The Journal of Frailty & Aging 15 (2026) 100186

Contents lists available at ScienceDirect

The Journal of Frailty & Aging

journal homepage: www.elsevier.com/locate/tjfa

Original Research

Research on the moderating role of age-friendly communities in the relationship between intrinsic capacity and functional ability

Hongsai Zhang [a], Shuqin Xiao [b,*], Luqi Dong [c], Xian Ma [d], Weiyao Li [b]

[a] Department of Anesthesiology, Beijing TongRen Hospital, Capital Medical University, Beijing, China
[b] School of Nursing, Capital Medical University, Beijing, China
[c] Department of Otolaryngology, Head and Neck Surgery, Beijing TongRen Hospital, Capital Medical University, Beijing, China
[d] Department of Nursing, Beijing Tiantan Hospital, Capital Medical University, Beijing, China

ARTICLE INFO

Keywords:
Intrinsic capacity
Community environment
Functional ability
Older adults

ABSTRACT

Background and aims: Maintaining functional ability (FA) is the core goal of healthy aging. The World Health Organization (WHO) emphasizes that FA is shaped by intrinsic capacity (IC) , the environment, and their interaction. However, this interaction remains underexplored. This study investigated the moderating role of age-friendly community environments in the IC–functional performance relationship among older adults to inform targeted environmental interventions for disability prevention and healthy aging.

Methods: A cross-sectional survey was conducted between May and October 2024 using convenience sampling to recruit 256 older adults from three distinct community contexts in Beijing. Data were collected via structured questionnaires, including demographic and health-related variables, the WHO Intrinsic Capacity Instrument, and the Instrumental Activities of Daily Living Scale. Hierarchical regression and moderation analyses were performed to examine the interactions between IC and age-friendly environments.

Results: Of 256 participants, 20.3% (n = 52) had IADL impairment. Age-friendly environments significantly mitigated the negative impact of declining IC on IADL (B = -0.284, P = 0.002), with housing showing the strongest overall effect (B = -0.281, P < 0.001). The buffering effect was most notable in individuals with low IC (B = -3.034, P = 0.010). Stratified results: (1) Low IC: housing (B = -1.913, P = 0.015) and social participation (B = -1.281, P = 0.024) were key; (2) Moderate IC: transportation (B=-0.191, P = 0.003) and social participation (B = -0.267, P = 0.013); (3) High IC: only social inclusion/health services worked (B = -0.576, P = 0.029).

Conclusion: Age-friendly community environments are crucial for maintaining functional performance, with varying effects depending on IC level, highlighting the importance of developing tailored and personalized supportive environments to promote healthy aging.

1. Introduction

Promoting and maintaining functional ability (FA) in older adults is a central objective of healthy aging and strategic priority in global public health. FA refers to the capacity to do what an individuals value [1]. Among the various indicators of FA, Instrumental Activities of Daily Living (IADL), such as managing finances, transportation, and medication, are particularly critical as they reflect the ability to live independently in later life [2].

Globally, approximately 45.2% of adults aged ≥ 60 years experience IADL impairment, a prevalence that is expected to increase with the continuing trend of population aging [3]. Beyond loss of independence, IADL decline is associated with a range of adverse outcomes, including depression [4], falls [5], hospitalization [6], and mortality [7], placing significant burdens on individuals, caregivers, and healthcare systems [8]. Therefore, understanding the underlying mechanisms and modifiable risk factors is essential for developing effective interventions to delay disability and promote healthy ageing.

Functional ability is shaped by intrinsic capacity (IC), the environment, and their interactions, as emphasized by the WHO [1]. Both intrinsic capacity and environmental factors have been extensively studied in relation to FA. Intrinsic capacity is strongly linked to current functional performance and predicts future trajectories of functional ability [2]. Higher intrinsic capacity helps delay functional decline,

* Corresponding author at: School of Nursing, Capital Medical University, No. 10, Xitoutiao, Youanmenwai, Fengtai District, Beijing, China.
E-mail address: tshfg@ccmu.edu.cn (S. Xiao).

https://doi.org/10.1016/j.tjfa.2026.100186
Received 24 February 2026; Received in revised form 27 May 2026; Accepted 26 June 2026
Available online 17 August 2026

while impairments in capacity increase the risk of IADL disability [2, 9–12]. In addition to intrinsic capacity, the environment plays a critical role in shaping functional abilities. Age-friendly community features—such as accessible public transportation, green spaces, and recreational facilities—have been shown to promote physical activity, mitigate functional decline, and reduce IADL impairment [9,13–15]. Optimizing these environments has become a key strategy for supporting functional abilities and promoting healthy aging.

Although the independent effects of intrinsic capacity and environmental factors on functional ability have been well established, their interactions remain underexplored. Emerging evidence suggests a potential interplay, and Stephens et al. [16]. found that the interaction between intrinsic capacity and community facilities significantly affected physical health-related quality of life but not mental health. However, their use of chronic disease counts as a proxy for intrinsic capacity limits the validity of their findings. Similarly, Jiang et al. reported that the community environment more strongly influenced mobile payment use among individuals with lower intrinsic capacity, whereas its effect on basic ADL remained minimal across capacity levels [17]. These findings highlight the need for more comprehensive investigations into the compensatory or buffering mechanisms between intrinsic capacity and environmental support.

Against this background, this study aimed to investigate how age-friendly community environments interact with intrinsic capacity to influence functional ability in older adults, and whether this interaction varies across different levels of intrinsic capacity. These findings are expected to inform targeted environmental interventions, support disability prevention, and advance the broader agenda of healthy aging.

2. Methods

2.1. Study participants

From May to October 2024, multi-center recruitment was performed across three Beijing communities (Xicheng: core urban, Fengtai: general urban, Fangshan: peri-urban) to improve representativeness and mitigate selection bias. Districts vary in terms of economy, infrastructure, and public services, enabling diverse environmental analyses.

Partial demographic/health data (e.g., age distribution and chronic disease prevalence) from local community health service centers guided recruitment to align the sample with the actual community population. A standardized manual was developed, and all investigators received unified training to ensure consistent application of inclusion/exclusion criteria and assessment procedures, reducing inter-investigator bias.The inclusion criteria were: (1) aged 60 years or older; (2) residing in the local community for at least six months; and (3) possessing adequate communication abilities and willingness to participate. Exclusion criteria included: (1) acute or severe illness; and (2) serious neurological or musculoskeletal disorders that significantly impaired mobility. A total of 256 older adults met the inclusion criteria and were included in the final analysis.

2.2. Intrinsic capacity

Intrinsic capacity was assessed based on the five domains recommended by the World Health Organization (WHO) [18]. All assessments were conducted through face-to-face interviews to ensure data authenticity. The measurement tools and scoring criteria for each domain are as follows:

Locomotion: Assessed using the Short Physical Performance Battery (SPPB) [19]; scores of 0–6 were coded as 0, 7–9 as 1, and 10–12 as 2.

Cognition was measured using the Mini-Mental State Examination (MMSE) [20]; scores of 0–9, 10–26, and 27–30 indicated moderate-to-severe impairment, mild impairment, and normal cognition, and were coded as 0, 1, and 2, respectively.

Vitality: Evaluated using the Mini Nutritional Assessment-Short Form (MNA-SF) [21]; scores of 0–7 were coded as 0, 8–11 as 1, and 12–14 as 2.

Psychological: Measured by the Patient Health Questionnaire-9 (PHQ-9) [22]; scores of 10–27 were coded as 0, 5–9 as 1, and 0–4 as 2.

Sensory function was assessed through self-report; dual impairment in vision and hearing was coded as 0, impairment in either as 1, and normal function in both as 2.

The total intrinsic capacity scores ranged from 0 to 10. Based on previous research [23], a total score below 9 was defined as "declined IC": 0∼4 as "low IC," 5∼8 as "moderate IC," and 9∼10 as "high IC."

2.3. Community environment

Community environment was evaluated using the Age-Friendly Community Assessment Scale developed by Park et al. [24]. and culturally adapted into Chinese by Xu et al. [25]., which consists of 36 items covering five dimensions: housing, transportation, community environment, social participation, and the combined dimension of social inclusion and health services. Each item was rated on a five-point Likert scale, ranging from 1 to 5. The total score ranges from 32 to 160, with higher scores reflecting a more age-friendly community environment.

2.4. Instrumental activities of daily living

The IADL was evaluated using the Lawton Scale [26], with scores ranging from 0 to 8, with higher scores indicating better function. A score of <8 was defined as IADL impairment.

2.5. Covariates

Demographic and health-related information was collected through structured questionnaires. Demographic variables included age, sex, educational level, income, living arrangements, and marital status. Health-related variables included the number of chronic conditions and the types of medications used. These variables were chosen as covariates based on literature reviews to effectively control for confounding bias.

2.6. Statistical analysis

All data were analyzed using IBM SPSS Statistics version 25.0. Continuous variables were summarized as means and standard deviations, while categorical variables were presented as frequencies and percentages. Group comparisons for categorical variables were performed using the chi-squared test. For continuous variables, independent-sample t-tests or one-way ANOVA were applied for normally distributed data, and the Kruskal–Wallis H test was used for non-normally distributed data

The IADL score was treated as a continuous outcome variable. Linear regression models were used to examine the associations among IC, age-friendly community environment, and IADL. Moderation analysis was conducted using the PROCESS macro for SPSS to examine whether an age-friendly community environment moderated the association between IC and IADL, estimated via ordinary least squares linear regression. To reduce multicollinearity and improve the interpretability of the interaction effects, all independent and moderating variables were mean-centered before creating the interaction terms.

Based on the Ecological model of aging [27] and WHO Integrated Care Framework for Older People [1], participants were further divided into low-, moderate-, and high-IC subgroups for stratified moderation analysis to examine gradient heterogeneity of the moderating effect.

Sample size estimation was conducted using G*Power 3.1 for hierarchical multiple regression. With $f^2 = 0.15$, $\alpha = 0.05$, power $= 0.90$, 18 total predictors, and 1 tested predictor, at least 73 participants were required for the overall moderation model. The final sample size of 256 provided sufficient statistical power (>0.95) for the primary analysis. For stratified analyses across three intrinsic capacity groups, statistical

power was lower in the low (n = 37) and high (n = 62) IC subgroups, and results were interpreted with caution after Bonferroni correction for multiple comparisons. Statistical significance was defined as a two-tailed P-value <0.05.

3. Results

3.1. Characteristics of the study population and factors associated with IADL impairment

A total of 256 older adults were included in this study, comprising 105 males (41%) and 151 females (59%) with a mean age of 71.32 ± 6.42 years. Among them, 204 (79.7%) exhibited normal instrumental activities of daily living (IADL), while 52 (20.3%) showed impaired IADL. Regarding sociodemographic characteristics, the prevalence of IADL impairment varied significantly with age, number of chronic diseases, and types of medications used (Table 1).

Univariate analyses revealed significant associations between IADL status and both intrinsic capacity and an age-friendly community environment. Older adults with impaired IADL demonstrated significantly lower scores in overall intrinsic capacity, with statistically significant differences observed across all domains, except sensory function. Likewise, across all dimensions of the age-friendly community environment, participants with IADL impairment reported significantly lower scores than those without impairment (Table 1).

Table 1
Comparison of demographics, intrinsic capacity, and age-friendly community environment by IADL status.

Characteristics	IADL Impaired(n = 52)	IADL Unimpaired(n = 204)	χ^2/t	P
Age			25.846	<0.001
60~69	13(12.1)	94(87.9)		
70~79	25(20.0)	100(80.0)		
≥80	14(58.3)	10(41.7)		
Gender			0.712	0.399
Male	24(22.9)	81(77.1)		
Female	28(18.5)	123(81.5)		
Marital status			0.109	0.741
Married	41(19.9)	165(80.1)		
Widowed and others	11(22)	39(78)		
Living arrangement			0.112	0.738
Living with others	45(20)	180(80)		
Living alone	7(22.6)	24(77.4)		
Educational level			3.042	0.385
No formal schooling	2(40.0)	3(60)		
Primary	5(33.3)	10(66.7)		
Secondary	32(18.7)	139(83.1)		
Post-Secondary and above	13(20)	52(80)		
Monthly income(yuan)				
<3000	7(31.8)	15(68.2)		
3000~<5000	15(17.9)	69(82.1)		
5000~<10,000	28(22.4)	97(77.6)		
≥10,000	2(8.0)	23(92.0)		
Number of chronic diseases			13.074	<0.001
0~3	34(16.1)	177(83.9)		
>3	18(40.0)	27(60.0)		
Numbers of medication use			8.293	0.004
0~4	30(16.0)	158(84.0)		
>4	22(32.4)	46(67.6)		
Intrinsic Capacity (score) (%)			37.472	<0.01
0~5	21(56.8)	16(43.2)		
6~8	26(16.6)	131(83.4)		
9~10	5(8.1)	57(91.9)		
Age-friendly community environment (mean ± SD)				
Housing	4.42±0.58	4.48±0.46	−2.185	0.030
Transportation	3.80±0.66	4.18±0.51	−4.640	<0.001
Community	3.91±0.69	4.27±0.51	−3.810	<0.001
Social participation	3.96±0.99	4.23±0.91	−1.920	0.046
Social inclusion and Health services	3.89±0.45	4.05±0.39	−2.539	0.012

3.2. Analysis of the interaction between age-friendly community environment and intrinsic capacity on IADL

To examine the moderating role of an age-friendly community environment in the relationship between intrinsic capacity and IADL, a two-step analysis was conducted.

First, hierarchical regression analysis was performed with IADL as the dependent variable, intrinsic capacity as the independent variable, and age-friendly community environment as the moderator. Both intrinsic capacity and community environment significantly affected IADL. The interaction term was significant (B = −0.284, P = 0.002), indicating that age-friendly community environment buffered the adverse association between reduced intrinsic capacity and IADL.Specifically, in communities with higher age-friendliness, the decline in IADL associated with lower intrinsic capacity was less pronounced. Demographic factors, including age, sex, and income, also influenced the IADL (Table 2).

Second, the differential moderating effects of the five dimensions of community environment were analyzed. The results showed that housing, transportation, and community support environments significantly moderated the relationship between intrinsic capacity and IADL (Housing: B = −0.281, P < 0.01; Transportation: B = −0.195, p = 0.002; Community: B = −0.215, P < 0.001). Among these, housing environment had the strongest moderating effect (Table 3, Fig. 1).

3.3. Analyze the differences in the moderating effect of elderly-friendly communities among elderly groups with different intrinsic ability levels

First, we analyzed the overall moderating effect of an age-friendly community environment across varying levels of intrinsic capacity. Statistical results showed that community environment played a significant moderating role in the relationship between intrinsic capacity and IADL, particularly for older adults with moderate and low intrinsic capacity(B = −0.809, P = 0.004; B = −3.034, P = 0.010, respectively). The effect was strongest in the low group, indicating that a supportive community environment is particularly beneficial for individuals with substantial decline in intrinsic capacity.

Next, we analyzed the moderating effects of specific dimensions of the age-friendly community environment within subgroups stratified by intrinsic capacity level. In the severely impaired group (low IC group), both housing and social participation environments significantly moderated the relationship (Housing: B = −1.913, P = 0.015; Social Participation: B = −1.281, P = 0.024), with the housing environment having the greatest impact (see Supplementary Table S1 and Supplementary Figures S1-S2.). In the mildly impaired group (moderate IC group), significant moderating effects were observed for the transportation and social participation environments (Transportation: B = −0.191, P = 0.003; Social Participation: B = −0.267, P = 0.013), with the social participation environment showing a stronger effect (see Supplementary Table S2 and Supplementary Figures S3-S4). Among individuals with stable intrinsic capacity (high IC group), the social inclusion and health services domains significantly moderated the relationship (B = −0.576, P = 0.029) (see Supplementary Table S3 and Supplementary Figures S5).

4. Discussion

This study focused on the moderating role of age-friendly community environments in the relationship between IC and IADL among older adults and revealed the heterogeneous characteristics of environmental

Table 2
Moderating effect of the age-friendly community environment on the relationship between IC and IADL (n = 256).

Variables	Model 1			Model 2			Model 3			Model 4		
	B	t	P	B	t	P	B	t	P	B	t	P
Constant	7.467	12.282	<0.001	5.326	7.537	<0.001	4.020	4.221	<0.001	7.212	12.564	<0.001
Age	**−0.528**	**−4.337**	**<0.001**	**−0.428**	**−3.654**	**<0.001**	**−0.435**	**−3.735**	**<0.001**	**−0.432**	**−3.778**	**<0.001**
Gender	**0.378**	**2.340**	**0.020**	**0.359**	**2.338**	**0.020**	**0.331**	**2.158**	**0.032**	**0.357**	**2.366**	**0.019**
Marital status	0.444	1.322	0.187	0.430	1.350	0.178	0.431	1.359	0.175	0.406	1.306	0.193
Living arrangement	−0.079	−0.620	0.536	−0.034	−0.282	0.778	−0.041	−0.339	0.735	−0.038	−0.316	0.753
Educational level	−0.058	−0.620	0.536	−0.061	−0.679	0.497	−0.054	−0.612	0.541	−0.050	−0.577	0.564
Monthly income(yuan)	**0.276**	**2.618**	**0.009**	**0.224**	**2.232**	**0.027**	**0.201**	**1.995**	**0.047**	**0.199**	**2.015**	**0.045**
Number of chronic diseases	**−0.542**	**−2.421**	**0.016**	−0.283	−1.296	0.196	−0.265	−1.224	0.222	−0.280	−1.313	0.190
Number of medication use	−0.159	−0.829	0.408	−0.046	−0.251	0.802	−0.063	−0.343	0.732	−0.074	−0.412	0.681
Intrinsic capacity				**0.229**	**5.259**	**<0.001**	**0.197**	**4.273**	**<0.001**	**0.174**	**3.777**	**<0.001**
Age-friendly community environment							**0.403**	**2.029**	**0.044**	0.296	1.496	0.136
Age-friendly community environment × Intrinsic capacity										**−0.284**	**−3.143**	**0.002**
R2	0.142			0.229			0.242			0.271		
F	5.116			8.112			7.805			8.250		

Notes: IC =intrinsic capacity IADL=instrumental activities of daily living, IADL was treated as a continuous dependent variable. Hierarchical linear regression analysis was conducted to examine the associations among intrinsic capacity, age-friendly community environment, their interaction term, and IADL.

Table 3
Moderating effects of different dimensions of the age-friendly community environment on the relationship between IC and IADL (n = 256).

Model	Variables	B	t	P	95%CI	R^2	F
1–1	**Intrinsic capacity**	**0.188**	**4.362**	**<0.001**	**0.103~0.272**	0.297	9.359
	housing	0.095	0.636	0.525	−0.200~0.391		
	Intrinsic capacity × housing	**−0.281**	**−3.789**	**<0.001**	**−0.427~−0.135**		
1–2	**Intrinsic capacity**	**0.174**	**4.052**	**<0.001**	**0.090~0.259**	0.302	9.617
	Transportation	**0.327**	**2.524**	**0.012**	**0.072~0.583**		
	Intrinsic capacity × Transportation	**−0.195**	**−3.073**	**0.002**	**−0.319~−0.070**		
1–3	**Intrinsic capacity**	**0.181**	**4.140**	**<0.001**	**0.095~0.268**	0.295	9.302
	Community	0.120	0.989	0.324	−0.119~0.360		
	Intrinsic capacity × Community	**−0.215**	**−3.616**	**<0.001**	**−0.333~−0.098**		
1–4	**Intrinsic capacity**	**0.211**	**4.744**	**<0.001**	**0.123~0.298**	0.257	7.660
	Social Participation	−0.006	−0.070	0.944	−0.168~0.156		
	Intrinsic capacity × Social Participation	−0.073	−1.650	0.100	−0.161~0.014		
1–5	**Intrinsic capacity**	**0.208**	**4.685**	**<0.001**	**0.121~0.296**	0.252	7.463
	Social Inclusion and Health Services	0.158	0.87	0.385	−0..200~0.516		
	Intrinsic capacity × Social Inclusion and Health Services	−0.040	−0.459	0.646	−0.211~0.131		

IC =intrinsic capacity IADL=instrumental activities of daily living.

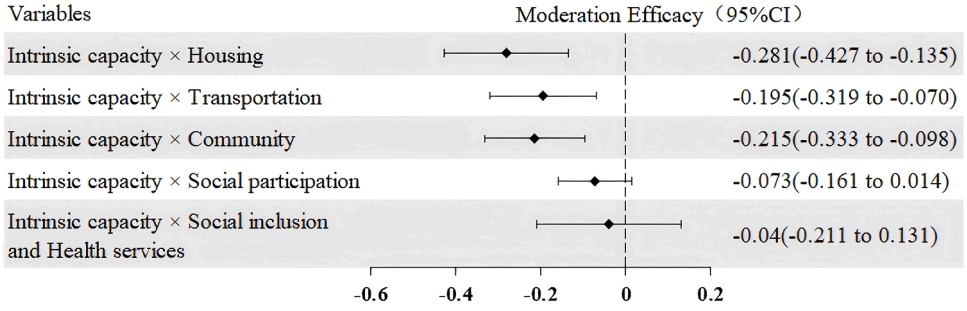

Fig. 1. Moderating effects of different dimensions of the age-friendly community environment on the relationship between IC and IADL.

effects through stratified analysis. The results showed that 75.6% of participants experienced a decline in intrinsic capacity, confirming IC as a key determinant of IADL impairment (B = 0.229, P < 0.01). Further analysis showed that an age-friendly community environment exerted a significant moderating effect on the association between IC and IADL (B = −0.284, P = 0.002), particularly among individuals with low IC (B = −3.034, P = 0.010). This finding not only validates Lawton's docility hypothesis, which posits that environmental influences are more pronounced among individuals with lower functional capacity [27] but also indicates that the supportive role of the environment is not uniformly distributed but varies with individual capacity levels.

Regarding the specific roles of the environmental dimensions, three dimensions (housing, transportation, and community environment) significantly mitigated the negative impact of IC decline on IADL (effect sizes: B = −0.274, P < 0.01; B = −0.191, P < 0.01; B= −0.211, P < 0.001, respectively), with the housing dimension showing the strongest moderating effect. This underscores the importance of optimizing the physical aspects of age-friendly communities, particularly housing, as a cornerstone of functional support. The core logic of this result lies in the fact that the physical environment is the direct contact scenario for older

adults' daily activities, as the most frequently used activity space. Housing's barrier-free design (e.g., grab bars, low thresholds) directly compensates for mobility deficits in older adults with declining intrinsic capacity [28,29], serving as the "basic support" for functional independence; transportation and community environment reduce activity barriers caused by IC decline by ensuring travel convenience and shortening activity radius.

Further stratified analysis by IC level revealed a clearer "dimension-capacity matching" pattern. For the low IC group, the housing environment had the most prominent moderating effect, (B = −1.913, P = 0.015), as their self-compensation capacity is severely insufficient, and daily activities rely heavily on short-distance physical support, making housing renovation a "necessary condition" rather than an "optimization option [30,31]; For the moderate IC group, the transportation environment had a more significant moderating role (B = −0.191, P = 0.003). While the moderate IC group had no severe functional deficits, mild mobility inconvenience (e.g., reduced walking speed) limited independent travel, and accessible transportation (e.g., low-floor buses) ensured social participation and medical accessibility, preventing accelerated IC decline due to reduced activity [2,32]. Social participation also acted as a significant moderator for both groups (low IC: B = −1.281, P = 0.024; moderate IC: B = −0.267, P = 0.013), with a stronger effect in the low IC group. Community activities, recreation, or volunteering foster social and emotional support, boost self-efficacy, and buffer functional limitations from IC decline [33,34]. Consistent with prior research, the benefits of social participation grow in importance with age [35,36] and its pathways vary across capacity levels [37]. For instance, older adults with mild capacity decline often benefit from physical or volunteer activities, whereas those with severe decline rely more on emotional support and social engagement to compensate for functional losses [37,38].

In the high IC group, social inclusion and healthcare environments significantly moderated the relationship among older adults (B = −0.576, P = 0.029). A socially inclusive environment that fosters respect, acceptance, and support can enhance self-efficacy, reduce isolation, and improve the quality of life. Supportive neighborhood relationships also provide emotional and instrumental support [39]. High-quality healthcare environments, including regular check-ups, preventive services, and personalized care, contribute to the maintenance of physical and cognitive stability [40]. Tailored social and health services for older adults with stable capacity can promote sustained functional independence.

Overall, this study reinforces the critical role of environmental factors in shaping functional outcomes later in life, particularly among those with declining capacity. For example, housing environments are vital for those with severe limitations. Policymakers and urban planners should prioritize age-friendly designs, including accessible housing and transportation systems. Furthermore, the benefits of social participation highlight that beyond physical infrastructure, opportunities for community engagement are essential for quality of life.

These findings also strengthen the person–environment fit framework, emphasizing that the interaction between personal capacity and environmental features determines behavioral outcomes and well-being. Environmental barriers are not inherently problematic, and their impacts depend on individual capacities [41]. Therefore, age-friendly environmental modifications should accommodate diverse levels of intrinsic capacity, enabling a better alignment between personal needs and environmental support.

4.1. Strength and limitations

This study had several strengths. A primary strength lies in the analysis of how the relationship between intrinsic capacity and functional ability varies across different levels of intrinsic capacity (low, moderate, and high). This nuanced approach provides a detailed understanding of how community environments can offer differentiated support based on the unique needs of the elderly. Such insights are valuable for the development of personalized and tailored interventions aimed at promoting healthy aging and preventing disability. Furthermore, the use of reliable and valid instruments, including the World Health Organization Intrinsic Capacity Instrument and Instrumental Activities of Daily Living (IADL) scale, ensures that the data accurately reflect the intrinsic capacity and functional ability of elderly participants.

However, this study had some limitations. Convenience sampling may limit the generalizability of the findings, as the sample may not fully represent the broader elderly population, particularly in terms of socioeconomic diversity. The cross-sectional design restricts the ability to establish causal relationships, as it captures only a snapshot of participants' functional abilities at a single point in time. Additionally, the study was conducted in Beijing, and data were collected from elderly individuals participating in community health service centers. This may limit the applicability of the results to other regions, especially rural or less-urbanized areas, where community environments and access to services may differ. Finally, although the overall sample size was sufficient for the primary moderation analysis, the stratified subgroup analyses had limited statistical power because of the relatively small sample sizes in some IC strata, particularly the low and high IC groups. Therefore, the subgroup-specific findings should be interpreted as exploratory and require validation in future studies with larger and more balanced samples.

5. Conclusion

This study highlights the significant role of age-friendly community environments in promoting functional ability among the elderly, particularly by moderating the relationship between intrinsic capacity and functional performance. These findings demonstrate that community environments can provide differentiated support based on the level of intrinsic capacity, which is essential for developing personalized interventions tailored to the specific needs of elderly individuals. The results emphasize the importance of designing and implementing age-friendly communities that address the specific needs of elderly individuals with a particular focus on housing and social participation.

Ethical approval

The study was approved by the Ethics Committee of the Capital Medical University (Z2024SY025), and all participants provided written informed consent.

Contributors

Hongsai Zhang contributed to the study conception and design, data collection, data analysis and interpretation, and manuscript drafting and revision. **Shuqin Xiao** contributed to study conception and design, data analysis and interpretation, and critically supervised the manuscript. **LuQi Dong** contributed to data collection and data analysis and interpretation. **Xian Ma** contributed to data collection, manuscript preparation, and revision. **WeiYao Li** contributed to data collection and manuscript preparation.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT to improve the language. After using this tool, the authors reviewed and edited the content as needed, and took full responsibility for the content of the publication.

Funding

This research did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

The authors would like to thank all older adults who participated in this study. We also sincerely thank the staff of the participating community health service centers in Beijing for their assistance with participant recruitment and data collection.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2026.100186.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical restrictions, but are available from the corresponding author upon reasonable request and with appropriate approvals.

References

[1] World Health Organization. World report on ageing and health. https://www.who.int/publications/i/item/world-report-on-ageing-and-health/2015 (accessed 15 March 2025).
[2] Lu S, Liu Y, Guo Y, Ho HC, Song Y, Cheng W, et al. Neighbourhood physical environment, intrinsic capacity, and 4-year late-life functional ability trajectories of low-income Chinese older population: a longitudinal study with the parallel process of latent growth curve modelling. EClinicalMedicine 2021;36:100927. https://doi.org/10.1016/j.eclinm.2021.100927.
[3] Amlak BT, Getinet M, Getie A, Kebede WM, Tarekegn TT, Belay DG. Functional disability in basic and instrumental activities of daily living among older adults globally: a systematic review and meta-analysis. BMC Geriatr 2025;25(1):413. https://doi.org/10.1186/s12877-025-06056-8.
[4] Arayici ME, Kose A, Dolu S, Gultekin Arayici S, Gedik G, Kilic BN, et al. Epidemiological assessment of depression, activities of daily living and associated factors in elderly individuals aged 65 years and older: evidence from a population-based study. J Clin Med 2025;14(8):2853. https://doi.org/10.3390/jcm14082853.
[5] Pluskiewicz W, Adamczyk P, Drozdzowska B. Functional status as a predictor of the incidence of falls in 10-year follow-up: results from the RAC-OST-POL study. Endokrynol Pol 2023. https://doi.org/10.5603/EP.a2023.0046. 10.5603/EP.a2023.0046. Advance online publication.
[6] Han W, Mao K, Li Y, Jiang M, Ren X, Zheng X, et al. Trajectories of activities of daily living/instrumental activities of daily living and the risk of cardiovascular diseases. Nutr Metab Cardiovasc Dis 2025;35(6):103969. https://doi.org/10.1016/j.numecd.2025.103969.
[7] Toda M, Kato M. Relationship between instrumental activities of daily living decline during hospitalization and one-year mortality in elderly patients with heart failure: a multi-center prospective cohort study. Arch Gerontol Geriatr 2023;110:104985. https://doi.org/10.1016/j.archger.2023.104985.
[8] Huang J, Qian X, Choi EPH, Chau PH. The consequences of unmet needs for assistance with daily life activities among older adults: a systematic review. Med Care Res Rev 2024;81(4):295–310. https://doi.org/10.1177/10775587241233798.
[9] Yu R, Leung G, Lai D, Tam LY, Cheng C, Kong S, et al. Incremental predictive value of intrinsic capacity and environmental characteristics in the risk prediction of incident disability. JAR Life 2025;14:100004. https://doi.org/10.1016/j.jarlif.2025.100004.
[10] Prince MJ, Acosta D, Guerra M, Huang Y, Jacob KS, Jimenez-Velazquez IZ, et al. Intrinsic capacity and its associations with incident dependence and mortality in 10/66 dementia research group studies in Latin America, India, and China: a population-based cohort study. PLoS Med 2021;18(9):e1003097. https://doi.org/10.1371/journal.pmed.1003097.
[11] Zeng Z, Li X, Yang W, Wang J, Zhu Y, Qi X, Xu W. Assessing healthy aging score and its association with all-cause mortality: findings from the China health and retirement longitudinal study. Innov Aging 2023;7(2):igad006. https://doi.org/10.1093/geroni/igad006.
[12] Zhou J, Chang H, Leng M, Wang Z. Intrinsic capacity to predict future adverse health outcomes in older adults: a scoping review. Healthcare (Basel) 2023;11(4):450. https://doi.org/10.3390/healthcare11040450.
[13] Zhu A, Yan LL, Wu CD, James P, Zeng Y, Ji JS. Residential greenness, activities of daily living, and instrumental activities of daily living: a longitudinal cohort study of older adults in China. Environ Epidemiol 2019;3(5):e065. https://doi.org/10.1097/EE9.0000000000000065.
[14] Howden-Chapman P, Bennett J, Edwards R, Jacobs D, Nathan K, Ormandy D. Review of the impact of housing quality on inequalities in health and well-being. Annu Rev Public Health 2023;44:233–54. https://doi.org/10.1146/annurev-publhealth-071521-111836.
[15] Zhou JJ, Zhou S, Cai X, Luo J. Longitudinal associations between neighborhood environments and functional disabilities among community-dwelling older adults in China. J Gerontol B Psychol Sci Soc Sci 2025;80(3):gbae206. https://doi.org/10.1093/geronb/gbae206.
[16] Stephens C, Allen J, Keating N, Szabó Á, Alpass F. Neighborhood environments and intrinsic capacity interact to affect the health-related quality of life of older people in New Zealand. Maturitas 2020;139:1–5. https://doi.org/10.1016/j.maturitas.2020.05.008.
[17] Jiang YS, Shi H, Kang YT, Shen J, Li J, Cui J, et al. Impact of age-friendly living environment and intrinsic capacity on functional ability in older adults: a cross-sectional study. BMC Geriatr 2023;23(1):374. https://doi.org/10.1186/s12877-023-04089-5.
[18] World Health Organization. Integrated care for older people (ICOPE): guidance for person-centred assessment and pathways in primary care. https://www.who.int/publications/i/item/WHO-FWC-ALC-19.1./2019 (accessed 15 March 2025).
[19] Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994;49(2):M85–94. https://doi.org/10.1093/geronj/49.2.m85.
[20] Katzman R, Zhang MY, Ouang-Ya-Qu Wang ZY, Liu WT, Yu E, et al. A Chinese version of the mini-mental state examination; impact of illiteracy in a Shanghai dementia survey. J Clin Epidemiol 1988;41(10):971–8. https://doi.org/10.1016/0895-4356(88)90034-0.
[21] Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001;56(6):M366–72. https://doi.org/10.1093/gerona/56.6.m366.
[22] Levis B, Benedetti A, Thombs BD, DEPRESsion Screening Data (DEPRESSD) Collaboration. Accuracy of patient health questionnaire-9 (PHQ-9) for screening to detect major depression: individual participant data meta-analysis. BMJ 2019;365:l1476. https://doi.org/10.1136/bmj.l1476.
[23] Liu Y, Ouyang XJ, Hu J, Lu B, Qin H. Influence of aging on intrinsic ability of elderly patients and analysis of related factors. Chin J Clin Healthcare 2022;25(04):460–7. https://doi.org/10.3969/J.issn.1672-6790.2022.04.006 (in Chinese).
[24] Park S, Lee S. Age-friendly environments and life satisfaction among South Korean elders: person-environment fit perspective. Aging Ment Health 2017;21(7):693–702. https://doi.org/10.1080/13607863.2016.1154011.
[25] Xu JX, Chen YW, Wang Y. Revision and reliability and validity testing of the age-friendly community rating scale based on a bifactor model in the context of healthy China. Med Soc (Berkeley) 2022;35(7):1–6. https://doi.org/10.13723/j.yxysh.2022.07.001. 23(in Chinese).
[26] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9(3):179–86.
[27] Lawton MP, Nahemow L. Ecology and the aging process.: the psychology of adult development and aging. Washington, DC, US: American Psychological Association; 1973. p. 619–74.
[28] Fang S, Liang H, Liang Y. Relationship between person, environmental factors, and activities of daily living performance among physically disabled older adults living at home: a structural equation model. BMC Geriatr 2023;23(1):285. https://doi.org/10.1186/s12877-023-04000-2.
[29] Ramadhani WA, Rogers WA. Understanding home activities challenges of older adults aging with long-term mobility disabilities: recommendations for home environment design. J Aging Environ 2023;37:341–63. https://doi.org/10.1080/26892618.2022.2092929.
[30] Pekalee A, Gray RS. In-home environment and happiness among older adults in Thailand. Front Public Health 2023;11:1159350. https://doi.org/10.3389/fpubh.2023.1159350.
[31] Heller C, Haak M, Schmidt SM, Chiatti C, Ekstam L, Nilsson MH, et al. The relationship between physical housing characteristics, housing accessibility and different aspects of health among community-dwelling older people: a systematic review. J Aging Health 2024;36(1–2):120–32. https://doi.org/10.1177/08982643231175367.
[32] Nguyen THT, Levasseur M. How does community-based housing foster social participation in older adults: importance of well-designed common space, proximity to resources, flexible rules and policies, and benevolent communities. J Gerontol Soc Work 2023;66(1):103–33. https://doi.org/10.1080/01634372.2022.2133199.
[33] Wilson L, Rice C, Thompson S. Social participation and loneliness in older adults in a rural Australian context: individual and organizational perspectives. Int J Environ Res Public Health 2024;21(7):886. https://doi.org/10.3390/ijerph21070886.
[34] de Albuquerque Araújo L, Icaza G, Márquez C, Albala C. Social relationships and their association with the functional capacity of older Chilean adults: longitudinal

evidence. BMC Geriatr 2024;24(1):616. https://doi.org/10.1186/s12877-024-05184-x.
[35] Lin SA, Xu X, Liu Y, Ai B. Mechanism of the impacts of older adults social participation on their health. Front Public Health 2024;12:1377305. https://doi.org/10.3389/fpubh.2024.1377305.
[36] Ang S. Social participation and health over the adult life course: does the association strengthen with age? Soc Sci Med 2018;206:51–9. https://doi.org/10.1016/j.socscimed.2018.03.042.
[37] Cui XD, Chen YH. Can social participation improve the elderly health?Tests based on the latent class analysis. Chin J Popul Sci 2024;38(06):112–26 (in Chinese).
[38] Sheng YN, Liu YZ. The influence of social participation on the health of the elderly. Chin J Popul Sci 2022;(06):97–110 (in Chinese).
[39] Arias-Fernández L, Carcedo-Argüelles L, Martín-Payo R, López-García E, Rodríguez-Artalejo F, Lana A. Association between neighborhood physical characteristics and mental health among older adults in Spain. Geriatr Nurs (Minneap) 2023;49:170–7. https://doi.org/10.1016/j.gerinurse.2022.12.009.
[40] Kim B, Park S, Bishop-Saucier J, Amorim C. Community-based services and depression from person-environment fit perspective: focusing on functional impairments and living alone. J Gerontol Soc Work 2017;60(4):270–85. https://doi.org/10.1080/01634372.2017.1310166.
[41] Liu Y, Pan Z, Liu Y, Li Z. Can living in an age-friendly neighbourhood protect older adults' mental health against functional decline in China? Landsc Urban Plan 2023;240:104897. https://doi.org/10.1016/j.landurbplan.2023.104897.