Prevalence and Determinants of Healthy Aging Among Older Adults in Jining, China

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Abstract

Population aging in China is accelerating rapidly, making the promotion of healthy aging a critical public health and nursing priority. This cross-sectional study, conducted in Jining City, Shandong Province, aimed to examine the prevalence and determinants of healthy aging among older adults and to provide empirical evidence for the design of targeted nursing and community-based interventions. From October 2024 to January 2025, a multi-stage random sampling method was employed to recruit 806 older adults aged 60 years and above from both urban and rural communities. Data were collected using a self-designed sociodemographic questionnaire, the Healthy Aging Questionnaire (HAQ), and the Simplified Chinese Version of the Health-Promoting Behaviours Scale for the Elderly, and were analyzed with SPSS version 27.0. Descriptive statistics, one-way ANOVA, and multiple linear regression analyses were performed to identify predictors of healthy aging. The mean healthy aging score was 50.21 ± 15.52, with only 13.5% of participants achieving a high level of healthy aging. Regression analysis revealed eleven significant predictors ($p < 0.05$), including age, gender, residence, marital status, family relationships, contact with children, education, income, chronic disease status, self-rated health, and health-promoting behaviours. Older adults who were married, urban residents, highly educated, financially secure, and actively engaged in health-promoting behaviours demonstrated better healthy aging outcomes. These findings indicate that the level of healthy aging among older adults in Jining remains relatively low. Nursing-led, community-based interventions focusing on health education, chronic disease management, psychosocial support, and family engagement are essential to enhance health-promoting behaviours and foster healthy aging among older adults in China.

Keywords: Older adults, Cross-sectional study, Healthy aging, Health-Promoting behaviour, Community

Introduction

Population aging has emerged as one of the most significant global public health and social development challenges, and China is no exception. Over the past three decades, the country's demographic structure has undergone a profound transformation. According to the (National Aging Development Report, 2023), people aged 60 years and above now account for 21.1% of the total population, while those aged 65 years and above represent 15.4% (Ministry of Civil Affairs of China, 2023). These figures indicate that China has officially entered a stage of deep aging. The implications are extensive—not only imposing substantial pressure on economic growth, labor supply, and long-term care systems, but also revealing the reality of "growing old before becoming rich", characterized by persistent inequalities in pension coverage, social welfare, and healthcare resource distribution (Lobanov-Rostovsky et al., 2023).

To address this global challenge and promote the health and well-being of older adults, the World Health Organization (WHO) introduced the concept of *Healthy Aging* in 2015 and launched the Decade of Healthy Aging (2020 - 2030) initiative (WHO, 2020). According to WHO, healthy aging is not merely the absence of disease, but a lifelong dynamic process of developing and maintaining functional ability—the capability to live independently and participate in society according to one's values and goals (Beard et al., 2016). This paradigm emphasizes that supporting older adults in maintaining physical, psychological, and social functioning enables them to achieve autonomy, vitality, and dignity in later life.

Previous studies have demonstrated that healthy aging is influenced by multiple interrelated factors, encompassing individual, social, socioeconomic, health-related, and behavioral dimensions (Beard et al., 2017; McLaughlin et al., 2020). This understanding aligns with the WHO *Functional Ability Framework* and the *Social Determinants of Health Model*, which conceptualize healthy aging as the outcome of interactions among multilevel determinants. Guided by these theoretical perspectives, the present study systematically identifies and examines key determinants of healthy aging across multiple dimensions, aiming to clarify their underlying mechanisms and interrelationships.

At the individual level, age and gender are fundamental biological and social attributes that influence disease susceptibility, health perception, and healthcare utilization (Carmel, 2019; Puts et al., 2017). Meanwhile, place of residence (urban versus rural) reflects structural and environmental inequalities, as differences in healthcare accessibility and community resources can substantially affect older adults' health outcomes (Chen et al., 2025).

At the social level, the quality of family and social support networks exerts a profound impact on both the physical and psychological well-being of older adults. Marital status, family relationships, and frequency of contact with children serve as indicators of social support and intergenerational connectedness—key protective factors against frailty, depression, and loneliness—particularly within the family-oriented cultural context of East Asia (Huang, 2024; Wang, 2023).

At the socioeconomic level, education and income are crucial indicators of health literacy and material resources. They influence individuals' ability to access healthcare, manage chronic

conditions, and engage in health-promoting activities. Higher education and income levels generally enhance self-management capacity and health decision-making, thereby fostering healthier behaviours (Bello et al., 2024; Tao et al., 2023).

Within the health status domain, multimorbidity and chronic diseases are major risk factors for physical and functional decline, whereas self-rated health provides an integrated measure of physical, psychological, and social well-being, serving as an important subjective indicator of healthy aging (Ahamad et al., 2025; Liu et al., 2023).

Finally, at the behavioral level, health-promoting behaviours—including regular physical activity, balanced nutrition, adequate sleep, stress management, and social participation—are modifiable determinants that enhance intrinsic capacity, delay frailty progression, and promote healthy aging (Chia et al., 2023).

Taken together, these determinants form the structural, social, and behavioral foundations of healthy aging and closely align with the nursing discipline's holistic care philosophy. This perspective underscores the dynamic interaction between individual lifestyle and environmental context and highlights the critical role of nurses in health promotion, prevention of decline, and preservation of autonomy among older adults (Amin et al., 2025; Cocchi et al., 2025). From a nursing standpoint, understanding these determinants is essential for designing targeted, nurse-led, community-based interventions that promote health, prevent frailty, and sustain independence in later life.

However, few studies have empirically examined how individual, social, and behavioral determinants interact to influence healthy aging in middle-income, third-tier Chinese cities. This study addresses this gap by integrating nursing and public health perspectives to identify context-specific determinants.

Although both international and national interest in healthy aging has grown substantially, empirical research in China remains limited, particularly at the community level. Most existing studies rely on secondary data or policy analyses, focus mainly on urban populations, and rarely adopt comprehensive, theory-driven approaches to interpretation. Moreover, evidence examining regional differences and modifiable behavioral determinants within China's unique sociocultural and healthcare contexts is still insufficient (Horgan et al., 2024).

Therefore, this study aims to conduct an empirical assessment of healthy aging among urban and rural older adults in Jining, Shandong Province. Specifically, it seeks to identify key sociodemographic, health-related, and behavioral determinants of healthy aging. The findings are expected to provide localized evidence for developing nurse-led, community-based health promotion strategies that strengthen functional ability, enhance social participation, and improve quality of life among older adults—thereby contributing to both national and global agendas on healthy aging.

Methodology
Study design and setting
This cross-sectional study was conducted in Yanzhou District, Jining City, Shandong Province, China, covering both urban and rural communities. Yanzhou District, located in central Jining.

Study population

This cross-sectional study was conducted among community-dwelling older adults aged 60 years and above in Yanzhou District, Jining City, Shandong Province, China. Yanzhou District has a permanent resident population of approximately 540,700, of whom 129,900 (24.06%) are aged 60 years and above, indicating a deeply aged demographic structure. A total of 806 participants were included in the final analysis, representing both urban and rural communities.

The required sample size was estimated using PASS version 15.0.5 (NCSS, Kaysville, Utah, USA) based on a single population proportion formula. Assuming a prevalence of healthy aging of 15.8% among Chinese older adults (Yin et al., 2021) , with a two-sided 95% confidence level and a confidence interval width of 0.05, the minimum required sample size was 856, calculated using the Exact (Clopper–Pearson) method. The final sample of 806 respondents was slightly below the target but remained sufficient to ensure acceptable estimation precision.

A multi-stage random sampling approach was employed. In Stage 1, 30 communities (15 urban and 15 rural) were randomly selected from a list of 347 communities provided by the National Bureau of Statistics of China (https://www.stats.gov.cn/sj/tjbz/qhdm/). In Stage 2, the local Public Health Department supplied rosters of residents aged ≥60 years, from which 30 individuals per community were randomly selected to participate. In both sampling stages, computerized random sampling was performed using the RAND () function in Microsoft Excel to ensure randomness and reproducibility of sample selection.

Inclusion criteria were: (1) aged 60 years or older; and (2) residence in Yanzhou District for at least six months.

Exclusion criteria included: (1) severe physical frailty (FRAIL scale score = 5) (Lyu et al., 2021); (2) inability to communicate (e.g., severe aphasia, complete deafness, or blindness); (3) clinically diagnosed severe psychiatric or cognitive disorders (e.g., schizophrenia, major depression, or dementia) that impeded participation; and (4) any acute or terminal illness, hospitalization, or physical condition that made participation unsafe or unfeasible.

Participation was entirely voluntary, and all respondents provided written informed consent prior to data collection.

Instruments

Validated instruments were used to assess sociodemographic characteristics, healthy aging, and health-promoting behaviours.

1) Sociodemographic questionnaire

The sociodemographic questionnaire was developed based on a literature review and expert consultation to ensure content validity and applicability to community-dwelling older adults. The items were adapted from previous studies on healthy aging and frailty, as well as national population health surveys, and were reviewed by experts in geriatric nursing, public health, and epidemiology. The final version was pretested among 20 older adults to verify clarity and feasibility.

The questionnaire consisted of closed-ended and categorical questions covering four domains; (1) personal information (age, sex); (2) living and family background (residence, marital status, living arrangements, family relationship satisfaction, frequency of interaction with children); (3) socioeconomic status (education level, monthly income, previous occupation); and (4) health-related characteristics (presence and number of chronic diseases, self-rated health status). Most questions were single-choice items, while family relationships and self-rated health were assessed using 3-point and 5-point Likert scales, respectively.

2) Healthy Aging Questionnaire Index (HAQ)

The HAQ, developed by Tze and colleagues in Singapore, consists of 15 items across three domains: (i) cognitive and psychological well-being, (ii) physical, socio-emotional, and occupational functioning, and (iii) participation in physical, social, and occupational activities. Scores range from 0 to 100, with higher scores reflecting higher levels of healthy aging. Based on total scores, individuals were categorized as low (<60), moderate (60 - 70), or high (>70).

The HAQ has demonstrated strong psychometric properties. Internal consistency was high (Cronbach's $\alpha = 0.907$). Exploratory factor analysis (EFA) yielded a three-factor structure consistent with the original domains, with factor loadings ranging from 0.52 to 0.83. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.86, and Bartlett's test of sphericity was significant ($\chi^2 = 1{,}245.6$, $p < 0.001$). The three factors accounted for 41.7% of the total variance, indicating acceptable construct validity (Ng et al., 2023).

3) Simplified Chinese version of the health-promoting behaviours scale for the elderly

This scale, adapted and validated by Li and colleagues from the original Geriatric Health Promotion Scale by (Wang et al., 2015), includes 22 items across six dimensions: healthy diet, health responsibility, health habits, social participation, physical exercise, and oral hygiene care. Items are rated on a 4-point Likert scale (1 = never to 4 = always), with total scores ranging from 22 to 88. Scores were classified into three levels; low (22 - 44), medium (45 - 66), and high (67 - 88).

The scale has shown good reliability and validity. Internal consistency was strong (Cronbach's $\alpha = 0.871$). EFA identified six factors with loadings between 0.56 and 0.88. The KMO value was 0.91, and Bartlett's test of sphericity was significant ($\chi^2 = 2{,}358.4$, $p < 0.001$). The six-factor solution explained 71.56% of the cumulative variance, supporting robust construct validity (Li et al., 2023).

Data collection

Data collection was carried out from October 2024 to January 2025 across 30 urban and rural communities in Yanzhou District, Jining City, Shandong Province. The process was led by the principal researcher and assisted by five undergraduate nursing students from the School of Nursing, Jining Medical University, who served as trained survey investigators. All investigators received standardized training that covered the study objectives, ethical principles, interview procedures, and

accurate data recording. To ensure consistency and reliability, mock interviews and field exercises were conducted before formal data collection commenced.

Data were primarily collected through questionnaire surveys. Older adults who were literate and able to read and write completed the questionnaires independently. For those who experienced difficulties due to visual, literacy, or physical limitations, trained investigators provided face-to-face assistance. Surveys were administered in community health service centers or activity rooms, where investigators read each question aloud when necessary, recorded participants' responses, and reviewed the questionnaires on-site to ensure completeness and accuracy. The principal researcher conducted daily supervision and quality control throughout the data collection process, while strict adherence to confidentiality and voluntary participation was maintained to uphold scientific and ethical standards.

Statistical analysis

Data were analyzed using SPSS version 27.0. Continuous variables were expressed as means ± standard deviations, and categorical variables as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Group differences in HAQ scores were examined using independent t-tests and one-way ANOVA, with post hoc tests applied where appropriate. Multiple linear regression was conducted to identify sociodemographic predictors of healthy aging. Missing data (<5%) were handled using mean substitution. All tests were two-tailed, and a *p*-value <0.05 was considered statistically significant.

Ethical approval

The study protocol was reviewed and approved by the Human Research Ethics Committee of Universiti Sains Malaysia (USM) (JEPeM Code: USM/JEPeM/KK/24040380), with approval valid from 7 October 2024 to 6 October 2025. Before data collection, all participants were thoroughly informed of the study objectives, procedures, potential risks, and benefits, and provided written informed consent. Participation was entirely voluntary, and participants were assured of their right to decline participation or withdraw from the study at any time without any negative consequences. All data were kept strictly confidential, securely stored, and accessible only to the research team. The study was conducted in accordance with the Declaration of Helsinki and institutional ethical guidelines.

Results

Sociodemographic differences in healthy aging scores

A total of 900 questionnaires were distributed, of which 806 were deemed valid and included in the final analysis, yielding an effective response rate of 89.56%. The mean age of participants was 70.61 ± 7.46 years; females accounted for 52.6%, and 49.6% were rural residents. Educational attainment was relatively low, with 60.3% having completed primary school or below. The majority of participants reported chronic diseases, with a prevalence of 86.1%.

Independent sample t-tests and one-way ANOVA revealed statistically significant differences in healthy aging scores across multiple sociodemographic characteristics. Specifically, younger participants, males, urban residents, married individuals, those with harmonious family relationships, those who met with their children at least weekly, individuals with higher educational attainment and income, those without chronic diseases, and those with good self-rated health all had significantly higher healthy aging scores compared with their counterparts. All these differences were statistically significant ($p < 0.05$) (**Table 1**).

Table 1 Socio-demographic and healthy aging scores of older adults in Jining City, China (n = 806).

Variables	n (%)	Healthy aging scores (Mean ± SD)	t/F	*p*-value[*]
Age			141.602	<0.001[b]
60~69	433 (53.7%)	56.90 ± 13.76		
70~79	262 (32.5%)	45.74 ± 12.84		
80~	111 (13.8%)	34.89 ± 13.04		
Gender			12.178	<0.001[a]
Male	382 (47.4%)	56.69 ± 14.52		
Female	424 (52.6%)	44.42 ± 14.06		
Place of residence			17.233	<0.001[a]
Urban area	406 (50.4%)	58.24 ± 12.90		
Rural area	400 (49.6%)	42.12 ± 13.66		
Marital status			334.324	<0.001[b]
Married	661 (82.0%)	55.13 ± 12.44		
Widowed	139 (17.2%)	27.63 ± 5.24		
Divorced/ Other	6 (0.8%)	35.11 ± 1.17		
Family relationship(s)			301.659	<0.001[b]
Harmonious	561 (69.6%)	56.86 ± 12.68		
Average	205 (25.4%)	36.49 ± 9.49		
Strained	40 (5.0%)	27.87 ± 8.07		
Frequency of in-person contact with children			181.521	<0.001[b]
Every day	296 (36.7%)	54.05 ± 13.01		
Every week	239 (29.7%)	60.95 ± 10.63		
Every month	142 (17.6%)	42.43 ± 9.68		
Every six months	77 (9.6%)	31.75 ± 11.15		
Every year /Other	52 (6.4%)	28.03 ± 6.88		
Educational attainment			207.315	<0.001[b]

Variables	n (%)	Healthy aging scores (Mean ± SD)	t/F	p-value[*]
Primary Education or Below	486 (60.3%)	43.26 ± 12.26		
Junior Secondary School	212 (26.3%)	54.58 ± 12.69		
Senior Secondary School	94 (11.7%)	72.20 ± 4.97		
Short-cycle education and above	14 (1.7%)	79.33 ± 4.53		
Individual monthly income, CNY			396.312	<0.001[b]
<1000	451 (56.0%)	41.44 ± 11.94		
1000 ~ 1999	168 (20.8%)	54.08 ± 10.80		
≥2000	187 (23.2%)	68.02 ± 8.72		
Self-reported chronic disease status			299.940	<0.001[a]
No	112 (13.9%)	70.38 ± 7.71		
Yes	694 (86.1%)	46.99 ± 13.95		
Self-rated health status			805.199	<0.001[b]
Good	341 (42.3%)	63.65 ± 9.81		
Average	264 (32.8%)	46.59 ± 8.55		
Poor	201 (24.9%)	32.29 ± 7.97		

[*]Notes: Statistical test – [a] Independent t-test, [b] One-way ANOVA, the significance level is set at $p < 0.05$, M = Mean, SD = standard deviations.

Classification of healthy aging levels and scores of various dimensions

This study indicates significant variations in Healthy Aging (HA) levels among older adults in Jining, China. Most of the participants, 71.2% were classified into the low HA group, while only 13.5% achieved a high level of HA (**Table 2**).

Table 2 Prevalence of different levels of healthy aging among older adults in Jining, China (n=806).

Healthy Aging Level	Score range	n (%)
High HA	≥70	109 (13.5)
Medium HA	60 - 69.99	123 (15.3)
Low HA	≤59.99	574 (71.2)

The results indicate that healthy aging among older adults in Jining City was at a relatively low level overall. Among the dimensions, Physical, Socio-Emotional, and Occupational Functioning had the highest average item score, suggesting better performance in daily functioning, while Activity Participation was the lowest, reflecting limited engagement in social and occupational activities. Cognitive and psychological wellbeing was also relatively high, whereas other dimensions showed moderate performance (**Table 3**).

Table 3 Distribution of healthy aging dimension scores.

Dimension (Number of items)	Score range	Min	Max	Dimension score (Mean ± SD)	Item average score (Mean ± SD)
Total score（15）	0~95.74	12.77	87.23	50.21 ± 15.52	3.35 ± 1.03
Cognitive and Psychological Wellbeing and Support (7)	0~53.19	4.26	48.94	25.92 ± 9.51	3.70 ± 1.36
Physical, Socio-Emotional, and Occupational Functioning (4)	0~27.66	2.13	27.66	15.38 ± 4.71	3.84 ± 1.18
Physical, Social, and Occupational Activity Participation (4)	0~12.77	0	12.77	8.91 ± 3.10	2.23 ± 0.77

Note. *Dimension Score (0 - 100) = (Raw Mean Score of Dimension / Maximum Possible Score of Dimension)×100.

Classification of health-promoting behaviours levels and dimension scores among older adults in Jining, China

The distribution of health-promoting behaviour (HPB) levels among older adults in Jining, China, differed significantly (**Table 4**). A moderate level of HPB was most prevalent (72.8%), followed by high (14.5%) and low (12.7%) levels.

Table 4 Prevalence of different levels of health-promoting behaviours among older adults.

HPB Level	Score range	Number of participants	Proportion (%)
High HPB	67~88	117	14.5%
Moderate HPB	45~66	587	72.8%
Low HPB	22~44	102	12.7%

The total score for health-promoting behaviours (HPB) among participants ranged from 22 to 88, with a mean of 55.44 ± 9.15, indicating a moderate level (**Table 5**). Among the six dimensions, healthy habits and health diet had the highest mean scores, whereas social participation and regular exercise were the lowest. These findings suggest that while participants maintained relatively good

daily habits and dietary practices, their engagement in social participation and physical activity remained limited.

Table 5 Mean total and dimension scores of health-promoting behaviours among older adults (n = 806).

Dimension (Number of items)	Score range	Min	Max	Dimension Mean ± SD	Item Mean ± SD
Total score (22)	22~88	37	81	55.44 ± 9.15	2.52 ± 0.42
Health diet (5)	5~20	7	19	12.74 ± 2.36	2.55 ± 0.47
Health responsibility (4)	4~16	4	16	9.88 ± 2.46	2.47 ± 0.61
Healthy habits (5)	5~20	7	19	14.47 ± 2.33	2.89 ± 0.47
Social participation (4)	4~16	4	15	8.27 ± 2.30	2.07 ± 0.58
Regular exercise (2)	2~8	2	8	4.61 ± 1.59	2.31 ± 0.79
Oral health care (2)	2~8	2	8	5.47 ± 1.37	2.73 ± 0.69

Differences in healthy aging across health-promoting behaviours levels

The one-way ANOVA analysis demonstrated significant differences in healthy aging scores across different levels of health-promoting behaviours (HPB) (F = 210.177, $p < 0.001$) (**Table 6**). Participants with high HPB had the highest healthy aging scores and participants with low HPB had the lowest healthy aging scores. These findings indicate a positive association between higher levels of HPB and better healthy aging outcomes.

Table 6 Comparison of healthy aging scores across different health-promoting behaviours levels.

Health-Promoting behaviours level	n	Healthy aging scores (Mean ± SD)	F	*p*-value*
Low HPB	102	33.48 ± 9.29		
Medium HPB	587	49.53 ± 13.66	210.177	＜0.001
High HPB	117	68.18 ± 8.85		

* Notes: Statistical test - one-way ANOVA, Significant difference at $p < 0.05$; M = Mean, SD = standard deviations.

Determinants of healthy aging

Multiple linear regression analysis revealed that both sociodemographic and health-related factors were significantly associated with healthy aging (**Table 7**, overall model: F = 444.303, $p < 0.001$, $R^2 = 0.860$). Negative predictors included older age, poor family relationships, infrequent contact with children, and chronic disease status. Positive predictors comprised being male, urban residence, higher education, higher income, good self-rated health, and engagement in health-promoting behaviours. Among these, marital status and self-rated health showed the strongest

positive associations, while strained family relationships had the strongest negative effect. No evidence of multicollinearity was detected (all VIF < 3.5).

Table 7 Multiple linear regression analysis of determinants of healthy aging (n = 806).

Variable	B	SE	Beta (β)	t-value	*p*-value	95% CI	VIF
(Constant)	42.335	3.707		11.420	<0.001	(35.058, 49.613)	
Age	−0.192	0.033	−0.092	−5.747	<0.001	(−0.258, −0.127)	1.469
Gender (Male)	2.116	0.452	0.068	4.685	<0.001	(1.230, 3.003)	1.202
Place of residence (Urban)	1.435	0.508	0.046	2.823	0.005	(0.437, 2.432)	1.525
Marital Status (Married)	9.995	0.845	0.248	11.824	<0.001	(8.336, 11.655)	2.491
Family relationship(s)	−3.797	0.473	−0.142	−8.027	<0.001	(−4.725, −2.868)	1.767
Frequency of contact with children (Every year)	−0.730	0.229	−0.060	−3.185	0.002	(−1.180, −0.280)	1.997
Educational attainment (Tertiary education or above)	3.355	0.466	0.167	7.203	<0.001	(2.441, 4.269)	3.038
Individual monthly income	0.001	0.000	0.060	2.529	0.012	(0.000, 0.001)	3.244
Chronic disease status (With chronic diseases)	−3.680	0.749	−0.082	−4.911	<0.001	(−5.151, −2.209)	1.588
Self-rated health status (Good)	7.768	0.631	0.248	12.315	<0.001	(6.530, 9.007)	2.295
Health-Promoting Behaviours	0.217	0.037	0.128	5.902	<0.001	(0.145, 0.289)	2.673

Notes: F = 444.303, *p* < 0.001, R = 0.927, R2 = 0.860, after adjustment R2 = 0.858; B = Unstandardized Regression Coefficients, SE = Standard Error, Beta = Standard Regression Coefficient, 95% CI = 95% Confidence Interval for B (Lower bound- Upper Bound); Individual monthly income was modelled as a continuous variable (CNY).

Discussion

This study investigated the status and determinants of healthy aging among urban and rural older adults in Jining, China. The results showed that only 13.5% of older adults in Jining achieved a high level of healthy aging, which is lower than the national average of 15.8% (Yin et al., 2021). These findings reveal notable regional disparities in healthy aging levels, which may stem from imbalances in economic development, healthcare resource allocation, and social support systems.

As a third-tier city, Jining faces structural disadvantages in economic growth, elder care services,

social security, and healthcare accessibility compared with first-tier cities. In addition, the city's aging population—accounting for 22% of the total population in 2023—together with limited primary healthcare resources and inadequate chronic disease management, has further intensified the health challenges faced by older adults (Fu & Lu, 2025). Consistent with studies conducted in other economically underdeveloped regions of China, the outmigration of younger laborers has led to an increase in "empty-nest" elderly, weakening daily caregiving and social support systems (Chen et al., 2025). Collectively, these socioeconomic and healthcare constraints contribute to the relatively low level of healthy aging in the region.

The relatively strong performance in the functional dimension indicates that, despite the high prevalence of chronic diseases, many older adults in Jining are still able to maintain independence in daily activities. This resilience may partly be explained by the local cultural context. As the birthplace of Confucian culture, Jining upholds strong values of filial piety and intergenerational support, which provide emotional comfort and informal caregiving for older adults. Such cultural mechanisms help mitigate the adverse effects of chronic illness, reduce loneliness, and enhance social support and psychological well-being (Jean Woo, 2020).

In addition, many older adults remain engaged in household tasks and grandchild care, which sustain physical activity levels and reinforce their sense of social value and purpose in later life. These behaviours may serve as protective mechanisms that buffer against the negative consequences of physical decline and foster functional independence (Dong et al., 2023).

In contrast, scores for the cognitive, psychological, and social support dimensions were moderate. Most older adults in Jining grew up during periods of limited educational opportunity, resulting in relatively low literacy and limited awareness of mental health. As a third-tier city, the region also faces shortages of mental health professionals and underdeveloped geriatric mental health services (Li et al., 2025). Moreover, traditional beliefs often lead older adults to perceive psychological counseling as unnecessary or even deceptive, further restricting their access to professional psychological support.

Meanwhile, rapid socioeconomic transformation has reshaped traditional family structures. Unlike the multigenerational households of the past, many older adults now live separately from their children due to urbanization and labor migration, reducing daily interaction and emotional companionship. The rapid development of digital and artificial intelligence technologies has also created an increasingly "smart" social environment; however, many older adults lack the digital literacy needed to navigate such systems, exacerbating social isolation and psychological vulnerability (Li et al., 2025; Welch et al., 2023).

Nevertheless, existing evidence suggests that active social participation and higher digital literacy can mitigate these challenges by enhancing social connectedness and emotional engagement. Older adults with stronger digital skills report lower loneliness and better psychological well-being (Welch et al., 2023). These findings indicate that technological progress should not marginalize older adults but rather serve the needs of an aging society. Promoting digital inclusion and community participation programs can help older adults adapt to technological change and maintain

psychological well-being and social integration in an increasingly digitalized environment.

Regression analysis identified age, sex, residence, marital status, family relationships, frequency of contact with children, education level, economic status, chronic disease condition, self-rated health, and health-promoting behaviours as significant predictors of healthy aging. In accordance with the Functional Decline Model (Jahan, 2024), aging is accompanied by progressive declines in physiological, cognitive, and social functions, which explains the observed decrease in healthy aging levels with advancing age.

Gender disparities were also evident, with women exhibiting lower levels of healthy aging than men, consistent with prior findings (Carmel, 2019). This difference is shaped by both biological and sociostructural factors. Women generally live longer but face greater chronic disease burden and functional decline, while lower educational attainment and weaker financial security further limit their capacity to maintain health (Deng et al., 2025).

In Jining, these disparities are particularly pronounced. Many older women received limited formal education and spent much of their lives in domestic roles with fewer opportunities for social participation. In rural areas, women often continue to perform physical agricultural labor and rely heavily on their children for economic and caregiving support, placing them in a position of compounded vulnerability. From the perspective of the Cumulative Disadvantage Theory, inequalities in education, income, and social resources accumulate across the life course, leading to wider health gaps in later years. These findings suggest that gender should not be viewed merely as a demographic variable but as a reflection of structural inequality (Qiu et al., 2023). Targeted interventions for older women—particularly widows and those living alone in rural areas—should focus on improving health management capacity, providing psychological support, and strengthening social protection systems to reduce gender-based health inequities and promote equitable healthy aging.

Social support and economic status also emerged as critical determinants of healthy aging. Older adults who were married, maintained harmonious family relationships, and had frequent contact with their children exhibited significantly higher levels of healthy aging. Close family ties and sustained emotional interaction enhance psychological resilience and health behaviours. In the Chinese sociocultural context, the family remains the primary source of social support, with filial piety and intergenerational caregiving serving as vital components of emotional stability (Rook & Charles, 2017).

Under limited financial resources, such support becomes even more essential. Many rural older adults rely on minimal pensions and depend heavily on their children for economic and daily assistance. Social support not only alleviates financial stress and improves life satisfaction but also fosters positive health behaviours, thereby indirectly promoting healthy aging (Zanjari et al., 2022). Strengthening family- and community-based support networks is therefore essential to enhance social connectedness, resilience, and sustainable healthy aging.

Educational attainment and economic status were also positively associated with healthy aging. Older adults with higher education and better financial conditions demonstrated greater health literacy, enabling them to understand disease risks, adhere to medical advice, and adopt health-

promoting behaviours such as regular exercise and appropriate healthcare utilization. This finding supports the Health Belief Model (HBM), which posits that individuals with higher health literacy are more likely to engage in health-promoting practices (Nematzad et al., 2023) .

Furthermore, better economic resources provide greater access to healthcare and social participation, while limited education and financial constraints may lead to poorer health awareness and reduced engagement in preventive behaviours (McMaughan et al., 2020). Thus, improving health literacy and narrowing socioeconomic disparities are vital strategies for advancing equitable healthy aging.

Chronic diseases exert a significant negative influence on healthy aging. The present study found that older adults with chronic conditions had markedly lower healthy aging scores than their healthier counterparts. Chronic diseases often lead to pain, fatigue, and physical limitations that reduce independence, while long-term treatment increases financial burden and restricts social participation, contributing to lower quality of life (Maresova et al., 2019).

There is also a bidirectional relationship between chronic disease and health-promoting behavior: illness may weaken individuals' motivation to engage in healthy practices, whereas adopting positive health behaviours can partially counteract the adverse effects of disease (Rahelić et al., 2024). Therefore, integrated interventions combining health education, functional rehabilitation, and psychological support are necessary to promote healthy aging among older adults with chronic diseases.

Health-promoting behaviours were also found to play a decisive role in influencing healthy aging levels among older adults in Jining. Regular physical activity, balanced nutrition, adequate sleep, and proactive health check-ups help maintain functional capacity, enhance immunity, and reduce chronic disease risk, thereby supporting healthy aging (Szychowska & Drygas, 2022).

Moreover, such behaviours improve psychological well-being and social participation, further enhancing quality of life. Sustained engagement in health-promoting behaviours strengthens self-efficacy and psychological resilience, enabling older adults to cope more positively with the aging process (Alinejad et al., 2025). However, many older adults—particularly in rural areas—still have limited health awareness and restricted access to health information.

Education level, economic conditions, and social support all influence the formation of health-promoting habits (Raghupathi & Raghupathi, 2020). Hence, community-based health education and behavioral interventions focusing on health literacy, self-management, and social participation are crucial to advancing healthy aging.

Overall, the findings underscore the need for targeted policy interventions to enhance healthy aging in economically underdeveloped regions. Early-life health literacy education should be prioritized to cultivate lifelong healthy behaviours. Primary healthcare institutions should play an active role in community-based outreach, including health education and chronic disease management.

Investment in age-friendly infrastructure and social participation programs should also be strengthened to promote physical activity and social engagement. Given the significant influence of

social support and economic security on healthy aging, policy efforts should focus on expanding social protection systems, improving pension coverage, and encouraging intergenerational caregiving mechanisms. Furthermore, initiatives to improve digital literacy and access to information technology can help alleviate psychological distress, reduce social isolation, and foster inclusive and positive aging within an increasingly digitalized society.

Conclusions

This study highlights the relatively low prevalence of healthy aging among older adults in Jining and underscores the significant influence of sociodemographic factors and health-promoting behaviours on aging outcomes. Advanced age, female gender, rural residence, and chronic disease prevalence were identified as key negative predictors. In contrast, higher education levels, better economic status, strong social support, positive self-rated health, and engagement in health-promoting behaviours were strong positive predictors of healthy aging. These findings emphasise the urgent need for targeted interventions to improve aging outcomes, particularly among vulnerable populations.

To promote healthy aging, a comprehensive, multi-level, and multidisciplinary approach is required. Strengthening community-based healthcare is essential, and this can be achieved by utilising community health centres to implement multidisciplinary chronic disease management (MDT) and home-based nursing follow-up programs, ensuring continuous and personalised care for older adults. Additionally, optimising individualised care and psychological support should be prioritized by developing personalised health management plans, particularly for high-risk groups such as empty-nest elderly, women, widowed individuals, and rural residents. Regular mental health screenings and accessible psychological counselling services should be integrated into routine healthcare to support emotional well-being.

Improving social support systems is another critical aspect of promoting healthy aging. Expanding elderly volunteer programs, fostering age-friendly communities, and increasing pension benefits and medical insurance reimbursement rates can reduce financial strain and enhance social well-being. Furthermore, healthcare accessibility must be improved through the expansion of geriatric specialty hospitals and nursing homes, as well as the advancement of telemedicine and AI-assisted healthcare services to support older adults with mobility impairments or those living in remote areas.

The integration of smart aging initiatives can further enhance self-care capabilities by promoting wearable health-monitoring devices and AI-driven health management tools, which encourage proactive health monitoring and improve digital health literacy among older adults. Finally, establishing a multidisciplinary collaboration framework that integrates medical, nursing, and psychological resources is essential. Strengthening coordination among governments, communities, and healthcare institutions and implementing stratified health interventions tailored to different aging populations can provide a more holistic and sustainable approach to aging care.

By implementing these strategies, policymakers and healthcare providers can reduce disparities in healthy aging, improve overall well-being, and create a more supportive and inclusive aging environment.

Limitations and future directions

This study has several limitations. First, its cross-sectional design restricts causal inference, allowing only associations to be identified. Second, the sample was drawn exclusively from Yanzhou District, Jining City, which may limit generalizability to other populations. Third, reliance on self-reported questionnaires introduces potential recall and social desirability biases.

Future research should employ longitudinal and multi-center designs with larger, more diverse samples to strengthen external validity and clarify causal mechanisms. Incorporating objective measures, such as functional assessments and biomarkers, would enhance data accuracy. Additionally, intervention-based studies and advanced analytical approaches, such as structural equation modelling, are recommended to develop more targeted and evidence-based strategies for promoting healthy aging.

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