Research Square

Preprints are preliminary reports that have not undergone peer review. They should not be considered conclusive, used to inform clinical practice, or referenced by the media as validated information.

Employment-type inequalities in healthy working life expectancy in China: evidence from CHARLS, 2011–2018

Yulong Li[1]
Zhengzhou University

Panpan Wang[1]
Zhengzhou University

Qianyu Zhou[2]
Zhengzhou University

Mingyang Zhao[2]
Zhengzhou University

Ruoyao Huang[3]
The First Affiliated Hospital of Zhengzhou University

Jiajun Chen
The First Affiliated Hospital of Zhengzhou University

Hexin Zhang[1]
Zhengzhou University

Yang Yang[1]
Zhengzhou University

Yuxin Chen[1]
Zhengzhou University

Changqing Sun
suncq@zzu.edu.cn

Zhengzhou University

Research Article

Keywords: healthy working life expectancy, employment type, retirement-age reform, health inequality, CHARLS

Posted Date: October 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10956294/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background: Healthy working life expectancy (HWLE) has become an important metric for evaluating the feasibility and equity of extended working lives. In China, ongoing retirement-age reform is occurring within a labour market characterized by significant differences in physical demands, social protection, and exit pathways across agricultural work, self-employment, and wage employment. This study estimated employment-type inequalities in HWLE among older Chinese adults.

Methods: We analysed pooled person-wave data from the 2011, 2013, 2015, and 2018 waves of the China Health and Retirement Longitudinal Study. The analytic sample included 34,644 person-wave observations from 11,626 adults aged 50–100 years. Four joint health-work states were defined by functional health and current work status: healthy-working, healthy-not working, unhealthy-working, and unhealthy-not working. Employment type was classified as agricultural work, self-employment, or family-business work, and employee or other work using CHARLS work-module variables. Sex- and employment-type-specific age prevalence in each state was combined with sex-specific United Nations life-table person-years to estimate state-specific expectancies from age 50. An illustrative value analysis examined how retirement-age conclusions changed when unhealthy work was assigned a lower value.

Results: Remaining life expectancy at age 50 was fixed at 27.11 years for men and 31.76 years for women. Among men, healthy-working life expectancy ranged from 17.12 years among employees or other workers to 18.91 years among agricultural workers, while unhealthy-working life expectancy was highest among agricultural workers (4.00 years). Among women, agricultural workers had the least favourable profile, with the lowest healthy-working life expectancy (16.06 years) and the highest unhealthy-working expectancy (7.65 years). Self-employed or family-business women had the highest healthy-working life expectancy (20.78 years) and the lowest unhealthy-working expectancy (3.22 years). Under the illustrative value specification, welfare-maximising ages differed by sex and employment type.

Conclusions: Employment type significantly influences the distribution of later life between healthy work, unhealthy work, and non-work in China. Evaluating retirement-age reform solely on the basis of average longevity is insufficient. A public health approach should account for the unequal burden of unhealthy work, particularly among women in agricultural employment.

Background

Population ageing and pension sustainability pressures have led many countries to consider policies that extend working lives [1]. However, longer life does not necessarily mean a longer healthy life. Global evidence shows that gains in life expectancy have not been fully matched by gains in healthy life expectancy[2, 3]. Therefore, the key public health question is whether extended working lives are feasible and equitable for older adults with different health capacities, job demands, and levels of social protection.

The key policy issue is not simply whether older adults can remain economically active, but whether they can do so in good health.Healthy working life expectancy (HWLE) was developed as a population-level indicator linking health and work in later life [4, 5]. Unlike total life expectancy, HWLE estimates the number of remaining years likely to be spent both working and in good health, and is therefore more informative for retirement policy than either healthy life expectancy or working life expectancy alone [4–6]. For public health policy, it is also important to distinguish healthy work from unhealthy work. Continued employment under functional limitations may reflect economic necessity rather than successful ageing, especially when older adults lack sufficient pension income or flexible exit pathways. Thus, retirement-age reform may be more defensible when additional working years are mainly healthy, but more problematic when they are achieved through prolonged work despite functional limitations. [7, 8].

Existing evidence shows that longer working lives are not always accompanied by longer healthy working lives. Studies from OECD countries and England have shown substantial gaps between working life expectancy and healthy working life expectancy, with differences by sex and socioeconomic position. However, evidence remains limited on how broad employment types shape the balance between healthy work and unhealthy work, particularly in China.

Employment type is an important but underexamined source of heterogeneity in later-life working capacity. Agricultural workers, self-employed or family-business workers, and wage employees may differ in physical workload, work autonomy, income security, pension protection, and the ability to exit or adjust work. These differences can shape whether older adults remain in work voluntarily and healthfully, or continue working despite functional limitations. Prior reviews also suggest that the health consequences of later-life work depend on job quality, work context, and individual circumstances [10].

China is a particularly important setting for examining these issues. Later-life work in China is structured by large differences between formal and informal employment, urban and rural pensions, and agricultural and non-agricultural work. Using nationally representative CHARLS data, Giles and colleagues documented stark differences in retirement patterns between urban and rural China: urban residents often leave work relatively early, whereas rural residents tend to continue working until advanced ages [11]. An ILO report similarly showed that old-age work in China is closely linked to income security, rural residence, gender, and work type, with agricultural work remaining a major component of work at older ages [12]. National retirement-age debates may therefore obscure substantial differences in health capacity, work intensity, and the practical feasibility of leaving work.The policy relevance of this heterogeneity increased after China approved a gradual increase in the statutory retirement age in September 2024, with implementation beginning on 1 January 2025 [16, 17]. Under the reform, the retirement age for men will gradually increase from 60 to 63 over 15 years; the retirement age for women in white-collar jobs will increase from 55 to 58; and the retirement age for women in blue-collar jobs will increase from 50 to 55. The reform responds to demographic ageing and pension sustainability pressures, but it also raises a public health question: do the groups expected to work longer have comparable health capacity, working conditions, and social protection to do so?

Recent Chinese studies have begun to document inequalities in HWLE by sex, socioeconomic status, region, education, occupation, and geography [13–15]. These studies have established the importance of HWLE in China. However, less is known about how broad employment types shape the balance between healthy work and unhealthy work in the context of retirement-age reform.Two empirical challenges are relevant to this question. Mortality follow-up in ageing surveys may be incomplete, and employment classifications must be broad enough to remain comparable across survey waves while still capturing meaningful differences in work organisation and social protection.

The present study addresses these issues through a life-table-anchored prevalence-based strategy. Using four waves of CHARLS, we defined four joint health-work states and stratified respondents by sex and employment type: agricultural work, self-employment or family-business work, and employee or other work [18, 19]. Instead of estimating mortality from survey follow-up, survival was anchored to sex-specific national life tables from the United Nations World Population Prospects, and life-table person-years were allocated to joint health-work states according to observed age-specific prevalence [18, 20].

The study then extended the descriptive analysis to an illustrative policy exercise. Specifically, it simulated a hypothetical retirement scenario in which all work ceased at a candidate retirement age and evaluated a value function that rewards healthy years, subtracts unhealthy working years, and assigns a positive value to work itself. The objectives were to estimate life-table-anchored healthy-working, healthy-not working, unhealthy-working, and unhealthy-not working expectancies from age 50 in China; to examine variation across employment types among women and men; and to show how different values assigned to unhealthy work lead to different retirement-age conclusions. By separating healthy work from unhealthy work, this study provides public health evidence for equity-oriented retirement-age reform in China.

Methods

Study design and data source

This study was a secondary analysis of publicly available, de-identified survey data. Joint health-work states were estimated from pooled person-wave observations, and survival was supplied externally through national life tables. The study therefore used a life-table-anchored prevalence-based design rather than a transition-based multistate model.

Data were drawn from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative longitudinal survey of Chinese residents aged 45 years and older and their spouses. CHARLS uses a multistage stratified probability sampling design and collects information on health, socioeconomic status, work, retirement, pension, family, and demographic characteristics [19]. To maximise comparability across waves, this study used harmonised variables from the 2011, 2013, 2015, and 2018 CHARLS waves, as provided in the Harmonized CHARLS documentation [21].

Analytic sample

The analytic target was the age-specific prevalence of joint health-work states among adults aged 50–100 years. All eligible person-wave observations from the four waves were pooled. Observations were excluded sequentially if respondents were not interviewed in the corresponding wave, had missing sex, were outside the target age range, had missing or non-positive respondent weights, lacked functional-health information, lacked work-status information, or could not be assigned to an employment type using work-module information. The final analytic sample included 34,644 person-wave observations contributed by 11,626 respondents. Details of the exclusion sequence and subgroup sample sizes are provided in Additional file 1: Tables S1–S3.

Because the primary estimator was prevalence-based rather than transition-based, pooling across waves improved precision at older ages without requiring complete observation of individual transitions between health-work states. Analyses were stratified by sex throughout because mortality schedules, statutory retirement ages, and later-life work patterns differ substantially between women and men in China.

State definitions and employment type

Health was defined by functional capacity. Respondents were classified as healthy if they reported no limitations in activities of daily living (ADL) and no limitations in instrumental activities of daily living (IADL). Because the harmonised 2011 file did not contain the IADL summary variable used in later waves, functional health in 2011 was defined using the ADL summary, whereas both ADL and IADL summaries were used in 2013, 2015, and 2018. This functional definition was chosen because limitation in daily activities is closely related to the practical ability to sustain work at older ages and is readily interpretable for retirement policy.

Work was defined as current paid work at interview, including wage employment, self-employment, and agricultural household work as recorded in CHARLS. Combining health and work yielded four mutually exclusive states: healthy-working (HW), healthy-not working (HN), unhealthy-working (UW), and unhealthy-not working (UN). The HW state corresponds to healthy working life expectancy. The UW state is especially important for policy because it captures years in which people remain economically active despite functional limitations.

To examine labour-market heterogeneity, employment type was classified using corrected variables from the CHARLS work module rather than household asset variables. Respondents reporting agricultural work or household agricultural production were classified as agricultural workers. Among the remaining respondents, those reporting self-employment or working in a family business were grouped as self-employed/family-business workers because both categories generally involve household-based or non-standard employment arrangements and less formal retirement separation than wage employment. The remainder were classified as employees or other workers. This grouping does not replace a full

occupational history, but it captures broad differences in work organisation, autonomy, physical demand, and access to formal retirement pathways in the Chinese context.

Life-table anchoring and expectancy estimation

Mortality was anchored to sex-specific Chinese life tables from the 2022 revision of the United Nations World Population Prospects [20]. Life-table person-years refer to the total number of years lived by a hypothetical life-table cohort within each age interval. In this study, life-table person-years from age 50 onwards were converted from abridged intervals to single-year ages under a constant-hazard assumption within each interval. Remaining life expectancy at age 50 was therefore fixed by sex within the external United Nations life table rather than estimated from survey deaths. This choice was made to avoid implausible survival estimates that may arise when deaths are incompletely observed in longitudinal survey follow-up.

For each sex-by-employment-type stratum and age x, the prevalence of each joint state was estimated using pooled person-wave observations and available survey weights. Let $p_k(x|s, g)$ denote the prevalence of state k for sex s and employment group g at age x. The externally supplied life-table person-years $L_x(s)$ were allocated to each state by multiplying $L_x(s)$ by $p_k(x|s, g)$. Summing state-specific person-years across ages 50 to 100 and dividing by the life-table radix at age 50 yielded the expected years spent in each joint state from age 50 onward. The four state-specific expectancies sum to the anchored remaining life expectancy within sex.

This estimator is conceptually related to the Sullivan method, which combines age-specific state prevalence with life-table person-years to estimate health expectancy [18, 22]. In the present study, the same logic was applied to joint health-work states rather than to health alone. The main strengths of this approach are transparency, interpretability, and robustness when mortality follow-up is imperfect. However, the estimates should be interpreted as prevalence-based period summaries rather than as reconstructed individual life-course trajectories[23]. Because the method uses age-specific state prevalence, it does not estimate transitions between healthy work, unhealthy work, non-work, and death, nor does it identify the causal effects of employment type on health or work participation. Observed differences across employment types may reflect a combination of work-related health effects, health selection into or out of work, pension coverage, job security, and broader socioeconomic conditions. Therefore, the resulting expectancies describe the contemporary distribution of later-life health-work states rather than forecasting the future cohort experience of specific individuals.

Illustrative retirement-age scenario and value analysis

An illustrative deterministic retirement-age scenario was constructed. For a candidate retirement age R, all work occurring at age R or older was removed. Under this rule, person-years that would otherwise have been allocated to HW were reassigned to HN, and person-years that would otherwise have been

allocated to UW were reassigned to UN. This counterfactual did not model partial retirement, re-entry into work, employer responses, pension eligibility, household behavioural responses, or causal health effects of retirement. Instead, it isolated the arithmetic implications of stopping work at different candidate ages.

Illustrative retirement-age trade-offs were summarised using a theta-weighted value function:

Welfare_theta(R) = E (HW + HN) − E (UW) + theta × E (HW + UW).

The first term values all healthy years, regardless of work status. The second term subtracts unhealthy working years. The final term assigns a positive value to work itself, representing income, social participation, or utility associated with continued work. When theta equals zero, work has no direct additional value, and any added exposure to unhealthy work lowers the score. As theta increases, later retirement can become more favourable if additional working years are sufficiently valued. This value analysis was intended as an illustrative sensitivity exercise rather than a direct policy prescription.

Statistical analysis

The primary value analysis used theta = 0.20 because this value generated informative interior welfare-maximising ages in the current application. Theta values from 0.00 to 0.30, in increments of 0.05, were also examined to show how strongly the implied welfare-maximising age depends on assumptions about the value assigned to work.

Uncertainty in the expectancy estimates was quantified using non-parametric bootstrap resampling of person-wave observations within each sex-by-employment-type stratum. For each bootstrap replicate, age-specific state prevalence was recalculated, and the life-table decomposition was repeated. Percentile-based 95% confidence intervals were then obtained for remaining life expectancy and each state-specific expectancy. Because the value curves are deterministic functions of the estimated state expectancies and the assumed value parameter, the illustrative value analysis emphasised point estimates and sensitivity patterns rather than interval estimates for a single optimum.

During manuscript preparation, a large language model was used only to assist with English language editing and formatting consistency. The authors reviewed and verified the statistical code, numerical results, and interpretation, and take full responsibility for the final content of the manuscript.

Results

Analytic sample

Across the four harmonised CHARLS waves, 102,344 possible respondent-wave records were generated. After restricting the data to interviewed respondents aged 50–100 years with non-missing sex, positive respondent weights, complete functional-health information, and non-missing work status and

classifiable employment type, the final analytic sample included 34,644 person-wave observations from 11,626 respondents. The analytic sample increased across waves, from 6,341 person-wave observations in 2011 to 10,608 in 2018. Agricultural workers contributed the largest number of observations, including 14,015 male and 13,063 female person-wave observations. Employees or other workers contributed 3,352 male and 1,695 female observations, while self-employed or family-business workers contributed 1,532 male and 987 female observations (Table 1). The full exclusion sequence and observed joint-state counts are provided in Additional file 1: Tables S1 and S4.

Table 1
Analytic sample distribution by survey wave, sex, and employment type

Panel	Category	Unique respondents	Person-wave observations
Survey wave	2011	6341	6341
Survey wave	2013	7660	7660
Survey wave	2015	10035	10035
Survey wave	2018	10608	10608
Male	Agricultural	4432	14015
Male	Employee/other	1322	3352
Male	Self-employed/family	582	1532
Female	Agricultural	4193	13063
Female	Employee/other	704	1695
Female	Self-employed/family	393	987

Values are based on the final analytic sample after all exclusions. Person-wave observations may exceed unique respondents because respondents could contribute observations in multiple survey waves. For survey-wave rows, the two columns are identical because each respondent contributes at most one observation per wave.

Life expectancy at age 50 and decomposition into joint states

Remaining life expectancy at age 50 was fixed by the United Nations life table at 27.11 years for men and 31.76 years for women. Differences across employment types therefore reflect differences in the allocation of remaining life across health-work states, rather than differences in total survival within sex. The most pronounced inequality was observed among women in agricultural work, who combined the lowest healthy-working expectancy with the highest unhealthy-working expectancy.

Among men, healthy-working life expectancy ranged from 17.12 years among employees or other workers to 18.91 years among agricultural workers (Table 2; Fig. 1). Agricultural men also had the

highest unhealthy-working expectancy, at 4.00 years (95% CI: 3.75, 4.28), followed by self-employed or family-business men at 3.79 years (95% CI: 2.43, 5.24). By contrast, employees or other workers had the lowest unhealthy-working expectancy, at 1.42 years (95% CI: 1.06, 1.75), and the highest healthy-not-working expectancy, at 8.05 years (95% CI: 4.45, 8.95).

Among women, employment-type inequalities were larger. Agricultural women had the lowest healthy-working life expectancy, at 16.06 years (95% CI: 15.62, 17.12), and the highest unhealthy-working expectancy, at 7.65 years (95% CI: 7.19, 8.27). Employees or other women had 17.61 years of healthy-working expectancy and 5.08 years of unhealthy-working expectancy. Self-employed or family-business women had the most favourable distribution, with the highest healthy-working expectancy, at 20.78 years (95% CI: 15.70, 22.57), and the lowest unhealthy-working expectancy, at 3.22 years (95% CI: 2.39, 4.66). This pattern shows that the least favourable female profile was not simply early exit from work, but prolonged work despite functional limitations.

Table 2
Remaining life expectancy at age 50 allocated across joint health-work states, by sex and employment type

Sex	Employment type	LE at 50	HWLE	HN	UW	UN
Male	Agricultural	27.11 [27.11–27.11]	18.91 [18.62–19.23]	2.74 [2.48–2.99]	4.00 [3.75–4.28]	1.47 [1.26–1.65]
Male	Employee/other	27.11 [27.11–27.11]	17.12 [16.27–20.74]	8.05 [4.45–8.95]	1.42 [1.06–1.75]	0.52 [0.29–0.76]
Male	Self-employed/family	27.11 [27.11–27.11]	18.65 [17.17–20.20]	3.46 [2.87–4.22]	3.79 [2.43–5.24]	1.21 [0.43–1.76]
Female	Agricultural	31.76 [31.76–31.76]	16.06 [15.62–17.12]	4.28 [3.93–5.34]	7.65 [7.19–8.27]	3.77 [2.68–4.15]
Female	Employee/other	31.76 [31.76–31.76]	17.61 [15.56–19.20]	6.99 [5.35–9.51]	5.08 [2.66–6.68]	2.08 [1.27–4.95]
Female	Self-employed/family	31.76 [31.76–31.76]	20.78 [15.70-22.57]	6.16 [4.59–10.68]	3.22 [2.39–4.66]	1.60 [0.88–2.60]

Values are years with 95% bootstrap confidence intervals. Remaining life expectancy is anchored to sex-specific United Nations life tables for China. HWLE = healthy-working life expectancy; HN = healthy-not working; UW = unhealthy-working; UN = unhealthy-not working.

Illustrative retirement-age trade-offs under the primary value specification

The illustrative retirement-age scenario made these inequalities more explicit. Under the primary value specification, in which theta was set to 0.20, the welfare-maximising age differed substantially by sex and employment type (Table 3; Fig. 2). Among men, the welfare-maximising age was 68 years for agricultural workers, 71 years for employees or other workers, and 74 years for self-employed or family-business workers. Among women, the welfare-maximising age was much younger for agricultural workers, at 55 years, than for employees or other workers, at 72 years, and self-employed or family-business workers, at 68 years. When employment groups were pooled, the welfare-maximising age was 70 years for men and 58 years for women.

Table 3
Illustrative welfare-maximising age under the primary value specification (theta = 0.20)

Sex	Employment type	Optimal retirement age (years)	Maximum welfare
Male	Agricultural	68	22.80
Male	Employee/other	71	27.23
Male	Self-employed/family	74	24.29
Female	Agricultural	55	20.50
Female	Employee/other	72	25.88
Female	Self-employed/family	68	28.07

Sensitivity to the value assigned to work

Sensitivity analysis showed that the welfare-maximising age depended strongly on the value assigned to work (Figure S1; Additional file 1: Table S5). When theta was close to zero, earlier work exit produced higher values because work contributed little direct value while unhealthy-working years were subtracted from the score. Among women, the pooled welfare-maximising age remained at 50 years when theta was 0.00, 0.05, or 0.10, then increased to 53 years at theta = 0.15, 58 years at theta = 0.20, 61 years at theta = 0.25, and 65 years at theta = 0.30. Among men, the pooled welfare-maximising age was 50 years at theta = 0.00 and 0.05, then increased to 60 years at theta = 0.10, 65 years at theta = 0.15, 70 years at theta = 0.20, and 75 years at theta = 0.25 and 0.30. This stronger upward shift among men reflects their lower unhealthy-working burden in several employment groups and therefore a smaller value penalty from continued work.

Discussion

This study showed that employment type was a major source of inequality in later-life health-work trajectories in China. The key finding is not simply that older adults differ in how long they remain healthy and working, but that some groups spend substantially more years working despite functional limitations. This distinction is important for public health because extended working life can represent either healthy participation or prolonged unhealthy work. The burden was most pronounced among

women in agricultural work, who had the lowest healthy-working life expectancy and the highest unhealthy-working expectancy. This pattern suggests that retirement-age reform may have unequal consequences across employment groups even when implemented through uniform national age thresholds.

The findings extend previous HWLE research in three ways. First, they separate healthy work from unhealthy work, rather than treating continued work as uniformly favourable. This was consistent with international evidence showing that increases in working-life expectancy may be accompanied by increases in unhealthy working-life expectancy [5, 7]. Second, the analysis adds an employment-type perspective to existing Chinese evidence on HWLE inequalities. Previous studies have shown that healthy working life in China differs by sex, socioeconomic position, region, education, and occupation [13–15]. Our findings suggest that broad employment type also matters because it captures differences in work organisation, physical demand, income security, and exit pathways. Third, by anchoring survival to national life tables, the study provides a transparent period measure of how later life is distributed across joint health-work states, avoiding reliance on potentially incomplete survey deaths [18, 20, 22].

The high unhealthy-working expectancy among agricultural workers, especially women, is consistent with evidence that later-life work in China differs sharply between rural/agricultural and formal urban sectors. Prior CHARLS-based work has shown that rural older adults are much more likely than urban older adults to remain economically active at older ages, often because retirement is gradual and not strongly tied to formal pension rules [11]. ILO evidence also suggests that old-age work in China is closely related to income security, rural residence, and work type, with agricultural work remaining an important component of later-life employment [12]. In this context, continued work among older agricultural women may reflect constrained necessity rather than healthy ageing or voluntary labour-force attachment.

Our results also align with broader evidence that the health consequences of working longer depend on job quality and worker choice. A BMC Public Health systematic review concluded that extended working life can be beneficial or neutral for some older workers, but that benefits are more likely among men, those working part-time or reducing hours, and those in jobs that are not low quality or low reward [10]. Another BMC Public Health review on retirement and social security policies similarly emphasised that health conditions shape work exit and retirement decisions, and that mechanisms linking social security reforms and health require further study [24]. The present study contributes to this literature by showing that the key public health issue is not simply whether older adults continue working, but whether they continue working in good health.

The comparatively favourable profile observed among self-employed or family-business women should be interpreted cautiously. Self-employment or family-business work may allow greater flexibility in pace, timing, and task selection than agricultural or wage work, which could help older adults remain active without accumulating as many unhealthy working years. However, this group may also be positively selected: those able to sustain self-employment or family-business work into later life may already be

healthier, have more household resources, or have more control over work intensity. This interpretation is consistent with evidence that health and job quality jointly influence involuntary retirement, and that workers in poorer health or lower-quality jobs are less able to choose when and how to leave work [25]. Therefore, the favourable estimates for self-employed or family-business women should not be interpreted as evidence that this type of work is universally protective.

Among men, agricultural workers had the highest healthy-working expectancy but also the highest unhealthy-working expectancy. This dual pattern is important. It shows that longer working life can coexist with a larger unhealthy-working burden. In public health terms, this means that a group may appear to have strong work capacity if only healthy-working years are considered, but still face a substantial burden if unhealthy work is also counted. This finding is consistent with scoping-review evidence that working life expectancy and healthy working life expectancy vary by occupational class and socioeconomic position, and that policy conclusions can change depending on how work and health states are operationalized [9].

These findings do not imply that retirement-age reform should be abandoned or that a single lower retirement age should be assigned to one employment group. Rather, they suggest that retirement-age reform should be evaluated using equity-oriented public health criteria. Average life expectancy alone is insufficient, because it does not distinguish between longer healthy participation and longer work despite functional limitations. Policies that extend working lives may improve sustainability and social participation for some groups, but may also increase unhealthy working years among groups with physically demanding work, weak pensions, or limited exit options [7, 10, 24].

For China, the most important implication is that gradual retirement-age reform should be accompanied by protective measures that reduce unhealthy work. Such measures may include flexible retirement pathways for workers with functional limitations, stronger income protection for older agricultural and informal workers, workplace adaptation, rehabilitation support, opportunities to transition into lighter work, and protection against involuntary full-time work driven by financial necessity. Evidence from reviews of older-worker interventions indicates that supporting work participation in later life requires more than changing pension ages; it also requires workplace-level and health-system-level measures that help older workers remain employed safely and voluntarily [27].

The findings also suggest that policy evaluation should distinguish between work as a choice and work as a necessity. For older adults with good health, flexible work and adequate protection, continued work may provide income, social participation, and a sense of usefulness[29]. For older adults with functional limitations, low pension income, or physically demanding jobs, the same extension of working life may represent prolonged exposure to unhealthy work[30]. This distinction is consistent with evidence that the effects of work exit and retirement differ across socioeconomic groups and that policy reforms may have unequal health consequences if social inequalities are not addressed [26, 28–30].

Strengths and limitations

This study has several strengths. It used nationally representative CHARLS data, focused on an important policy issue, and estimated joint health-work expectancies separately by sex and employment type. By separating healthy-working, healthy-not working, unhealthy-working, and unhealthy-not working states, the analysis moves beyond a simple distinction between work and non-work. The life-table-anchored design also ensured that total remaining life expectancy was consistent with national mortality schedules, reducing the influence of incomplete death observation in survey follow-up. A further strength is that employment type was defined using work-module variables, which more directly reflect current labour-market participation than household agricultural asset variables.

Several limitations should also be acknowledged. First, the analysis was prevalence-based and should be interpreted as a period summary rather than a cohort forecast. It does not estimate individual transitions between health-work states or model the causal effects of retirement on subsequent health. Second, functional health was measured using ADL/IADL limitations, which are policy-relevant but do not capture all dimensions of work ability, such as chronic pain, cognitive function, depressive symptoms, or job-specific physical capacity. Third, employment type was broad. The employee or other category combined heterogeneous workers, and the self-employed or family-business group may include both relatively advantaged and economically vulnerable workers. Fourth, although survey weights were used to estimate age-specific prevalence, residual selection may remain because healthier people are more likely to remain in work at older ages. This healthy-worker selection may lead to conservative estimates of unhealthy work in some groups. Fifth, the illustrative value analysis depended on assumed values assigned to healthy years, unhealthy working years, and work itself. It should therefore be interpreted as a sensitivity exercise showing how policy conclusions change under different value assumptions, not as a direct estimate of an optimal retirement age.

Finally, the primary analysis used CHARLS waves up to 2018 and should therefore be interpreted as describing pre-reform and pre-pandemic patterns of later-life work and functional health. Recent policy changes and external shocks may have substantially reshaped these patterns. The gradual increase in the statutory retirement age, changes in pension coverage, and the economic and health impacts of COVID-19 could affect labour-force participation, job security, functional health, and the relative prevalence of different employment types among older adults. Therefore, the generalisability of these pre-2018 estimates to current and future cohorts may be limited, and continued monitoring using newer CHARLS waves will be needed when comparable work and functional-health measures are available.

Conclusions

Employment type substantially shapes how later life is divided between healthy work, unhealthy work, and non-work in China. Women in agricultural work had the most disadvantaged profile, with low healthy-working life expectancy and high unhealthy-working life expectancy. These findings suggest that retirement-age reform should not be evaluated using average longevity alone. A public health approach requires attention to whether longer working lives are achieved through healthy participation or through extended work despite functional limitations. Equity-oriented reform should therefore combine gradual

changes in the statutory retirement age with protective measures for older workers in physically demanding, informal, or poorly protected employment.

Abbreviations

ADL: activities of daily living

CHARLS: China Health and Retirement Longitudinal Study

HN: healthy-not working

HW: healthy-working

HWLE: healthy working life expectancy

IADL: instrumental activities of daily living

LE: life expectancy

UN: unhealthy-not working

UW: unhealthy-working

WPP: World Population Prospects

Declarations

Ethics approval and consent to participate

This study used publicly available, de-identified data from the China Health and Retirement Longitudinal Study. Ethical approval for CHARLS was obtained from the Biomedical Ethics Review Committee of Peking University. All participants provided informed consent before participation. The present secondary analysis did not involve direct contact with participants and did not require additional ethical approval.

Availability of data and materials

The CHARLS data used during the current study are available to registered users through the official CHARLS data portal (https://charls.pku.edu.cn/) and the harmonised CHARLS data are available through the Gateway to Global Aging Data (https://g2aging.org/). United Nations World Population Prospects life tables are publicly available from the United Nations Population Division (https://population.un.org/wpp/). The analysis code used to reproduce the corrected employment-type definition and the main tables can be uploaded as an additional file or made available by the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was supported by the National Social Science Fund of China (25BRK002). The funders had no role in the design of the study, data analysis, interpretation of results, or writing of the manuscript.

Authors' contributions

YL and CS conceived and designed the study. YL conducted the data management, statistical analysis, and drafted the initial manuscript. PW, HZ, YY, and YC contributed to data checking, literature review, and preparation of tables and figures. QZ and MZ contributed to the methodological design, statistical interpretation, and verification of the analytic results. RH contributed to the interpretation of findings from a public health and clinical perspective. CS supervised the study, provided critical intellectual input, and revised the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors thank the China Health and Retirement Longitudinal Study team for providing publicly available data. The authors also acknowledge the United Nations Department of Economic and Social Affairs, Population Division, for providing World Population Prospects life-table data.

References

1. OECD. Pensions at a Glance 2023: OECD and G20 Indicators. Paris: OECD Publishing; 2023. 10.1787/678055dd-en.
2. World Health Organization. Global Health Estimates: Life expectancy and healthy life expectancy. Geneva: World Health Organization; 2024. Accessed 17 June 2026.
3. GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy, and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1160–203. 10.1016/S0140-6736(20)30977-6.
4. Parker M, Bucknall M, Jagger C, Wilkie R. Extending working lives: a systematic review of healthy working life expectancy at age 50. Soc Indic Res. 2020;150:337–50. 10.1007/s11205-020-02302-1.
5. Parker M, Bucknall M, Jagger C, Wilkie R. Population-based estimates of healthy working life expectancy in England at age 50 years: analysis of data from the English Longitudinal Study of Ageing. Lancet Public Health. 2020;5(7):e395–403. 10.1016/S2468-2667(20)30114-6.
6. Head J, Hyde M. Measuring progress towards healthy working lives. Lancet Public Health. 2020;5(7):e366–7. 10.1016/S2468-2667(20)30111-3.

7. Boissonneault M, Rios P. Changes in healthy and unhealthy working-life expectancy over the period 2002–17: a population-based study in people aged 51–65 years in 14 OECD countries. Lancet Healthy Longev. 2021;2(10):e629–38. 10.1016/S2666-7568(21)00202-6.
8. Dudel C. Healthy and unhealthy working-life expectancy: opportunities and challenges. Lancet Healthy Longev. 2021;2(10):e604–5. 10.1016/S2666-7568(21)00211-7.
9. Solovieva S, de Wind A, Undem K, Dudel C, Mehlum IS, van den Heuvel SG, et al. Socioeconomic differences in working life expectancy: a scoping review. BMC Public Health. 2024;24:735. 10.1186/s12889-024-18229-y.
10. Baxter S, Blank L, Cantrell A, Goyder E. Is working in later life good for your health? A systematic review of health outcomes resulting from extended working lives. BMC Public Health. 2021;21:1356. 10.1186/s12889-021-11423-2.
11. Giles J, Lei X, Wang G, Wang Y, Zhao Y. One country, two systems: evidence on retirement patterns in China. J Pension Econ Financ. 2023;22(2):188–210. 10.1017/S1474747221000391.
12. Henry C, Fraga F, Yu T. What drives old age work in China? ILO Research Department Working Paper No. 40. Geneva: International Labour Organization; 2018.
13. Li C, Wang L, Ding L, Zhou Y. Determinants and inequities in healthy working life expectancy in China. Nat Med. 2024;30(11):3318–26. 10.1038/s41591-024-03184-3.
14. Huang G, Pan Y, Luo Y. Population-based estimates of healthy working life expectancy in China. BMC Geriatr. 2025;25:700. 10.1186/s12877-025-06262-4.
15. Zhu J, Li S, Fu H, An N, Gao J. Healthy working life expectancy of adults aged 50 years old in China. J Environ Occup Med. 2024;41(9):988–94. 10.11836/JEOM24150.
16. Xinhua. China to gradually raise retirement age. The State Council Information Office of the People's Republic of China. 2024. Accessed 17 June 2026.
17. Xinhua. China implements gradual retirement age increase to address population aging. The State Council Information Office of the People's Republic of China. 2025. Accessed 17 June 2026.
18. Sullivan DF. A single index of mortality and morbidity. HSMHA Health Rep. 1971;86(4):347–54. 10.2307/4594169.
19. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort profile: the China Health and Retirement Longitudinal Study. Int J Epidemiol. 2014;43(1):61–8. 10.1093/ije/dys203.
20. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2022: Methodology of the United Nations population estimates and projections. New York: United Nations; 2022.
21. Phillips D, Green H, Petrosyan S, Shao K, Wilkens J, Lee J, Harmonized CHARLS. Documentation. Version D (2011–2018). Gateway to Global Aging Data; 2021.
22. Imai K, Soneji S. On the estimation of disability-free life expectancy: Sullivan's method and its extension. J Am Stat Assoc. 2007;102(480):1199–211. 10.1198/016214507000000040.

23. Lièvre A, Brouard N, Heathcote C. The estimation of health expectancies from cross-longitudinal surveys. Math Popul Stud. 2003;10(4):211–48.
24. de Oliveira Teixeira LM, Rincón Uribe FA, Moreira HLF, Pedroso JS. Associations between retirement, social security policies and the health of older people: a systematic review. BMC Public Health. 2024;24:2473. 10.1186/s12889-024-19979-5.
25. Welsh J, Strazdins L, Charlesworth S, Kulik CT, D'Este C. Losing the workers who need employment the most: how health and job quality affect involuntary retirement. Labour Ind. 2018;28(4):261–78. 10.1080/10301763.2018.1522609.
26. Schaap R, de Wind A, Coenen P, Proper K, Boot C. The effects of exit from work on health across different socioeconomic groups: a systematic literature review. Soc Sci Med. 2018;198:36–45. 10.1016/j.socscimed.2017.12.015.
27. Steenstra I, Cullen KL, Irvin E, Van Eerd D, Alavinia M, Beaton DE, et al. A systematic review of interventions to promote work participation in older workers. J Saf Res. 2017;60:93–102. 10.1016/j.jsr.2016.12.004.
28. Carrino L, Glaser K, Avendano M. Later retirement, job strain, and health: evidence from the new state pension age in the United Kingdom. Health Econ. 2020;29(8):891–912. 10.1002/hec.4025.
29. Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, et al. The World report on ageing and health: a policy framework for healthy ageing. Lancet. 2016;387(10033):2145–54. 10.1016/S0140-6736(15)00516-4.
30. Edge CE, Cooper AM, Coffey M. Barriers and facilitators to extended working lives in Europe: a gender focus. Public Health Rev. 2017;38:2. 10.1186/s40985-017-0053-8.

Figures

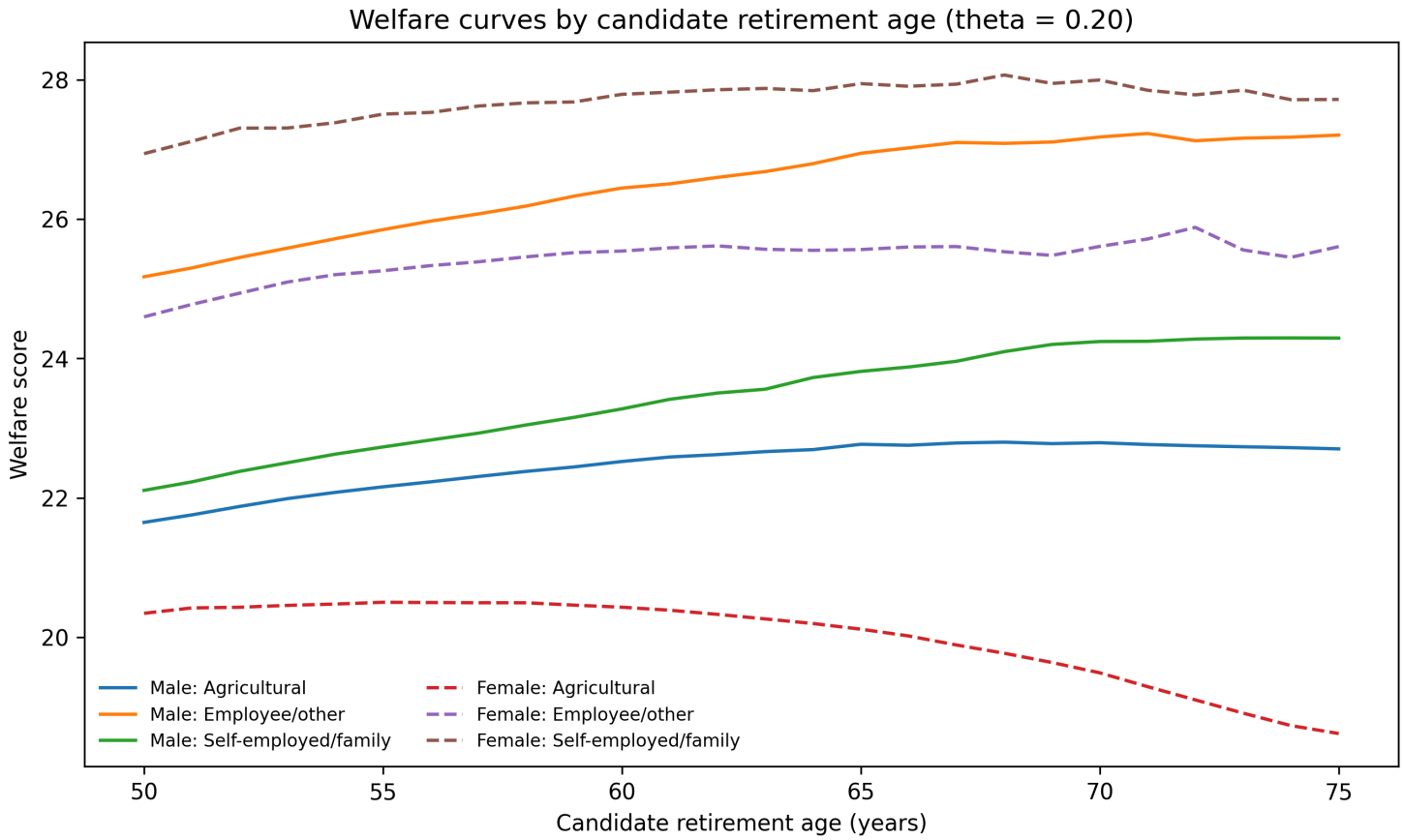

Figure 1

Composition of remaining life expectancy at age 50 across joint health-work states, by sex and employment type.
The x-axis shows sex and employment type; the y-axis shows expected years after age 50. HWLE = healthy-working life expectancy; HN = healthy-not working; UW = unhealthy-working; UN = unhealthy-not working. Mortality is anchored to sex-specific United Nations life tables for China.

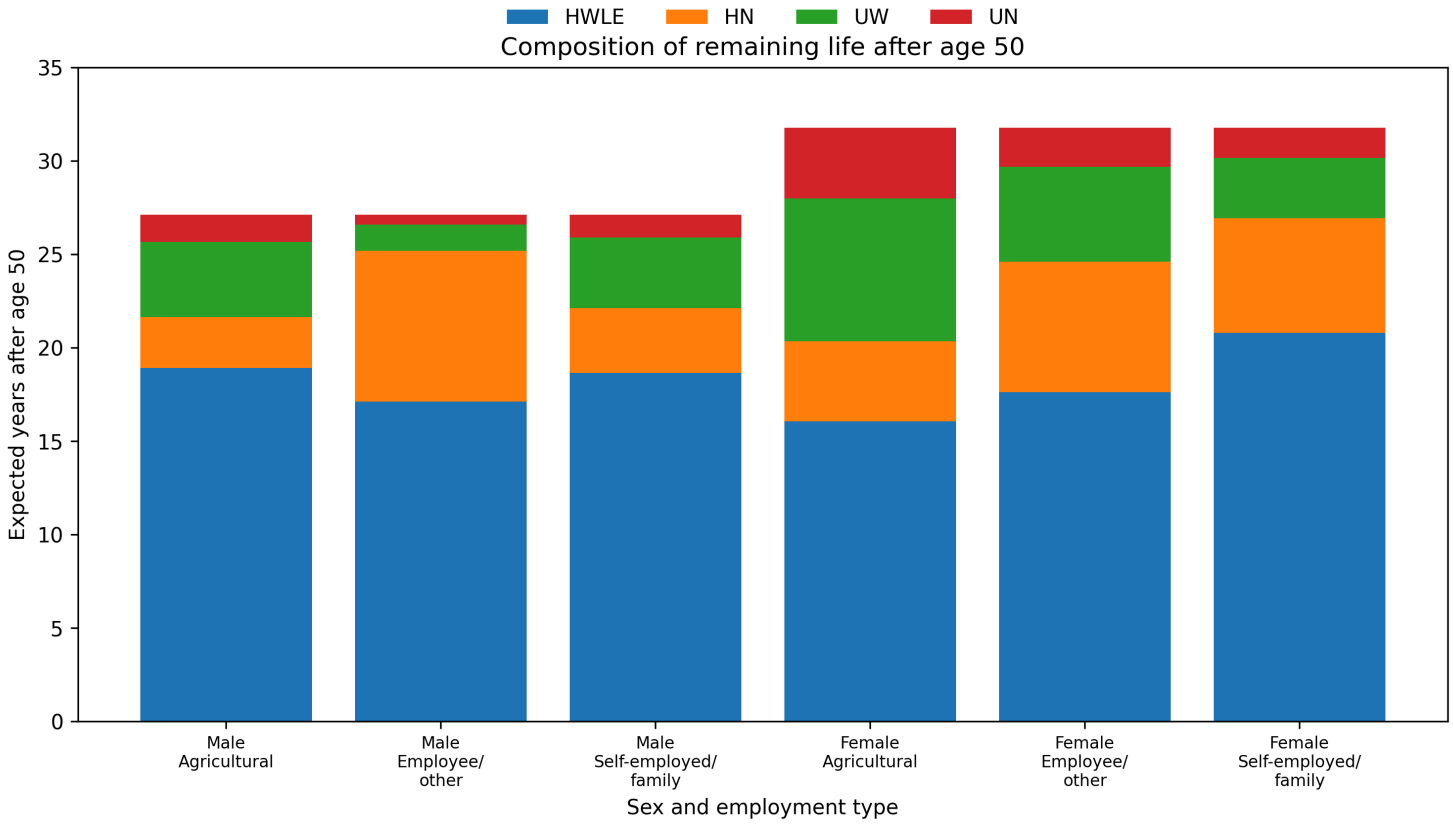

Figure 2

Illustrative value curves by candidate retirement age under theta = 0.20, by sex and employment type. The x-axis shows candidate retirement age in years; the y-axis shows the value score. Welfare_theta(R) = E (HW + HN) − E(UW) + theta × E (HW + UW). Under the illustrative deterministic retirement-age scenario, all work ceases at age R.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- expectanciespointestimates.csv
- FigureS1sensitivity.png
- thetasensitivitypooled.csv
- lifetableweightcalibrationdiagnostics.csv
- samplebywave.csv
- expectancieswith95CI.csv
- reconstructedlifetableageweights.csv
- sampleflow.csv
- expectancytableformatted.csv

- statecountsbysexemployementtype.csv
- samplebysexemployementtype.csv
- welfaregroupoptimatheta020.csv
- bootstrapexpectancieslong.csv
- welfarecurveslong.csv
- Additionalfile1.Supplementaryappendix.docx