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Can older urban migrants achieve active aging? Variations by migration motivation, geographical scale and residential duration

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Abstract

Grounded in the theory of active aging and considering the dual attributes of mobility and aging, this study systematically assessed the levels of active aging among older urban migrants and uncovered patterns of subgroup heterogeneity within this population. A cross-sectional comparative research design with quantitative methods was employed. Data were collected through a field survey conducted across four cities and 14 urban districts in within Zhejiang Province. A multidimensional evaluation framework was developed, encompassing six dimensions, including individual factors, health-related behaviors, economic conditions, social environments, physical environments, and health and social services. The findings revealed that the overall level of active aging among older urban migrants remained relatively low, with significant deficiencies across core dimensions such as volunteering participation, property ownership, healthcare utilization, and medical insurance accessibility. Moreover, substantial internal heterogeneity was observed, shaped by variations in migration motivation, geographical scale, and length of residence. Quality-of-life-oriented migrants demonstrated higher levels of active aging compared with family-support and economically-driven migrants, while inter-provincial migrants and short-term residents faced greater barriers to accessing health services, social participation, and urban integration. These findings underscore the need to shift public service delivery from a household registration-based model to a residency-oriented approach. Targeted interventions are needed to enhance social inclusion, institutional adaptation, and individual empowerment among older urban migrants. Furthermore, stronger policy coordination and localized support mechanisms are essential for optimizing active aging within urban contexts shaped by migration.

Keywords Cross-regional migration, Health services, Social adaptation, Quality of life

Introduction

Under the concurrent global trends of population aging and intensifying migration, the cross-regional movement of older populations has emerged as a crucial factor shaping the trajectory of social sustainability. In China, with ongoing urbanization and profound

transformations in family structures, migration among older adults has become more prevalent. According to China's Seventh National Population Census, the number of older migrants aged 60 and above exceeded 33 million (National Bureau of Statistics, 2021). Nevertheless, despite its substantial size, this population has long remained at the intersection of migration and aging research and has consequently received insufficient scholarly and policy attention (Yang, 2018).

Existing studies reveal that the health status and overall well-being of older migrants are marked by significant complexity (Kristiansen et al., 2016). On the one hand, this population often reports relatively favorable levels of self-rated health (Lu & Guo, 2017). On the other hand, they face multiple health-related challenges, including heightened exposure to chronic disease risks, limited awareness of preventive health practices, and a tendency toward irrational or delayed healthcare-seeking behavior (Chu et al., 2015; Song & Zhang, 2018). Institutional barriers rooted in the household registration system further exacerbate these difficulties, particularly persistent obstacles to cross-regional medical insurance reimbursement and the fragmented accessibility of urban health resources (Liu & Liang, 2025). Regional disparities in economic development have deepened inequalities in health and welfare entitlements (Baeten et al., 2013). In many developed regions, it has become common practice to establish separate social welfare systems for migrants, which are consistently inferior to those available to local residents (Wang, 2017). As a result, older migrants are more likely than their local counterparts to forego needed health services, leading to greater health deterioration and poorer overall health outcomes (Zheng et al., 2018; Zhang et al., 2017). Accordingly, their subjective well-being and life satisfaction in urban areas consistently lag behind those of local residents (Jin and Liu, 2017; Li et al., 2020). Beyond the health domain, issues of social adaptation further complicate the lived experience of older migrants. Empirical evidence indicates a distinctive pattern characterized by relatively high levels of psychological adaptation, moderate degrees of behavioral adjustment, and persistently low levels of cultural adaptation (Lu & Guo, 2017; Yang, 2021). In other words, while many demonstrate emotional resilience and are able to adjust their daily practices to urban contexts, they frequently struggle with cultural assimilation and the development of a strong sense of belonging within unfamiliar social environments (Boccagni et al., 2021). Relocation often disrupts long-standing kinship networks, daily routines, and community-based cultural practices rooted in their rural origins (Guo, 1994). Such disruptions not only intensify feelings of marginalization but also diminish the protective effects of social capital.

Moreover, heterogeneity in migration trajectories exerts a profound influence on the health and well-being of older migrants. From the perspective of migration motivation, this population in urban China can broadly be classified into three categories (Yue et al., 2010): quality-of-life-oriented (QLO), family-support (FS), and economically-driven (ED) migrants. In this study, migration motivation was operationalized based on respondents' self-reported primary reason for migration and used to assign individuals to one of these three groups. This typology captures distinct configurations of resources, constraints, and life-course strategies that shape opportunities for active aging. QLO migrants typically relocate voluntarily in pursuit of improved living environments, better housing conditions, or enhanced access to healthcare and leisure services (Benson & O'Reilly, 2009). Such relocation reflects proactive life planning and is usually

underpinned by relatively robust economic and health resources. As a result, QLO migrants tend to demonstrate stronger health management awareness and higher levels of community engagement, suggesting a comparatively favourable alignment between individual capacities and urban opportunity structures. In contrast, FS and ED migrants often move under passive or constrained circumstances. FS migrants relocate primarily to provide childcare for grandchildren or to support adult children, and they often prioritize family needs over their own well-being (Vullnetari, 2023). ED migrants, by comparison, are driven by financial necessity, and they often seek to supplement inadequate pension income, minimize living expenses, or gain access to urban social services through low-skilled or informal employment (Schulz et al., 2015). These differing motivations imply unequal starting points in terms of health, income security, and social integration, thereby generating systematic variation in active aging outcomes. Beyond motivational differences, the geographical scale of migration also shapes adaptive capacity. Inter-provincial migrants are more likely than intra-provincial migrants to encounter adaptation challenges linked to institutional misalignments and cultural disparities (Liu et al., 2023). Such challenges include rebuilding social support networks, navigating non-portable medical insurance systems, and adjusting to unfamiliar cultural norms and dialects (Li et al., 2020). These barriers tend to amplify vulnerability among FS and ED migrants while placing fewer constraints on QLO migrants with stronger resource endowments. In addition, the temporal dimension of migration further influences trajectories of active and healthy aging. Mukherjee and Diwan (2016) observed that longer durations of residence in host cities facilitate the accumulation of place-based resources and the reconstruction of social ties, which in turn reinforces their sense of belonging, social identity, and overall life satisfaction. Conversely, short-term or transient residents often remain at the margins of urban society, face persistent risks of social isolation, and experience limited access to institutional support.

Despite the growing body of research on older migrants in China, the majority of existing studies remain confined to single-dimensional analytical frameworks, often focusing narrowly on health status (Nguyen & Shibusawa, 2013), social integration (Gerst & Burr, 2011; Stanaway et al., 2011), or living conditions (Bongaarts & Zimmer, 2002) in isolation. Such approaches risk obscuring the multifaceted and interdependent nature of migration experiences in later life. In particular, relatively limited attention has been devoted to systematically evaluating active aging outcomes across different migration trajectories. These limitations highlight the need for a differentiated analytical approach that integrates health, social adaptation, and migration characteristics into a unified framework. Such an approach is essential for uncovering the mechanisms through which heterogeneity in migration experiences shapes subjective well-being, as well as for informing the design of policies and interventions that promote active and healthy aging in rapidly urbanizing societies. Accordingly, this study employs the active aging perspective to provide a comprehensive assessment of active aging levels among older urban migrants. It further seeks to identify patterns of subgroup heterogeneity, with particular attention to how variations in migration motivation, geographical scale, and duration of residence influence active aging outcomes. Guided by these objectives, the study formulates the following hypotheses:

H1 Older urban migrants are expected to exhibit relatively lower levels of active aging, as reflected in their position within the distribution of the composite active aging index.

H2a Migrants who relocate for quality-of-life reasons are expected to exhibit higher levels of active aging than those who migrate for family-support or economic reasons.

H2b Intra-provincial migrants are expected to achieve higher levels of active aging compared to inter-provincial migrants.

H2c A longer duration of residence in host cities is expected to be positively associated with higher levels of active aging.

Methods

Active aging evaluation framework

Active aging, as a pivotal global strategy for addressing the challenges of population aging, was first introduced at the 1997 Denver Summit of the Western G7 nations. Since then, the concept has been closely associated with related notions such as successful aging and productive aging, which have become central components of national and international strategies, as well as influential constructs within gerontological theory and research. The World Health Organization (WHO, 2002) formally defined active aging as the process of optimizing opportunities for health, participation, and security in order to enhance quality of life across the life course. This definition represents a paradigmatic shift from a purely needs-based to a rights-based approach to aging. Rather than focusing solely on the fulfillment of basic material needs, it underscores the importance of creating enabling environments and institutional structures that empower older adults to realize personal value, exercise agency, and improve overall quality of life.

An alternative and complementary way of conceptualizing active aging is provided by the capability approach, which offers a normative framework for understanding aging well in terms of individuals' real freedoms to achieve valued ways of being and doing (Sen, 2002). Within this framework, well-being is not defined by the possession of resources alone, but by the extent to which individuals are able to convert those resources into meaningful achievements or functionings. Capabilities refer to the genuine opportunities individuals have to achieve these functionings, which are shaped by a range of personal, social, and environmental conversion factors (Rodríguez-Peña, 2025). This highlights the complex determinants of active aging, including the role of broader structural forces such as hukou-related inequalities, which condition access to welfare entitlements, public services, and supportive environments. Moreover, the spatial dimension of capabilities aligns closely with the concept of person-environment fit (Lawton & Nahemow, 1979), which posits that well-being in later life depends on the degree of congruence between individuals' functional capacities and environmental demands or supports. Different places provide distinct configurations of material resources, infrastructures, and social relations, which shape the capability sets available to older adults. Some capabilities, such as mobility, social participation, or access to care, are inherently dependent on engagement with particular physical and social environments. From

these perspectives, active aging can be understood as a set of valued functionings supported by adequate capability sets, rather than merely as observable behaviors or health outcomes.

In recent years, the concept of active aging has been broadened, refined and operationalized in diverse ways. Some scholars have developed multidimensional models and active aging phenotypes grounded in WHO's framework. Key components of this phenotype generally include: good functional ability and physical fitness (Takken et al., 2003); sustained physical, social, and mental health (Ludwig-Dehm et al., 2023); continued involvement in family and peer networks (Ding, 2024); ongoing engagement with the community throughout the aging process (Grander, 2013); and maintenance of positive subjective well-being (Baker et al., 2005). These dimensions constitute the widely recognized attributes of active aging and provide a comprehensive framework for evaluating both individual outcomes and policy effectiveness in diverse contexts.

While conceptual definitions provide an essential theoretical foundation, considerable efforts have been made to translate them into quantifiable indicators that enable cross-national and regional comparisons. One of the most influential tools in this regard is the Active Aging Index (AAI), which operationalizes active aging into measurable outcomes such as labor force participation, healthy life expectancy, and levels of social engagement (São José et al., 2017). The AAI illustrates how the abstract concept of active aging can be transformed into practical benchmarking tools for monitoring societal progress (Petrová Kafková, 2018). This approach was institutionalized in the European Union, which designated 2012 as the European Year for Active Ageing and Solidarity between Generations and launched the AAI project to promote and track progress in active aging (Zaidi et al., 2013). Although the AAI and related frameworks differ in emphasis, they share a common objective of identifying and promoting the essential conditions for health, e.g., accessible and affordable healthcare, opportunities for physical activity (Fries, 2012), social security, e.g., financial stability, housing affordability, and community safety (Hall et al., 2021), and active participation, e.g., accessible transportation, volunteer opportunities, recreational programs, and cultural or religious involvement (Li et al., 2020). These frameworks have set an international precedent for systematically measuring and comparing active aging outcomes across populations (Sousa & Barros, 2020). Drawing on these international developments, and informed by the policy framework on active aging in China, this study extends the AAI logic to capture the intersecting realities of aging and mobility among older urban migrants. Specifically, it constructs a multidimensional active aging evaluation index system encompassing six dimensions (Table 1): (i) individual factors—biological and genetic characteristics, physical health, and psychological well-being (Zhu, 2024); (ii) behavioral factors—health-related lifestyles such as exercise and social participation (Li, 2017); (iii) economic factors—income, property ownership, and access to social security (Zhang & Yu, 2002; Chen, 2000); (iv) social environment factors—institutional inclusivity, policy support, and social integration (Bian & Li, 2019); (v) physical environment factors—housing conditions, safety, and neighborhood convenience (Li et al., 2025); (vi) health and social service factors—equitable and proactive access to healthcare and elderly care services (Zhang et al., 2018; Han & Meng, 2019). Rather than functioning solely as an organizing schema, these dimensions are conceptualized as interacting components of a relational system. Individual capacities condition the ability to engage in health-related behaviors; behavioral practices mediate

Table 1 Theoretical framework for the evaluation of active aging

Dimensions and Indicators	Variable Type	Variable Definition & Explanation
Individual Factors		
Self-rated Health (X11)	Ordinal (Q)	Subjective evaluation of health status (1 = Very Poor to 5 = Very Good)
Chronic Diseases (X12)	Dichotomous (D)	Whether the individual has chronic diseases (0 = Yes, 1 = No)
Negative Emotions (X13)	Ordinal (Q)	Frequency of negative emotions (1 = Always to 5 = Never)
Behavioral Factors		
Physical Exercise (X21)	Ordinal (Q)	Frequency of physical exercise (1 = Never to 5 = Six times or more per week)
Volunteer Participation (X22)	Dichotomous (D)	Participation in volunteer activities (0 = No, 1 = Yes)
Economic Factors		
Self-rated Economic Status (X31)	Ordinal (Q)	Subjective evaluation of economic status (1 = Very Poor to 5 = Very Good)
Property Ownership at Destination (X32)	Dichotomous (D)	Whether the individual owns property at the destination (0 = No, 1 = Yes)
Social Environment Factors		
Community Care (X41)	Ordinal (Q)	Perception of community care (1 = Not at all to 5 = Fully perceived)
City Inclusivity (X42)	Ordinal (Q)	Perception of overall city inclusivity (1 = Not at all to 5 = Fully perceived)
Convenience of Medical Reimbursement (X43)	Ordinal (Q)	Convenience of cross-regional medical reimbursement (1 = Very Inconvenient to 5 = Very Convenient)
Physical Environment Factors		
Private Room (X51)	Dichotomous (D)	Whether the individual has a private room (0 = No, 1 = Yes)
Satisfaction with Living Environment (X52)	Ordinal (Q)	Satisfaction with living environment (1 = Very Dissatisfied to 5 = Very Satisfied)
Health and Social Service Factors		
Use of Health Services (X61)	Dichotomous (D)	Whether the individual has used community health services (0 = No, 1 = Yes)
Impact of Timely Medical Access (X62)	Ordinal (Q)	Impact of cross-regional medical insurance on timely access to healthcare (1 = Always affected to 5 = Not affected at all)
Access to Elderly Care Services (X63)	Dichotomous (D)	Whether the individual has used community elderly care services (0 = No, 1 = Yes)

the translation of resources into health and participation outcomes; and social, physical, and institutional environments shape the extent to which these capacities and behaviors can be effectively realized following migration. Active aging is therefore understood as a context-dependent outcome shaped by the interaction between individual capacities, environmental conditions, and institutional structures. This framework provides a robust theoretical basis for systematically evaluating active aging within the specific context of urban migrants in China and for identifying both individual vulnerabilities and structural barriers to healthy and active later life.

Data collection

This study adopts a cross-sectional research design and applies quantitative methods to evaluate and compare levels of active aging among older urban migrants. Primary data were collected through a field survey conducted across 14 urban districts in four major cities of Hangzhou, Ningbo, Wenzhou, and Jiaxing within Zhejiang Province. The selection of these cities was guided by three principal considerations. First, all four cities are located within the Yangtze River Delta, a region characterized by a high concentration of

migrant populations and advanced urban governance, thus ensuring regional representativeness. Second, the selected districts exhibit relatively high proportions of residents without local household registration, which provides an empirical basis for capturing diverse migrant samples. Third, the survey was facilitated through the support of local administrative authorities and sampling frames were drawn from the migrant population management system operated by local police stations, ensuring both data validity and procedural rigor.

The target population comprised urban migrants aged 60 and above who had resided in their host communities for at least six months. A combined sampling strategy, incorporating directory screening and snowball sampling techniques, was employed to identify eligible participants. Questionnaires were administered in person by trained survey personnel, with logistical support from local community staff during household visits. In total, 1,216 questionnaires were distributed. After excluding incomplete or invalid responses, 1,105 valid questionnaires were retained, resulting in an effective response rate of 90.87%. To assess the structural adequacy of the variables, the KMO measure of sampling adequacy for the 15 core indicators of active aging was 0.706, while Bartlett's test of sphericity produced an approximate chi-square value of 2197.389 (Sig. = 0.000). Together, these results demonstrate a satisfactory level of inter-variable correlation, confirming the dataset's appropriateness for subsequent factor analysis and fuzzy comprehensive evaluation.

Data analysis

Active aging, as a concept encompassing both quality of life and social participation among older adults, exhibits an inherent degree of fuzziness (Yang & Gu, 2000). Its multidimensional character relies partly on subjective appraisals (e.g., personal health, economic conditions, and living environments) that resist exact quantification, and partly on the coordinated expression of capabilities across multiple life domains. As with welfare measurement, these attributes are multidimensional, non-linear, and interwoven, spanning both subjective and objective components. Given this complexity, traditional deterministic analytical methods have limited capacity to capture the overlapping and uncertain boundaries of active aging dimensions. By contrast, fuzzy mathematics offers distinct advantages in handling such ambiguity. Proposed by Zadeh (1965), fuzzy mathematics represents uncertain or imprecise conditions through membership functions, which assign each observation a degree of belonging to a given set. This approach has been widely applied in welfare measurement (Cheli & Lemmi, 1995; Tavousi et al., 2022), demonstrating its ability to accommodate both gradations and overlaps in social indicators. Based on Sen's (2002) capability approach, this study conceptualizes active aging as the realized capabilities of older migrants to maintain health, participate socially, and secure well-being in later life. Accordingly, a fuzzy comprehensive evaluation method is employed to assess their active aging levels. This approach enables the integration of heterogeneous indicators across subjective and objective domains, while also capturing degrees of achievement rather than imposing rigid thresholds. As such, it provides a more nuanced and holistic assessment of active aging outcomes among older urban migrants.

Fuzzy set and membership function specification

The level of active aging among older urban migrants can be modeled as a fuzzy set X, with W denoting the subset of possible variations in active aging levels following spatial mobility. The active aging status of the *n*th older migrant is expressed by a membership function $\mathrm{W}^{(\mathrm{n})}=\{x,\mu_{w}(x)\}$, where $x \in \mathrm{X}$ represents the observed state of active aging for the individual, and $\mu_{w}(x)$ indicates the membership degree of x in the fuzzy set W. In $\mu_{w}(x) \in [0,1]$, a membership degree of 0 indicates a very low level of welfare, whereas a value of 1 signifies a very high level. According to Dubois and Prade (1998), a membership value within the interval of [0.4, 0.6] reflects a medium level of welfare. In this study, a larger membership value of $\mu_{w}(x)$ indicates a higher level of active aging as reflected by a given indicator among older urban migrants, while a smaller value reflects a lower level. Membership values within the range of [0.4, 0.6] are interpreted as an intermediate status with respect to the dimension of active aging measured by the variable.

Construction of membership functions for different variable types

The specification of membership functions depends on both the research context and the nature of the indicators used. Following Muthén (1984), indicators can generally be classified into three categories: binary dummy variables, continuous variables, and qualitative dummy variables. In this study, only binary dummy variables and qualitative dummy variables are employed. Linear membership functions are adopted because they provide a transparent and monotonic transformation of observed indicators into degrees of membership, preserving ordinal information while allowing comparability across indicators measured on different scales. Let x_i denote the *i*th functional subset of active aging among older urban migrants, determined by the primary indicators x_{ij}. The set of primary indicators is represented as x=[$x_{11},\ldots,x_{ij},\ldots$].

Binary dummy variables are characterized by two distinct states. The membership function for such variables is defined as:

$$\mu(x_{ij})=f(x)=\begin{cases}0 & x_{ij}=0\\ 1 & x_{ij}=1\end{cases} \tag{1}$$

This function specifies that when an older migrant does not possess the attribute represented by the indicator, e.g. $x_{ij}=0$, the membership degree of this indicator in the *i*th functional subset is $\mu(x_{ij})$= 0. Conversely, when the attribute is present, e.g. $x_{ij}=1$, the membership degree is $\mu(x_{ij})$= 1. To ensure computational robustness and avoid distortions from extreme values in fuzzy operations, the value of 0 is adjusted to 0.001 and the value of 1 is adjusted to 0.999. This adjustment serves as a pragmatic numerical treatment that avoids the undue influence of boundary values in weighted aggregation and sensitivity analysis. It is also consistent with the continuous logic of fuzzy-set theory, in which membership degrees are rarely assumed to be exactly 0 or 1. As the membership values represent the degree of achieved functionings, this technical adjustment does not affect their substantive interpretation.

In the evaluation of active aging levels, some indicators cannot be directly measured with quantitative data and must instead be represented by using qualitative descriptions, leading to the construction of qualitative dummy variables. According to Cerioli and Zani (1990), the membership function for qualitative dummy variables is defined as:

$$\mu(x_{ij}) = \begin{cases} 0 & x_{ij} \leqslant x_{ij}^{min} \\ \frac{x_{ij} - x_{ij}^{min}}{x_{ij}^{max} - x_{ij}^{min}} & x_{ij}^{min} < x_{ij} < x_{ij}^{max} \\ 1 & x_{ij} \geqslant x_{ij}^{max} \end{cases} \tag{2}$$

where x_{ij}^{max} and x_{ij}^{min} denote the maximum and minimum values of x_{ij}, respectively. This function normalizes that higher values represent stronger membership in the subset "higher active aging".

Weight assignment and comprehensive index calculation

After calculating the membership degrees for each indicator, these values must be aggregated to generate indices for each functional subset, and ultimately the overall active aging index. Based on the method proposed by Cheli and Lemmi (1995), the weight assigned to each primary indicator is calculated as:

$$\begin{aligned} w_{ij} &= ln\left[\frac{1}{\overline{\mu\left(x_{ij}\right)}}\right] \\ \overline{\mu\left(x_{ij}\right)} &= \frac{1}{n}\sum_{p=1}^{n}\mu(x_{ij})^{p} \end{aligned} \tag{3}$$

where $\overline{\mu\ (x_{ij})}$ represents the average membership degree of the *j*th indicator across n older migrants within the *i*th functional subset. This weighting approach offers a systematic means of synthesizing all indicators within functional subset *i* into a single composite measure. It embodies the principle of diminishing marginal contribution, whereby indicators with higher average membership degrees are assigned lower weights, while those with lower average membership degrees receive higher weights. Consequently, dimensions in which individuals already perform well contribute less to differentiating overall active aging levels, whereas dimensions in which performance is generally weak exert a greater influence on the composite index. In the context of this study, this implies that as an older migrant's status in a particular dimension improves, the marginal contribution of that dimension to the overall active aging level decreases, underscoring the importance of balanced progress across multiple dimensions. By integrating multiple indicators from a system-oriented and holistic perspective, this weighting method enables a comprehensive assessment of active aging levels (Salaffi et al., 2009).

Once the weights for each indicator are determined, the membership degrees are aggregated to calculate the fuzzy index for each functional subset as follows:

$$f\left(x_i\right) = \frac{\sum_{j=1}^{k}\overline{\mu\left(x_{ij}\right)}w_{ij}}{\sum_{i=1}^{|w|}\sum_{j=1}^{k}w_{ij}} \tag{4}$$

Where $|w|$ represents the total number of functional subsets such as x_1, x_2..., $x_{|w|}$ and *k* denotes the number of primary indicators within the *i*th functional subset. The resulting value $f\left(x_i\right)$ represents the fuzzy index for the corresponding functional subset or dimension of active aging.

Finally, the comprehensive fuzzy evaluation index for the overall active aging level among older urban migrants is calculated by aggregating the indices across all functional subsets:

$$f(x) = \sum_{i=1}^{|w|} f(x_i) \tag{5}$$

This values $f(x)$ represents the final fuzzy index of overall active aging. It ranges from 0 to 1 and should be interpreted as a relative and proportional measure of active aging. Values closer to 1 indicate a higher degree of achievement across the evaluated dimensions, whereas values closer to 0 indicate lower levels of achievement relative to the maximum attainable level. Accordingly, an index value can be read as the proportion of overall realization, and references to "low" or "high" levels denote comparative positions within the observed distribution.

Results

Overall level of active aging among older urban migrants

Table 2 reveals that the overall level of active aging among older urban migrants was situated toward the lower end of the composite index distribution. The fuzzy comprehensive index for the entire sample was only 0.2892, a comparatively low degree of achievement across the evaluated dimensions. As a group, older urban migrants demonstrated a limited capacity to achieve the core goals of health, participation, and security within their host cities, highlighting the presence of multidimensional constraints. Across the six dimensions evaluated, the indices ranked as follows: social environment (0.0702) > individual factors (0.0580) > health and social services (0.0562) > economic factors (0.0427) > behavioral factors (0.0354) > physical environment (0.0266). With the exception of the social environment dimension, all other domains displayed relatively low values, with particularly low levels observed in health-related behaviors and housing

Table 2 Fuzzy index for evaluating the active aging level of older urban migrants

Dimensions and Indicators	Membership Degree	Weight	Fuzzy Index
Individual Factors (X1)			0.0580
Self-rated Health (X11)	0.7213	0.3267	
Chronic Diseases (X21)	0.4408	0.8191	
Negative Emotions (X31)	0.6537	0.4251	
Behavioral Factors (X2)			0.0354
Physical Exercise (X21)	0.5732	0.5565	
Volunteer Participation (X22)	0.0895	2.4079	
Economic Factors (X3)			0.0427
Self-rated Economic Status (X31)	0.5387	0.6186	
Property Ownership at Destination (X32)	0.1816	1.7148	
Social Environment (X4)			0.0702
Community Care (X41)	0.5311	0.6328	
City Inclusivity (X42)	0.4521	0.7939	
Convenience of Medical Reimbursement (X43)	0.3165	1.1504	
Physical Environment (X5)			0.0266
Private Room (X51)	0.8735	0.1352	
Satisfaction with Living Environment (X52)	0.6433	0.4412	
Health and Social Services (X6)			0.0562
Use of Health Services (X61)	0.1509	1.8910	
Impact on Timely Medical Access (X62)	0.4633	0.7693	
Access to Elderly Care Services (X63)	0.0859	2.4079	
Total Fuzzy Index			0.2892

conditions. These findings suggest comparatively weaker outcomes in lifestyle-related practices and the quality of physical living environments among older urban migrants.

Based on the distribution of membership degrees and indicator weights, the active aging indicators were categorized into three distinct groups. The first group comprised indicators with relatively high membership levels and limited marginal effects. This group included self-rated health, negative emotional status, availability of private rooms, and satisfaction with the living environment. All of these indicators had membership degrees above 0.6, suggesting that a substantial proportion of older migrants achieved comparatively higher levels in these domains. The second group consisted of indicators with intermediate membership levels and considerable room for improvement. This group included indicators such as chronic illness status, frequency of physical exercise, self-rated economic status, perceptions of community care, sense of urban inclusivity, and the impact of timely access to medical services. With membership degrees ranging between 0.4 and 0.6, these indicators represent dimensions in which achievement is moderate and where further improvement may be observed across the sample. The third group included indicators with comparatively low membership levels and strong marginal effects. This group comprised participation in volunteer activities, property ownership, convenience of medical reimbursement, utilization of health services, and access to elderly care services. These indicators generally had membership degrees below 0.4 and were assigned relatively high weights, which indicate that older urban migrants tend to achieve lower levels in these aspects of active aging and that these domains hold substantial potential for improvement.

Effects of migration motivations on active aging

Further analyses based on migration characteristics revealed significant disparities in active aging levels according to migration motivation, spatial scale, and length of residence. Table 3 reports variations in the fuzzy index of active aging across three migration-motivation groups of ED, FS and QLD migrants. Overall, the three groups showed a clear descending pattern in active aging levels: QLO (0.3224) > FS (0.2552) > ED (0.2369). At the dimensional level, QLO migrants consistently achieved higher fuzzy index values across all six dimensions, with particularly notable levels in individual factors (0.0664), social environment (0.0796), and health and social services (0.0716). FS migrants generally occupied an intermediate position, while ED migrants recorded the lowest overall index values, indicating comparatively weaker performance across several dimensions. These differences may be associated with variation in resource endowments, health-related behaviors and access to services. This typological differentiation was further reflected in specific indicators. For instance, ED migrants recorded low membership degrees in physical exercise (0.3825) and property ownership at the destination (0.1095), both accompanied by relatively high indicator weights (0.9610 and 2.2118, respectively). QLO migrants, despite their overall stronger performance, showed low membership in convenience of medical reimbursement (0.2558) and the utilization of health services (0.0971), paired with relatively high indicator weights (1.3634 and 2.3320). Moreover, both FS and QLO migrants performed poorly in chronic disease prevention and management, as evidenced by consistently low membership degrees (< 0.4) and relatively high indicator weights (> 0.8).

Table 3 Variation in the fuzzy index of active aging by migration motivation

Dimensions and Indicators	Membership Degree			Weight			Fuzzy Index		
	ED	FS	QLO	ED	FS	QLO	ED	FS	QLO
Individual Factors (X1)							0.0460	0.0544	0.0664
Self-rated Health (X11)	0.7474	0.7015	0.7505	0.2912	0.3545	0.2870			
Chronic Diseases (X12)	0.5904	0.3943	0.3799	0.5270	0.8191	0.9678			
Negative Emotions (X13)	0.6484	0.6381	0.7150	0.4332	0.4251	0.3355			
Behavioral Factors (X2)							0.0279	0.0315	0.0367
Physical Exercise (X21)	0.3825	0.5731	0.8549	0.9610	0.5567	0.1568			
Volunteer Participation (X22)	0.0372	0.0803	0.1985	3.2914	2.5220	1.6170			
Economic Factors (X3)							0.0334	0.0300	0.0410
Self-rated Economic Status (X31)	0.5018	0.5202	0.6564	0.6896	0.6535	0.4210			
Property Ownership at Destination (X32)	0.1095	0.0539	0.7268	2.2118	2.2906	0.3191			
Social Environment (X4)							0.0614	0.0640	0.0796
Community Care (X41)	0.4683	0.5350	0.6108	0.7586	0.6255	0.4930			
City Inclusivity (X42)	0.4620	0.4261	0.5267	0.7722	0.8531	0.6411			
Convenience of Medical Reimbursement (X43)	0.3832	0.3055	0.2558	0.9592	1.1858	1.3634			
Physical Environment (X5)							0.0260	0.0239	0.0271
Private Room (X51)	0.8435	0.8700	0.9396	0.1702	0.1393	0.0730			
Satisfaction with Living Environment (X52)	0.5851	0.6591	0.6795	0.5360	0.4169	0.3930			
Health and Social Services (X6)							0.0422	0.0515	0.0716
Use of Health Services (X61)	0.1493	0.1673	0.0971	1.9018	1.7880	2.3320			
Impact of Timely Medical Access (X62)	0.5036	0.4965	0.2904	0.6860	0.7002	1.2365			
Access to Elderly Care Services (X63)	0.0335	0.0834	0.1718	3.3962	2.4841	1.7614			
Total Fuzzy Index							0.2369	0.2552	0.3224

Effects of geographical scale on active aging

Table 4 presents variations in the fuzzy index of active aging between intra-provincial and inter-provincial older migrants. Overall, intra-provincial migrants exhibited higher overall levels of active aging compared to inter-provincial migrants, with fuzzy indices of 0.2955 and 0.2831, respectively. In other words, the greater the spatial distance of migration, the more difficult it becomes for older adults to achieve active aging. Across the six dimensions, intra-provincial migrants generally performed better in health status, health-related behaviors, physical environment, and access to services, whereas inter-provincial migrants achieved relatively stronger outcomes in the economic dimension. At the indicator level, both groups demonstrated consistently low membership degrees (<0.4) combined with high indicator weights (>1) in domains such as volunteer participation, property ownership at destination, convenience of medical reimbursement, health service utilization, and access to elderly care services. Notably, inter-provincial migrants recorded lower membership degrees in urban inclusivity (0.4188 vs. 0.5324) and access to elderly care services (0.0751 vs. 0.1119), accompanied by higher indicator weights (0.8704 and 2.5889, respectively). By contrast, intra-provincial migrants showed comparatively lower membership in chronic disease status (0.3953 vs. 0.4597), accompanied by a higher indicator weight (0.9281 vs. 0.7772), suggesting persistent health-related vulnerabilities despite their overall advantages in other domains.

Table 4 Variation in the fuzzy index of active aging by spatial hierarchy

Dimensions and Indicators	Membership Degree		Weight		Fuzzy Index	
	Intra-provincial	Inter-provincial	Intra-provincial	Inter-provincial	Intra-provincial	Inter-provincial
Individual Factors (X1)					0.0601	0.0564
Self-rated Health (X11)	0.7007	0.7301	0.3557	0.3146		
Chronic Diseases (X12)	0.3953	0.4597	0.9281	0.7772		
Negative Emotions (X13)	0.6526	0.6542	0.4268	0.4243		
Behavioral Factors (X2)					0.0377	0.0342
Physical Exercise (X21)	0.5447	0.5850	0.6075	0.5361		
Volunteer Participation (X22)	0.0996	0.0853	2.3066	2.4616		
Economic Factors (X3)					0.0401	0.0429
Self-rated Economic Status (X31)	0.5347	0.5403	0.6260	0.6156		
Property Ownership at Destination (X32)	0.1273	0.2042	2.0612	1.5887		
Social Environment (X4)					0.0698	0.0694
Community Care (X41)	0.5269	0.5329	0.6407	0.6294		
City Inclusivity (X42)	0.5324	0.4188	0.6304	0.8704		
Convenience of Medical Reimbursement (X43)	0.3312	0.3104	1.1050	1.1699		
Physical Environment (X5)					0.0278	0.0259
Private Room (X51)	0.8511	0.8827	0.1612	0.1248		
Satisfaction with Living Environment (X52)	0.6564	0.6378	0.4210	0.4497		
Health and Social Services (X6)					0.0599	0.0543
Use of Health Services (X61)	0.1735	0.1416	1.7516	1.9547		

Table 4 (continued)

Dimensions and Indicators	Membership Degree		Weight		Fuzzy Index	
	Intra-provincial	Inter-provincial	Intra-provincial	Inter-provincial	Intra-provincial	Inter-provincial
Impact of Timely Medical Access (X62)	0.5107	0.4437	0.6718	0.8126		
Access to Elderly Care Services (X63)	0.1119	0.0751	2.1901	2.5889		
Total Fuzzy Index					0.2955	0.2831

Table 5 Variation in the fuzzy index of active aging by residential duration

Indicators	Membership Degree		Weight		Fuzzy Index	
	< 5 years	≥ 5 years	< 5 years	≥ 5 years	< 5 years	≥ 5 years
Individual Factors (X1)					0.0556	0.0605
Self-rated Health (X11)	0.7204	0.7228	0.3274	0.3246		
Chronic Diseases (X12)	0.4349	0.4507	0.8326	0.7970		
Negative Emotions (X13)	0.6611	0.6415	0.4139	0.4439		
Behavioral Factors (X2)					0.0317	0.0404
Regular Physical Exercise (X21)	0.5908	0.5439	0.5263	0.6090		
Volunteer Participation (X22)	0.0704	0.1212	2.6536	2.1103		
Economic Factors (X3)					0.0419	0.0423
Self-rated Economic Status (X31)	0.5427	0.5319	0.6112	0.6313		
Property Ownership at Destination (X32)	0.2049	0.1429	1.5852	1.9456		
Social Environment (X4)					0.0676	0.0725
Community Care (X41)	0.5376	0.5204	0.6206	0.6532		
City Inclusivity (X42)	0.4226	0.5012	0.8613	0.6908		
Convenience of Medical Reimbursement (X43)	0.3078	0.3309	1.1783	1.1059		
Physical Environment (X5)					0.0255	0.0279
Private Room (X51)	0.8775	0.8667	0.1307	0.1431		
Satisfaction with Living Environment (X52)	0.6412	0.6468	0.4444	0.4357		
Health and Social Services (X6)					0.0516	0.0622
Use of Health Services (X61)	0.1138	0.2126	2.1733	1.5483		
Impact of Timely Medical Access (X62)	0.4497	0.4862	0.7992	0.7211		
Access to Elderly Care Services (X63)	0.0806	0.0948	2.5183	2.3570		
Total Fuzzy Index					0.2740	0.3058

Effects of residence duration on active aging

Table 5 presents differences in the fuzzy index of active aging between older migrants with a residence duration of less than five years and those residing in host communities for five years or more. Overall, migrants with longer duration of residence displayed a higher total fuzzy index of active aging (0.3058) than those with shorter residence duration (0.2740). This pattern indicates a positive association between residence duration and active aging outcomes. Across all six dimensions, long-term residents consistently achieved higher fuzzy index values than short-term residents, with particularly pronounced advantages in behavioral factors (0.0404 vs. 0.0317) and health and social services (0.0622 vs. 0.0516). At the indicator level, the benefits of long-term residence were

especially evident in health service utilization, where the membership degree for long-term residents reached 0.2126, compared to only 0.1138 for short-term residents. In addition, long-term residents recorded higher membership in urban inclusivity (0.5012 vs. 0.4226), accompanied by lower indicator weights (0.6908 vs. 0.8613). Despite these differences, access to elderly care services remained weakly achieved in both groups, as reflected by low membership degrees.

Discussion

This study provides a systematic assessment of active aging levels among older urban migrants in China by using a multidimensional fuzzy evaluation framework. The results indicate that the overall level of active aging is relatively low, placing this group in the lower-middle range when compared with findings from similar studies (Wu et al., 2024). For instance, the AAI for this population is only marginally higher than that reported for older migrant samples in Yixing and Taicang within Jiangsu Province (Yang & Lu, 2023), and in Changsha within Hunan Province (Qu et al., 2016). However, it falls substantially below the levels observed among local older adults in some central and western regions, such as Guizhou Province (Wang et al., 2021). These findings suggest that even within highly urbanized eastern regions, where resources and service infrastructures are comparatively advanced, older migrants tend to occupy less advantaged positions across key dimensions of active aging. This pattern is consistent with previous research, which has highlighted ongoing challenges related to urban adaptation, access to essential resources, and integration into public service systems (Sun & Schafer, 2022). At the dimensional level, relatively higher index values are observed in the domains of social environment, individual factors, and health and social services. This pattern is consistent with the expansion of age-related policy initiatives in recent years, including the Healthy China strategy and local efforts to promote age-friendly communities. By contrast, indices for behavioral factors and physical environment remain markedly low. These deficiencies underscore two critical challenges: first, limited achievement in sustaining health-related behaviors, and second, continued constraints in access to adequate housing and neighborhood infrastructure in host cities. Taken together, weaker outcomes in proactive health behaviors and enduring disadvantages in the built environment are indicative of structural conditions that may constrain capabilities for active aging among urban migrant populations (Burholt et al., 2020).

Analysis at the indicator level reveals several domains characterized by low membership degrees combined with high indicator weights, underscoring their substantial effects on the overall level of active aging. Substantively, these indicators highlight aspects of daily life in which older migrants tend to experience limited realization of active aging during spatial transitions. First, low participation in community volunteer activities aligns with previous findings on barriers to social participation among mobile older populations (Xie, 2017). Frequent relocations are often associated with weaker local attachment and a reduced sense of belonging, which may limit engagement with new communities (Petrová Kafková, 2018). In addition, difficulties in accessing information about local activities can further constrain opportunities for participation (Townsend et al., 2021). Second, low rates of homeownership in destination areas are descriptively associated with lower economic capacity and may also reflect a continued orientation of returning to one's roots (Wiktor-Mach et al., 2025). Existing studies

suggest that many older migrants perceive themselves as temporary residents, which may reduce incentives to make long-term investments in host communities (Siqeca et al., 2022). Third, limited utilization of health and elderly care services aligns with a broader literature on institutional exclusion linked to China's household registration system. Even under broadly comparable conditions, older migrants may face restricted access to services and reduced welfare entitlements, resulting in uneven utilization of available resources (Fagerström et al., 2020). Finally, low convenience in medical insurance reimbursement reflects persistent misalignments between household registration status and place of residence within China's fragmented healthcare systems. Complicated reimbursement procedures and higher out-of-pocket costs are frequently cited as obstacles to healthcare access among older migrants. These patterns point to institutional and structural conditions that may constrain capabilities for active aging among older migrants.

The relatively low overall level of active aging among older urban migrants is accompanied by marked heterogeneity across subgroups within this population. In particular, variation across migration motivation groups reveals distinct patterns of active aging. QLO migrants consistently perform better across all dimensions, which is descriptively consistent with their stronger resource endowments and more voluntary, proactive migration trajectories. However, they display comparatively low membership levels in timely access to medical services, pointing to persistent constraints in service portability even among more advantaged subgroups. This finding highlights an empirically observed gap in cross-regional continuity of care, which may warrant further attention in the design of interregional coordination mechanisms for medical insurance. FS migrants occupy an intermediate position within the lower index distribution. This may be associated with relatively constrained in material resources and limited time available for self-care. These patterns suggest that measures aimed at enhancing financial security, such as expanded social assistance and pension supplementation, coupled with tailored health education to improve health literacy and encourage early disease prevention, may be particularly relevant for this group (Yu et al., 2022). ED migrants appear at the lower end of the active aging distribution, with comparatively weaker outcomes across multiple dimensions, including health status and social participation. This pattern indicates that ED migrants are more likely to face overlapping and cumulative capability constraints in daily life. From a policy perspective, community-based health promotion programs that focus on preventive care and chronic disease management may represent promising avenues for supporting engagement and reducing isolation.

Beyond migration motivation, the spatial scale of migration profoundly shapes both the probability and pathways of achieving active aging. Intra-provincial migrants tend to occupy relatively more favorable positions in several dimensions of active aging, including social connections and adaptation to local institutional arrangements, although they continue to struggle with chronic disease prevention and management. In contrast, inter-provincial migrants display lower membership levels in indicators related to access to public services and information, especially with regard to urban belonging and healthcare accessibility. These differences are consistent with greater institutional complexity and adjustment challenges associated with crossing administrative boundaries (Baldassar & Wilding, 2020). Such patterns point to the potential relevance of strengthening cross-regional coordination mechanisms to reduce institutional fragmentation.

Measures such as improving information sharing across jurisdictions, establishing centralized community information platforms, and providing personalized guidance on navigating public services may help address commonly observed barriers faced by interprovincial migrants.

Finally, the length of residence exerts a clear positive impact on the active aging levels of older urban migrants. Longer-term residents tend to display higher composite index values than those with shorter residence durations, which may be associated with greater familiarity with local environments, daily routines, and service systems. These associations align with previous studies, which suggest that prolonged exposure to host communities is linked to higher levels of social participation and service utilization (Serrat et al., 2020). The differences between long- and short-term residents suggest the potential value of measures aimed at facilitating earlier integration into host communities. Initiatives that strengthen community inclusion and enhance access to health, social welfare, and recreational services for newer migrants may help address commonly observed gaps during the initial stages of settlement. In addition, streamlining administrative procedures, providing clear and accessible information, and offering newcomer-oriented programs, such as orientation sessions, information campaigns, and peer support networks linking new and long-term residents, represent plausible strategies for reducing institutional barriers.

Contributions and limitations

This study advances the literature on active aging and later-life migration in three important ways. First, by integrating the active aging framework with insights from the capability approach and person-environment fit perspectives, the study moves beyond viewing active aging solely as an individual attribute or behavioral outcome. Instead, it highlights how opportunities for active aging are structured by migration-related constraints and institutional contexts, thereby extending existing active aging theory to explicitly account for mobility and spatial inequality in later life. Second, the study extends the application of the AAI framework by combining it with a fuzzy comprehensive evaluation approach. This allows active aging to be assessed as a relative and multidimensional construct that captures both subjective perceptions and objective conditions. The fuzzy framework also makes it possible to identify domains of systematically low achievement and enhance the analytical sensitivity of active aging measurement in migration contexts. Third, the study contributes to gerontological research by demonstrating how heterogeneity in migration motivation, geographical scale, and residence duration is associated with differentiated patterns of active aging. These differences move beyond treating older migrants as a homogeneous group and offer a clearer analytical lens for understanding subgroup disparities. In turn, they provide an empirical foundation for more differentiated and context-sensitive discussions of public policies aimed at promoting active aging under conditions of later-life mobility.

Despite these contributions, this study also has some limitations. First, because the data were drawn from four representative cities in Zhejiang Province, an economically advanced coastal region of China, the empirical findings are likely shaped by the region's specific level of economic development, social policy environment, and migrant demographic characteristics. Caution is therefore warranted when generalizing the results to less developed regions, rural areas, or other migration contexts. Future studies

are encouraged to broaden the geographical scope by incorporating cities from other regions, particularly rural-to-rural or cross-border migration contexts, in order to capture a wider range of migration experiences and enhance external validity. Second, owing to the challenges in data collection and the practical difficulties of surveying older migrants, the current indicator system does not include variables related to cognitive functioning or protections against violence and discrimination. This somewhat limits the explanatory power regarding disparities between migrant and non-migrant older groups. Future research should seek to enrich the evaluation system by integrating these dimensions, thereby enabling more holistic assessments of active aging and more robust cross-group comparisons.

Conclusion

This study systematically evaluated the levels of active aging among older urban migrants and found that overall attainment remained relatively low, as reflected in consistently low membership levels across six core dimensions. Simultaneously, the combined conditions of aging and migration are associated with complex institutional, spatial, and behavioral challenges in urban contexts, giving rise to pronounced internal heterogeneity within this population. Differences in active aging levels are observed across migration motivation, geographic scale, and length of residence, revealing a pattern of relatively low overall achievement alongside substantial variation across subgroups. These findings point to uneven opportunities for active aging among older urban migrants, rather than uniform disadvantage, within existing structural and institutional contexts.

Fundamentally, the host city, as the primary implementing unit of national macro policies, plays a decisive role in shaping the living conditions of older migrants through its institutional arrangements and service provision logic. Under the current household registration system, older migrants are frequently excluded from universal access to welfare resources, leaving them in a "gray zone" of entitlement. From a policy perspective, these conditions point to the potential relevance of strengthening the residence permit system as a mechanism for establishing a more inclusive and differentiated service delivery framework. A gradual shift from a household registration-oriented model toward a more residency-based approach to public resource allocation may help reduce some of the institutional gaps identified in this study. Building on this shift, host communities could play a more active role in safeguarding the rights and interests of older migrants. Measures aimed at improving informational accessibility, reducing administrative barriers, and supporting community-based organizations, including those initiated by older migrants themselves, may help address empirically observed constraints in service provision and social participation. Such efforts would not only enhance active aging outcomes for older urban migrants but also contribute to the development of more inclusive, resilient, and age-friendly urban communities in the context of demographic aging and internal migration.

Abbreviations

QLO	quality-of-life-oriented
FS	family-support
ED	economically-driven
AAI	Active Aging Index
WHO	World Health Organization

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Author contributions
All authors contributed to the research design and approved the final version of the manuscript. Specifically, WSZ was responsible for drafting and revising the manuscript; JXZ organized the data collection and conducted the data analysis; and ZHL interpreted the results and provided critical discussion and insights.

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Data availability
The data presented in this study are available from the corresponding author on reasonable request. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Declarations

Ethics approval and consent to participate
Before collecting data, this study was evaluated and approved by the University Research Committee. It was carried out in line with the ethical principles, all participants were informed of all aspects of the research and gave their consent.

Competing interests
The authors declare no competing interests.

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