Scientific Research Publishing

Open Journal of Social Sciences, 2025, 13(10), 446-464
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

The Mediating Role of Hypnotic Medication in the Association between Sleep Disturbances and Instrumental Activities of Daily Living in Community-Dwelling Brazilian Older Adults

Pedro Olivares-Tirado

Mental Health Program, School of Public Health, Faculty of Medicine, University of Chile, Santiago de Chile, Chile
Email: olivarestirado@gmail.com

How to cite this paper: Olivares-Tirado, P. (2025). The Mediating Role of Hypnotic Medication in the Association between Sleep Disturbances and Instrumental Activities of Daily Living in Community-Dwelling Brazilian Older Adults. *Open Journal of Social Sciences, 13,* 446-464.
https://doi.org/10.4236/jss.2025.1310026

Received: September 26, 2025
Accepted: October 20, 2025
Published: October 23, 2025

Abstract

Aim: This study aimed to determine whether hypnotic medications mediate the effects of sleep disturbances on Instrumental Activities of Daily Living (IADL) deficits among community-dwelling older adults in Brazil. **Methods:** This cross-sectional study involved 21,701 individuals aged 60 years or older. IADL performance was assessed using the Lawton Scale, while sleep disturbances and hypnotic medication use were evaluated through standardized questions from the Brazilian National Health Survey. Multivariate logistic regression and mediation analysis using structural equation modelling were conducted, adjusting for relevant confounding factors. **Results:** The prevalence of IADL deficits among the participants was 15.7%. Of those with IADL deficits, 57% reported sleep disturbances, and 38% of this group were using hypnotic medications. The adjusted multiple regression analysis indicated a significant association between sleep disturbances and IADL deficits. Mediation analysis suggests that approximately 19.0% of the impact of sleep disturbances on IADL deficits is mediated by the use of hypnotic medications. Furthermore, the mediated effect of these medications accounts for 23.2% of the direct effect of sleep disturbances on IADL deficits in older adults. **Conclusions:** Hypnotic medications were a mediating factor in the relationship between sleep disturbances and IADL deficits. Screening for sleep disturbances and promoting non-pharmacological interventions could help manage sleep issues and prevent IADL deficits in community-dwelling older adults.

Keywords

Sleep Disturbances, Instrumental Activities of Daily Living, Hypnotics Drugs, Mediation Analysis, Older Adults

1. Introduction

According to the World Health Organization, by 2050, an estimated 22% of the global population will be over 60, totalling around 2.1 billion, with two-thirds living in low- and middle-income countries (WHO, 2024). As people age, they often face declines in physical and mental capacities, along with chronic diseases and cognitive impairments, leading to polypharmacy due to multiple health conditions (WHO, 2024).

Sleep is a vital component of health and wellness throughout a person's life (Miner & Kriger, 2017). As people age, their sleep patterns changes; they tend to experience an earlier sleep phase, a reduction in the proportion of deep sleep, and the appearance of a short mid-afternoon nap. Older adults have a longer sleep onset latency and more nocturnal awakenings (Dzierzewski et al., 2018). Poor sleep quality can heighten the risk of mental and physical health issues, reduce quality of life, and affect safety (NIA, 2025).

Sleep disturbances are common in older adults but often go undiagnosed (Ryden et al., 2019). Factors such as age-related changes, health conditions, medications, lifestyle habits, and psychosocial issues are often associated with sleep problems in older adults (Miner & Kriger, 2017). Approximately 40% of adults aged 60 and older experience sleep problems, with obstructive sleep apnoea (46%) being the most prevalent, followed by poor sleep quality (40%) and insomnia (29%). There are no significant differences in prevalence between sexes (Canever et al., 2024).

Additionally, the use of hypnotic medications for sleep disorders in older adults is frequent, with prevalence rates between 5% and 25% depending on the population and country (Jaqua et al., 2023; Tully et al., 2021; Lundqvist et al., 2025; Kuo et al., 2022). Prolonged use of these medications, such as Z-drugs and benzodiazepines, is linked to ongoing sleep disturbances and raises concerns about inappropriate usage, especially in those with persistent sleep disturbances (Jaqua et al., 2023; Tully et al., 2021; Kuo et al., 2022; Tanielian et al., 2022).

Managing sleep disorders in older adults can be challenging due to the presence of multiple comorbidities and potential medications side effects. Treatments are based on the underlying causes and may include both non-pharmacological and pharmacological options (Jaqua et al., 2023). The use of hypnotic medications for sleep disorders in older adults is frequent, with prevalence rates between 5% and 25% depending on the population and country (Tully et al., 2021; Lundqvist et al., 2025; Kuo et al., 2022; Tanielian et al., 2022). Prolonged use of these medications, such as Z-drugs and benzodiazepines, is linked to ongoing sleep disturbances and raises concerns about inappropriate usage, especially in those with persistent sleep disturbances (Tully et al., 2021; Lundqvist et al., 2025; Tanielian et al., 2022; Masse et al., 2022).

In older adults, sleep disorders such as insomnia and obstructive sleep apnoea are associated with decreased cognitive performance, which can lead to memory loss, difficulties with concentration, and issues with executive functioning. These

conditions increase the risk of functional limitations, dementia, disability, and a poor quality of life (Canever et al., 2024; Raimo et al., 2024; Idalino et al., 2024). Functional limitations, refer to restrictions in physical and mental abilities capabilities that affect the performance of basic (BADLs) or instrumental activities of daily living (IADLs). IADLs involve more complex cognitive and motor skills than BADLs, allowing individuals to live independently in a community. These activities include preparing food, handling money, using a phone, shopping, taking medications and using transportation (Idalino et al., 2024; Huang et al., 2024; Shin & Kim, 2022; Waidmann & Liu, 2000).

The prevalence of IADL limitations among older adults is significant and varies depending on factors like age, gender, socioeconomic status, and health conditions. Lower levels of education and income are associated with high risk of IADLs limitations. Poor health status, physical inactivity, cognitive decline, depression and multiple chronic diseases are also linked to increased IADL limitations (Shin & Kim, 2022; Connolly et al., 2017; Liao & Chang, 2020). Previous studies have consistently demonstrated that neuropsychological variables (primarily memory and executive functions) or neuroanatomical changes (hippocampal atrophy and white matter hyper-intensity) are independently associated with IADL deficits (Overdorp et al., 2016; Apostolova et al., 2010; Inzitari et al., 2009).

Additionally, both poor sleep quality and abnormal sleep duration are strongly linked to challenges in performing IADLs (Idalino et al., 2024; Huang et al., 2024; Alam et al., 2022). The situation can be further exacerbated by the prolonged use of hypnotic medications, which may increase the risk of dependence, cognitive decline, and falls (Cross et al., 2019). Furthermore, there is a bidirectional relationship between sleep disorders and the ability to perform instrumental activities of daily living (IADL). Older adults with greater IADL limitations are at an increased risk of developing sleep problems (Lee et al., 2022). According to stress process theory, declining IADL function can deplete self-resources, such as sleep, negatively affecting mental health (Pearlin, 1999).

Previous literature indicates that deficits in instrumental activities of daily living (IADL) among older adults significantly impact their ability to perform self-care and social functioning, impacting their independence (Cipriani et al., 2020). When older individuals experience functional loss, they face various negative outcomes, including increased healthcare utilization and costs, as well as a higher risk of cognitive impairment and dementia (Cipriani et al., 2020; Brown et al., 2019).

Understanding the relationship between sleep disturbances, IADL deficits, and the role of hypnotic medication is crucial for developing strategies that support the independence and well-being of older adults. Mediation analysis is particularly helpful to explore the explanatory role of hypnotic medication by estimating the magnitude of its mediating effect in the relationships between sleep disturbances and IADL deficits. Therefore, this study aims to determine whether hypnotic medication mediates the effects of sleep disturbances on IADL deficits among community-dwelling Brazilian older adults.

2. Methods

2.1. Design, Data and Sample Population

This observational cross-sectional study was conducted using a secondary database from the Brazilian National Health Survey 2019, conducted by the Brazilian Institute of Geography and Statistics (IBGE) with the Ministry of Health. It represents Brazil's non-institutionalized population at national, regional, state, and metropolitan levels. The sample was taken from an IBGE master sample, stratified into three stages: census tracts were selected based on proportional probability, households were randomly sampled, and individuals aged 15 or older were selected from each household. Interviews were conducted between August 2019 and March 2020 using smartphones with the survey questionnaire. A total of 90,846 households and 275,323 individuals participated, yielding a household response rate of 93.6% (IBGE, 2020; Stopa et al., 2020). The present analysis focuses on 21,701 surveys from individuals aged 60 years or older who could answer the questions independently.

2.2. Measures

2.2.1. Outcome Variable

Instrumental activities of daily living (IADLs) are those activities that allow an individual to live independently in a community. Deficits in IADLs can be a sign of executive dysfunction, which is a common feature of cognitive decline (Guo & Sapra, 2022).

IADL deficits was assessed by asking participants, "In general, how difficult is it to ____ by yourself?". The examined activities included shopping, managing finances, taking medications, visiting the doctor, and using public transportation. For each activity, the possible responses were: "I do not have any difficulty", "I have little difficulty", "It is very difficult" and "I cannot do it". The outcome variable is binary and the interest group includes those who reported having "very difficult and/or cannot do it" in one or more of these activities, while that those reporting "do not have or have little difficulty", for all five activities were classified as a reference group.

2.2.2. Independent Variable

Sleep disturbance was evaluated using a straightforward question instead of a structured and standardized questionnaire. The question asked was: "In the last two weeks, how often have you experienced sleep problems, such as difficulty falling asleep, waking up frequently at night, or sleeping more than usual?" The response options provided were: "Not at all", "Less than half the days", "More than half the days", and "Almost every day". Sleep disturbance was categorized as zero if the response was "Not at all"; otherwise, it was classified as one, indicating the presence of sleep problems.

2.2.3. Mediator Variable

In the survey questionnaire, data regarding the use of hypnotic medications is col-

lected through a straightforward dichotomous question, rather than utilizing a specific, structured, and validated instrument. Respondents were asked, "In the last two weeks, have you used any hypnotic medication?" The response options were "yes" or "no". Those who answered "yes" were categorized as one, while those who answered "no" were categorized as zero.

2.3. Other Covariates

Empirical evidence on IADLs and sleep health has revealed that socioeconomic, demographic, cultural, and regional differences may influence executive function and alter the quality and amount of sleep among older adults (Hale et al., 2015; Samson et al., 2017; Nóbrega et al., 2021; Patel et al., 2021).

Covariates included demographic and geographic characteristics, Socioeconomic Position (SEP), and health-related variables. A person's age, gender and marital status were included in demographic characteristics. Participants were categorized into the following age groups: 60 - 64 years (reference group), 65 - 69 years, 70 - 74 years, 75 - 79 years, and 80 years or older. Gender was a binary variable, with men as the reference group. Marital status was categorized as married, widowed, single, divorced or separated (reference group).

Geographic covariates include region and place of residence. Brazil is divided into five regions: North, Northeast, Central-West, Southeast, and South. These regions were included in the models as categorical variables with the South as the reference group due to its higher socioeconomic development level. The place of residence was categorized as urban or rural (reference group). Two variables of the SEP were included: the highest level of education achieved (illiterate, elementary school, high school and graduate), and household income quintiles. The graduate education level and the fifth quintile income were the reference groups.

The health-related variables include sensory deficiencies (visual and auditory), multimorbidity and lifestyles. Visual deficiency was inquired with the question: "Do you have permanent difficulty seeing even when using glasses, contact lenses or magnifying glasses?", and auditory deficiency with the question: "Do you have permanent difficulty hearing even when using hearing aids?". Response options for both sensory deficiencies were "No, difficulty", "some difficulty", "very difficult" and "I cannot do it at all". A binary variable was created categorizing as one if the response was "very difficult" or "I cannot do it at all" in either of the two sensory impairments, and otherwise zero, representing some or no sensory difficulty.

Multimorbidity was assessed by the number of self-reported physician diagnoses of 15 chronic diseases. These conditions include hypertension, diabetes mellitus, hypercholesterolemia, heart problems, stroke, asthma or wheezing, arthritis, spine problems, work-related musculoskeletal disorders (WMSD), depression, other mental health disorders, chronic obstructive pulmonary disease (COPD), cancer, chronic kidney failure and other chronic diseases. Participants reported their diagnoses in response to the question, "Has any doctor ever diagnosed you with...?" For depression, the question specified, "Has any doctor or mental health

professional ever diagnosed you with depression?". Responses were yes or no. Multimorbidity was defined as having at least two of the fifteen selected conditions mentioned above, and was categorized as a dichotomous variable (1 = multimorbidity; 0 = none or one chronic disease).

Unhealthy lifestyle behaviours have been associated with difficulties in performing IADLs and sleep disturbances in older adults (Ding et al., 2024; Zhou et al., 2022; Artaud et al., 2013; Liao et al., 2011; Oliveira et al., 2024; Amaral Gomes et al., 2021). Time spent in sports or recreational activities during a week was categorized as one if the total time was 75 minutes or more per week, and otherwise as zero, representing a physically inactive condition. Additionally, sedentary behaviour was measured by the usual time spent watching television and the time spent using a computer or other electronic devices at home. Both activities were categorized as; "does not or less than 1 hour/day" (reference group), "from 1 hour to less than 3 hours" and "3 hours or more". Tobacco and alcohol use were included as dichotomous variables (1 = yes; 0 = no).

Based on previous studies showing that social participation can prevent functional disability (James et al., 2011; Kanamori et al., 2014; Tomioka et al., 2016) and considering Brazil's religious culture, two types of social participation were included. Current social participation involves engaging in sports, recreational activities, group meetings, community movements, academic centres, or volunteer work. Religious participation includes attending collective activities of one's own or another religion. Both types were classified as "one" if the older adult participated at least twice per month; otherwise, they were classified as "zero".

2.4. Statistical Analysis

Descriptive statistics were utilized to analyse the baseline characteristics of participants based on their IADL deficits. The chi-square test was conducted to assess the significance of the associations between covariates and the dependent variable. Multicollinearity was examined using correlation matrices and the variance inflation factor (VIF).

A pathway diagram was created to illustrate the mediation analysis, specifically the potential mediating effect of hypnotic medication on the relationship between sleep disturbances and IADL deficits (see **Figure 1**).

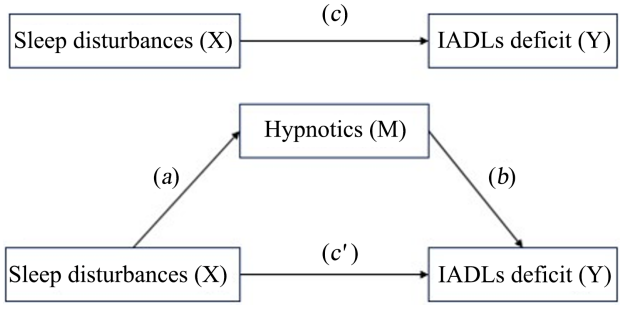

Figure 1. Pathway diagram of the mediating effect of hypnotic medications on the association between sleep disturbances and IADLS deficit.

The mediation analysis was conducted with structural equation modelling (SEM) according the next equations:

$$Y = i_1 + cX + \varepsilon_1 \quad (1)$$

$$M = i_2 + aX + \varepsilon_2 \quad (2)$$

$$Y = i_3 + c'X + bM + \varepsilon_3 \quad (3)$$

First, Equation (1) it is running with a multivariate logistic regression and, if the null hypothesis is rejected (H0: $c \neq 0$) it becomes of interest to assess partial mediation via the direct, indirect and total effects. Then with SEM, the Equations (2) and (3) are fitted simultaneously as one model and their inference parameters are made concurrently. The *sem* command and post-estimation *estat teffects* were used to obtain the direct, indirect and total effects.

The pathway from the exogenous variable (X) to the outcome (Y) while controlling for the mediator (M), i.e., the c' path, is the direct effect. The pathway from the exogenous variable (X) to the outcome (Y) through the mediator (M) describes the indirect effect ($a * b$ path). This path is represented through the product of a and b coefficients. Finally, the total effect is the sum of the direct and indirect effects of the exogenous variable (X) on the outcome (Y) ($ab + c'$) (Rijnhart et al., 2017). Since both the outcome and the mediator are binary variables, the indirect effect can be estimated using a linear probability model for the coefficient a in Equation (2). This approach helps standardize the mediator coefficient on a linear probability scale from 0 to 1, allowing the indirect effect of the model to be calculated by multiplying coefficient a by coefficient b (Rijnhart et al., 2023).

The models for the three equations were adjusted for relevant confounders. Individual survey weights were included in the models to make the estimates nationally representative. The standard error and 95% C. I. were calculated with the observed information matrix (OIM). The OIM standard errors are robust to various data conditions, including non-normality, resulting in more accurate and reliable estimates of the model's parameters.

Additionally, the Ratio of Indirect to Total effect (RIT)—also called the mediation proportion- and the Ratio of Indirect to Direct effect (RID) were calculated. In mediation analysis, RIT and RID are effect size measures that help quantify the proportion of the total effect that is mediated through a mediating variable. The RIT represents the proportion of the total effect that is explained by the indirect effect (through the mediator), while the RID indicates how much larger the indirect effect is compared to the direct effect (Ditlevsen et al., 2005). Data Analyses were carried out using STATA version 14.0, and statistical significance was evaluated using Wald's chi-square test, with a 5% significance level.

3. Results

Table 1 summarizes the sample characteristics and the relationship between independent mediators and outcome among participants. Out of 21,701 individuals

aged 60 and older, 15.7% reported IADL deficits. The average participant age was 69.5 years (SD = 7.43), with 69% being women and 68% aged 70 or older. Additionally, 41% were widowed, 35% had a college degree, 43% lived in the Northeast, and 58% were in the lowest socioeconomic quintile. Health conditions included multimorbidity (74%), sensory deficiencies (29%), and depression (15%). In terms of lifestyle, 89% either did not engage in or participated in less than 75 minutes of physical activity weekly, and 34% spent over 3 hours per day watching television. Those with IADL deficits also reported lower social and religious participation.

Table 1. Sample characteristics according IADL deficits in older adults. NHS-2019.

Characteristics	IADLs deficit	
	No (n: 18,291)	Yes (n: 3410)
Sleep disturbances**	38%	57%
Hypnotic medication**	12%	22%
Sex (% women)**	52%	69%
Age groups**		
60 - 64 year-old (ref.)	34%	15%
65 - 69 year-old	28%	17%
70 - 74 year-old	19%	19%
75 - 79 year-old	12%	19%
80 or more years	8%	30%
Marital status**		
married	46%	34%
widowed	23%	41%
single/divorced/separated (ref.)	31%	24%
Urban residence (%)**	76%	73%
Education level**		
illiterate	14%	4%
elementary school	17%	9%
high school	52%	52%
graduate (ref.)	17%	35%
Household income quintile**		
1st quintile	21%	28%
2nd quintile	24%	30%
3rd quintile	18%	18%
4th quintile	17%	15%
5th quintile (ref.)	20%	9%

Continued

Region**		
north	15%	16%
northeast	32%	43%
central west	11%	9%
southeast	26%	22%
south (ref.)	15%	11%
Multi-morbidity**	52%	74%
Sensory deficiencies**	8%	29%
Depression**	9%	15%
Physically active (75 min or more/week)**	29%	11%
Sitting time watching television**		
do not - <1 hours/day (ref.)	23%	26%
1 hour - <3 hours/day	50%	40%
≥3 hours/day	27%	34%
Sitting time using computer at home**		
do not - <1 hours/day (ref.)	78%	93%
1 hour - <3 hours/day	17%	5%
≥3 hours/day	6%	2%
Social participation**	47%	24%
Religious participation**	51%	41%
Alcohol consumption**	29%	10%
Smoker*	12%	11%
Survey weight (mean) (Std)*	1.050 (1.399)	0.986 (1.293)

ref.: reference group; *: p-value < 0.05; **: p-value < 0.001; **n.s.**: non-significant.

Among participants with IADL deficits, 57% reported sleep disturbances, and among them, 38% used hypnotic medication, prescribed by physicians for 95% of them.

The result of the logistic regression of Equation (1) shows a significant relation between sleep disturbances and IADL deficits; therefore, partial mediation was assessed. The total effect of sleep disturbances on IADL deficits in the multivariate-adjusted logistic regression model was 1.62 (95% CI 1.48 - 1.76), indicating that older individuals with sleep disturbances had a 1.62 statistically significant higher odds of having IADL deficits compared to those without sleep disturbances.

Table 2 summarizes the results of the structural equation modelling. The estimated effect of sleep disturbances on hypnotic medication intake (a-path) is

0.28676 (95% C. I.: 0.27855 - 0.29497), indicating a positive and significant association. Hypnotic medication intake also significantly predicts IADL deficits (*b*-path), with an estimated effect of 0.03536 (95% C. I.: 0.02010 - 0.05061). This suggests that the indirect effect of sleep disturbances on IADL deficits through hypnotic medication is significant. This implies that the positive effect of sleep disturbances on IADL deficits is partially explained by the influence of sleep disturbances on hypnotic medication intake.

Table 2. Result of the structural equation model of hypnotic medication on the relationship between sleep disturbance and IADLs deficit.

	Coef.	Std. Err.	[95% C. I.]	*p*-value
Direct effects (*c*' path)				
SD > *IADLs*	0.04366	0.005296	(0.03328 - 0.05404)	<0.0001
***a* path**				
SD > *HM*	0.28676	0.004188	(0.27855 - 0.29497)	<0.0001
***b* path**				
HM > *IADLs*	0.03536	0.007784	(0.02010 - 0.05061)	<0.0001
Indirect effects (*a* * *b* path)				
SD > *HM* > *IADLs*	0.01014	0.002237	(0.00575 - 0.01452)	<0.0001
Total effects (*c* path)				
SD > *IADLs*	0.05380	0.004805	(0.04439 - 0.06322)	<0.0001

SD: Sleep disturbances; **IADLs**: IADLs deficit; **HM**: Hypnotic medication; **Coef.**: coefficient; **Std. Err.**: Standard error; **C. I.**: Confidence Interval.

The estimated indirect effect (*a* * *b*-path) of sleep disturbances on IADL deficits through hypnotic medication is 0.01014 (95% C. I.: 0.00575 - 0.01452), indicating that sleep disturbances significantly and indirectly influences IADL deficits by increasing hypnotic medication. Finally, the estimated total effect of sleep disturbances on IADL deficits (*c*-path) via hypnotic medication is 0.05380 (95% C. I.: 0.04439 - 0.06322). This represents the overall direct (*c*'-path) and indirect effects (*a* * *b*-path) combined. Overall, these results highlight the significant mediating role of hypnotic medication in the relationship between sleep disturbances and IADL deficits in older adults.

To determine the proportion of the overall effect that is mediated by the intake of hypnotic medications, we calculated the RIT and RID. The RIT (calculated as 0.01014/0.05380) was 0.188, which indicates that approximately 19.0% of the effect of sleep disturbances on IADL deficits in older adults is mediated by the use of hypnotic medications. Additionally, the RID (calculated as 0.01014/0.04366) was 0.232, indicating that the mediated effect of hypnotic medications is 23.2% of the direct effect of sleep disturbances on IADL deficits in older adults.

4. Discussion

Population ageing poses significant challenges globally, including declining health and functional limitations. These issues impact activities of daily living, quality of life and increasing healthcare use, especially in low and middle-income countries (WHO, 2020).

This study found that 16.0% of older adults in Brazil were unable or had significant difficulty performing one or more IADLs. Including those with mild difficulty, the prevalence increases to 31%. Previous studies indicate that the prevalence of at least one IADL limitation ranges from 36% to 47% (Germain et al., 2016; Ćwirlej-Sozańska et al., 2019; Yau et al., 2022), varying based on measurement tools and influenced by factors such as age, gender, socioeconomic status, and health conditions.

Furthermore, the prevalence of sleep disturbances in the sample was 41.0%, increasing to 57.0% among older adults with IADL deficits. Similar findings have been reported in previous studies, which indicated that the prevalence of sleep problems in older adults typically ranges from 40% to 50% and increases with age (Canever et al., 2024; Jaqua et al., 2023; Patel et al., 2018; Fu et al., 2025). Notably, 32% of those with sleep issues in the sample reported using hypnotic medications, compared to 15% - 25% in other studies (Jaqua et al., 2023; Tully et al., 2021; Lundqvist et al., 2025; Kuo et al., 2022).

Research shows a consistent and reciprocal relationship between sleep disorders and IADLs deficits among older adults. As individuals age, they often experience changes in their sleep patterns, which have been linked to cognitive decline. This cognitive impairment, in turn, is associated with a higher risk of functional limitations in daily life, emphasizing a significant connection between sleep duration and daily functioning (Canever et al., 2024; Raimo et al., 2024; Idalino et al., 2024; Connolly et al., 2017; Romanella et al., 2021; Luo et al., 2024; Peng et al., 2023; Solfrizzi et al., 2017; Shimada et al., 2016; Suh et al., 2018). Overdorp et al. (2016) found that declines in cognitive function—measured through neuropsychological tests—are linked to changes in hippocampal volume and white matter. These cognitive declines are associated with IADL impairment and can predict future declines in daily functioning.

The current study developed a mediation model to investigate the potential mediating role of hypnotic medication intake in the relationship between sleep disturbances and IADL deficits among community-dwelling older adults in Brazil. While there are several reports on the bidirectional relationship between sleep disturbances and IADL deficits, to the best of our knowledge, no other studies have directly examined the mediates role of hypnotic medication on the relationship between sleep disturbance and IADL deficits in older adults.

The mediation analysis confirmed the hypothesis that sleep disturbances directly affect IADL deficits and indirectly influence IADL deficits mediated by the use of hypnotic medication. From the structural equation modelling, the Ratio of Indirect to Total effect (RIT) indicates that approximately 19.0% of the effect of

sleep disturbances on IADL deficits in older adults is mediated by the use of hypnotic medications, and the Ratio of Indirect to Direct effect (RID) indicates that the mediated effect of hypnotic medications is 23.2% of the direct effect of sleep disturbances on IADL deficits in older adults.

Despite strong recommendations based on high-quality evidence highlighting the potential adverse cognitive effects of sedative-hypnotic drugs—such as benzodiazepines and Z-drugs—many older adults continue to use these medications chronically (Picton et al., 2018). The maximum recommended length of treatment with sedative-hypnotic drugs is between 2 and 4 weeks for insomnia or anxiety among older adults (Torres-Bondia et al., 2022). As people age, they become more sensitive to the side effects of sedative-hypnotics due to changes in pharmacokinetics and pharmacodynamics. Evidence indicates that higher doses, long-term use, and the extended half-lives of these medications in older individuals are linked to cognitive decline (Torres-Bondia et al., 2022; Mura et al., 2013).

Current research does not clearly support that hypnotic medications mediate the relationship between sleep disturbances and IADL impairment. Although hypnotic medications, particularly Z-drugs, may help alleviate sleep symptoms in older adults, their effect on functional outcomes such as IADL is not well established (Richardson et al., 2021; Fox et al., 2018). More focused research is needed to determine any mediating effects on IADL. However, chronic use of hypnotic benzodiazepines significantly increases the risk of IADL limitations, even when adjusting for age, comorbidities, and mental health conditions (Carrière et al., 2015). Additionally, polypharmacy—taking five or more medications, often including hypnotics—is associated with a greater ADL/IADL disability (Connolly et al., 2017).

This study had several limitations. First, self-reported measures may introduce recall bias, especially in older adults and those with lower education levels. To minimize this, only individuals who could independently complete the survey were included. Second, sleep disorders and the use of hypnotic medications were assessed using general measures. Unfortunately, the questionnaire survey used in this study did not include structured or standardized questions to evaluate these variables. As a result, there is a potential risk of misclassification, which could influence the estimation of the mediating role of hypnotic medications in the relationship between sleep disturbances and Instrumental Activities of Daily Living (IADL). Furthermore, the cross-sectional design of this study limits causal mediation inference as it hinders the establishment of the necessary temporal order to demonstrate a causal chain of events. Nonetheless, it is important to recognize that subjective measures may have broader applicability in population studies. Finally, as an observational study, the findings may be influenced by unmeasured confounding variables, so caution is advised when interpreting these findings in light of these limitations.

Despite the above limitations, the study has particular strengths. The study findings can be generalised as the data collected and analysed are nationally representative. A larger sample size guarantees the accuracy of the results, including

individual survey weights that make estimates generalizable and controlling for relevant confounding factors offers reliable estimates. Furthermore, the use of structural equations modelling provides an appropriate inference framework for mediation analysis, permitting a better understanding of the causal relationship between the variables. These findings support the implementation of interventions aimed at the safe use of sedative-hypnotic drugs. It is important to identify geriatric patients who are at risk of experiencing severe side effects from these medications, particularly those that impact cognitive functions and functional abilities, as well as independence in community-dwelling older adults. However, recent systematic reviews and meta-analyses have demonstrated the effectiveness of non-pharmacological interventions in improving sleep quality and reducing insomnia among older adults. The recommended first-line treatments for sleep disturbances in this population include Cognitive Behavioural Therapy for Insomnia (CBT-I), physical exercise, mindfulness practices, music therapy, light therapy, and complementary therapies like Tai Chi and aromatherapy. These interventions can be used individually or in combination to achieve the best outcomes (Sella et al. 2022; Gu & Lee, 2023; McPhillips et al., 2024; Chang et al., 2024).

Future research should focus on longitudinal surveys using structured and validated tools to assess specific aspects of sleep disturbances and hypnotic medications use. It would also be valuable to explore the links between cognitive decline, sleep disorders, and IADL functioning in older adults. Furthermore, it must be interesting to examine the relationship between sleep disturbance or cognitive decline with each IADL, separately. Additionally, future studies should incorporate other variables to explore the underlying mechanisms of mediation in more detail and consider gender and socioeconomic disparities.

In conclusion, this study shows that sleep disturbances are linked to deficits in IADL with hypnotic medication playing a mediating role in this relationship among older adults in Brazil. Therefore, effectively assessing and treating sleep issues may reduce the risks of functional impairments and cognitive decline while also helping to maintain or enhance brain health outcomes in this population. These findings highlight the importance of implementing primary healthcare strategies that screen for sleep problems and promote non-pharmacological interventions, such as cognitive-behavioural therapy (which includes sleep education, sleep hygiene practices, and encouraging active lifestyles for social participation), to improve sleep quality among older adults living in the community.

5. Ethical Statement

The PNS project was approved under Protocol No. 3529376 (2019) by the National Research Ethics Commission, which operates under the National Health Council. All participants provided their consent by signing a Free and Informed Consent Form. The data gathered from the PNS study is public, while the personal information of the participants is maintained with confidentiality. This study utilizes these secondary data.

Data Availability

https://www.ibge.gov.br/estatisticas/sociais/saude/9160-pesquisa-nacional-de-saude.html?=&t=microdados

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Alam, R., Quintero Silva, L., Jahan, N., Chodzko-Zajko, W., Ogunjesa, B., Selzer Ninomiya, A. et al. (2022). Relationships of Low Cognitive Performance and Sleep Disorder with Functional Disabilities among Older Adults. *Journal of Aging and Health, 35,* 525-534. https://doi.org/10.1177/08982643221143221

Amaral Gomes, E. S., Ramsey, K. A., Rojer, A. G., Reijnierse, E. M., & Maier, A. B. (2021). The Association of Objectively Measured Physical Activity and Sedentary Behavior with (Instrumental) Activities of Daily Living in Community-Dwelling Older Adults: A Systematic Review. *Clinical Interventions in Aging, 16,* 1877-1915. https://doi.org/10.2147/cia.s326686

Apostolova, L. G., Mosconi, L., Thompson, P. M., Green, A. E., Hwang, K. S., Ramirez, A. et al. (2010). Subregional Hippocampal Atrophy Predicts Alzheimer's Dementia in the Cognitively Normal. *Neurobiology of Aging, 31,* 1077-1088. https://doi.org/10.1016/j.neurobiolaging.2008.08.008

Artaud, F., Dugravot, A., Sabia, S., Singh-Manoux, A., Tzourio, C., & Elbaz, A. (2013). Unhealthy Behaviours and Disability in Older Adults: Three-City Dijon Cohort Study. *British Medical Journal, 347,* f4240. https://doi.org/10.1136/bmj.f4240

Brown, R. T., Diaz-Ramirez, L. G., Boscardin, W. J., Lee, S. J., Williams, B. A., & Steinman, M. A. (2019). Association of Functional Impairment in Middle Age with Hospitalization, Nursing Home Admission, and Death. *JAMA Internal Medicine, 179,* 668-675. https://doi.org/10.1001/jamainternmed.2019.0008

Canever, J. B., Zurman, G., Vogel, F., Sutil, D. V., Diz, J. B. M., Danielewicz, A. L. et al. (2024). Worldwide Prevalence of Sleep Problems in Community-Dwelling Older Adults: A Systematic Review and Meta-Analysis. *Sleep Medicine, 119,* 118-134. https://doi.org/10.1016/j.sleep.2024.03.040

Carrière, I., Mura, T., Pérès, K., Norton, J., Jaussent, I., Edjolo, A. et al. (2015). Elderly Benzodiazepine Users at Increased Risk of Activity Limitations: Influence of Chronicity, Indications, and Duration of Action—The Three-City Cohort. *The American Journal of Geriatric Psychiatry, 23,* 840-851. https://doi.org/10.1016/j.jagp.2014.10.006

Chang, H., Chen, Y., & Wang, Z. (2024). Comparative Efficacy of Non-Pharmacological Interventions on Sleep Quality in Old Adults: A Systematic Review and Network Meta-Analysis. *Journal of Clinical Nursing, 33,* 1948-1957. https://doi.org/10.1111/jocn.17086

Cipriani, G., Danti, S., Picchi, L., Nuti, A., & Fiorino, M. D. (2020). Daily Functioning and Dementia. *Dementia & Neuropsychologia, 14,* 93-102. https://doi.org/10.1590/1980-57642020dn14-020001

Connolly, D., Garvey, J., & McKee, G. (2017). Factors Associated with ADL/IADL Disability in Community Dwelling Older Adults in the Irish Longitudinal Study on Ageing (TILDA). *Disability and Rehabilitation, 39,* 809-816. https://doi.org/10.3109/09638288.2016.1161848

Cross, N. E., Carrier, J., Postuma, R. B., Gosselin, N., Kakinami, L., Thompson, C. et al.

(2019). Association between Insomnia Disorder and Cognitive Function in Middle-Aged and Older Adults: A Cross-Sectional Analysis of the Canadian Longitudinal Study on Aging. *Sleep, 42,* zsz114. https://doi.org/10.1093/sleep/zsz114

Ćwirlej-Sozańska, A., Wiśniowska-Szurlej, A., Wilmowska-Pietruszyńska, A., & Sozański, B. (2019). Determinants of ADL and IADL Disability in Older Adults in Southeastern Poland. *BMC Geriatrics, 19,* Article No. 297. https://doi.org/10.1186/s12877-019-1319-4

Ding, H., Wang, K., Li, Y., & Zhao, X. (2024). Trends in Disability in Activities of Daily Living and Instrumental Activities of Daily Living among Chinese Older Adults from 2011 to 2018. *Aging Clinical and Experimental Research, 36,* Article No. 27. https://doi.org/10.1007/s40520-023-02690-7

Ditlevsen, S., Christensen, U., Lynch, J., Damsgaard, M., & Keiding, N. (2005). The Mediation Proportion: A Structural Equation Approach for Estimating the Proportion of Exposure Effect on Outcome Explained by an Intermediate Variable. *Epidemiology, 16,* 114-120.

Dzierzewski, J. M., Dautovich, N., & Ravyts, S. (2018). Sleep and Cognition in Older Adults. *Sleep Medicine Clinics, 13,* 93-106. https://doi.org/10.1016/j.jsmc.2017.09.009

Fox, C., Arthur, A., Ballard, C., Howard, R., Maidment, I. et al. (2018). Beyond Antipsychotics: Exploring Efficacy and Harms of Z-Drugs for Sleep Disturbances on the Progression of Key Dementia Outcomes. *Alzheimer's & Dementia, 14,* 1072-1073.

Fu, T., Guo, R., Wang, H., Yu, S., & Wu, Y. (2025). The Prevalence and Risk Factors of Sleep Disturbances in Community-Dwelling Older Adults: A Systematic Review and Meta-Analysis. *Sleep and Breathing, 29,* Article No. 110. https://doi.org/10.1007/s11325-025-03267-6

Germain, C. M., Vasquez, E., Batsis, J. A., & McQuoid, D. R. (2016). Sex, Race and Age Differences in Muscle Strength and Limitations in Community Dwelling Older Adults: Data from the Health and Retirement Survey (HRS). *Archives of Gerontology and Geriatrics, 65,* 98-103. https://doi.org/10.1016/j.archger.2016.03.007

Gu, H., & Lee, O. (2023). Effects of Non-Pharmacological Sleep Interventions in Older Adults: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health, 20,* Article 3101. https://doi.org/10.3390/ijerph20043101

Guo, H. J., & Sapra, A. (2022). *Instrumental Activity of Daily Living*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK553126/

Hale, L., Emanuele, E., & James, S. (2015). Recent Updates in the Social and Environmental Determinants of Sleep Health. *Current Sleep Medicine Reports, 1,* 212-217. https://doi.org/10.1007/s40675-015-0023-y

Huang, S., Zhong, W., Cheng, Q., Shuai, Y., Zhu, J., & Diao, J. (2024). Instrumental Activities of Daily Living Function and Cognitive Status among Chinese Older Adults: A Serial Multiple Mediation Model. *Frontiers in Public Health, 12,* Article 1378979. https://doi.org/10.3389/fpubh.2024.1378979

IBGE (2020). Pesquisa nacional de saúde 2019: Informações sobre domicílios, acesso e utilização dos serviços de saúde. Brasil, grandes regiões e unidades da federação/IBGE, Coordenação de Trabalho e Rendimento. Rio de Janeiro, IBGE, 2020. https://biblioteca.ibge.gov.br/visualizacao/livros/liv101748.pdf

Idalino, S. C. C., Cândido, L. M., Wagner, K. J. P., de Souza Moreira, B., de Carvalho Bastone, A., Danielewicz, A. L. et al. (2024). Association between Sleep Problems and Functional Disability in Community-Dwelling Older Adults. *BMC Geriatrics, 24,* Article No. 253. https://doi.org/10.1186/s12877-024-04822-8

Inzitari, D., Pracucci, G., Poggesi, A., Carlucci, G., Barkhof, F., Chabriat, H. et al. (2009). Changes in White Matter as Determinant of Global Functional Decline in Older Independent Outpatients: Three Year Follow-Up of LADIS (Leukoaraiosis and Disability) Study Cohort. *British Medical Journal, 339,* b2477. https://doi.org/10.1136/bmj.b2477

James, B. D., Boyle, P. A., Buchman, A. S., & Bennett, D. A. (2011). Relation of Late-Life Social Activity with Incident Disability among Community-Dwelling Older Adults. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 66,* 467-473. https://doi.org/10.1093/gerona/glq231

Jaqua, E. E., Hanna, M., Labib, W., Moore, C., & Matossian, V. (2023). Common Sleep Disorders Affecting Older Adults. *The Permanente Journal, 27,* 122-132. https://doi.org/10.7812/tpp/22.114

Kanamori, S., Kai, Y., Aida, J., Kondo, K., Kawachi, I., Hirai, H. et al. (2014). Social Participation and the Prevention of Functional Disability in Older Japanese: The JAGES Cohort Study. *PLOS ONE, 9,* e99638. https://doi.org/10.1371/journal.pone.0099638

Kuo, C., Chien, I., & Lin, C. (2022). Trends, Correlates, and Disease Patterns of Sedative-Hypnotic Use among Elderly Persons in Taiwan Region. *BMC Psychiatry, 22,* Article No. 316. https://doi.org/10.1186/s12888-022-03964-6

Lee, Y., Kong, D., Lee, Y. H., Lin, C., Liu, C., & Chang, Y. (2022). Functional Disabilities and Changes in Sleep Quality and Duration among Older Adults: Results from a Longitudinal Study in China, 2005–2014. *European Geriatric Medicine, 13,* 967-975. https://doi.org/10.1007/s41999-022-00619-3

Liao, W. C., Li, C. R., Lin, Y. C., Wang, C. C. et al. (2011). Healthy Behaviors and Onset of Functional Disability in Older Adults: Results of a National Longitudinal Study. *Journal of the American Geriatrics Society, 59,* 200-206. https://doi.org/10.1111/j.1532-5415.2010.03272.x

Liao, W. L., & Chang, Y. H. (2020). Age Trajectories of Disability in Instrumental Activities of Daily Living and Disability-Free Life Expectancy among Middle-Aged and Older Adults in Taiwan Region: An 11-Year Longitudinal Study. *BMC Geriatrics, 20,* Article No. 530. https://doi.org/10.1186/s12877-020-01939-4

Lundqvist, C., Simonsen, T. B., & Siddiqui, T. G. (2025). Self-Reported Sleep Disturbance and Inappropriate Z-Hypnotic Use among Older Adults in General Practice. *Scandinavian Journal of Primary Health Care, 43,* 555-562. https://doi.org/10.1080/02813432.2025.2475300

Luo, M., Dong, Y., Fan, B., Zhang, X., Liu, H., Liang, C. et al. (2024). Sleep Duration and Functional Disability among Chinese Older Adults: Cross-Sectional Study. *JMIR Aging, 7,* e53548. https://doi.org/10.2196/53548

Masse, M., Henry, H., Cuvelier, E., Pinçon, C., Pavy, M., Beeuwsaert, A. et al. (2022). Sleep Medication in Older Adults: Identifying the Need for Support by a Community Pharmacist. *Healthcare, 10,* Article 147. https://doi.org/10.3390/healthcare10010147

McPhillips, M. V., Petrovsky, D. V., Lorenz, R., Lee, J., George, T., Smyth, A. et al. (2024). Treatment Modalities for Insomnia in Adults Aged 55 and Older: A Systematic Review of Literature from 2018 to 2023. *Current Sleep Medicine Reports, 10,* 232-256. https://doi.org/10.1007/s40675-024-00285-w

Miner, B., & Kryger, M. H. (2017). Sleep in the Aging Population. *Sleep Medicine Clinics, 12,* 31-38. https://doi.org/10.1016/j.jsmc.2016.10.008

Mura, T., Proust-Lima, C., Akbaraly, T., Amieva, H., Tzourio, C., Chevassus, H. et al. (2013). Chronic Use of Benzodiazepines and Latent Cognitive Decline in the Elderly: Results from the Three-City Study. *European Neuropsychopharmacology, 23,* 212-223.

https://doi.org/10.1016/j.euroneuro.2012.05.004

National Institute on Aging (NIA) (2025). *Sleep and Older Adults*. https://www.nia.nih.gov/health/sleep/sleep-and-older-adults

Nóbrega, J. C. L., Medeiros, J. B., Santos, T. T. D. M., Alves, S. A. V., Freitas, J. L. G. D. S., Silva, J. M. M. et al. (2021). Socioeconomic Factors and Health Status Disparities Associated with Difficulty in Adls and Iadls among Long-Lived Populations in Brazil: A Cross-Sectional Study. *Inquiry, 58,* Article 469580211007264. https://doi.org/10.1177/00469580211007264

Oliveira, R. L., Freitas, R. L., & Bof de Andrade, F. (2024). Sleep Problem and Its Association with Physical Activity and Functional Limitation: Brazilian National Health Survey. *Sleep Epidemiology, 4,* Article 100080. https://doi.org/10.1016/j.sleepe.2024.100080

Overdorp, E. J., Kessels, R. P. C., Claassen, J. A., & Oosterman, J. M. (2016). The Combined Effect of Neuropsychological and Neuropathological Deficits on Instrumental Activities of Daily Living in Older Adults: A Systematic Review. *Neuropsychology Review, 26,* 92-106. https://doi.org/10.1007/s11065-015-9312-y

Patel, D., Steinberg, J., & Patel, P. (2018). Insomnia in the Elderly: A Review. *Journal of Clinical Sleep Medicine, 14,* 1017-1024. https://doi.org/10.5664/jcsm.7172

Patel, R., Srivastava, S., Kumar, P., Chauhan, S., Govindu, M. D., & Jean Simon, D. (2021). Socio-economic Inequality in Functional Disability and Impairments with Focus on Instrumental Activity of Daily Living: A Study on Older Adults in India. *BMC Public Health, 21,* Article No. 1541. https://doi.org/10.1186/s12889-021-11591-1

Pearlin, L. I. (1999). The Stress Process Revisited. In C. S. Aneshensel, & J. C. Phelan (Eds.), *Handbooks of Sociology and Social Research* (pp. 395-415). Springer.

Peng, Y., Bu, J., Dai, N., Huang, C., Liu, Y., Yang, H. et al. (2023). Association of Nocturnal Sleep Duration and Nocturnal Sleep Changes with Instrumental Activities of Daily Living Disability among Middle-Aged and Elderly Chinese. *Sleep Medicine, 109,* 90-97. https://doi.org/10.1016/j.sleep.2023.06.017

Picton, J. D., Marino, A. B., & Nealy, K. L. (2018). Benzodiazepine Use and Cognitive Decline in the Elderly. *American Journal of Health-System Pharmacy, 75,* e6-e12. https://doi.org/10.2146/ajhp160381

Raimo, S., Maggi, G., Ilardi, C. R., Cavallo, N. D., Torchia, V., Pilgrom, M. A. et al. (2024). The Relation between Cognitive Functioning and Activities of Daily Living in Normal Aging, Mild Cognitive Impairment, and Dementia: A Meta-Analysis. *Neurological Sciences, 45,* 2427-2443. https://doi.org/10.1007/s10072-024-07366-2

Richardson, K., Savva, G. M., Boyd, P. J., Aldus, C., Maidment, I., Pakpahan, E. et al. (2021). Non-Benzodiazepine Hypnotic Use for Sleep Disturbance in People Aged over 55 Years Living with Dementia: A Series of Cohort Studies. *Health Technology Assessment, 25,* 1-202. https://doi.org/10.3310/hta25010

Rijnhart, J. J. M., Twisk, J. W. R., Chinapaw, M. J. M., de Boer, M. R., & Heymans, M. W. (2017). Comparison of Methods for the Analysis of Relatively Simple Mediation Models. *Contemporary Clinical Trials Communications, 7,* 130-135. https://doi.org/10.1016/j.conctc.2017.06.005

Rijnhart, J. J. M., Valente, M. J., Smyth, H. L., & MacKinnon, D. P. (2023). Statistical Mediation Analysis for Models with a Binary Mediator and a Binary Outcome: The Differences between Causal and Traditional Mediation Analysis. *Prevention Science, 24,* 408-418. https://doi.org/10.1007/s11121-021-01308-6

Romanella, S. M., Roe, D., Tatti, E., Cappon, D., Paciorek, R., Testani, E. et al. (2021). The Sleep Side of Aging and Alzheimer's Disease. *Sleep Medicine, 77,* 209-225.

https://doi.org/10.1016/j.sleep.2020.05.029

Ryden, A. M., Martin, J. L., Matsuwaka, S., Fung, C. H., Dzierzewski, J. M., Song, Y. et al. (2019). Insomnia Disorder among Older Veterans: Results of a Postal Survey. *Journal of Clinical Sleep Medicine, 15,* 543-551. https://doi.org/10.5664/jcsm.7710

Samson, D. R., Crittenden, A. N., Mabulla, I. A., & Mabulla, A. Z. P. (2017). The Evolution of Human Sleep: Technological and Cultural Innovation Associated with Sleep-Wake Regulation among Hadza Hunter-Gatherers. *Journal of Human Evolution, 113,* 91-102. https://doi.org/10.1016/j.jhevol.2017.08.005

Sella, E., Toffalini, E., Canini, L., & Borella, E. (2022). Non-Pharmacological Interventions Targeting Sleep Quality in Older Adults: A Systematic Review and Meta-Analysis. *Aging & Mental Health, 27,* 847-861. https://doi.org/10.1080/13607863.2022.2056879

Shimada, H., Makizako, H., Lee, S., Doi, T., Lee, S., Tsutsumimoto, K. et al. (2016). Impact of Cognitive Frailty on Daily Activities in Older Persons. *The Journal of Nutrition, Health and Aging, 20,* 729-735. https://doi.org/10.1007/s12603-016-0685-2

Shin, J., & Kim, G. S. (2022). Patterns of Change and Factors Associated with IADL Function Decline in Community-Dwelling Older Adults with Arthritis. *Scientific Reports, 12,* Article No. 16840. https://doi.org/10.1038/s41598-022-19791-4

Solfrizzi, V., Scafato, E., Lozupone, M., Seripa, D., Giannini, M. et al. (2017). Italian Longitudinal Study on Aging Working Group Additive Role of a Potentially Reversible Cognitive Frailty Model and Inflammatory State on the Risk of Disability: The Italian Longitudinal Study on Aging. *American Journal of Geriatric Psychiatry, 25,* 1236–1248.

Stopa, S. R., Szwarcwald, C. L., de Oliveira, M.M. et al. (2020). Pesquisa Nacional de Saude 2019: Historico, metodos et perspectivas. *Epidemiol et Servicos Saude, 29,* e2020315.

Suh, S. W., Han, J. W., Lee, J. R., Byun, S., Kwon, S. J., Oh, S. H. et al. (2018). Sleep and Cognitive Decline: A Prospective Nondemented Elderly Cohort Study. *Annals of Neurology, 83,* 472-482. https://doi.org/10.1002/ana.25166

Tanielian, M., Antoun, J., Sidani, M., Halabi, A., Hoballah, M., Hawatian, K. et al. (2022). Sleep Pattern and Predictors of Daily versus As-Needed Hypnotics Use in Middle-Aged and Older Adults with Insomnia. *BMC Primary Care, 23,* Article No. 98. https://doi.org/10.1186/s12875-022-01707-w

Tomioka, K., Kurumatani, N., & Hosoi, H. (2016). Association between Social Participation and Instrumental Activities of Daily Living among Community-Dwelling Older Adults. *Journal of Epidemiology, 26,* 553-561. https://doi.org/10.2188/jea.je20150253

Torres-Bondia, F., Dakterzada, F., Galván, L., Buti, M., Besanson, G., Grill, E. et al. (2022). Benzodiazepine and Z-Drug Use and the Risk of Developing Dementia. *International Journal of Neuropsychopharmacology, 25,* 261-268. https://doi.org/10.1093/ijnp/pyab073

Tully, I., Simpson, N., Dietch, J., Tutek, J., & Manber, R. (2021). 356 Examining Use and Beliefs about Sleep Medications in a Sample of Older Adults: The Role of Hypnotic Dependency. *Sleep, 44,* A142. https://doi.org/10.1093/sleep/zsab072.355

Waidmann, T. A., & Liu, K. (2000). Disability Trends among Elderly Persons and Implications for the Future. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 55,* S298-S307. https://doi.org/10.1093/geronb/55.5.s298

WHO (2020). *Decade of Healthy Ageing: Baseline Report.*

WHO (2024). *Ageing and Health.* https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

Yau, P. N., Foo, C. J. E., Cheah, N. L. J., Tang, K. F., & Lee, S. W. H. (2022). The Prevalence of Functional Disability and Its Impact on Older Adults in the ASEAN Region: A Sys-

tematic Review and Meta-Analysis. *Epidemiology and Health, 44,* e2022058. https://doi.org/10.4178/epih.e2022058

Zhou, J., Wei, M. Y., Zhang, J., Liu, H., & Wu, C. (2022). Association of Multimorbidity Patterns with Incident Disability and Recovery of Independence among Middle-Aged and Older Adults. *Age and Ageing, 51,* 1-9. https://doi.org/10.1093/ageing/afac177