



A Structural Equation Modeling Approach to Disease Burden, Functional Limitation, Loneliness, and Depression in Older Adults: Evidence from the Indonesian Family Life Survey

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Abstract

Depression in later life is a growing public health concern, as it often emerges from the complex pathways. This study aimed to examine the direct and indirect association between multimorbidity, functional ability, physical dependency, loneliness, and depression among the elderly. A total of 2,928 individuals aged 60 years who were participated on the 5th Indonesian Family Life Survey (IFLS). Structural Equation Modeling (SEM) was employed to investigate the relationships among key variables, including gender, place of residence, marital status, healthcare services, comorbidities, functional ability, history of falls, loneliness, and depression. Model fit was evaluated using the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker–Lewis Index (TLI). Depression was directly influenced by loneliness ($b = 0.30$; 95% CI: 0.26 to 0.33; $p < 0.001$), functional ability ($b = -0.04$; 95% CI: -0.07 to -0.01; $p = 0.039$), history of falls ($b = 0.09$; 95% CI: 0.05 to 0.12; $p < 0.001$), and adequacy of healthcare services ($b = -0.07$; 95% CI: -0.10 to -0.03; $p < 0.001$). Depression was indirectly affected by gender, marital status, comorbidities, functional independence, and place of residence. These findings underscore the complex and interconnected nature of physical and psychosocial factors in late-life depression and highlight the necessity for integrated interventions that address both the physical and emotional needs of the aging population.

INTRODUCTION

Older adults are particularly vulnerable to declines in physical function and psychosocial well-being, including loneliness and depression (Pollak et al., 2023). Functional decline often reduces independence in activities of daily living (ADL), limits social participation, and is consistently associated with poorer mental health outcomes (Sutin et al., 2020). Although the prevalence of functional dependence varies across countries, studies from diverse settings indicate that limitations in daily functioning remain common among older adults and constitute an impor-

tant public health concern (Urrunaga-Pastor et al., 2019; Burman et al., 2019; Cwirlej-Sozanska et al., 2018; Meucci et al., 2020).

Beyond physical functioning, the adequacy of healthcare services may also influence psychosocial well-being. Access to timely, person-centered healthcare can facilitate the management of chronic conditions, preserve functional independence, and provide opportunities for emotional support and social engagement (Cabanero-Garcia et al., 2025). Recognition of the healthcare system as a setting for addressing loneliness and social isolation has increased in

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recent years (National Academies of Sciences, Engineering, and Medicine, 2020). Community-based interventions delivered through healthcare services have been shown to reduce loneliness among older adults (Findlay, 2003), while qualitative evidence suggests that older adults experiencing loneliness frequently seek support from healthcare professionals, including social workers (Abo-Rass et al., 2025). Together, these findings suggest that adequate healthcare may contribute to lower loneliness by providing both clinical care and opportunities for social connection.

Despite growing evidence linking healthcare access, functional status, and mental health, the pathways through which healthcare adequacy and functional functioning are associated with loneliness and depression remain insufficiently understood, particularly in low- and middle-income countries. Most previous studies have examined these factors independently rather than as interconnected processes.

Therefore, this study used path analysis to examine the direct and indirect relationships among healthcare adequacy, functional status, loneliness, and depression among older adults in Indonesia using nationally representative data from the Indonesian Family Life Survey (IFLS). By identifying the pathways linking physical, functional, and psychosocial factors, this study aims to provide evidence to support integrated health and social care strategies for promoting healthy ageing.

METHOD

Study design

This study employed a quantitative approach with a cross-sectional design to analyze the relationships between various biological and social factors and their association with loneliness and depression among older adults.

Study sample

The study sample was derived from the 2014 Indonesian Family Life Survey (IFLS-5), a nationally representative survey. A total of 2,928 respondents aged 60 years and above were included, representing the older adult population in Indonesia. The participant selection and data merging process are illustrated in Figure 1. Briefly, 4,228 older adults (≥ 60 years) were identified from the IFLS-5 dataset and merged with the depression dataset using the unique participant identifier (pidlink). Of these, 2,938 participants had available depression data. This sample substantially exceeded the recommended minimum sample size for structural equation modeling

(SEM) and path analysis, which generally recommend a minimum of 200 participants or approximately 10–20 observations per estimated parameter (Nicolaou & Masoner, 2013; Wolf et al., 2013; Hair et al., 2021). Therefore, the final sample was considered adequate to provide sufficient statistical power and stable parameter estimation for the path or SEM analyses.

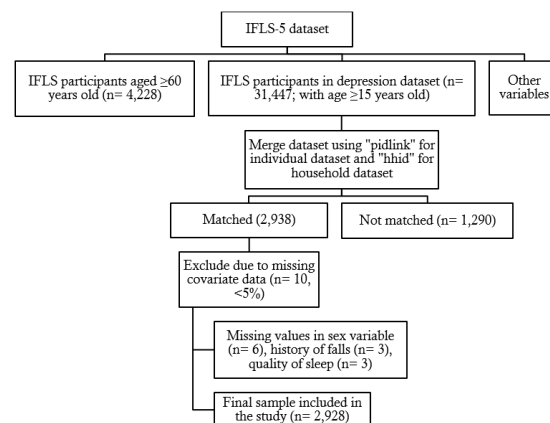


Figure 1. Flow diagram of participant selection for the final analytical sample from the IFLS-5 dataset

Variable measurement

Depression is conceptualized as a subjective mental health condition characterized by persistent feelings of sadness, hopelessness, and a loss of interest in daily activities. In this study, depression was assessed through self-reported frequency of experiencing depressive feelings, as measured by the question: “How often do you feel depressed?”. Responses were recorded using a Likert scale with the following categories: 0 = rarely or never, 1 = occasionally, 2 = sometimes, and 3 = nearly all the time. Higher scores indicate greater severity of depressive symptoms.

Loneliness is defined as a subjective psychological condition characterized by feelings of social isolation or the absence of meaningful social relationships. It was assessed using a self-reported question: “How often do you feel lonely?”. Responses were recorded on a Likert scale with the following categories: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, and 4 = always. Higher scores indicated a greater perceived level of loneliness.

Depression and loneliness were assessed using single-item self-reported questions available in the IFLS-5 dataset. These indicators were selected because the objective of this study was to examine self-perceived depressive symptoms and loneliness at the population level rather than to establish a clinical diagnosis of depression.

Single-item measures of depression and loneliness are widely used in large-scale epidemiological surveys because of their feasibility and minimal respondent burden. Such measures have also been employed in previous research (Nurjanah and Intening, 2025; Chamberlain et al., 2026).

Marital status was categorized based on the respondent's relationship status at the time of the survey. A value of 0 was assigned to individuals who were unmarried, widowed, divorced, or living alone without a partner, whereas a value of 1 was assigned to those who were married or cohabiting with a partner.

Multimorbidity refers to the coexistence of two or more chronic health conditions within an individual. Data on multimorbidity were obtained from respondents' self-reports regarding their medical history, included: (1) asthma, (2) diabetes mellitus, (3) hypertension, (4) hypercholesterolemia, and (5) arthritis. The measurement score represents the total number of these conditions experienced by each respondent. A score of 0 indicates that the respondent did not report having any of the listed conditions, thereby being classified as healthy.

Fall history is defined as an incident experienced by an elderly, characterized by a fall resulting from the inability to maintain body balance. For this variable, responses were coded as 0 if the respondent had never experienced a fall and 1 if they had experienced at least once.

Functional ability is defined as the capacity of older adults to perform basic daily activities. This variable was assessed using the question, "Are you able to perform the following activities?" for five specific tasks: dressing, getting up from a lying position, eating, urinating, and bathing.

Independence in daily activities is defined as the ability of an individual to perform routine physical tasks, such as mobility and self-care (e.g., bathing, dressing, toileting), without reliance on external assistance from family members or caregivers, despite potential declines in physical capacity. This variable was measured using the question, "If you need to perform daily activities, do you require assistance from others?". Response options were coded as 0 = no and 1 = yes.

Healthcare adequacy refers to an individual's subjective perception or assessment of the healthcare services they receive, reflecting the perceived quality of those services. The assessment was conducted using a Likert scale with the following categories: 0 = inadequate, 1 = adequate, and 2 = highly adequate. Higher scores indicate a more favorable perception of the

quality of healthcare services received by the respondents.

Place of residence refers to the geographical location where the respondent lives, which may influence access to healthcare services, social support, and the physical environment. This variable was categorized as rural (coded as 0) or urban (coded as 1).

Data analysis

Descriptive analysis was performed to present the characteristics of respondents using frequency (n) and percentage (%) for each study variable. Bivariate analysis was conducted to examine the independent associations between each independent variable and the outcomes of loneliness and depression, using simple linear regression. Subsequently, path analysis was applied to evaluate the direct and indirect relationships among the study variables. Model fit was assessed using goodness-of-fit tests with the following statistical indicators: Chi-square, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and coefficient of determination (CD).

Ethical statement

This study utilized secondary data from the Indonesian Family Life Survey (IFLS-5), a nationally representative population survey that had undergone ethical review by the data provider. The IFLS was reviewed and approved by the Institutional Review Boards (IRBs) in the United States (at RAND) and in Indonesia through Universitas Gadjah Mada (UGM). The researchers did not have direct interaction with respondents, and all data used were anonymized to ensure the confidentiality and privacy of individuals. In accordance with research ethics principles, the use of these secondary data was solely for scientific purposes and complied with the data usage requirements set by the data provider. As the data were anonymous and contained no personally identifiable information, this study did not require additional ethical approval from a local research ethics committee.

RESULTS AND DISCUSSION

Table 1 presents the demographic and health characteristics of older adults in Indonesia based on the 2014 IFLS-5 data, both overall and stratified by sex. The univariate analysis in Table 1 indicates significant differences between males and females in terms of employment status, marital status, and number of diseases. In contrast, the

proportions by age group, place of residence, history of falls, and independence in daily activities were relatively similar between the two groups.

Table 2 presents the results of the independent analyses of each biological and social factor in relation to loneliness and depression. Psychosocial factors, particularly marital status, play a significant role in mitigating loneliness. In contrast, physical and medical factors, including comorbidities, history of falls, and dependence in daily activities, exhibit a strong association with increased levels of both loneliness and depression. Meanwhile, demographic variables such as age, sex, place of residence, and employment status show no statistically significant relationship with depression.

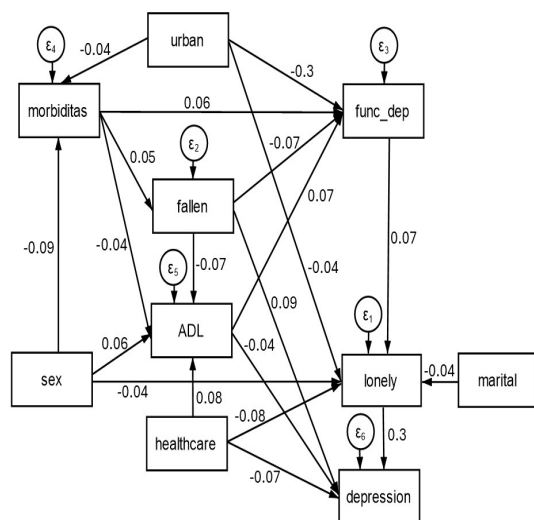


Figure 2. Path analysis model illustrating the interaction between biological and social factors in relation to loneliness and depression among older adults.

Figure 2 illustrates a model depicting both direct and indirect pathways among sex, place of residence, marital status, morbidity, history of falls, adequacy of healthcare services, functional capacity, dependence in physical activities, loneliness, and depression. Loneliness among older adults was directly lower in males ($\beta = -0.04$; 95% CI = -0.08 to 0.01 ; $p = 0.070$), those who were married ($\beta = -0.04$; 95% CI = -0.08 to 0.01 ; $p = 0.063$), those with adequate healthcare services ($\beta = -0.08$; 95% CI = -0.12 to -0.04 ; $p < 0.001$), and those residing in urban areas ($\beta = -0.04$; 95% CI = -0.07 to -0.01 ; $p = 0.048$). Conversely, loneliness was directly higher among individuals with dependence in daily physical activities ($\beta = 0.07$; 95% CI = 0.03 to 0.10 ; $p < 0.001$). Indirectly, loneliness was influenced by functional capacity,

comorbidities, and history of falls.

Depression was directly increased by the presence of loneliness ($\beta = 0.30$; 95% CI = 0.26 to 0.33 ; $p < 0.001$) and a history of falls ($\beta = 0.09$; 95% CI = 0.05 to 0.12 ; $p < 0.001$). Conversely, depression was directly reduced by better functional capacity ($\beta = -0.04$; 95% CI = -0.07 to -0.01 ; $p = 0.039$) and adequate healthcare services ($\beta = -0.07$; 95% CI = -0.10 to -0.03 ; $p < 0.001$). Indirectly, depression was influenced by sex, marital status, morbidity, independence in daily activities, and place of residence.

The model fit indices for the path analysis indicated a p -value of < 0.001 . Although the significant Chi-square value suggests a difference between the model and the observed data, this is a common occurrence in large samples (Alavi et al., 2020). Therefore, greater emphasis was placed on alternative fit indices, which demonstrated acceptable model fit: RMSEA = 0.025 (< 0.050), CFI = 0.959 (≥ 0.90), TLI = 0.915 (≥ 0.90), and SRMR = 0.016 (< 0.050).

Loneliness and depression

The present study identified loneliness as the strongest correlate of depressive symptoms, followed by history of falls, adequate healthcare, and functional ability. The pathway model further suggests that loneliness is associated with both social and functional factors. Older men tended to report lower levels of loneliness than women, although this association was marginally significant. Previous studies suggest that women are generally more likely to express emotions and place greater importance on interpersonal relationships, which may increase their susceptibility to loneliness when social support is limited. In contrast, men often adopt more independent coping styles and may be less likely to report feelings of loneliness (Kim & Lee, 2022; Danvers et al., 2023). Similarly, older adults who were married or living with a partner tended to report lower loneliness than those who were unmarried, widowed, or living alone, possibly reflecting the protective role of emotional companionship and regular social interaction in later life (Valle et al., 2022; Freak-Poli et al., 2025).

Consistent with previous studies, loneliness was strongly associated with depressive symptoms. Loneliness has been linked to negative emotional experiences, maladaptive cognitive processes such as rumination, and physiological stress responses that may adversely affect psychological well-being (Hackett et al., 2012; Wang et al., 2018; Lambert Van As et al., 2022; Malli et al., 2022). Although the cross-sectional design

Table 1. Characteristics of Older Adults in Indonesia, 5th Wave of the Indonesian Family Life Survey (IFLS-5), 2014 (n = 2,928)

Variables	Overall n (%)	Female n (%)	Male n (%)	p-value
Age (years old)				
60-69	1,966 (67.1)	1,011 (66.9)	955 (67.4)	0.844
70-79	820 (28.0)	429 (28.4)	391 (27.6)	
≥80	142 (4.9)	71 (4.7)	71 (5.0)	
Employment				
Unemployed	1,512 (51.6)	998 (66.0)	513 (36.3)	<0.001
Employed	1,416 (48.4)	513 (34.0)	903 (63.7)	
Residence				
Rural	1,333 (45.5)	683 (45.2)	650 (45.9)	0.716
Urban	1,595 (54.5)	828 (54.8)	767 (54.1)	
Marital status				
Single/ separated/ widow/ widowed	1,030 (35.2)	848 (56.1)	182 (12.8)	<0.001
Married/ living with partner	1,898 (64.8)	663 (43.9)	1,235 (87.2)	
Multimorbidity				
None	1,868 (63.8)	881 (58.3)	987 (69.7)	<0.001
1 illness	807 (27.6)	489 (32.4)	318 (22.4)	
More than 1 illnesses	253 (8.6)	141 (9.3)	112 (7.9)	
Type of morbidity				
Hypertension	839 (28.7)	511 (33.8)	328 (23.2)	<0.001
Diabetes	197 (6.7)	94 (6.2)	103 (7.3)	0.258
Asthma	108 (3.7)	60 (4.1)	48 (3.4)	0.403
Arthritis	404 (13.8)	260 (17.2)	144 (10.2)	<0.001
High cholesterol	215 (7.3)	130 (8.6)	85 (6.0)	0.007
History of falls				
Never	2,572 (87.8)	1,318 (87.2)	1,254 (88.5)	0.293
Yes, ever	356 (12.2)	193 (12.8)	163 (11.5)	
Daily activities				
Independent	2,359 (80.6)	1,214 (80.3)	1,145 (80.8)	0.753
Need help	569 (19.4)	297 (19.7)	272 (19.2)	

does not allow conclusions regarding temporal relationships, the findings reinforce the close association between loneliness and depression among older adults.

Functional dependence was also associated with higher loneliness. Older adults who remain independent in activities of daily living are generally more likely to maintain social participation, self-confidence, and interpersonal engagement, whereas dependence may limit opportunities for social interaction and increase feelings of isolation (Ryu et al., 2021; Ryszewska-Łabędzka et al., 2022; Idaiani & Indrawati, 2021). This finding

is consistent with the pathway model, in which reduced functional independence was linked to greater loneliness, which in turn showed the strongest association with depressive symptoms. Together, these findings suggest that maintaining functional independence and strengthening social connectedness may be important considerations for promoting psychological well-being in older adults.

Functional ability, falls, and depression

Older men tended to have better functional ability than women, as reflected by higher ADL

Table 2. Results of Simple Linear Regression (Crude Analysis) of Factors Associated with Loneliness and Depression among Older Adults

Variables	Loneliness			Depression		
	β	95% CI	p-value	β	95% CI	p-value
Age (years old)	-0.01	-0.01 to 0.01	0.200	-0.01	-0.01 to 0.01	0.198
Male	-0.08	-0.14 to -0.02	0.007	-0.01	-0.05 to 0.05	0.870
Employed	-0.01	-0.07 to 0.05	0.806	-0.1	-0.06 to 0.04	0.679
Living in urban	-0.07	-0.13 to -0.01	0.015	-0.03	-0.08 to 0.02	0.284
Married/ living with partner	-0.10	-0.16 to -0.03	0.002	0.02	-0.04 to 0.07	0.542
Comorbidity						
None	Ref.			Ref.		
1 illness	0.01	-0.06 to 0.08	0.790	0.08	0.02 to 0.14	0.008
>1 illnesses	-0.02	-0.12 to 0.09	0.739	0.03	-0.06 to 0.12	0.561
Type of comorbidity						
Hypertension	0.02	-0.04 to 0.09	0.498	0.06	0.01 to 0.12	0.029
Diabetes	-0.11	-0.23 to 0.01	0.065	-0.03	-0.13 to 0.07	0.533
Asthma	0.08	-0.08 to 0.23	0.350	0.21	0.07 to 0.34	0.002
Arthritis	0.12	0.03 to 0.21	0.008	0.16	0.09 to 0.23	<0.001
High cholesterol	-0.06	-0.17 to 0.06	0.310	-0.05	-0.15 to 0.05	0.337
Ever had falls	0.09	0.01 to 0.19	0.042	0.22	0.14 to 0.29	<0.001
Functional dependency (with help)	0.16	0.08 to 0.23	<0.001	0.10	0.04 to 0.16	0.002

scores. Previous studies have similarly shown that women are more likely to experience functional decline in later life because of biological ageing, longer life expectancy, and lifelong social and occupational factors that may limit physical capacity (Lee, 2025). Reduced functional ability may restrict mobility and social participation, thereby increasing dependence on others for daily activities and reducing opportunities for interpersonal interaction. These circumstances may contribute to greater loneliness, which, in turn, was strongly associated with depressive symptoms in the present study. This finding is consistent with evidence that maintaining social connectedness is an important component of psychological well-being in older adults (Holt-Lunstad, 2024).

A history of falls was also associated with depressive symptoms, both directly and indirectly through functional decline. Falls may lead to fear of falling, reduced confidence, and avoidance of daily or social activities, all of which have been linked to poorer psychological well-being (Tamaulayte-Morozoviene et al., 2024). In addition, fall-related injuries and pain may reduce mobility and physical function, increasing dependence in activities of daily living and limiting social engagement (Smee et al., 2012; Adam et al., 2024).

Multimorbidity, functional decline, and depression

The pathway model further indicates that multimorbidity was indirectly associated with depressive symptoms through falls, functional ability, and dependence in daily activities. This finding is consistent with the disablement process framework, whereby chronic health conditions contribute to physical impairments that subsequently limit functional capacity (Skou et al., 2022). Older adults with multiple chronic conditions are more likely to experience muscle weakness, balance impairment, and mobility limitations, increasing their susceptibility to falls and functional decline. As independence in daily activities decreases, older adults may become increasingly reliant on others for self-care, which has been associated with lower self-esteem, reduced autonomy, and poorer psychological well-being (Komalasari et al., 2025; Zeng et al., 2024).

Functional ability and independence

Functional ability was associated with depressive symptoms both directly and indirectly through dependence in activities of daily living. Older adults with better functional ability are more likely to remain independent in essential

Table 3. Estimated values from the path analysis model for direct and indirect relationships between biological and social factors in relation to loneliness and depression among older adults

Dependent variables		Independent variables	b* (95% CI)	p	β** (95% CI)	p
Direct effect						
Depression	←	Loneliness	0.25 (0.22 to 0.28)	<0.001	0.30 (0.26 to 0.33)	<0.001
	←	Ever had falls	0.18 (0.11 to 0.26)	<0.001	0.09 (0.05 to 0.12)	<0.001
	←	Functional ability	-0.03 (-0.05 to -0.01)	0.039	-0.04 (-0.07 to -0.01)	0.039
	←	Adequate health care	-0.07 (-0.11 to -0.03)	<0.001	-0.07 (-0.10 to -0.03)	<0.001
Loneliness	←	Married	-0.07 (-0.14 to 0.01)	0.063	-0.04 (-0.08 to 0.01)	0.063
	←	Male	-0.06 (-0.12 to 0.01)	0.070	-0.04 (-0.08 to 0.01)	0.070
	←	Dependent to daily activity	0.14 (0.07 to 0.22)	<0.001	0.07 (0.03 to 0.10)	<0.001
	←	Living in urban	-0.06 (-0.12 to -0.01)	0.048	-0.04 (-0.07 to < -0.01)	0.048
	←	Adequate health care	-0.10 (-0.15 to -0.06)	<0.001	-0.08 (-0.12 to -0.04)	<0.001
Indirect effect						
Functional ability	←	Male	0.11 (0.04 to 0.17)	0.001	0.06 (0.02 to 0.10)	0.001
	←	Ever had falls	-0.20 (-0.30 to -0.10)	<0.001	-0.07 (-0.11 to -0.04)	<0.001
	←	Multimorbidity	-0.06 (-0.10 to -0.01)	0.019	-0.04 (-0.08 to -0.01)	0.019
	←	Adequate health care	0.12 (0.07 to 0.17)	<0.001	0.08 (0.05 to 0.12)	<0.001
Dependent to daily activity	←	Ever had falls	0.08 (0.04 to 0.12)	<0.001	0.07 (0.03 to 0.10)	<0.001
	←	Functional ability	-0.12 (-0.14 to -0.11)	<0.001	-0.27 (-0.31 to -0.24)	<0.001
	←	Multimorbidity	0.04 (0.02 to 0.06)	<0.001	0.06 (0.03 to 0.09)	<0.001
	←	Living in urban	-0.03 (-0.06 to -0.01)	0.023	-0.04 (-0.07 to -0.01)	0.023
Ever had falls	←	Multimorbidity	0.02 (0.01 to 0.04)	0.006	0.05 (0.01 to 0.09)	0.006
Multimorbidity	←	Male	-0.13 (-0.18 to -0.08)	<0.001	-0.09 (-0.13 to -0.06)	<0.001
	←	Living in urban	0.18 (0.13 to 0.23)	<0.001	0.13 (0.09 to 0.17)	<0.001
Goodness of fit						
Chi²: 53.02						
P: <0.001						
df: 32						
RMSEA: 0.025						
CFI: 0.959						
TLI: 0.915						
SRMR: 0.016						
CD: 5.4%						

*b= unstandardized path coefficient; **β= standardized path coefficient

self-care activities, including bathing, dressing, toileting, transferring, and eating (Patrizio et al., 2021; Sari et al., 2022). In contrast, dependence in these activities has consistently been associated with reduced social participation, feelings of helplessness, and depressive symptoms (Rachmatika et al., 2022; Gao et al., 2022; Öztürk et al., 2011). Although the cross-sectional design precludes conclusions regarding temporal relationships, our findings suggest that preserving functional independence may be an important consideration in strategies aimed at promoting psychological well-being among older adults.

Place of residence and depression

Place of residence showed indirect associations with loneliness and depressive symptoms through several pathways. Older adults living in urban areas had a higher comorbidity burden but were less likely to experience dependence in activities of daily living and loneliness than those living in rural areas. The higher prevalence of chronic conditions in urban settings is consistent with previous studies linking urban environments to sedentary lifestyles, environmental pollution, and chronic disease risk (Zhang et al., 2022; Cacciatore et al., 2025). Conversely, lower dependence and loneliness among urban residents may reflect greater access to healthcare services, transportation, public facilities, and community resources that facilitate independent living and social participation (Ochnik et al., 2024). These findings suggest that the relationship between place of residence and psychological well-being is complex. While urban living may increase exposure to chronic health conditions, it may also provide environmental and social resources that support functional independence and reduce loneliness.

Healthcare adequacy and depression

Adequate healthcare was directly associated with lower depressive symptoms and indirectly associated with depression through reduced loneliness and better functional ability. Access to appropriate healthcare may facilitate the early detection and management of physical and psychological conditions while providing opportunities for counselling, continuity of care, and social support. Regular interactions with healthcare professionals may also enhance older adults' sense of connectedness and reduce feelings of isolation. These findings are consistent with previous evidence suggesting that healthcare services contribute not only to physical health but also to psychological well-being by promot-

ing social engagement and reducing loneliness (Sirey et al., 2020). Although causal relationships cannot be inferred from this cross-sectional study, the findings highlight the potential role of accessible, person-centered healthcare in supporting both physical and mental well-being among older adults.

Although the final structural model demonstrated acceptable fit, the coefficient of determination ($CD = 5.4\%$) indicated that only a modest proportion of the variance in loneliness and depression was explained. This suggests that these outcomes are shaped by additional biological, psychological, social, and environmental factors that were not available in the IFLS dataset, including cognitive function, personality traits, perceived social support, life events, financial security, and neighborhood characteristics. Accordingly, the identified pathways should be interpreted as theoretically informed associations rather than a comprehensive representation of the determinants of loneliness and depression. Future studies incorporating a broader range of psychosocial and contextual factors, preferably using longitudinal designs, are warranted to improve the explanatory power and further clarify the relationships among these variables.

STUDY LIMITATION

In this study, depression and loneliness were measured using single-item self-reported questions rather than validated multi-item instruments, such as the full Center for Epidemiologic Studies Depression Scale (CES-D) available in the IFLS questionnaire. This approach was adopted because the study focused on participants' self-perceived psychological status and to maintain comparability with previous IFLS-based studies that employed the same measures. Nevertheless, single-item measures may not fully capture the multidimensional nature, severity, or clinical characteristics of depression and loneliness. Consequently, some degree of measurement error or misclassification is possible, and the findings should be interpreted with caution. Future studies should consider using validated multi-item instruments to provide a more comprehensive assessment of psychological health while examining the consistency of findings with those obtained using single-item measures.

CONCLUSION

This study demonstrates that depression among older adults is associated with interconnected physical, functional, and social pathways. Multimorbidity was linked to falls, reduced func-

tional ability, and greater dependence in activities of daily living, whereas loneliness emerged as the strongest correlate of depressive symptoms. Adequate healthcare was associated with lower depressive symptoms both directly and indirectly through better functional ability and lower loneliness, highlighting the importance of integrating physical, functional, and psychosocial care in later life.

The findings underscore the need for community- and primary care-based healthy ageing strategies that combine chronic disease management, fall prevention, rehabilitation to preserve functional independence, and routine screening for loneliness and depressive symptoms. In addition, the observed urban–rural differences suggest that improving access to healthcare, rehabilitation, and community support services in rural areas may help reduce disparities in mental well-being among older adults.

Overall, the proposed pathway model provides a theoretically informed framework for understanding how physical health, functional independence, healthcare access, and social connectedness are associated with depression in older adults. These findings support the development of integrated multidisciplinary interventions and public health policies that address both physical and psychosocial determinants of healthy ageing.

AUTHOR CONTRIBUTIONS

Wahyu Tri Sudaryanto was responsible for the conceptualization and design of the study, and drafted the initial manuscript. Ika Yuli Ayuningrum contributed to the statistical analysis using secondary data, interpretation of the findings, and provided critical revisions to the manuscript. Both authors reviewed, edited, and approved the final version of the manuscript.

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DECLARATION OF GENERATIVE AI

This manuscript received limited assistance

from an AI-based language tool (Quillbot and ChatGPT) for language refinement and grammar checking. The authors critically reviewed and finalized all content and accept full responsibility for the published work. No AI tools were used in data analysis or the interpretation of findings.

DECLARATION OF COMPETING INTEREST

The authors declare no conflicts of interest related to the research activities or the publication of the study findings.

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