorders	1.14 (1.03,1.26)**	1.23 (1.08,1.39)***	1.08 (0.96,1.21)
Unsafe bathroom settings	0.98 (0.89,1.07)	0.71 (0.64,0.77)***	0.80 (0.74,0.86)***
Unsafe House/Building Features	0.99 (0.81,1.20)	0.84 (0.67,1.05)	1.02 (0.80,1.31)
House disrepairs	0.92 (0.80,1.06)	0.94 (0.80,1.12)	1.16 (1.00,1.35)*
Baseline covariates			
Fall history			
No falls	Ref[d]	Ref	Ref
One or more falls	3.45 (2.63,4.52)***	2.45 (1.91,3.14)***	1.49 (1.15,1.93)***
Age Groups			
65-74 years	Ref	Ref	Ref
75-84 years	0.99 (0.79,1.24)	1.59 (1.17,2.15)***	1.30 (1.00,1.70)*
85 and over	1.08 (0.80,1.45)	3.94 (2.87,5.40)***	2.79 (2.02,3.83)***
Race/ethnicity			
NH White	Ref	Ref	Ref
NH Black	0.47 (0.33,0.67)***	1.75 (1.26,2.45)***	1.43 (1.06,1.93)**
Hispanic	0.95 (0.55,1.66)	1.01 (0.55,1.86)	1.24 (0.64,2.40)
NH Other		1.39 (0.83,2.33)	2.11 (1.20,3.72)**
Sex			
Male	Ref	Ref	Ref
Female	1.05 (0.85,1.29)	0.77 (0.62,0.97)**	0.44 (0.33,0.60)***
Marital Status			
Married/living with a partner	Ref	Ref	Ref
Separated/divorced/widowed/never married	1.07 (0.76,1.49)	0.90 (0.68,1.18)	0.16 (0.13,0.20)***
Income categories ($)			
0-14,999	Ref	Ref	Ref
15,000-24,999	1.15 (0.73,1.81)	0.50 (0.30,0.81)***	0.40 (0.25,0.64)***
25,000-34,999	1.12 (0.70,1.80)	0.51 (0.33,0.79)***	0.33 (0.20,0.54)***
35,000-49,999	1.23 (0.85,1.80)	0.30 (0.18,0.50)***	0.26 (0.17,0.39)***
≥50,000	1.02 (0.71,1.47)	0.29 (0.17,0.50)***	0.22 (0.15,0.34)***
Neighborhood Characteristics	0.93 (0.74,1.18)	1.03 (0.78,1.36)	1.01 (0.75,1.38)
Functional limitations			
No ADL Difficulties	Ref	--	--
One or more ADL Difficulties	1.38 (1.08,1.78)**	--	--
No IADL Difficulties	Ref	--	--
One or more IADL Difficulties	1.25 (1.00,1.56)**	--	--
Chronic conditions	1.07 (1.00,1.14)**	1.55 (1.43,1.68)***	1.40 (1.26,1.55)***
Difficulty in vision			
No	Ref	Ref	Ref

Yes	1.01 (0.78,1.30)	1.42 (1.13,1.79)***	1.32 (1.02,1.71)**
Difficulty in hearing			
No	Ref	Ref	Ref
Yes	1.05 (0.76,1.43)	1.10 (0.83,1.47)	1.12 (0.83,1.51)

Notes:
[a] NHATS National Health and Aging Trends Study; ADL activities of daily living; IADL instrumental ADL; [b] aOR adjusted odds ratio; [c] CI confidence interval; [d] Ref Reference group
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4. Mediation Analysis using the Karlson–Holm–Breen (KHB) methodology: Falls among older adults, NHATS 2018, 2019 [a]

Variable	Falls (2019)
	aOR[b] (95% CI[c])
Home disorders	
Total effect	1.16 (1.04,1.28) ***
Direct effect	1.14 (1.03,1.26) **
Indirect effect via ADLs and IADLs [a]	1.01 (1.00,1.03) **
PEM[d]	9.3%
Unsafe bathroom settings	
Total effect	0.95 (0.87,1.03)
Direct effect	0.98 (0.89,1.06)
Indirect effect via ADLs and IADLs	0.97 (0.96,0.99) ***
PEM	52.6%
Unsafe House/Building Features	
Total effect	0.98 (0.80,1.20)
Direct effect	0.99 (0.81,1.20)
Indirect effect via ADLs and IADLs	0.99 (0.98,1.01)
PEM	29.8%
House disrepairs	
Total effect	0.92 (0.80,1.06)
Direct effect	0.92 (0.80,1.06)
Indirect effect via ADLs and IADLs	1.00 (0.99,1.02)
PEM	-4.0%

Notes:
[a] NHATS National Health and Aging Trends Study; ADL activities of daily living; IADL instrumental ADL; [b] aOR adjusted odds ratio; [c] CI confidence interval; PEM: [d] Percent of effect mediated
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$