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Health-Related Work Capacity and Labor Participation Among Middle-Aged and Older Adults in China: Evidence From CHARLS

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Abstract: Background: In the context of population ageing and retirement policy reform, sustaining labor participation among middle-aged and older adults has become an important socioeconomic issue. This study examined the association between health-related work capacity and labor participation among Chinese middle-aged and older adults. Methods: Data were drawn from the China Health and Retirement Longitudinal Study (CHARLS). The study included 6600 middle-aged and older adults (mean age, 63 years; 51% female). Labor participation was measured as a binary variable reflecting engagement in any form of work. Health-related work capacity was assessed using a three-level self-reported scale regarding work limitations due to health or disability. We used a binary logistic regression model to analyze the data, and we adjusted for many different social background and health factors. Subgroup analyses were performed according to retirement-age thresholds, age, gender, educational level, and urban-rural residence. Results: Health-related work capacity was positively associated with labor participation. In the fully adjusted model, each increase in work-capacity category was associated with higher odds of labor participation (OR = 2.223, $p < 0.001$). The association remained significant across all major subgroups and was particularly strong among men below retirement age, rural respondents, and participants with lower educational attainment. Discussion: This study can help us to understand the complex effects of health-related work capacity on labor participation more comprehensively from a theoretical point of view. Thus, it provides a scientific basis and further recommendations for policy making in practice.

Keywords: health-related work capacity; labor participation

1. Introduction

Population aging has become one of the most profound demographic changes in the global labor market. With the decline in fertility and the increase in life expectancy, many countries are facing the challenges of shrinking working-age population, increasing pressure on pensions, and difficulties in maintaining the supply of elderly labor [1,2]. In China, this problem is particularly prominent. In 2024, the Standing Committee of the National People's Congress passed a decision to gradually postpone the legal retirement age, indicating that policymakers continue to pay attention to the sustainability of the workforce and the full use of the elderly population [3]. At the same time, recent demographic statistics show that the labor participation rate of adults aged 60–69 in China is still high, but there are significant differences in gender, education level, geography and health status. While reflecting the possibility of employment in the elderly, this result also reveals the constraints it faces [4].



Yet later-life work in China is far from homogeneous. Older adults participate in diverse forms of employment, including agricultural work, wage employment, self-employment, and informal work. Census-based evidence indicates that adults aged 60–69 in rural areas are predominantly engaged in agricultural production, whereas their urban counterparts have greater access to nonagricultural employment but often encounter low-income jobs with limited social protection. Older women also face additional institutional, sociocultural, and individual-level barriers to continued employment [4]. Retirement patterns further differ substantially between urban and rural China: urban residents generally exit the labor market earlier, whereas rural residents tend to continue working to more advanced ages, partly because of unequal access to pensions and other economic resources [5]. Although recent national policies have promoted flexible employment opportunities, vocational training, and age-friendly workplaces for older adults [6], evidence from online job vacancies suggests that the availability of age-friendly jobs has declined in recent years [7]. Consequently, whether health-related work capacity can be translated into actual labor participation depends not only on individual health but also on employment opportunities, retirement institutions, social protection, and the availability of supportive work environments [5–9].

Against this background, understanding why some middle-aged and older adults remain economically active while others withdraw from labor has become both a theoretical and a practical issue. Existing research consistently shows that health is one of the most important determinants of labor participation in later life. International research has shown that inclusive labor-force participation in ageing societies depends not only on labor demand or retirement institutions, but also on whether individuals possess the health, safety, and functional resources required to remain in work [1]. Empirical evidence similarly associates poor self-rated health, chronic conditions, and health shocks with lower employment retention and earlier labor-market exit [10]. Chinese studies also find that health and public medical insurance shape older adults' labor supply and labor participation [11,12].

However, although health is consistently associated with later-life labor participation, general health status is not identical to the capacity to work under health constraints. Recent research suggests that labor market outcomes in later life are shaped by multidimensional health profiles, with physical functioning playing a particularly important role [13,14]. Furthermore, evidence on healthy working life expectancy in China shows that the years adults can expect to remain both healthy and working are substantially fewer than their total remaining life-years [15]. These findings indicate that health influences labor participation not simply as an abstract status, but by determining one's practical capability to work. To capture this transition, our "ability-behavior framework" focuses on health-related work capacity, which must be distinguished from two established literatures. First, it is distinct from Ilmarinen's concept of work ability [16], which is a comprehensive framework that includes health, competence, motivation, and the work environment. Although long-term studies have shown that sustained overall work ability is linked to delayed retirement [17], this study focuses only on the health-limitation dimension, that is, whether disability or health problems restrict a person's ability to work. Second, it differs from the "health capacity to work" literature, which uses the relationship between health and employment to estimate the remaining work capacity of older populations at the population level [18,19]. In contrast, our framework examines a more proximate issue: whether older adults' self-assessed capacity is actually realized in their labor behavior. In essence, our analytical framework treats perceived work capacity and actual labor participation as two distinct but sequential stages at the individual level.

Within the highly heterogeneous institutional context of China, prior macro-level studies have demonstrated that older adults possess substantial latent work potential. For instance, Hou, et al. [19] and Cheng, et al. [18] found significant excess health capacity among urban adults and older women, respectively. These studies provide valuable evidence that many older adults retain substantial health-related work potential. However, estimating potential work capacity at the population level does not necessarily explain whether such capacity is translated into actual labor participation at the individual level. Evidence from CHARLS further indicates that health trajectories in later life involve progressive functional decline and may be dynamically related to labor participation, underscoring the importance of focusing on work-specific functional capacity rather than general health status alone [20–23].

Nevertheless, at least three gaps remain in the literature. First, many studies continue to rely on broad indicators such as self-rated health, chronic disease burden, or disability status to explain later-life employment, whereas relatively fewer studies directly examine health-related work capacity as a proximal determinant of labor participation. This conceptual distinction remains important because health-related work capacity reflects whether health limitations directly constrain an individual's ability to work, thereby providing a more proximal predictor of labor participation than general health measures [20,24]. Second, although Chinese studies have estimated potential work capacity at the aggregate level or examined retirement-aged workers' employment outcomes under specific health and insurance conditions, fewer studies have investigated how self-assessed health-related work

capacity translates into actual labor participation behavior at the individual level [18,19,23,25]. Third, although later-life labor participation is clearly shaped by social stratification and institutional arrangements, evidence remains limited regarding whether the effect of health-related work capacity differs across gender, education, retirement stage, and urban-rural residence in China [4,26,27]. These research gaps are particularly important in China because the translation of health-related work capacity into labor participation occurs within a highly heterogeneous institutional context. Differences in employment opportunities and social protection between urban and rural areas, along with gender-specific statutory retirement ages, may substantially influence whether individuals with health-related work capacity actually participate in the labor market [3,4,12,24,26,28].

To address these issues, this study investigates the association between health-related work capacity and labor participation among Chinese middle-aged and older adults using data from the China Health and Retirement Longitudinal Study (CHARLS) [29]. Health-related work capacity is measured by respondents' self-assessment of whether disability or related health problems prevent them from working completely, prevent them from working for long periods, or pose no problem for work [25]. Labor participation is defined as a binary indicator capturing whether respondents engaged in agricultural production, performed paid work, or remained connected to work through temporary leave or training [18]. By focusing on a work-oriented capability that is conceptually closer to actual labor behavior than general health alone, this study seeks to clarify how health is translated into later-life labor participation in China.

This study makes three main contributions. First, this study conceptually distinguishes health-related work capacity from both the broader work ability framework and the population-level health capacity to work literature, thereby providing a more proximal explanatory concept linking health to labor participation. Second, it provides individual-level evidence from China on how work-specific health capability is associated with actual labor participation, rather than only with retirement intentions or aggregate excess work capacity. Third, it examines heterogeneity along dimensions that are substantively important in the Chinese institutional setting, including gender, age, education, and urban-rural residence, with particular attention to the implications of gender-specific retirement thresholds.

The remainder of this paper is structured as follows. Section 2 describes the data, variables, and empirical strategy. Section 3 presents the results of the main and subgroup analyses. Section 4 discusses the findings and their implications. Section 5 concludes.

2. Materials and Methods

2.1. Data Source

This study used data from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative survey of Chinese residents aged 45 years and above [29]. CHARLS adopts a multistage probability-proportional-to-size sampling strategy and collects extensive information on demographic characteristics, health conditions, labor status, household structure, and social support. Because the survey is specifically designed to capture the living conditions of middle-aged and older adults in China, it is well suited for examining labor participation under health constraints.

To improve the completeness and consistency of key demographic variables, the original CHARLS data were linked with the Harmonized CHARLS dataset. This harmonization was particularly important for variables affected by the questionnaire skip patterns, such as educational attainment. The merged dataset substantially reduced missing values for education and also provided more complete information on age and sex, thereby improving the completeness of the analytical sample.

This study primarily utilized the 2020 Wave 5 data from CHARLS to capture post-pandemic labor participation. To address potential reverse causality, we integrated 2018 Wave 4 data for a time-lagged sensitivity analysis, to assess the robustness of the main findings using an earlier survey wave.

The sample selection process is illustrated in Figure 1. We began with an initial sample of 33,897 respondents from the 2020 CHARLS Wave 5 dataset. We applied a stepwise exclusion process: first, we excluded respondents with missing data on labor participation ($n = 14,538$, 42.9%); second, we excluded those missing data on the core independent variable, health-related work capacity ($n = 39$, 0.1%); finally, we removed cases with missing values for any of the control variables ($n = 12,720$, 37.5%). This resulted in a final analytic sample of 6600 respondents (19.5% of the original sample).

The data utilized in this study were de-identified and publicly available. Ethical approval for the original data collection was obtained from the Biomedical Ethics Review Committee of Peking University (Ethics Approval Number: IRB00001052-11015). This secondary analysis was exempt from additional ethical review.

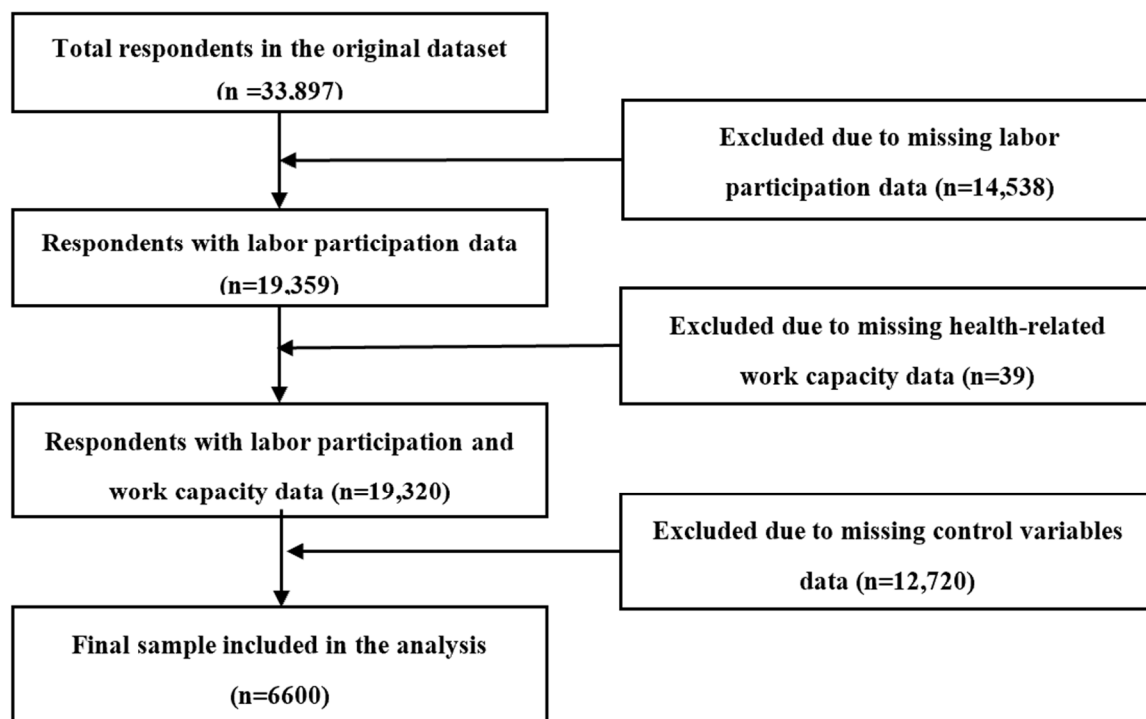


Figure 1. Flowchart of sample selection.

2.2. Measures

2.2.1. Dependent Variable: Labor Participation

The dependent variable was labor participation, coded as a binary variable. Respondents were coded as 1 if they met at least one of the following conditions: engaging in agricultural production for more than 10 days during the past year, having performed paid work for at least 1 h during the previous week, or currently being temporarily absent from work because of leave, sickness, training, or similar reasons. Otherwise, respondents were coded as 0. This operationalization follows prior CHARLS-based research on later-life work participation [18].

2.2.2. Key Independent Variable: Health-Related Work Capacity

The key independent variable was health-related work capacity, measured by a self-assessment item asking whether disability or related health problems affected the respondent's ability to work. Responses were classified into three ordered categories:

- (1) Completely unable to work because of disability or health-related problems;
- (2) Unable to work for a long time because of disability or health-related problems; and
- (3) No problem working because of disability or health-related problems.

Higher values indicated better health-related work capacity. This measure captures the respondent's perceived functional ability to engage in work under health constraints, rather than general health status alone, and is consistent with the work-related capability approach used in prior CHARLS research [25].

To validate the self-assessed work capacity, objective functional disability was also assessed using the Basic Activities of Daily Living (BADL, 6 items) and Instrumental Activities of Daily Living (IADL, 6 items) scales available in CHARLS [30,31]. For each item, experiencing difficulty or being unable to complete the task was coded as 1 (otherwise 0), with higher sum scores indicating more severe functional impairment. Validation analysis revealed that our health-related work capacity score was significantly and negatively correlated with both BADL impairments (Spearman's $\rho = -0.466$, $p < 0.001$) and IADL impairments (Spearman's $\rho = -0.522$, $p < 0.001$), demonstrating strong convergent validity.

2.2.3. Control Variables

To reduce confounding, the regression models controlled for age (Age), gender (Gender), depressive symptoms (CESD10_sum), number of chronic diseases (Chronic_Count), general health (Self-rated health), and

social isolation (Social isolation), education level (Education), household total income (Household_total_income), pension receipt (Pension), spousal employment status (s_work), and urban/rural residency (Urban).

2.3. Statistical Analysis

Binary logistic regression was used to estimate the association between health-related work capacity and labor participation. Odds ratios (ORs), 95% confidence intervals (CIs), and *p* values were reported. The main analytic sample consisted of 6600 valid observations after adjusting for all covariates. Model fit was assessed using Cox–Snell R^2 , Nagelkerke R^2 , and classification accuracy.

To examine heterogeneity, subgroup analyses were conducted in two ways. First, a two-dimensional subgroup analysis was performed based on gender-specific retirement policy thresholds: men aged <60 years, men aged ≥60 years, women aged <55 years, and women aged ≥55 years. Furthermore, a pooled interaction model was constructed to formally test the moderating effects of these gender-specific retirement statuses. Second, one-dimensional subgroup analyses were conducted by age, gender, education, and urban–rural residence. These subgroup and interaction analyses were designed to assess whether the effect of health-related work capacity differed across institutional and social strata. As detailed stratification across three or more dimensions simultaneously produced sparse data bias, we restricted our reporting to these adequately powered subgroups.

To address potential reverse causality, we conducted a sensitivity analysis using a time-lagged design. Specifically, we used the respondents' health-related work capacity data from the previous CHARLS wave (2018) to predict their labor participation in the current wave (2020).

3. Results

3.1. Main Regression Results

Prior to the main regression analysis, collinearity diagnostics were conducted to ensure the stability of the estimates. The results confirmed that there was no severe multicollinearity among the key independent variables, including health-related work capacity, self-rated health, and chronic disease burden. Descriptive statistics suggested substantial variation in health-related work capacity, labor participation, health status, psychosocial characteristics, and expanded socioeconomic and household factors across the analytic sample (Table 1). In the multivariable logistic model, health-related work capacity remained a positive and independent predictor of labor participation after adjustment for sociodemographic, physical-health, psychosocial, and economic covariates. Specifically, while age, gender, education level, and urban residency were negatively associated with labor participation, self-rated health, depressive symptoms, spousal employment, and social isolation were positively associated with it (Table 2).

Taken together, the main model showed robust fit (Nagelkerke $R^2 = 0.373$) and high classification performance (79.4% accuracy), supporting the central role of work-specific capability in later-life labor participation.

To further validate the temporal direction of our ability-behavior framework, a lagged logistic regression was conducted ($N = 10,356$). The results demonstrated that health-related work capacity in 2018 significantly and positively predicted labor participation in 2020 ($OR = 2.392$, 95% CI [2.259, 2.533], $p < 0.001$). This longitudinal evidence confirms that the observed association is robust and largely mitigates the concern of reverse causality.

Table 1. Descriptive statistics.

Variable	N	Min	Max	Mean	SD
Labor participation	19,359	0.00	1.00	0.6449	0.47857
Health-related work capacity	19,345	1.00	3.00	2.5074	0.70715
Social isolation	33,897	0.00	4.00	0.4084	0.84655
Self-rated health	17,576	1.00	5.00	3.0526	1.02593
Chronic disease count	28,195	0.00	15.00	0.4101	0.86063
CESD10_sum	16,165	10.0	40.00	18.620	6.44729
Age	33,454	18.0	110.0	63.150	10.9189
Gender	33,689	1.00	2.00	1.5101	0.49990
Pension	19,395	0.00	1.00	0.8497	0.35742
Education	25,542	0.00	2.00	0.0341	0.52532
Household_total_income	33,897	−28.0	2,000,002.00	4783.0	33102.5
s_work	16,343	0.00	1.00	0.6800	0.46600
Urban	19,361	0.00	1.00	0.3663	0.48179
Complete cases in main model	6600				

Table 2. Main regression results.

Variable	B	SE	OR	p
Health-related work capacity	0.799	0.057	2.223	<0.001
Social isolation	0.099	0.042	1.104	0.018
Self-rated health	0.154	0.038	1.167	<0.001
Chronic disease count	0.019	0.039	1.019	0.632
CESD10_sum	0.026	0.006	1.026	<0.001
Age	−0.075	0.004	0.928	<0.001
Gender	−1.080	0.071	0.340	<0.001
Pension	0.149	0.093	1.161	0.109
Education	−0.361	0.066	0.697	<0.001
Household_total_incomes_work	0.000	0.000	1.000	0.519
Urban	−1.453	0.072	0.234	<0.001
Nagelkerke R ²	0.373			
Overall classification accuracy	79.4%			

3.2. Cross-Tabulation Between Health-Related Work Capacity and Labor Participation

The cross-tabulation revealed a clear monotonic gradient, with labor participation becoming progressively more common as health-related work capacity improved (Table 3). The intermediate category also maintained substantial participation, suggesting that partial work capacity may still support lower-intensity, flexible, or intermittent work.

Table 3. Cross-Tabulation.

Health-Related Work Capacity	No Labor Participation	Labor Participation	Total
Completely unable to work	377 (71.0%)	154 (29.0%)	531
Unable to work for a long time	455 (28.5%)	1140 (71.5%)	1595
No problem working	1084 (24.2%)	3390 (75.8%)	4474
Total	1916 (29.0%)	4684 (71.0%)	6600

Note: The sample size (N = 6600) is restricted to complete cases utilized in the main multivariate logistic regression models to ensure consistency across descriptive and inferential analyses.

3.3. Subgroup Analyses

3.3.1. Two-Dimensional Subgroup Analysis Based on Gender-Specific Retirement Thresholds

Across the gender-by-retirement-threshold subgroups, the association between work capacity and labor participation remained statistically significant and appeared strongest among men below retirement age (OR = 3.491, $p < 0.001$) (Table 4). Consistent with this pattern, the pooled interaction model indicated that only this subgroup exhibited a significantly stronger work-capacity effect than the reference group (Table 4).

It should be noted that the relatively high odds ratio observed in men below retirement age (OR = 3.491) is partially driven by the smaller size of the reference category (i.e., those completely unable to work, representing 4.5% of this subgroup, N = 175). To facilitate a more intuitive interpretation across subgroups, we calculated the absolute predicted probabilities (marginal effects) after adjusting for all covariates. For men below retirement age, the absolute predicted probability of labor participation was 70.1% for those who were completely unable to work, rising to 81.6% for those with long-term work limitations, and reaching 89.0% for those with no health-related work problems. This represents a substantial absolute difference of 18.9 percentage points, illustrating the critical role of health-related work capacity in labor force attachment for this demographic.

3.3.2. One-Dimensional Subgroup Analyses

The positive association between health-related work capacity and labor participation remained significant across all the one-dimensional subgroup models. Comparatively stronger patterns were observed among older adults (aged ≥ 70 years), men, rural respondents, and respondents with low education (Table 4).

Table 4. Subgroup analysis results.

Subgroup	N	OR	95% CI	p
Panel A. Retirement-threshold subgroups				
Men below retirement age	1457	3.491	2.447–4.981	<0.001
Men at/above retirement age	1716	2.659	2.175–3.251	<0.001
Women below retirement age	1283	1.797	1.351–2.390	<0.001
Women at/above retirement age	2144	2.342	1.983–2.766	<0.001
Panel B. Interaction model				
Work capacity (reference-group slope)	6600	2.012	1.725–2.347	<0.001
Work capacity × men below retirement age	6600	1.688	1.204–2.366	0.002
Work capacity × men at/above retirement age	6600	1.233	0.993–1.532	0.058
Work capacity × women below retirement age	6600	0.887	0.658–1.197	0.433
Panel C. One-dimensional subgroups				
Age <60 years	3357	2.095	1.735–2.529	<0.001
Age 60–69 years	2255	2.217	1.865–2.635	<0.001
Age ≥70 years	988	3.041	2.388–3.873	<0.001
Men	3173	2.587	2.168–3.088	<0.001
Women	3427	2.017	1.747–2.327	<0.001
Low education	4413	2.293	2.018–2.605	<0.001
Middle/high education	2187	2.110	1.689–2.637	<0.001
Rural	4308	2.599	2.270–2.976	<0.001
Urban	2292	1.691	1.398–2.046	<0.001

4. Discussion

This study examined the association between health-related work capacity and labor participation among middle-aged and older Chinese adults. The results consistently showed that better health-related work capacity was associated with a higher probability of labor participation. This finding supports the ability–behavior framework, according to which labor participation is not a direct outcome of health status per se, but rather the behavioral realization of work-related capability under health constraints. In this framework, health-related work capacity functions as a proximal capability indicator that connects health status with actual labor behavior.

The results also support the conceptual distinction between general health and health-related work capacity. Although self-rated health and chronic disease burden were both associated with labor participation, health-related work capacity retained a strong independent association after adjustment for these covariates. This suggests that a work-oriented health capability measure captures something more specific than general health alone. It reflects whether health can actually be transformed into labor behavior in real-life settings. This interpretation is also consistent with previous studies suggesting that work-oriented measures, such as health-related work capacity, are more closely related to labor market behavior than general health indicators alone [1,17].

The findings also resonate with previous Chinese studies on later-life work capacity. Hou, et al. [19] argued that a substantial number of older adults in urban China still possess excess health capacity to remain in work, while Cheng, et al. [18] showed that older Chinese women retain some potential for continued employment from a health perspective. The present study refines this insight by focusing on the individual-level transition from capability to behavior. Rather than estimating abstract residual work potential, this study shows that respondents' self-assessed ability to work under health constraints is directly and strongly associated with whether they actually participate in labor.

The subgroup analyses provide further insight into how the conversion of capacity into behavior depends on institutional and social context. First, the association between health-related work capacity and labor participation was strongest among men below the retirement threshold. This may indicate that before the statutory retirement age is reached, work-related capability is more directly converted into labor behavior, especially among men whose labor force attachment is typically stronger. After retirement age, the effect remained significant but weaker, suggesting that institutional exit channels and retirement norms partly attenuate the behavioral relevance of work capacity.

Second, the stronger association observed in rural respondents suggests that labor participation in rural China may depend more directly on physical and functional capability. Because agricultural and informal work remain common in rural settings, the ability to work may be more immediately reflected in actual labor behavior than in urban areas, where formal retirement systems, pensions, and non-labor income can facilitate labor market withdrawal. This interpretation is also consistent with the broader literature showing that older adults in rural China often continue working under more physically demanding conditions and with fewer institutional protections.

Third, the education-stratified findings suggest that work capacity translates into labor participation more strongly among respondents with low education (OR = 2.293) compared to those with middle or higher education (OR = 2.110). A plausible explanation is that older adults with low educational attainment typically face limited

pension coverage and restricted financial resources, compelling them to rely on physically demanding agricultural or informal work to sustain their livelihood. Consequently, for this socioeconomically vulnerable group, their actual labor participation is strictly dictated by their residual physical capability, making health-related work capacity a more critical determinant.

These results are very important for making policies. Changing pension rules is not enough to help people work longer. We must also help workers keep their basic work abilities. Our group studies show that different people need different plans. First, policies should allow flexible land management for older people in rural areas. This helps them continue farming with less hard work. Second, men near retirement age can easily turn their ability into actual work. Step-by-step retirement plans should be the top choice for them. Finally, workplaces should redesign jobs for older adults with less education. Modifying tasks based on health can help them overcome physical problems and keep working.

Several limitations should be acknowledged. First, health-related work capacity was measured using a single self-reported item, which may be subject to reporting bias and may not capture the full multidimensionality of work ability. However, as demonstrated in the Methods section, our validation analysis confirmed that this self-reported measure has strong convergent validity with objective functional metrics (i.e., BADL and IADL). This indicates that the single item reliably reflects actual physical limitations, ensuring the robustness of our findings. Second, the dependent variable was defined as a binary indicator capturing the absolute presence or absence of labor participation, aligning with prior research focusing on complete labor force withdrawal [14]. However, this binary outcome treats all labor participation equally and does not distinguish among job quality, work intensity, working hours, or agricultural versus non-agricultural sectors. Given China's urban-rural divide, agricultural work often allows for partial disability and low-intensity subsistence farming, whereas formal sector work does not. Future research should employ multinomial outcomes or analyze agricultural and non-agricultural work separately to capture these critical nuances and provide more targeted policy implications. Third, the analysis was associational rather than causal. Although the results are strongly consistent with an ability-to-behavior pathway, future research should use longitudinal or quasi-experimental designs to strengthen causal inference.

5. Conclusions

Using CHARLS data, this study found that health-related work capacity is a strong and robust predictor of labor participation among Chinese middle-aged and older adults. Respondents with better self-assessed work capacity under health constraints were significantly more likely to engage in labor. This association remained significant across age, gender, education, and urban–rural subgroups, although its strength varied by institutional and social context. The strongest effect was observed among men below retirement age, and the association was also more pronounced among rural respondents and those with lower educational attainment.

These findings indicate that health-related work capacity is a meaningful bridge between health status and labor behavior. In the context of population ageing and retirement policy adjustment, maintaining older adults' capacity to work may be an important pathway for sustaining labor participation. Future research should continue to refine the measurement of work-related capability, distinguish between different forms of labor participation, and further investigate the mechanisms through which health-related work capacity shapes later-life labor behavior.

Author Contributions

Y.W. (Yutong Wu): Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing—original draft. Y.W. (Ying Wang): Conceptualization, Supervision, Writing—review & editing. T.W.: Supervision, Writing—review and editing. W.D.: Project administration, Resources, Supervision, Writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study used publicly available data from the China Health and Retirement Longitudinal Study (CHARLS). Ethical approval for the original data collection was obtained from the Biomedical Ethics Review Committee of Peking University (Ethics Approval Number: IRB00001052-11015), and all participants provided

informed consent prior to participation. In this study, only de-identified secondary data were used. The informed consent form provided with the CHARLS database has been uploaded as an attachment.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data utilized in this study are publicly available from the China Health and Retirement Longitudinal Study (CHARLS) repository at <http://charls.pku.edu.cn/> (accessed on 15 July 2026). Researchers can apply for access independently via the website, or obtain the datasets from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the authors used ChatGPT-5.5 to translate parts of the initial draft into English. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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