Community Demographic Change, Community Size, and Cognitive Health Among Older Adults in China

Abstract

China's rapid urbanization and demographic shifts raise key questions about how community changes impact cognitive health in later life. Using data from the China Family Panel Studies (2010–2014; N = 9,642 across 559 communities), we created typologies of demographic trajectories that reflect combinations of population growth or decline and shifts in the share of older adults, while also examining how these interact with community size. Results show that demographic typologies matter. Older adults in communities experiencing aging with growth and in declining communities with growth have lower cognitive scores, whereas those in shrinking communities with aging perform better than expected, probably due to bonding social capital. Community size strongly influences these relationships, with large cities helping to buffer risks, likely through institutional capacity and a variety of engagement opportunities, while moderate-sized towns are particularly vulnerable. These findings highlight that cognitive health is shaped by evolving community demographic processes.

Key words: Neighborhood demographic change; Cognitive health; Population aging; Community size

Community Demographic Change, Community Size, and Cognitive Health Among Older Adults in China

Background

China is experiencing one of the most rapid population aging transitions in the world. Recent estimates suggest that more than 15 million older Chinese adults are living with dementia, and the number is projected to rise sharply as the population ages (Jia et al., 2020). By 2050, nearly one-third of China's population will be aged 60 or above, making dementia a pressing health concern and a major social and economic challenge (World Health Organization, 2025). The costs of dementia care in China are already substantial, with total expenditures estimated at over 110 billion USD in 2015 and projected to continue increasing in the coming decades (J. Jia et al., 2018). As individual-level medical interventions have not yet proven broadly effective (Prince et al., 2015), identifying social and environmental factors that shape cognitive aging may provide new avenues for public health strategies and community-based interventions in China.

One potential mechanism lies in characteristics of the local geographic and social environment. A growing body of international and Chinese research shows that neighborhood-level factors are associated with health and well-being in later life (Feng et al., 2018; Liang et al., 2020). Features of the neighborhood environment, including socioeconomic conditions, demographic composition, built environment, perceived safety, and social cohesion, have been linked to physical and mental health outcomes such as mortality, functional decline, depression, and health behaviors (Bosma et al., 2001; Chen et al., 2022; Choi & Matz-Costa, 2018; Cramm et al., 2013; Menec et al., 2010; Tucker-Seeley et al., 2009). More recently, neighborhood socioeconomic context has also been connected to cognitive health and dementia risk (Chaar et al., 2025; Meyer et al., 2023; Röhr et al., 2024). These factors may be particularly important in China, where older adults often spend more time within their immediate neighborhoods due to limited mobility, retirement from the labor force, and strong community-based social networks (Li et al., 2024; Li & Morrow-Howell, 2024).

Building on this literature, it is important to recognize that demographic age composition itself represents a core dimension of neighborhood context. Yet, despite its salience as a defining feature of neighborhood contexts, few studies have examined how shifts in the number and proportion of older adults shape cognitive health. These dynamics can take several forms: *aging with stable and growth* (stable population and simultaneous increases in both the number and proportion of older adults), *declining share with stable and growth* (stable and increasing numbers but a shrinking proportion of older adults), *shrinking with aging* (declining numbers but a rising share), and *shrinking with decline* (declines in both the number and proportion). Each trajectory may shape cognitive health in distinct ways. For example, population growth may heighten risks of marginalization or the erosion of peer networks, while shrinking with aging may foster bonding social capital that sustains cognitive reserve. Alongside these demographic dynamics, community size itself represents a key predictor: large cities may offer stronger institutional resources that buffer risks, whereas small and mid-sized communities may be more vulnerable to demographic shocks.

In this paper, we use data from the China Family Panel Studies (CFPS, 2010–2014), a nationally representative longitudinal survey, to examine how changes in community age structure and community size shape the cognitive health of adults aged 50 and older. This conceptual approach moves beyond cross-sectional snapshots of neighborhood composition to capture dynamic demographic processes that reflect both shifts in overall population size and changes in the relative share of older residents. By linking these demographic trajectories to cognitive outcomes, we provide new evidence on how community-level aging patterns and institutional capacity jointly shape the cognitive health and healthy aging in the context of China's rapid demographic transition.

Theoretical Framework and Hypotheses

While neighborhood socioeconomic conditions have been widely studied as determinants of cognitive health (Best, 2024; Liu et al., 2022; Rosso et al., 2016; Shih et al., 2011), the influence of community demographic change remains largely unknown. Fueled by rapid economic growth, infrastructure expansion, and historically high rural-to-urban migration, China underwent massive urban and peri-urban development in the 2010s before the Covid-19 pandemic. The national urbanization rate rose from about 50% in 2010 to nearly 55% in 2014 (National Bureau of Statistics of China, 2015), with tens of millions of people moving into cities or peri-urban areas in just a few years. These forces reshaped communities quickly, as villages were absorbed into city boundaries, new housing and transportation networks attracted younger migrants, and older adults remained in depopulating rural areas. Given the scale and speed of these demographic shifts, even a four-year period captures substantial changes in the demographic composition of many communities. Such changes in population size and age structure represent critical structural features that can alter opportunities for social engagement, access to support, and the distribution of resources. Moreover, the consequences of demographic change are likely to vary by community size. Larger cities typically possess stronger institutional capacity, greater service availability, and more diverse opportunities for engagement while smaller and moderate-sized communities often face persistent scarcity and greater vulnerability to demographic shocks. By integrating demographic trajectories with community size, we situate cognitive aging within the broader dynamics of population change, institutional capacity, and community structure.

Ecological models of aging (Lawton & Nahemow, 1973) emphasize that cognitive health is shaped by the dynamic fit (or misfit) between individual competencies and the opportunities, demands, and resources embedded in surrounding environments. Contemporary extensions in environmental gerontology (e.g., Wahl & Gerstorf, 2018; Wahl & Oswald, 2010) stress that this fit evolves across the life course, as both individuals and their contexts change. Communities experiencing demographic shifts may therefore alter the person–environment balance, either straining resources and increasing barriers to engagement or generating new possibilities for stimulation and social integration. Complementing this perspective, the concept of cognitive reserve (Stern, 2002, 2009) suggests that resilience to age-related decline is not solely determined by individual attributes such as education, occupation, and lifelong learning, but also by sustained access to cognitively enriching environments. These theoretical frameworks converge to suggest that community demographic change is a structural force that, in interaction with community size, organizes patterns of inclusion and exclusion, the distribution of resources, and the density and diversity of opportunities for cognitive enrichment. Situating cognitive health within these ecological and reserve-based perspectives highlights how trajectories of demographic change intersect with community size to shape cognitive aging.

We conceptualize community demographic change in two distinct ways: the overall population growth or decline and shifts in the relative size of older adults. Their combinations yield four distinct typologies with implications for cognitive health: (1) *aging with stable and growth* (stable population and increases in both number and proportion of older adults), (2) decline share with stable and *growth* (stable and increasing numbers but a shrinking proportion of older adults), (3) *shrinking with aging* (declining numbers but a rising share), and (4) *shrinking with decline* (declines in both number and proportion of older adults). These typologies capture key demographic regimes that may create or constrain opportunities for cognitive engagement through their effects on visibility, social cohesion, institutional capacity, and peer networks.

We use *Shrinking with Aging* communities as the reference category based on a theoretical consideration. Shrinking with Aging represents the modal or "typical" trajectory of demographic change in many rapidly aging societies. These communities combine two processes, population decline and population aging, that place particular strain on local infrastructure, social institutions, and labor markets. Conceptually, they provide a meaningful baseline for comparison, as they represent the demographic endpoint toward which many other communities may be moving. Contrasting alternative trajectories against Shrinking with Aging allows us to identify whether communities with more favorable growth or age structures confer relative advantages, or mitigate disadvantages, for cognitive health, net of individual- and community-level factors. Based on these theoretical perspectives, we derive a set of hypotheses that specify how different community demographic trajectories and community sizes are expected to shape cognitive outcomes among older adults.

First, in peri-urban and industrializing regions, communities may undergo overall growth or stability together with an expanding share of older adults. While population stability and growth might suggest stronger support systems, these contexts are often driven by economic restructuring and selective migration that prioritize younger, working-age residents (X. Chen et al., 2024; Gao et al., 2022; Zhang et al., 2025). From a life course and cumulative disadvantage perspective (Dannefer, 2003; Jr., 1994), older adults risk marginalization as healthcare, housing, and infrastructure are directed toward younger populations. Even when collective activities such as *guangchang wu* (square dancing, a popular form of social activity among older adults in China) persist, older residents may encounter greater competition for resources and public space (Qian & Lu, 2019; Song et al., 2024). Consistent with the ecological model of aging (Lawton & Nahemow, 1973), this mismatch between environmental priorities and older adults' needs undermines person–environment fit and limits opportunities for cognitive engagement. Unlike the "growth or stability with declining share" scenario, where older adults become proportionally less visible, this trajectory involves both numerical and proportional growth of older residents yet still exposes them to marginalization due to competing institutional priorities. Therefore, ***we hypothesize that older adults in aging-with-stable/growth communities will exhibit lower cognitive outcomes relative to those in shrinking-with-aging communities.***

Second, in rapidly urbanizing or structurally stable regions, population growth or stability is often driven by the in-migration or retention of younger cohorts, which reduces the relative share of older adults. In these contexts, older residents face declining social visibility, erosion of age-peer networks, and weakened social cohesion as neighborhoods reshape to accommodate younger labor forces. Generativity theory (McAdams & de St. Aubin, 1992) highlights the cognitive benefits of intergenerational ties, but when older adults become numerically and socially peripheral, opportunities for such engagement diminish. As their visibility decreases, age-peer networks weaken, and institutional priorities shift toward younger groups, older residents face heightened risks of social isolation and reduced cognitive engagement. Accordingly, ***we hypothesize that older adults in stable and growth-with-declining-share communities will demonstrate lower cognitive outcomes relative to those in aging-with-growth and shrinking-with-aging communities.***

Third, rural and outmigration-dominated areas are characterized by population decline and a rising share of older adults. These communities often face shrinking economic activities, loss of institutional capacity, and limited access to healthcare and social services. From a stress process perspective (Pearlin, 1989), such structural disadvantages accumulate and heighten risks to cognitive health. At the same time, however, the concentration of older adults may foster dense bonding social capital and mutual support networks 10/2/2025 9:39:00 PM, which could partially buffer against isolation and cognitive decline (e.g, dense age-peer concentrations allow older residents to maintain bonding social capital through daily collective activities) in village squares or other communal spaces. This suggests that dense peer networks and bonding social capital may buffer risks and provide cognitive stimulation, partially offsetting institutional decline. Thus, ***we hypothesize that older adults in shrinking-with-aging communities will maintain relatively better cognitive outcomes compared to those in aging-with-growth and growth-with-declining-share communities.***

Fourth, in some transitional or depopulating areas, both younger and older residents migrate away, leading to overall population decline and a shrinking share of older adults. These communities are marked by institutional contraction, weakened local economies, and diminished service availability (Johnson & Lichter, 2019; Long & Woods, 2011). The rural restructuring and out-migration processes that drive this decline have been widely documented across North America, Europe, and East Asia (Frey, 1987; Hedlund & Lundholm, 2015; Johnson & Lichter, 2019; Long & Woods, 2011). The demographic loss in these communities undermines local tax bases, erodes civic organizations, and reduces the capacity of local institutions to support residents due to a lack of resources (Thiede et al., 2017). However, unlike "shrinking-with-aging" contexts where older adults become disproportionately concentrated, "shrinking-with-decline" communities also experience a decrease in older residents (due to mortality or/and outmigration), resulting in a reduced burden of age-related needs. This demographic profile may temporarily alleviate pressures on already constrained healthcare and caregiving infrastructures (Walsh et al., 2012; Wilson 2022). In ecological terms, the mismatch between population needs and environmental capacity is less pronounced because the demand for elder-oriented services is relatively lower. Consequently, the absence of concentrated aging-related demands may buffer some of the institutional risks of decline, producing ambiguous implications for cognitive health. On this basis, ***we hypothesize that older adults in shrinking-with-decline communities will show no significant differences in cognitive outcomes compared to those in shrinking-with-aging contexts.***

These four typologies capture how different combinations of population growth or decline and shifts in the relative size of older residents shape cognitive health risks. These associations between population change dynamics and cognitive outcomes among the elderly may vary by the broader structural and institutional context of community size. Larger cities have more robust infrastructures to absorb demographic change, while small towns and villages face chronic scarcity but often maintain traditional kinship and neighborly networks. As a result, the cognitive consequences of demographic typologies are expected to vary systematically across community size, with older adults in moderate- and small-sized communities facing the greatest disadvantages when demographic structures become unfavorable. Therefore, we develop these two additional hypotheses:

First, independent of demographic typology, community size constitutes a critical determinant of cognitive health. Larger communities provide richer environments through greater access to healthcare, cultural institutions, educational opportunities, and transportation infrastructure. These features expand opportunities for social participation and cognitive engagement, consistent with theories of collective efficacy (Sampson, 2012). In contrast, small towns and villages face persistent structural scarcity and limited institutional depth, conditions that constrain enrichment opportunities and are reflected in systematically lower cognitive outcomes among older adults. ***Therefore, we hypothesize that older adults in larger cities will demonstrate the most favorable cognitive outcomes, followed by those in moderate-sized towns, with small towns experiencing the greatest disadvantage.***

Finally, community size is also expected to condition the consequences of demographic change. Moderate-sized towns, such as county-level cities and rapidly urbanizing townships in China, are structurally vulnerable: they lack the institutional depth of large cities while also being more exposed to demographic turnover than rural villages. Small towns and villages similarly face chronic scarcity and weak institutional capacity. Both settings heighten risks of marginalization, resource constraints, and disrupted social cohesion, particularly under unfavorable demographic regimes such as declining elderly populations or shrinking communities. In contrast, larger cities are better positioned to buffer these risks through stronger institutions and broader opportunities for engagement. We ***hypothesize that the disadvantages of unfavorable demographic typologies will be most pronounced in moderate- and small-sized communities, while larger cities will buffer these effects.***

Data and Methods

The data are drawn from two waves of China Family Panel Studies (CFPS), 2010 and 2014. CFPS is a nationally representative longitudinal survey that has collected information biennially since 2010 at the individual, family, and community levels. This survey provides valuable data to capture changes in China's society, economy, population, education, and health.

Because community-level data are only available in 2010 and 2014, we focus on these two waves for the present study. Community questionnaires are completed by knowledgeable local informants, such as village leaders or neighborhood committee representatives, who provide information on population characteristics, infrastructure, and community resources. At the community level, demographic characteristics are available from selected community samples, including the age structure of the permanent resident population and the population size. At the individual level, CFPS provides detailed demographic, socioeconomic, and health-related information, providing a solid basis for our analysis. Aging typologies were constructed from community demographic characteristics, including the age structure of the permanent resident population as well as the population size, based on the 2010 and 2014 data, and then merged into the 2014 individual-level dataset. All dependent and control variables are measured using 2014 data, which allows us to establish temporal ordering by linking prior community change (2010–2014) to subsequent individual cognitive outcomes in 2014.

Key Dependent Variable

Cognitive health of older adults is measured using the combined score from a word test and a math test administered in the CFPS. In the word test, respondents were asked to read up to 34 words, with the starting point determined by their educational attainment. One point was assigned for each correct response, yielding scores from 0 to 34. The math test followed a similar procedure that assesses respondents' basic numerical ability with scores ranging from 0 to 24. The two components were summed to generate a composite cognitive score ranging from 0 to 58. For the analysis, we standardized this measure to a z-score. This combined indicator, which is widely used in CFPS-based research (Lu et al., 2025), captures both verbal memory and numeracy and thus provides a valid and reliable measure of cognitive functioning in later life.

Key Independent Variables

Neighborhood typology

Neighborhood typology is constructed using community-level data from 2010 and 2014 CFPS to capture changes in both the total permanent resident population and the proportion of older adults. In each wave, the community questionnaire included items on (1) the total permanent resident population ("Among the total population, what was the permanent resident population in your village/residential community?") and (2) the number of permanent residents aged 60 or older ("Among the permanent resident population in your village/residential community, how many were aged 60 and older?"). Using these measures, we calculated (a) the change in total permanent resident population and (b) the change in the share of older adults between 2010 and 2014. Based on these two dimensions, we constructed four typologies of community demographic change and aging dynamics. A community was defined as "stable" if the change in total population between 2010 and 2014 was within ±5%. Based on these two dimensions, we classified communities into four typologies of demographic change and aging dynamics as shown below:

Table 1: Neighborhood change typology construction

Neighborhood Typology	Total permanent residents	% of Residents Aged 60+
Aging with Stable and Growth	Stable or ↑	↑
Declining Share with Stable and Growth	Stable or ↑	↓
Shrinking with Aging	↓	↑
Shrinking with Decline	↓	↓

These typologies capture distinct demographic regimes that are key to our analysis. "Aging with stable and growth" reflects communities experiencing both overall growth (or stable) and a rising share of older adults, while "Declining share with stable and growth" reflects growth driven largely by younger cohorts. "Shrinking with aging" captures rural or outmigration contexts with declining population but a rising aging burden, whereas "shrinking with decline" represents depopulating areas where both overall numbers and the share of older adults are falling.

Community size

Community size was measured using responses to this question: "What was the total number of households in your village/residential community?" To account for differences between urban and rural contexts, tertile cutoffs were calculated separately within urban and rural areas. Based on these cutoffs, communities were classified into three groups: small, moderate, and large.

Individual-Level Control Variables

At the individual level, we controlled for demographic, socioeconomic, and health characteristics. Age was measured continuously, with the analytic sample restricted to adults aged 50 and older. Gender was coded as a binary variable (1 = male, 0 = female). Household income was based on total family income during the past 12 months, including operational income, wages, property income, and transfers, which we recoded into quartiles to capture relative income status. Co-residence with children was derived from a constructed CFPS variable that aggregated household roster information; respondents were coded as 1 if they lived with at least one child and 0 otherwise. Self-rated health was measured using the question, *"How would you rate your health status?"* with five response options ranging from excellent to poor. We reverse-coded the variable so that higher scores indicate better health. Marital status was recoded into a binary measure, where 1 indicates being married and 0 indicates never married, cohabiting, divorced, or widowed. We constructed a categorical variable of residential mobility, *move*, based on changes in respondents' community identifiers across survey waves.

Respondents who reported a different community ID than in the previous wave were coded as 1 = moved, those whose community ID remained the same were coded as 2 = did not move, and cases for which continuity of community membership could not be established were coded as 3 = missing.

Finally, education and employment were included as indicators of socioeconomic position. Education was based on a constructed variable for years of schooling, recoded into three categories: illiterate, primary school, and junior high school or above. Employment status was measured from a constructed variable distinguishing "employed," "unemployed," "out of the labor market," and "not applicable." After restricting the sample to adults aged 50 and older, no respondents fell into the "not applicable" category. We therefore collapsed the remaining categories into a binary variable indicating whether the respondent was employed (1) or not employed (0).

Although hukou status is an important determinant of health and cognition in China, we did not include it as a covariate in our main models. Hukou is not merely a demographic characteristic but a structural institution that encodes cumulative advantage and disadvantage across the life course. From birth onward, hukou status shapes education, employment, healthcare, and pension systems, with long-term consequences for cognitive health in later life. In this sense, hukou represents a constitutive element of the institutional framework that structures inequality across community types. Adjusting for hukou would risk overcontrol, obscuring the very mechanisms through which community-level demographic change and urban hierarchy shape cognitive outcomes. For this reason, we treat hukou as part of the explanatory context rather than as an exogenous control variable.

Community-Level Control Variables

At the community level, we included three controls. First, urban status is a constructed variable in the 2014 CFPS dataset, coded according to the Census Bureau's definition. Communities located in urban areas were coded as 1, and those in rural areas as 0. Second, community resources were measured by the reported number of hospitals/medical facilities and drugstores within the village or residential community. These two indicators were summed to create a continuous measure of resource availability. Finally, community socioeconomic status was proxied by the proportion of households meeting the enrollment requirements for the *minimum living standard security system*, which reflects the share of households receiving social assistance.

Analytical Strategy

We employed multilevel modeling to examine the relationship between community demographic change, community size, and cognitive outcomes among older adults. This approach is appropriate given the hierarchical structure of the CFPS data, with individuals nested within communities, and allows us to simultaneously estimate the effects of individual- and community-level predictors on cognitive health. Multilevel models correct for the non-independence of observations within communities, reduce bias in standard errors, and enable the assessment of cross-level influences of community demographic trajectories on individual outcomes.

In this study, Level 1 represents the individual level, including demographic, socioeconomic, and health characteristics such as age, gender, education, employment, household income, marital status, living arrangement, and self-rated health. These variables capture within-community variation in cognitive outcomes. Level 2 represents the community level, including neighborhood typology, community size, urban status, resource availability, and socioeconomic context. These variables capture between-community variation and allow us to test how structural features of communities shape individual cognition. By modeling both levels simultaneously, we are able to distinguish the extent to which cognitive health disparities reflect individual characteristics versus broader community demographic and institutional contexts. Formally, the models can be expressed as:

Level 1 (individual): $Yij = \beta_{0j} + \sum_{k=1}^{K} \beta_{kj} X_{kij} + \varepsilon_{ij}$

where Yij is the cognitive outcome for the individual i in community j, $Xkij$ are individual-level covariates, $\beta 0 j$ is the community-specific intercept, βkj are coefficients for individual-level predictors, and εij is the individual-level error term.

Level 2 (community): $\beta 0 j = \gamma_{00} + \sum_{m=1}^{M} \gamma_{0m} Z_{mj} + u_{0j}$

where Z_{mj} are community-level predictors (e.g., typology, community size, urban status), γ_{00} is the overall intercept, γ_{0m} are effects of community-level predictors, and u_{0j} is the random effect capturing unobserved community variation.

We estimated random-intercept models only, which allows the average level of cognitive health to vary across communities while holding the slopes of individual-level predictors fixed across settings. This specification is appropriate given our focus on how community demographic typologies and community size shape variation in average cognitive outcomes, rather than on heterogeneity in individual-level associations across communities.

Results

Table 2 presents descriptive statistics for the analytic sample of 9,642 older adults, stratified by neighborhood typology. Overall, the mean raw cognitive score was 16.22 (SD = 14.86), corresponding to a standardized mean of 0. Cognitive outcomes varied across typologies.

Older adults in shrinking with increasing aging communities had the highest mean scores (raw = 17.49; z = 0.09), whereas those in declining elderly with stable/growing population communities had the lowest (raw = 15.25; z = –0.07).

[Table 2 about here]

Individual-level characteristics were broadly comparable across groups. For example, the mean age of respondents was 62 years, with little variation by typology. About half of respondents were male (49.8%), and roughly 85% were married across all categories. Educational attainment varied more substantially. Illiteracy was most prevalent in declining elderly with stable/growing population communities (38.9%) and least common in shrinking with increasing aging communities (33.4%), while attainment of junior high school or above was highest in shrinking with increasing aging (43.6%) and shrinking with decreasing aging communities (44.1%). Employment rates were highest in declining elderly with stable/growing population communities (64.6%). Household income distributions were relatively even across quartiles, though the lowest quartile accounted for about one-third of the sample overall. Living with children was slightly more common in declining elderly with stable/growing population (53.0%) and shrinking with decreasing aging communities (54.3%) than in shrinking with increasing aging communities (47.6%). Self-rated health was moderate across all groups, with average values ranging from 2.55 to 2.65 on the five-point scale. Overall, very few respondents reported changing communities with only 32 individuals (0.33%) moved between survey waves. The vast majority remained in the same community (87.69%), while 11.98% had unknown mobility status due to missing or unmatched community identifiers. Patterns of residential mobility varied slightly across community contexts. The prevalence of moving was highest in shrinking with aging communities (0.77%), while no moves were observed in shrinking with decline communities. Rates of unknown status were also somewhat higher in shrinking with decline (14.72%) compared to other contexts. These descriptive statistics suggest that community change is rare in the sample and that stability of residence is the predominant pattern.

Community-level characteristics reflected expected contrasts. The share of households enrolled in the minimum living standard security system averaged 10.8% overall, with higher rates in shrinking with increasing aging (12.1%) and shrinking with decreasing aging communities (11.6%). The number of health facilities averaged 3.1, ranging from 2.7 in declining elderly with stable/growing population to 3.5 in aging with stable/growing population communities. Urban residence accounted for 43% of the sample, highest in shrinking with increasing aging (47.9%) and lowest in declining elderly with stable/growing population communities (36.5%). Community size was roughly evenly distributed across the sample, though shrinking with decreasing aging communities were disproportionately small (41.7%), whereas aging with stable/growing population communities were more evenly spread across small, moderate, and large categories.

Table 3 reports results from three multilevel models predicting cognitive outcomes among older adults. In Model 1, which includes only neighborhood typology and community size, older adults in declining elderly with stable/growing population communities also exhibited lower scores relative to the shrinking with increasing aging reference group ($b = –0.18$, $p < .01$). Residents of aging with stable/growing population communities and-shrinking with decreasing aging communities did not differ significantly from the reference group. With respect to community size, older adults in both moderate-sized communities ($b = 0.30$, $p < .001$) and large communities ($b = 0.37$, $p < .001$) scored significantly higher than those in small communities.

[Table 3 about here]

Model 2 of Table 3 adjusts for age and gender and shows consistent patterns observed in Model 1. Cognitive scores were significantly lower in aging with stable/growing population communities (b = –0.14, p < .05) and in declining elderly with stable/growing population communities (b = –0.20, p < .01), relative to shrinking with increasing aging communities. The advantage of larger community size also persisted, with moderate-sized (b = 0.34, p < .001) and large communities (b = 0.42, p < .001) both associated with higher scores than small communities. Age was negatively associated with cognition (b = –0.03, p < .001), while men scored higher than women (b = 0.55, p < .001).

Model 3 includes interactions between neighborhood demographic typologies and community size, along with a full set of individual- and community-level controls. Overall model fit improves substantially compared to Models 1 and 2 (BIC decreases to 20,632), and the addition of interaction terms reduces both the community-level and residual variance components, indicating that a portion of between-community heterogeneity is explained by the combined effects of neighborhood trajectories and community size.

Turning to the main effects, relative to the reference group (shrinking population with increasing aging in small communities), older adults in small communities experiencing aging with stable or growing populations have significantly lower cognitive scores (β = –0.18, p < .05). Similarly, those in small communities with declining elderly but stable/growing overall populations show a negative but non-significant association (β = –0.14). These results suggest that, in small communities, neighborhood demographic change tends to be detrimental or at least not beneficial for cognitive outcomes.

The interaction terms, however, reveal an important moderating role of community size. In large communities, the disadvantages associated with demographic change are attenuated and, in some cases, reversed. For example, the negative association of aging with stable/growing populations in small communities becomes significantly positive in large communities (interaction $\beta = 0.23$, $p < .05$). Similarly, large communities buffer the negative implications of declining elderly with stable/growing populations (interaction $\beta = 0.23$, $p < .05$). In contrast, the interaction terms for moderate-sized communities are small and not significant, suggesting that the buffering effect is distinctive to large communities.

Figure 1 illustrates the interaction effects of neighborhood typology and community size on cognitive outcomes. Estimates are drawn from fully adjusted multilevel model 3, with *Shrinking with Aging–Small communities* as the reference category. All other combinations are expressed relative to this baseline. The figure demonstrates that negative associations between community demographic change and cognitive outcomes are concentrated in small communities across most typologies, where limited institutional resources likely amplify risks. By contrast, in large urban communities the adverse effects of demographic change are buffered or even reversed, reflecting stronger infrastructures and more diverse opportunities for engagement. Moderate-sized towns fall in between, highlighting their structural fragility: too large to rely primarily on kin-based cohesion yet too small to sustain robust institutional depth.

[Figure 1 about here]

The control variables behave as expected. Advancing age is associated with lower cognitive scores ($\beta = -0.01$, $p < .001$), while being male, having higher family income, better self-rated health, being married, and higher educational attainment all predict significantly better cognitive performance. Notably, education has a strong gradient effect, with high school and above associated with more than one standard-unit increase in cognitive scores ($\beta = 1.17$, $p < .001$ compared to illiterate). Living with children is negatively associated with cognition ($\beta = –$

0.09, $p < .001$), consistent with prior evidence of role strain or caregiving burden (S. E. Choi et al., 2024; Pan et al., 2022). At the community level, residing in urban areas predicts higher cognitive outcomes (β = 0.27, $p < .001$), net of other factors.

Table 4 presents stratified models by community size. This part of the analysis allows us to examine whether the association between neighborhood typologies and cognitive health differs in small, moderate, and large communities. In small communities (Model 1), neighborhood demographic trajectories are significantly associated with cognitive outcomes. Relative to the reference category (shrinking population with increasing aging), older adults in *aging with stable/growing population, a shrinking population with aging* and a *shrinking population with decreasing aging* exhibit lower cognitive scores (β = –0.17, $p < .01$; β = –0.13, $p < .05$; β = –0.17, $p < .05$, respectively). These results suggest that in small communities, demographic change, whether through aging with growth or overall decline, tends to coincide with disadvantages for cognitive health.

[Table 4 about here]

In moderate-sized communities (Model 2), the effects of neighborhood typologies are weaker and largely nonsignificant. This pattern suggests that moderate-sized communities may partly buffer the negative consequences of demographic change, possibly due to intermediate levels of institutional capacity and service availability. In large communities (Model 3), the direction of associations shifts. None of the neighborhood typologies is associated with cognitive disadvantages relative to the shrinking-with-aging reference; instead, the coefficients for all three types are positive (though not statistically significant). This reversal indicates that in large communities, demographic shifts may coincide with stable or even advantageous environments for cognitive health, likely due to stronger institutions, better service provision, and more diverse opportunities for engagement.

Discussion and Conclusions

Research on neighborhood socioeconomic conditions as determinants of cognitive health has advanced considerably, yet efforts to fully integrate demographic change into these frameworks have been limited. Most existing studies either treat communities as static environments or focus on single indicators such as aging or migration, overlooking the ways population size and age composition evolve together. We attempted to redress this limitation by using prospective data from the China Family Panel Studies (CFPS, 2010–2014), a nationally representative longitudinal survey that tracks individuals within more than 500 communities across a period of rapid demographic transformation. We constructed typologies of neighborhood demographic change that capture distinct combinations of aging and population growth or decline, and we examined how these trajectories interact with community size to shape older adults' cognitive health. By applying multilevel models to a large panel dataset, our analysis highlights how dynamic demographic contexts contribute to cognitive outcomes above and beyond individual- and household-level factors. We believe this approach not only extends ecological and cognitive reserve perspectives to the community-demographic domain but also offers a framework for comparative research on aging in fast-changing societies. Our analysis leads to three main conclusions: (1) demographic typologies highlight distinct risks and opportunities for cognitive health, (2) community size strongly moderates the consequences of demographic change, and (3) cognitive reserve may serve as a central mechanism linking demographic environments to resilience in later life.

Our first conclusion is that demographic typologies matter, and the specific trajectory of population change in a community shapes cognitive outcomes for older adults. Even in expanding or stable communities (*H1: aging with stable and growth*), older adults may experience disadvantages when institutional and policy priorities shift toward younger, working-age groups, limiting age-appropriate opportunities for engagement. By contrast, the largest penalties occur in *H2: declining elderly with stable and growth* communities, where reductions in age-peer networks and social visibility weaken collective cultural activities such as *guangchangwu*, eroding key sources of cognitive stimulation. At the same time, not all demographic decline is uniformly harmful. In *H3: shrinking with aging* communities, dense concentrations of older adults foster bonding social capital and shared routines that appear to sustain cognitive reserve, producing better-than-expected outcomes. Finally, in *H4: shrinking with declining aging* contexts, the results are mixed. While institutional contraction reduces service capacity, lower age-related demand tempers these pressures, yielding more ambiguous cognitive implications. These findings show that demographic trajectories capture more than simple population counts, rather, they organize social visibility, peer networks, and the availability of cognitively stimulating environments.

Second, the consequences of demographic change are contingent on community size. The stratified models show that adverse associations between neighborhood typology and cognitive health are concentrated in small communities, where limited institutional capacity and scarce resources amplify the risks of demographic turnover. For example, in small towns, living in aging-with-growth ($\beta = -0.17$, $p < .01$), growth-or-stable-with-declining-share ($\beta = -0.13$, $p < .05$), or shrinking-with-decline ($\beta = -0.17$, $p < .05$) communities is consistently associated with lower cognitive outcomes compared to the shrinking-with-aging reference. By contrast, in large communities, these disadvantages largely disappear and, in some cases, reverse direction (e.g., positive though nonsignificant coefficients for aging-with-growth and growth-with-declining-share). The institutional depth, service availability, and diverse opportunities in urban areas appear to buffer older adults from the risks of demographic change, reflecting an urban advantage (supporting H5). Meanwhile, moderate-sized towns emerge as particularly fragile settings. Here, the negative associations are weaker or nonsignificant, but these places lack both the kin-based cohesion of small villages and the institutional capacity of large cities. This structural in-between position leaves older adults vulnerable when demographic turnover erodes social activities and local networks, consistent with H6.

Third, across typologies and sizes, the key pathway linking demographic change to cognitive health lies in the maintenance of cognitive reserve through socially embedded opportunities for stimulation. Where demographic change erodes age-peer networks, reduces collective activities, or disrupts culturally embedded practices, older adults face greater risks of cognitive decline. This is most evident in small communities, where shrinking institutional capacity coincides with demographic disadvantage. Conversely, where demographic change preserves or enhances opportunities for engagement, such as in shrinking-with-aging contexts, where older adults are concentrated, or in large urban settings with resource-rich environments, older adults demonstrate relative resilience. This interpretation extends cognitive reserve theory beyond individual-level resources (e.g., education, occupation) to encompass community-level demographic and institutional dynamics (Bettcher et al, 2019; Kim et al., 2024). It highlights the interplay between environmental press and person–environment fit, long emphasized in ecological models of aging, and underscores the need to consider how demographic trajectories structure opportunities for cognitive engagement across diverse community contexts.

Although these dynamics are especially visible in China, where rapid aging and unprecedented rural-to-urban migration have produced compressed demographic transitions, the framework developed here applies more broadly. Many fast-developing societies across Asia, Latin America, and Eastern Europe are simultaneously experiencing urban expansion, population redistribution, and rising old-age dependency ratios (Biegańska et al., 2018; Jayanthakumaran et al., 2019; Schneider et al., 2015). Our findings highlight the value of integrating demographic typologies and community size into the study of cognitive aging and provide a comparative framework to assess how population dynamics intersect with health across diverse contexts. Future research should test these hypotheses in other national settings, explore how policy environments condition these relationships, and extend the analysis to longitudinal cognitive decline trajectories.

Several limitations should be acknowledged. First, although the CFPS provides nationally representative longitudinal data, the analytic window is limited to four years. While this period coincides with massive demographic restructuring in China, longer-term data would allow stronger inferences about cumulative exposures and trajectories of cognitive decline. Second, our measures of community demographic change are constructed from survey-based population profiles, which may not fully capture underlying migration flows or unobserved heterogeneity in settlement dynamics. Future work could integrate administrative or census data to validate and refine typologies of demographic change. Third, while our models adjust for a wide range of individual- and community-level covariates, unmeasured factors, such as local governance quality, environmental conditions, or cultural norms, may also shape cognitive outcomes (Berry, 2015; Carl, 2015; Chaar et al., 2025). Finally, our study is situated in China, a country undergoing unusually rapid urbanization and demographic transition. Comparative analyses across different national and regional contexts will be critical to assess the generalizability of these findings. Future research should also move beyond static measures to explore how dynamic feedback loops between migration, institutional capacity, and social participation shape cognitive health over the life course.

The analysis presented here lays the groundwork for a more thorough understanding of how community demographic trajectories shape cognitive aging. Our most important findings concern the interplay between demographic typologies and community size. Prior research on cognitive health has tended to emphasize individual-level education, health, and socioeconomic resources (Fletcher et al., 2021; Lee et al., 2010; Ye et al., 2022), while studies of neighborhood environments have highlighted the role of static socioeconomic conditions (Meyer et al., 2021; Rosso et al., 2016; Tang et al., 2023). Our results suggest that dynamic processes of demographic change, both population growth and decline, as well as shifts in the share of older adults, also play a central role. Just as ecological models of aging emphasize person–environment fit and cognitive reserve theory underscores the importance of stimulating contexts, we find that "trajectories" of change over time in demographic features contribute significantly to cognitive outcomes in later life.

Reference

Berry, J. W. (2015). Chapter 6 - Culture and Cognition: A Forty-Year Overview. In T. C. Papadopoulos, R. K. Parrila, & J. R. Kirby (Eds.), *Cognition, Intelligence, and Achievement* (pp. 101–115). Academic Press. https://doi.org/10.1016/B978-0-12-410388-7.00006-3

Best, J. R. (2024). Individual socioeconomic status, neighborhood disadvantage, and cognitive aging: A longitudinal analysis of the CLSA. *Journal of the American Geriatrics Society*, *72*(11), 3335–3345. https://doi.org/10.1111/jgs.19155

Biegańska, J., Środa-Murawska, S., Kruzmetra, Z., & Swiaczny, F. (2018). Peri-Urban Development as a Significant Rural Development Trend. *Quaestiones Geographicae*, *37*(2), 125–140. https://doi.org/10.2478/quageo-2018-0019

Bosma, H., Dike van de Mheen, H., Borsboom, G. J. J. M., & Mackenbach, J. P. (2001). Neighborhood Socioeconomic Status and All-Cause Mortality. *American Journal of Epidemiology*, *153*(4), 363–371. https://doi.org/10.1093/aje/153.4.363

Carl, N. (2015). Cognitive ability and political beliefs in the United States. *Personality and Individual Differences*, *83*, 245–248. https://doi.org/10.1016/j.paid.2015.04.029

Chaar, D. L., Tu, L., Moore, K., Du, J., Opsasnick, L. A., Ratliff, S. M., Mosley, T. H., Kardia, S. L. R., Zhao, W., Zhou, X., Diez Roux, A. V., Faruque, F. S., Butler, K. R., & Smith, J. A. (2025). Neighborhood environment associations with cognitive function and structural brain measures in older African Americans. *BMC Medicine*, *23*(1), 15. https://doi.org/10.1186/s12916-024-03845-7

Chen, M., Gong, Y., Li, Y., Lu, D., & Zhang, H. (2016). Population distribution and urbanization on both sides of the Hu Huanyong Line: Answering the Premier's question. *Journal of Geographical Sciences*, *26*(11), 1593–1610. https://doi.org/10.1007/s11442-016-1346-4

Chen, S., Wang, T., Bao, Z., & Lou, V. (2022). A Path Analysis of the Effect of Neighborhood Built Environment on Public Health of Older Adults: A Hong Kong Study. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.861836

Chen, X., Yu, L., Li, Y., Liu, T., Liu, J., Peng, D., Zhang, X., Fang, C., & Gong, P. (2024). China's ongoing rural to urban transformation benefits the population but is not evenly spread. *Communications Earth & Environment*, *5*(1), 416. https://doi.org/10.1038/s43247-024-01580-8

Choi, S. E., Zhang, Z., & Liu, H. (2024). Gender Differences in the Protective Role of Grandparenting in Dementia Risk. *The Journals of Gerontology: Series B*, *79*(6), gbae034. https://doi.org/10.1093/geronb/gbae034

Choi, Y. J., & Matz-Costa, C. (2018). Perceived Neighborhood Safety, Social Cohesion, and Psychological Health of Older Adults. *The Gerontologist*, *58*(1), 196–206. https://doi.org/10.1093/geront/gnw187

Cramm, J. M., van Dijk, H. M., & Nieboer, A. P. (2013). The Importance of Neighborhood Social Cohesion and Social Capital for the Well Being of Older Adults in the Community. *The Gerontologist*, *53*(1), 142–152. https://doi.org/10.1093/geront/gns052

Dannefer, D. (2003). Cumulative Advantage/Disadvantage and the Life Course: Cross-Fertilizing Age and Social Science Theory. *The Journals of Gerontology: Series B*, *58*(6), S327–S337. https://doi.org/10.1093/geronb/58.6.S327

Dong, Y., He, X., Ye, L., Sun, L., Li, J., Xu, J., Cui, Y., Li, Z., Hu, L., & Bai, G. (2023). Determinants of depression, problem behavior, and cognitive level of adolescents in China: Findings from a national, population-based cross-sectional study. *Frontiers in Psychiatry*, *14*. https://doi.org/10.3389/fpsyt.2023.1159739

Feng, J., Tang, S., & Chuai, X. (2018). The impact of neighbourhood environments on quality of life of elderly people: Evidence from Nanjing, China. *Urban Studies*, *55*(9), 2020–2039. https://doi.org/10.1177/0042098017702827

Fletcher, J., Topping, M., Zheng, F., & Lu, Q. (2021). The effects of education on cognition in older age: Evidence from genotyped Siblings. *Social Science & Medicine*, *280*, 114044. https://doi.org/10.1016/j.socscimed.2021.114044

Frey, W. H. (1987). Migration and Depopulation of the Metropolis: Regional Restructuring or Rural Renaissance? *American Sociological Review*, *52*(2), 240. https://doi.org/10.2307/2095452

Gao, Y., Pitts, A., & Jiang, W. (2022). Peri-urban villages in Kunming, Southwest China: History of change with dual urban–rural characteristics. *The Journal of Architecture*, *27*(7–8), 1063–1089. https://doi.org/10.1080/13602365.2022.2156911

Hedlund, M., & Lundholm, E. (2015). Restructuring of rural Sweden – Employment transition and out-migration of three cohorts born 1945–1980. *Journal of Rural Studies*, *42*, 123–132. https://doi.org/10.1016/j.jrurstud.2015.10.006

Jayanthakumaran, K., Verma, R., Wan, G., & Wilson, E. (Eds.). (2019). *Internal Migration, Urbanization and Poverty in Asia: Dynamics and Interrelationships*. Springer Singapore. https://doi.org/10.1007/978-981-13-1537-4

Jia, J., Wei, C., Chen, S., Li, F., Tang, Y., Qin, W., Zhao, L., Jin, H., Xu, H., Wang, F., Zhou, A., Zuo, X., Wu, L., Han, Y., Han, Y., Huang, L., Wang, Q., Li, D., Chu, C., … Gauthier, S. (2018). The cost of Alzheimer’s disease in China and re-estimation of costs worldwide. *Alzheimer’s & Dementia*, *14*(4), 483–491. https://doi.org/10.1016/j.jalz.2017.12.006

Jia, L., Du, Y., Chu, L., Zhang, Z., Li, F., Lyu, D., Li, Y., Zhu, M., Jiao, H., Song, Y., Shi, Y., Zhang, H., Gong, M., Wei, C., Tang, Y., Fang, B., Guo, D., Wang, F., Zhou, A., … Qiu, Q. (2020). Prevalence, risk factors, and management of dementia and mild cognitive impairment in adults aged 60 years or older in China: A cross-sectional study. *The Lancet Public Health*, *5*(12), e661–e671. https://doi.org/10.1016/S2468-2667(20)30185-7

Johnson, K. M., & Lichter, D. T. (2019). Rural Depopulation: Growth and Decline Processes over the Past Century. *Rural Sociology*, *84*(1), 3–27. https://doi.org/10.1111/ruso.12266

Jr., G. H. E. (1994). Time, Human Agency, and Social Change: Perspectives on the Life Course. *Social Psychology Quarterly*, *57*(1), 4. https://doi.org/10.2307/2786971

Kim, B., Yannatos, I., Blam, K., Wiebe, D., Xie, S. X., McMillan, C. T., ... & Lee, E. B. (2024). Neighborhood disadvantage reduces cognitive reserve independent of neuropathologic change. *Alzheimer's & Dementia*, *20*(4), 2707-2718.

Lawton, M. P., & Nahemow, L. (1973). Ecology and the aging process. In *The psychology of adult development and aging* (pp. 619–674). American Psychological Association. https://doi.org/10.1037/10044-020

Lee, Y., Back, J. H., Kim, J., Kim, S.-H., Na, D. L., Cheong, H.-K., Hong, C. H., & Kim, Y. G. (2010). Systematic review of health behavioral risks and cognitive health in older adults. *International Psychogeriatrics*, *22*(2), 174–187. https://doi.org/10.1017/S1041610209991189

Li, J., Cai, X., & Wamsiedel, M. (2024). Perceptions, opportunities and barriers of social engagement among the Chinese older adults: A qualitative study. *BMC Geriatrics*, *24*(1), 1033. https://doi.org/10.1186/s12877-024-05629-3

Li, Y., & Morrow-Howell, N. (2024). Assessing Social Capital Among Chinese Older Adults: Dimensions and Associative Factors. *Health & Social Care in the Community*, *2024*(1), 1599530. https://doi.org/10.1155/2024/1599530

Liang, Z., Nau, C., Xie, F., Vogel, R., & Chen, W. (2020). The Application of Community-Based Information from the American Community Survey in a Large Integrated Health Care Organization. *The Permanente Journal*, *25*, 20.010. https://doi.org/10.7812/TPP/20.010

Liu, Y., Liu, Z., Liang, R., & Luo, Y. (2022). The association between community-level socioeconomic status and cognitive function among Chinese middle-aged and older adults: A study based on the China Health and Retirement Longitudinal Study (CHARLS). *BMC Geriatrics*, *22*(1), 239. https://doi.org/10.1186/s12877-022-02946-3

Long, H., & Woods, M. (2011). Rural Restructuring Under Globalization in Eastern Coastal China: What Can be Learned From Wales? *Journal of Rural and Community Development / Revue Du Développement Rural et Communautaire*, *6*(1). https://journals.brandonu.ca/jrcd/article/view/426

Lu, Z., Hu, T., Kang, S., Fan, K., Liu, L., & Zhou, Y. (2025). Associations of family socioeconomic status during childhood with cognitive development in later life in China: A population-based cohort study. *Journal of Affective Disorders*, *379*, 297–303. https://doi.org/10.1016/j.jad.2025.03.035

McAdams, D. P., & de St. Aubin, E. (1992). A theory of generativity and its assessment through self-report, behavioral acts, and narrative themes in autobiography. *Journal of Personality and Social Psychology*, *62*(6), 1003–1015. https://doi.org/10.1037/0022-3514.62.6.1003

Menec, V. H., Shooshtari, S., Nowicki, S., & Fournier, S. (2010). Does the Relationship Between Neighborhood Socioeconomic Status and Health Outcomes Persist Into Very Old Age? A Population-Based Study. *Journal of Aging and Health*, *22*(1), 27–47. https://doi.org/10.1177/0898264309349029

Meyer, O. L., Besser, L., Mitsova, D., Booker, M., Luu, E., Tobias, M., Farias, S. T., Mungas, D., DeCarli, C., & Whitmer, R. A. (2021). Neighborhood racial/ethnic segregation and cognitive decline in older adults. *Social Science & Medicine*, *284*, 114226. https://doi.org/10.1016/j.socscimed.2021.114226

Meyer, O. L., Besser, L., Tobias, M., George, K. M., Gavett, B., Farias, S. T., Bhagat, N., Pham, M. L., Chrisphonte, S., & Whitmer, R. A. (2023). Neighborhood socioeconomic status and segregation linked to cognitive decline. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*, *15*(1), e12401. https://doi.org/10.1002/dad2.12401

National Bureau of Statistics of China, 2015. Statistical Communiqué of the People's Republic of China on the 2014 National Economic and Social Development. https://www.stats.gov.cn/english/PressRelease/201502/t20150228_687439.html#:~:text=Of%20this%20total%2C%20urban%20permanent%20residents%20numbered,natural%20growth%20rate%20was%205.21%20per%20thousand.

Pan, X., Zhang, D., & Shi, L. (2022). Longitudinal Evidence on Grandparenting and Cognitive Function in Older Adults in China. *Journal of Intergenerational Relationships*, *20*(1), 18–38. https://doi.org/10.1080/15350770.2020.1742845

Pearlin, L. I. (1989). The Sociological Study of Stress. *Journal of Health and Social Behavior*, *30*(3), 241. https://doi.org/10.2307/2136956

Prince, M., Wimo, A., Guerchet, M., Ali, G.-C., Wu, Y.-T., & Prina, M. (n.d.). *World Alzheimer Report 2015. The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends.*

Qian, J., & Lu, Y. (2019). On the trail of comparative urbanism: Square dance and public space in China. *Transactions of the Institute of British Geographers*, *44*(4), 692–706. https://doi.org/10.1111/tran.12321

Röhr, S., Gibson, R. H., & Alpass, F. M. (2024). Higher socioeconomic deprivation in areas predicts cognitive decline in New Zealanders without cognitive impairment. *Scientific Reports*, *14*(1), 28314. https://doi.org/10.1038/s41598-024-79583-w

Rosso, A. L., Flatt, J. D., Carlson, M. C., Lovasi, G. S., Rosano, C., Brown, A. F., Matthews, K. A., & Gianaros, P. J. (2016). Neighborhood Socioeconomic Status and Cognitive Function in Late Life. *American Journal of Epidemiology*, *183*(12), 1088–1097. https://doi.org/10.1093/aje/kwv337

Sampson, R. J. (2012). *Great American City: Chicago and the Enduring Neighborhood Effect*. University of Chicago Press.

Schneider, A., Mertes, C. M., Tatem, A. J., Tan, B., Sulla-Menashe, D., Graves, S. J., Patel, N. N., Horton, J. A., Gaughan, A. E., Rollo, J. T., Schelly, I. H., Stevens, F. R., & Dastur, A. (2015). A new urban landscape in East–Southeast Asia, 2000–2010. *Environmental Research Letters*, *10*(3), 034002. https://doi.org/10.1088/1748-9326/10/3/034002

Shih, R. A., Ghosh-Dastidar, B., Margolis, K. L., Slaughter, M. E., Jewell, A., Bird, C. E., Eibner, C., Denburg, N. L., Ockene, J., Messina, C. R., & Espeland, M. A. (2011). Neighborhood Socioeconomic Status and Cognitive Function in Women. *American Journal of Public Health*, *101*(9), 1721–1728. https://doi.org/10.2105/AJPH.2011.300169

Song, J., Liu, L., Miao, H., Xia, Y., Li, D., Yang, J., Kan, H., Zeng, Y., & Ji, J. S. (2024). Urban health advantage and penalty in aging populations: A comparative study across major megacities in China. *The Lancet Regional Health – Western Pacific*, *48*. https://doi.org/10.1016/j.lanwpc.2024.101112

Stern, Y. (2002). What is cognitive reserve? Theory and research application of the reserve concept. *Journal of the International Neuropsychological Society*, *8*(3), 448–460. https://doi.org/10.1017/S1355617702813248

Stern, Y. (2009). Cognitive reserve. *Neuropsychologia*, *47*(10), 2015–2028. https://doi.org/10.1016/j.neuropsychologia.2009.03.004

Tang, F., Li, K., Rosso, A. L., Jiang, Y., & Li, M. (2023). Neighborhood segregation, socioeconomic status, and cognitive function among older Chinese immigrants. *Journal of the American Geriatrics Society*, *71*(3), 916–926. https://doi.org/10.1111/jgs.18167

Thiede, B. C., Brown, D. L., Sanders, S. R., Glasgow, N., & Kulcsar, L. J. (2017). A Demographic Deficit? Local Population Aging and Access to Services in Rural America, 1990–2010. *Rural Sociology*, *82*(1), 44–74. https://doi.org/10.1111/ruso.12117

Tucker-Seeley, R. D., Subramanian, S. V., Li, Y., & Sorensen, G. (2009). Neighborhood Safety, Socioeconomic Status, and Physical Activity in Older Adults. *American Journal of Preventive Medicine*, *37*(3), 207–213. https://doi.org/10.1016/j.amepre.2009.06.005

Wahl, H.-W., & Gerstorf, D. (2018). A conceptual framework for studying COntext Dynamics in Aging (CODA). *Developmental Review*, *50*, 155–176. https://doi.org/10.1016/j.dr.2018.09.003

Wahl, H.-W., & Oswald, F. (2010). Environmental Perspectives on Ageing. In D. Dannefer & C. Phillipson, *The SAGE Handbook of Social Gerontology* (pp. 111–124). SAGE Publications Ltd. https://doi.org/10.4135/9781446200933.n8

Walsh, K., O'Shea, E., Scharf, T., & Murray, M. (2012). Ageing in changing community contexts: Cross-border perspectives from rural Ireland and Northern Ireland. *Journal of Rural Studies*, *28*(4), 347–357. https://doi.org/10.1016/j.jrurstud.2012.01.012

Wilson, W. J. (2022). *The truly disadvantaged: The inner city, the underclass, and public policy*. University of Chicago press.

World Health Organization, 2025. Caring for an old population. https://www.who.int/china/activities/caring-for-an-ageing-population.

Ye, X., Zhu, D., & He, P. (2022). Direct and indirect associations between childhood socioeconomic status and cognitive function in the middle-aged and older adults in China. *Aging & Mental Health*, *26*(9), 1730–1737. https://doi.org/10.1080/13607863.2021.1935459

Zhang, H., Chen, C., & Li, X. (2025). Spatial patterns and determinants of inter-provincial migration across age groups in China. *PLOS ONE*, *20*(8), e0330948. https://doi.org/10.1371/journal.pone.0330948

Table 1. Descriptive Statistics by Neighborhood Change Typology, Chinese Family Panel Survey 2010-2014

	Overall	Aging with Stable and Growth	Declining Share with Stable and Growth	Shrinking with Aging	Shrinking with Decline
Dependent variables					
Cognitive Skills Raw Score	16.22 (14.86)	16.20 (15.06)	15.25 (14.30)	17.49 (15.06)	16.43 (15.18)
Cognitive Skills Z-score	-0.00 (1.00)	-0.00 (1.01)	-0.07 (0.96)	0.09 (1.01)	0.01 (1.02)
Individual-level variables					
Age	62.13 (8.82)	62.06 (8.85)	62.21 (8.73)	62.22 (8.83)	61.94 (8.95)
Self-rated Health	2.59 (1.24)	2.57 (1.23)	2.55 (1.25)	2.65 (1.26)	2.61 (1.23)
Male	4,798 (49.76%)	1,807 (49.83%)	1,455 (49.52%)	1,094 (49.84%)	442 (50.06%)
Married	8,179 (84.83%)	3,061 (84.42%)	2,486 (84.62%)	1,877 (85.51%)	775 (85.50%)
Never married/Cohabitation/ Divorced/Widowed	1,463 (15.17%)	565 (15.58%)	452 (15.38%)	318 (14.49%)	128 (14.50%)
Education					
Illiterate	3,534 (36.65%)	1,337 (36.87%)	1,142 (38.87%)	733 (33.39%)	322 (36.47%)
Primary School	2,146 (22.26%)	784 (21.62%)	685 (23.32%)	505 (23.01%)	172 (19.48%)
Junior High School and above	3,962 (41.09%)	1,505 (41.51%)	1,111 (37.81%)	957 (43.60%)	389 (44.05%)
Employed	5,810 (60.26%)	2,170 (59.85%)	1,899 (64.64%)	1,209 (55.08%)	532 (60.25%)
Total family income					
Low	3,379 (35.04%)	1,289 (35.55%)	1,046 (35.60%)	748 (34.08%)	296 (33.52%)
Low-medium	2,438 (25.29%)	942 (25.98%)	757 (25.77%)	533 (24.28%)	206 (23.33%)
Medium-high	1,675 (17.37%)	652 (17.98%)	470 (16.00%)	389 (17.72%)	164 (18.57%)
High	2,150 (22.30%)	743 (20.49%)	665 (22.63%)	525 (23.92%)	217 (24.58%)
Live with Children	4,907 (50.89%)	1,826 (50.36%)	1,557 (53.00%)	1,054 (47.61%)	479 (54.25%)
Move	32 (0.33%)	9 (0.25%)	6 (0.20%)	17 (0.77%)	0 (0.00%)
Not move	8,455 (87.69%)	3,154 (86.98%)	2,615 (89.01%)	1,933 (88.06%)	753 (85.28%)
Unknown	1,155 (11.98%)	463 (12.77%)	317 (10.79%)	245 (11.16%)	130 (14.72%)
Community-level variables					
Minimum Living Standard Security Coverage Rate	10.80 (12.66)	10.20 (10.81)	10.34 (9.81)	12.10 (16.64)	11.55 (15.98)
Number of Health Facilities	3.12 (3.58)	3.49 (3.57)	2.68 (2.94)	3.18 (4.43)	2.95 (3.05)
Urban area	4,178 (43.33%)	1,675 (46.19%)	1,071 (36.45%)	1,052 (47.93%)	380 (43.04%)
Community size					
Small	3,101 (32.16%)	1,111 (30.64%)	892 (320.36%)	730 (33.26%)	368 (41.68%)
Moderate	3,259 (33.80%)	1,205 (33.23%)	1,102 (37.51%)	717 (32.67%)	235 (26.61%)
Large	3,282 (34.04%)	1,310 (36.13%)	944 (32.13%)	748 (34.08%)	280 (31.71%)
Number of observations	9,642	3,626	2,938	2,195	883

Table 2 Multilevel Models Predicting Older Adults' Cognitive Ability, Chinese Family Panel Survey 2010-2014

	Model 1		Model 2		Model 3	
	β	(s.e)	β	(s.e)	β	(s.e)
Intercept	0.06	(0.06)	1.37***	(0.09)	-0.40***	(0.10)
Neighborhood typology						
(Reference= Shrinking with Aging)						
Aging with stable and growth	-0.13+	(0.07)	-0.14*	(0.06)	-0.18*	(0.07)
Declining share with stable and growth	-0.18**	(0.07)	-0.20**	(0.07)	-0.14*	(0.07)
Shrinking with decline	-0.09	(0.10)	-0.10	(0.09)	-0.17+	(0.09)
Community size (reference=Small)						
Moderate	0.30***	(0.06)	0.34***	(0.06)	0.08	(0.08)
Large	0.37***	(0.06)	0.42***	(0.06)	-0.06	(0.08)
*Neighborhood typology * Community size*						
Aging with stable and growth * Moderate					0.09	(0.10)
Aging with stable and growth * Large					0.23*	(0.09)
Declining share with stable and growth * Moderate					-0.01	(0.10)
Declining share with stable and growth * Large					0.23*	(0.10)
Shrinking with decline * Moderate					0.19	(0.15)
Shrinking with decline * Large					0.24+	(0.13)
Individual-level control variables						
Age			-0.03***	(0.00)	-0.01***	(0.00)
Male			0.55***	(0.02)	0.24***	(0.02)
Total family income (reference=low)						
Low-medium					0.03	(0.02)
Medium-high					0.12***	(0.02)
High					0.19***	(0.02)
Live with children					-0.09***	(0.02)
Self-rated health					0.01*	(0.01)
Married					0.03	(0.02)
Education (reference=illiterate)						
Primary school					0.56***	(0.02)
High school and above					1.17***	(0.02)
Employed					-0.01	(0.02)
Whether move (reference =not move)						
Move					-0.15	(0.12)
Unknown					-0.08***	(0.02)
Community-level control variables						
Urban area					0.27***	(0.03)
Community resources					-0.00	(0.00)
Socioeconomic status of community					-0.00	(0.00)
Variances of random effects						
Community	0.11		0.27		0.08	
Residual	0.74		0.61		0.45	
BIC fit statistics	25564		23797		20632	

Number of observations	9,642	9,642	9,642
Number of communities	559	559	559

Note: * < 0.05, ** < 0.01, *** < 0.001, Standard errors in parentheses

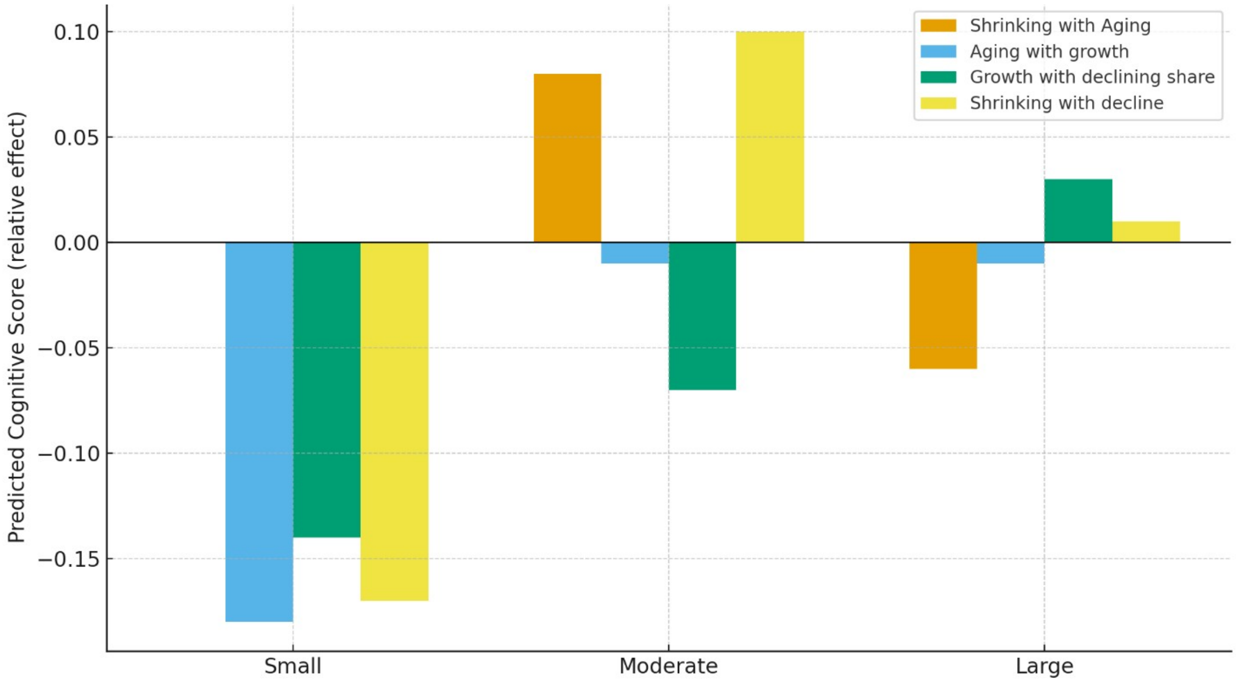
Table 3 Multilevel Models Predicting Older Adults' Cognitive Ability, Stratified by Community Size, Chinese Family Panel Survey 2010-2014

	Model 1		Model 2		Model 3	
	Small-sized		Moderate-sized		Large-sized	
	β	(s.e)	β	(s.e)	β	(s.e)
Intercept	-0.30*	(0.15)	-0.57***	(0.15)	-0.30	(0.16)
Neighborhood typology						
(Reference= Shrinking with Aging)						
Aging with stable and growth	-0.17**	(0.06)	-0.07	(0.07)	0.06	(0.07)
Declining share with stable and growth	-0.13*	(0.06)	-0.15*	(0.07)	0.11	(0.08)
Shrinking with decline	-0.17*	(0.08)	0.02	(0.11)	0.06	(0.10)
Individual-level control variables						
Age	-0.01***	(0.00)	-0.00**	(0.00)	-0.01***	(0.00)
Male	0.30***	(0.03)	0.23***	(0.03)	0.19***	(0.03)
Total family income						
Low (reference)						
Low-medium	0.04	(0.03)	0.06	(0.03)	-0.00	(0.04)
Medium-high	0.14***	(0.04)	0.08*	(0.04)	0.13**	(0.04)
High	0.13**	(0.04)	0.22***	(0.04)	0.20***	(0.04)
Live with children	-0.05	(0.03)	-0.06*	(0.03)	-0.14***	(0.03)
Self-rated health	0.01	(0.01)	0.02*	(0.01)	0.01	(0.01)
Married	0.01	(0.04)	0.08*	(0.04)	0.00	(0.04)
Education						
Illiterate (reference)						
Primary school	0.52***	(0.03)	0.61***	(0.03)	0.53***	(0.04)
High school and above	1.11***	(0.03)	1.23***	(0.03)	1.13***	(0.04)
Employed	-0.00	(0.03)	0.00	(0.03)	-0.01	(0.03)
Whether move (reference =not move)						
Move	-0.21	(0.24)	0.05	(0.25)	-0.23	(0.18)
Unknown	-0.05	(0.04)	-0.06	(0.04)	-0.13***	(0.04)
Community-level control variables						
Urban area	0.11*	(0.05)	0.25***	(0.06)	0.45***	(0.06)
Community resources	-0.01	(0.01)	-0.00	(0.01)	-0.01	(0.01)
Socioeconomic status of community	-0.00*	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Variances of random effects						
Community	0.06		0.08		0.10	
Residual	0.42		0.45		0.47	
Number of observations	3,101		3,295		3,282	

BIC fit statistics	6502	7028	7295

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, Standard errors in parentheses

Figure 1: Interaction effects of neighborhood typology and community size, Chinese Family Panel Survey 2010-2014



Note: Interaction effects of neighborhood typology and community size on cognitive outcomes. Predicted effects are shown relative to shrinking-with-aging small communities (reference). Negative associations are concentrated in small communities, while adverse effects are buffered or reversed in large communities, with moderate-sized towns falling in between.