Are Older Adults in China Living Longer Happy Years? A Multistate Analysis across Birth Cohorts in China, 2002–2018

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Abstract

Objective: As China's population ages and life expectancy rises, a critical question is whether older adults are living longer happy years. This study examines changes in happy life expectancy (HapLE) across birth cohorts and investigates socioeconomic disparities in these changes.

Methods: Using data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) for 2002–2018, we applied multistate life table models to estimate partial-cohort HapLE (PC-HapLE) for four age ranges. We compared earlier cohorts with later cohorts born 10 years apart and stratified analyses by gender, education, and urban-rural residence.

Results: Results show that later cohorts experienced a significant increase in the number and proportion of happy years, driven by a "compression of unhappiness." However, these gains were unequally distributed. Urban older adults saw substantial and significant increases in PC-HapLE across all age groups, whereas gains for rural residents were modest and often statistically insignificant. Similar patterns of widening inequality were found by education and gender, with literate individuals and women experiencing greater improvements.

Conclusion: While Chinese older adults are living longer happy years on average, this positive trend masks widening inequalities. Socioeconomic development has disproportionately benefited urban, educated, and female older adults, creating a growing "happiness gap." Policies must shift from merely extending lifespan to promoting equitable aging by addressing these disparities.

Keywords: happy life expectancy, multi-state model, cohort analysis, China

1. Introduction

Over the past few decades, China has undergone a rapid process of population aging. In 2023, the number of individuals aged 65 and older reached 210 million, accounting for more than 15.3% of the total population, a proportion that has doubled in just over two decades (National Bureau of Statistics of China, 2023). By 2050, projections estimate that the number of older adults aged 65 and above will reach 390 million, comprising nearly 30% of the population (United Nations, 2024). Population aging has been accompanied by increases in life expectancy (LE). In 2023, LE at birth in China stood at 78.0 years, up from just 43.8 years in 1950. Over the same period, LE at age 65 nearly doubled, rising from 9.1 years in 1950 to 17.5 years in 2023 (United Nations, 2024). However, whether longer LE translates into improved quality of life remains a less understood question.

Health status is considered a key indicator of quality of life, and research uses healthy life expectancy (HLE) as a summary measure of quantity and quality of life to evaluate whether gains in longevity are accompanied by improvements in health (Payne, 2022; Sanders, 1964). Although health status is a significant component of life quality, it does not capture its entirety (The WHOQOL Group, 1998; Y. Yang, 2008). Happiness is a cognitive, global judgment of the quality of life, which is defined as the extent to which an individual positively evaluates their overall life as a whole (Veenhoven, 1996). As an analog of HLE, happy life expectancy (HapLE) has been proposed as another summary measure of quantity and quality of life, which reflects not only how long people live but also how long they live in a happy state. Integrating information on longevity and happiness, HapLE serves as a useful indicator to examine whether the increase in life expectancy is accompanied by improved happiness (Duan & Chen, 2020; Y. Yang, 2008).

A large number of studies have used HLE to explore whether older adults in China are living longer healthy lives (Jiao, 2019; Liu et al., 2019; Zhang et al., 2022). However, whether they are living longer happy lives remains less investigated. Some studies have explored the trends in happiness among the Chinese population over time, but the findings have been mixed. Certain studies support the Easterlin paradox, suggesting that economic growth has not led to an overall improvement in happiness (Easterlin et al., 2012, 2021; Li & Raine, 2014). In contrast, others indicate that the level of happiness among Chinese people has increased over time (H. Cai et al., 2023; Wu & Li, 2017). So far, only one study has used HapLE as an indicator to explore trends in longevity and happiness of Chinese people, finding that HapLE has increased both in absolute and relative terms, meaning that Chinese people are not only expected to live longer in happiness but also to spend a higher proportion of their remaining lives in happiness (Duan & Chen, 2020).

Some limitations of previous studies can be identified. First, most studies have focused on the general population or adults, with relatively few examining changes in happiness among older adults, particularly those at advanced ages. Older people face higher health risks, functional decline, and social isolation (Liu et al., 2019). Understanding happiness trajectories in this population is crucial for improving social support systems to promote healthy aging. Second, previous research has primarily relied on period comparisons, measuring happiness at different time points and observing changes over time. However, relying solely on period comparison may obscure substantial heterogeneity across cohorts and provide limited insights into the trend of happiness over time and across birth cohorts. In contrast, cohort changes better capture individuals' life course experiences (Payne, 2022). Third, studies have indicated that happiness and happy life expectancy among older adults in China vary by urban-rural residence and educational attainment (Cheng & Yan, 2021; Wan & Jiang, 2024). Given China's rapid socioeconomic transformation, urban-rural gaps and educational access have shifted significantly (M. Wang et al., 2020). However, there is no examination of how these socioeconomic disparities change across birth cohorts.

To fill these research gaps, this study used nationally representative data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) and the multi-state life table (MSLT) method to examine the trends in LE and HapLE among older adults across successive birth cohorts in China. Additionally, it investigated whether these trends show socioeconomic disparities based on urban-rural residence and educational attainment. This study aims to assess that, from a cohort perspective, whether Chinese older adults can expect to live more happy years and whether the potential gains are equitably distributed across different subgroups. This study is expected to provide new empirical evidence on the changing quality of life during China's aging process and offer insights for designing more equitable and sustainable aging policies.

2. Method

2.1 Data

This study used data from CLHLS (Center for Healthy Aging and Development Studies, 2020). CLHLS covers 23 provinces, municipalities, and autonomous regions across China and is the first and longest-running social science survey of its kind in the country. The survey includes approximately 85% of the elderly population in China, ensuring strong representativeness (Gu, 2008; Zeng, 2008). CLHLS was launched with a baseline survey in 1998 and has since conducted longitudinal follow-ups in 2000, 2002, 2005, 2008/2009, 2011/2012, 2014, and 2017/2018, accumulating eight waves of longitudinal data spanning two decades. In the 1998 and 2000 waves, the survey targeted individuals aged 80 and above, while from 2002 onward, the age range was expanded to include those aged 65 and older. The analyses in this study used individuals who participated in at least two of the three waves conducted in 2002, 2005, and 2008, or who passed away between these waves (N=6371) and individuals who participated in at least two of the three waves conducted in 2011/2012 (2012 thereafter), 2014, and 2017/2018 (2018 thereafter), or who passed away between these waves (N=4221).

2.2 Measures

This study used HapLE as the outcome to examine cohort trends in longevity and happiness among older adults in China. By decomposing LE into the number of years lived in happy and unhappy states, both HapLE and unhappy life expectancy (UHapLE) can be derived. HapLE can be viewed from an absolute perspective, referring to the number of years an individual is expected to live in a happy state, or from a relative perspective, as the proportion of HapLE in LE (HapLE%).

Happiness was assessed using a single-item measure of life satisfaction in CLHLS. The terms subjective well-being, life satisfaction, and happiness are often considered interchangeable in relevant literature (Easterlin et al., 2021; Y. Yang, 2008). This measurement approach has been widely applied in large-scale surveys due to its simplicity and effectiveness and has demonstrated high reliability and validity in assessing individual well-being (Baur & Okun, 1983; Lucas et al., 2018). Specifically, CLHLS evaluated respondents' life satisfaction through the question: "How do you feel about your life at present?" Responses were rated on a five-point scale, where 1 represents "very good" and 5 represents "very bad." For analytical convenience and consistency with existing research (Duan & Chen, 2020; Wan & Jiang, 2024), this study dichotomized the variable: respondents answering 1 or 2 were classified as "happy," while those answering between 3 and 5 were categorized as "unhappy." CLHLS primarily collected mortality information from official death certificates when available. If an official certificate was not accessible, mortality data were obtained from local community committees or reports from close relatives. When a respondent's death was confirmed in a specific survey wave, their survival status in that wave was recorded as "dead."

This study included four covariates: age, sex, urban-rural residence, and education level. Urban-rural residence is closely linked to inequalities in healthcare access, income levels, economic growth, and infrastructure development in Chinese society, which have been extensively studied (Liu et al., 2019). Education level is a well-established indicator of socioeconomic status and serves as a key predictor of an individual's social and economic conditions (Wan & Jiang, 2024). In this study, urban-rural residence and educational level were further used in subgroup analyses. Regarding variable definitions, age was treated as a continuous variable, and sex was categorized as men or women. Urban-rural residence was measured at baseline using the survey question: "Where do you currently live?" Response options included "city," "town," and "rural area." In this analysis, the "city" and "town" categories were combined into "urban." Educational level was coded based on respondents' years of schooling at baseline, derived from the survey question: "How many years of formal education have you completed in total?" Respondents with zero years of schooling were classified as "illiterate," while those with more than zero years were categorized as "literate."

2.3 Model

This study used a method for estimating state-specific partial-cohort life expectancy (PC-LE), which is calculating total life expectancy within a specified age range for a given cohort, as well as the expected years lived in the happy state. This method had been used to examine trends in healthy life expectancy (HLE), disability-free life expectancy (DFLE), and morbidity-free life expectancy (MFLE) across successive birth cohorts (Liu et al., 2019; Payne, 2022; Payne & Wong, 2019; Shen & Payne, 2023). Compared to estimates of full-cohort life expectancy, PC-LE estimates do not require data from fully extinct cohorts, making them more practical for contemporary demographic analyses. Furthermore, using cohort-based estimates help mitigate biases arising from structural changes across generations, thereby providing clearer comparisons between different population groups (Payne, 2022).

Table 1. Information on age-group, period, and birth cohort comparisons

Age Range	Period	
	2002–2008 Earlier cohort	2012–2018 Later cohort
68–73	1932–1937	1942–1947
74–79	1926–1931	1936–1941
80–85	1920–1925	1930–1935
86–91	1914–1919	1924–1929

Table 1 presents information on the eight period–cohort groupings analyzed in this study. Specifically, PC-LE and partial-cohort happy life expectancy (PC-HapLE) were compared across two birth cohorts within four independent 6-year age ranges (68-73, 74-79, 80-85, and 86-91). For instance, in the 68-73 age range, PC-LE and PC-HapLE were compared between individuals born in 1932–1937 (earlier cohort, observed during 2002–2008) and those born in 1942–1947 (later cohort, observed during 2012–2018). Figure 1 illustrates the Lexis diagram used for cohort comparisons in the 68–73 age range.

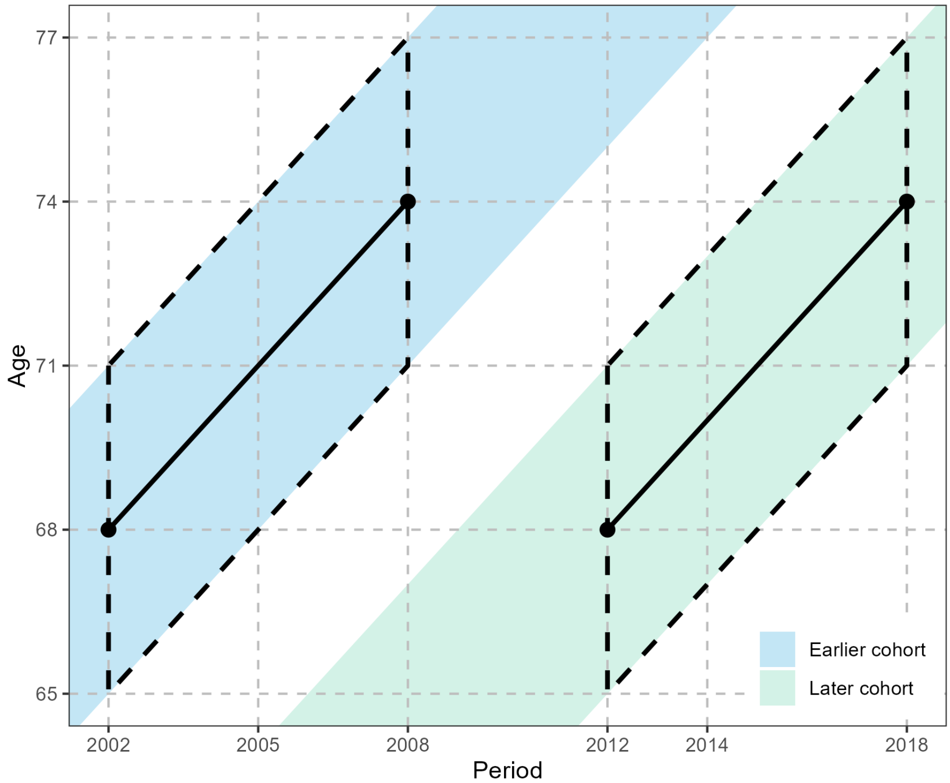

Figure 1. Lexis diagram used for cohort comparisons in the 68-73 age group

This study applied the MSLT method to estimate PC-LE and PC-HapLE. As shown in Figure 2, three discrete states were defined: happy, unhappy, and dead. Four potential transitions were considered: happy to unhappy, unhappy to happy, happy to dead, and unhappy to dead. The estimation of MSLT functions was performed using the Stochastic Population Analysis for Complex Events (SPACE) program (L. Cai et al., 2010) in SAS 9.4.

The SPACE computation process consisted of three sequential steps. First, data preprocessing was conducted to accommodate the varying intervals between CLHLS survey waves. SPACE converted CLHLS data into person-years format and imputed annual state values, filling missing years with pseudo-data to represent consecutive years of observation. Second, annual transition probabilities were estimated for each age group using multinomial logistic regression. The base model incorporated age, sex, cohort, and their two-way interaction terms to generate transition probability matrices stratified by these demographic variables. Two additional models were fitted to examine subgroup differences: one incorporating education level and another including urban-rural residence, both with interaction terms between the added variable and age, sex, and cohort. Third, microsimulation was employed to compute PC-LE and PC-HapLE based on the estimated transition probability matrices. A synthetic cohort of 100,000 individuals was created, with each person assigned an initial happiness state according to the weighted distribution observed at the starting age of each age group. Annual transitions were simulated by comparing random uniform numbers against age-specific transition probabilities until individuals reached the upper bound of their respective age range. PC-LE was calculated as the mean survival years within the age range, while PC-HapLE represented the mean years spent in the happy state. Confidence intervals were derived through bootstrap resampling with 300 iterations to capture uncertainty in both parameter estimation and microsimulation processes.

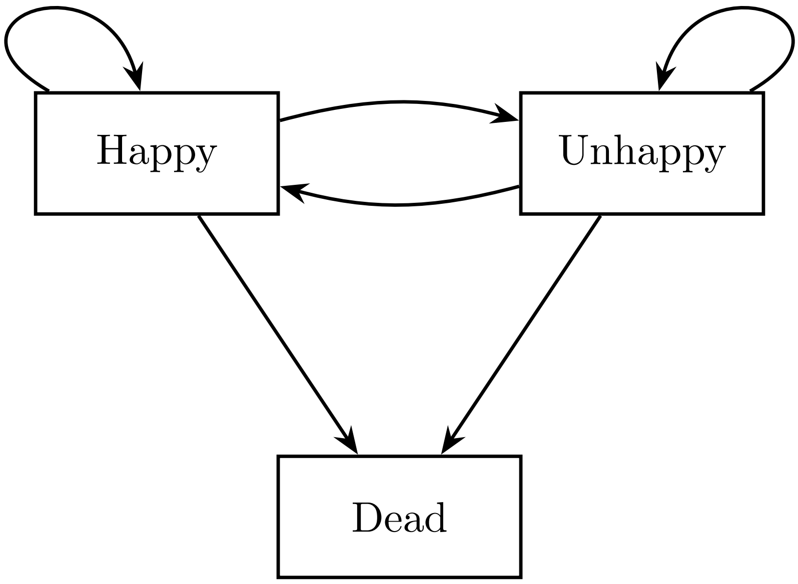

Figure 2. State space in the multi-state model

Inverse probability weighting (IPW) was applied to adjust for potential biases arising from differential loss to follow-up. This method assigned higher weights to individuals who completed follow-up, where weights were inversely proportional to the probability of completing follow-up. The probability models included all sociodemographic and a disability variable measured by Activities of Daily Living (ADL). IPW weights were estimated separately for each period and birth cohort, and the final analytical weight was derived by multiplying the IPW weight by the combined respondent weight from CLHLS (DuGoff et al., 2014; Liu et al., 2019).

3. Results

Table S1 in the Appendix presents the baseline characteristics of each birth cohort within the four age ranges examined in this study. Gender distribution remained relatively stable across cohorts within each age group, with men comprising approximately 50%-56% of each cohort. There is a clear trend of increasing educational attainment across cohorts within most age groups, with the proportion of literate individuals rising notably from earlier to later cohorts in the 68-73 age range (57.6% to 72.7%), 74-79 age range (49.3% to 60.2%), and 80-85 age range (43.6% to 48.0%). No consistent patterns are apparent in urban-rural residence distribution, which varied across cohorts within age groups. Within each age range, later cohorts generally showed higher proportions of individuals reporting happiness, with increases ranging from 1.9 to 2.9 percentage points across most age groups.

3.1 Overall Cohort Differences in PC-LE and PC-HapLE

Figure 3 and the Appendix Table S2 present estimated partial-cohort life expectancy (PC-LE), partial-cohort happy life expectancy (PC-HapLE), and partial-cohort unhappy life expectancy (PC-UnHapLE) across birth cohorts for four age ranges (68–73, 74–79, 80–85, and 86–91). Overall, later-born cohorts of Chinese older adults experienced significant increases in both the absolute number and relative proportion of happy years, accompanied by a compression of unhappy years.

Across all age ranges examined, PC-HapLE increased substantially between earlier and later cohorts. The most pronounced gains were observed in the 68–73 age range, where PC-HapLE rose 0.60 years, though this difference approached but did not reach statistical significance (95% CI: -0.00, 1.21; $p>0.05$). In the 74–79 age range, the increase was statistically significant, with PC-HapLE rising by 0.40 years (95% CI: 0.15, 0.65; $p<0.01$). Similar significant patterns emerged in older age ranges: 0.52 years in ages 80–85 (95% CI: 0.23, 0.81; $p<0.001$) and 0.47 years in ages 86–91 (95% CI: 0.21, 0.73; $p<0.001$). Concurrently, PC-UnHapLE decreased significantly across all age ranges where PC-HapLE gains were observed. The proportion of partial life expectancy spent in happiness (HapLE%) increased substantially across cohorts, with gains ranging from 7.1 percentage points in ages 74–79 ($p<0.01$) to 11.5 percentage points in ages 68–73 ($p<0.05$). Notably, total PC-LE showed minimal change across cohorts in most age groups, with only the oldest age range 86-91 showing a statistically significant increase of 0.21 years (95% CI: 0.04, 0.37; $p<0.05$).

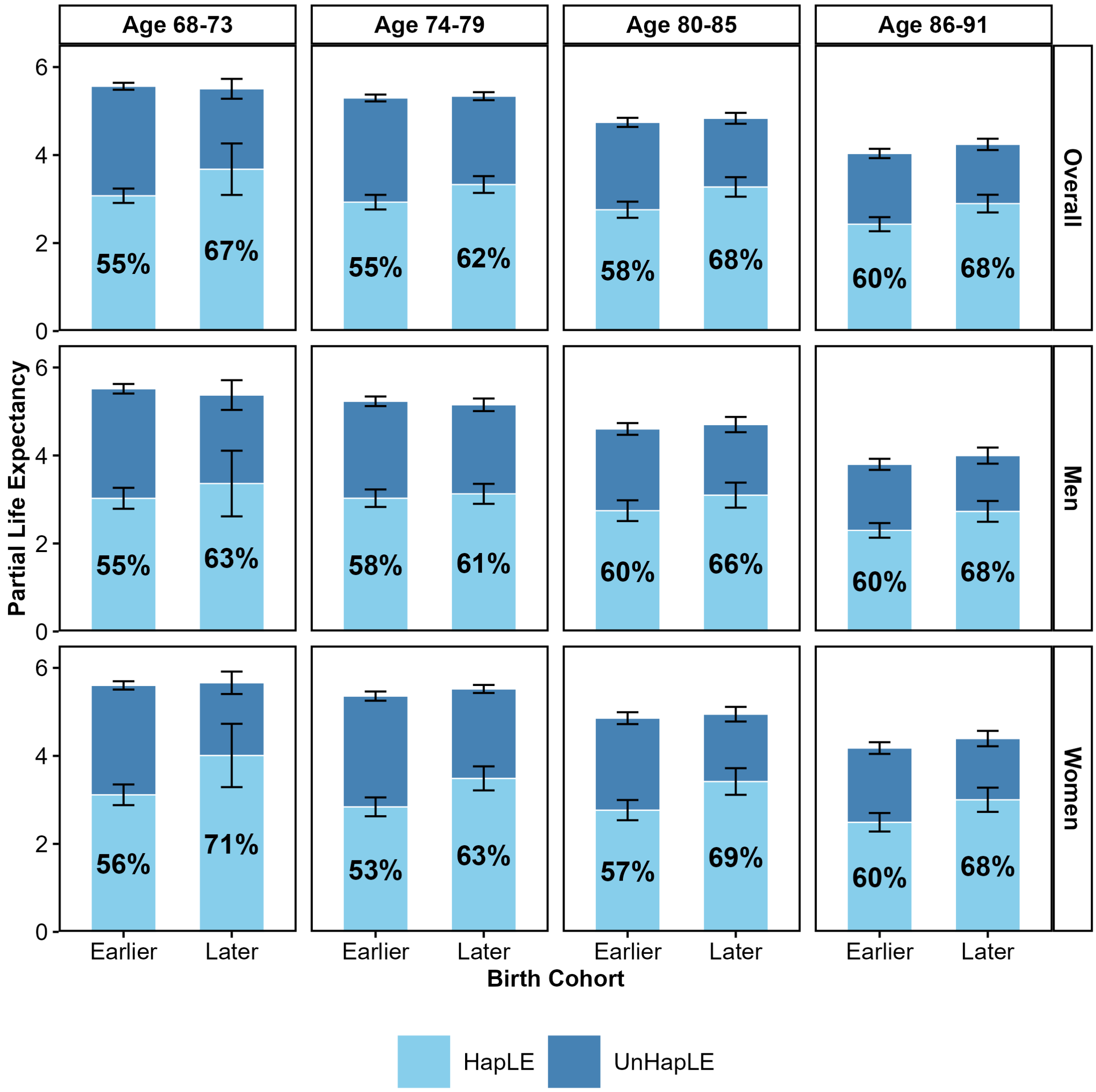

Figure 3. Estimated PC-LE, PC-HapLE and PC-UnHapLE across birth cohorts by age range and sex. The black vertical lines denote the 95% CI around each point estimate. The percentage figure in each bar shows HapLE%.

3.2 Cohort Differences in PC-LE and PC-HapLE by Gender

Figure 3 and Table S2 also show substantial gender disparities in cohort changes of PC-HapLE. Older women experienced consistently larger and more statistically significant improvements in PC-HapLE compared to men across most age ranges.

Among women, significant increases in PC-HapLE were observed in all four age groups examined: 0.89 years in ages 68–73 (95% CI: 0.14, 1.65; $p<0.05$), 0.65 years in ages 74–79 (95% CI: 0.30, 0.99; $p<0.001$), 0.65 years in ages 80–85 (95% CI: 0.27, 1.03; $p<0.001$), and 0.51 years in ages 86–91 (95% CI: 0.17, 0.86; $p<0.01$). In contrast, men showed more modest and less consistent gains. A statistically significant increase in PC-HapLE among men was observed only in the oldest age group (86–91), with a gain of 0.43 years (95% CI: 0.14, 0.72; $p<0.01$). For other age groups, while point estimates suggested modest improvements, the wide confidence intervals indicated considerable uncertainty around these estimates, and the changes did not reach statistical significance. These patterns resulted in larger proportional gains in HapLE% for women, with increases ranging from 8.7 to 15.2 percentage points across age groups, compared to more modest gains for men.

3.3 Cohort Differences in PC-LE and PC-HapLE by Education

As detailed in Figure 4 and the Appendix Table S3, there were significant differences in PC-HapLE between literate and illiterate older adults across most age ranges. Literate older adults consistently experienced larger and more statistically significant gains in PC-HapLE compared to their illiterate counterparts across most age ranges examined.

Among literate older adults, significant increases in PC-HapLE were observed in three age groups: 0.58 years in ages 68–73 (95% CI: -0.06, 1.21; approaching significance), 0.47 years in ages 74–79 (95% CI: 0.15, 0.79; $p<0.01$), 0.70 years in ages 80–85 (95% CI: 0.26, 1.13; $p<0.01$), and 0.70 years in ages 86–91 (95% CI: 0.22, 1.18; $p<0.01$). These improvements were accompanied by substantial increases in HapLE%, particularly notable in ages 80–85 where the proportion rose by 13.9 percentage points ($p<0.001$). In contrast, illiterate older adults showed smaller and less consistent improvements. Statistically significant gains in PC-HapLE were observed only in the oldest age group (86–91), with an increase of 0.35 years (95% CI: 0.06, 0.63; $p<0.05$). For other age groups, while point estimates suggested modest improvements, the differences were not statistically significant.

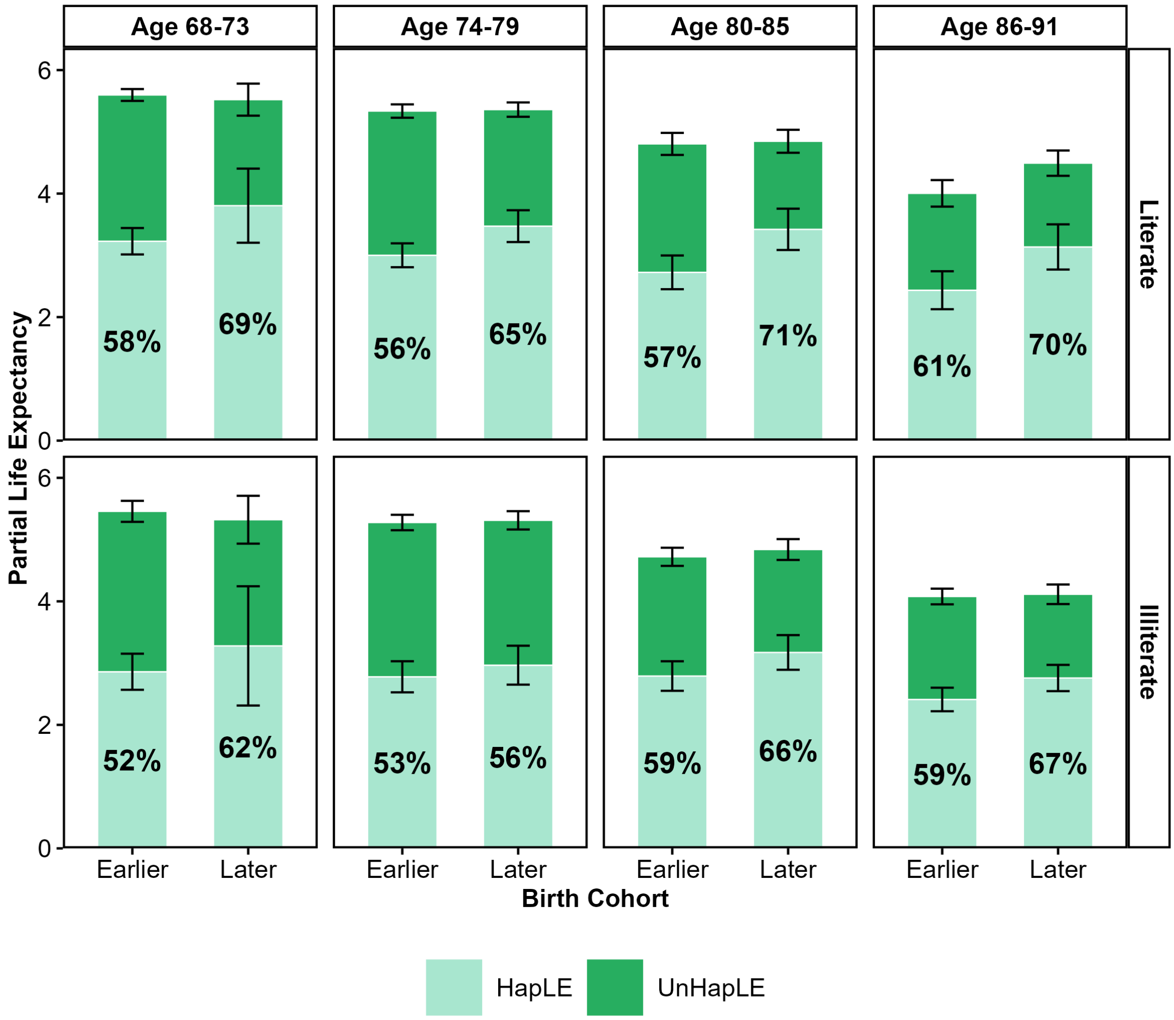

Figure 4. Estimated PC-LE, PC-HapLE and PC-UnHapLE across birth cohorts by age range and education. The black vertical lines denote the 95% CI around each point estimate. The percentage figure in each bar shows HapLE%.

3.4 Cohort Differences in PC-LE and PC-HapLE by Residence

The most pronounced disparities in cohort trends were observed between urban and rural residents (Figure 5 and the Appendix Table S4). Urban older adults experienced substantial and highly significant improvements in PC-HapLE and HapLE% across all age groups, while rural residents showed more modest and inconsistent gains.

Among urban residents, significant increases in PC-HapLE were observed across all four age ranges: 1.05 years in ages 68–73 (95% CI: 0.45, 1.64; $p<0.001$), 0.51 years in ages 74–79 (95% CI: 0.19, 0.83; $p<0.01$), 0.56 years in ages 80–85 (95% CI: 0.21, 0.91; $p<0.01$), and 0.45 years in ages 86–91 (95% CI: 0.14, 0.77; $p<0.01$). These improvements were accompanied by dramatic increases in HapLE%, most notably in ages 68–73 where the proportion increased by 17.0 percentage points ($p<0.01$). Rural residents showed a markedly different pattern. Statistically significant increases in PC-HapLE were observed only in the two oldest age groups: 0.43 years in ages 80–85 (95% CI: 0.05, 0.81; $p<0.05$) and 0.45 years in ages 86–91 (95% CI: 0.11, 0.79; $p<0.01$). In the younger age groups (68–73 and 74–79), while point estimates suggested modest improvements, the differences were not statistically significant.

4. Discussion

Using the national representative longitudinal data and a cohort-based multi-state life table approach, this study provides novel evidence to address the question of whether older adults in China are living longer happy years. Our findings reveal a significant and positive trend: later-born cohorts, across all examined age ranges from 68 to 91, are expected to live a greater number of years in a happy state and a higher proportion of their remaining life in happiness compared to their earlier-born counterparts. This gain in happy years was primarily achieved through a "compression of unhappiness"—a notable reduction in the expected years lived in an unhappy state—while total partial-cohort life expectancy remained largely stable across most age groups. However, this optimistic aggregate trend masks profound and widening disparities. The gains in happy years were not equitably distributed, with improvements being substantially larger for women, literate individuals, and especially urban residents, suggesting that the benefits of socioeconomic progress have disproportionately favored more advantaged subgroups.

The observed "compression of unhappiness" across birth cohorts extends previous research and offers a cohort-based perspective on a widely debated topic in China. Our finding is consistent with the period-based analysis by Duan and Chen (Duan & Chen, 2020), who also documented an "unhappiness compression" pattern in the general

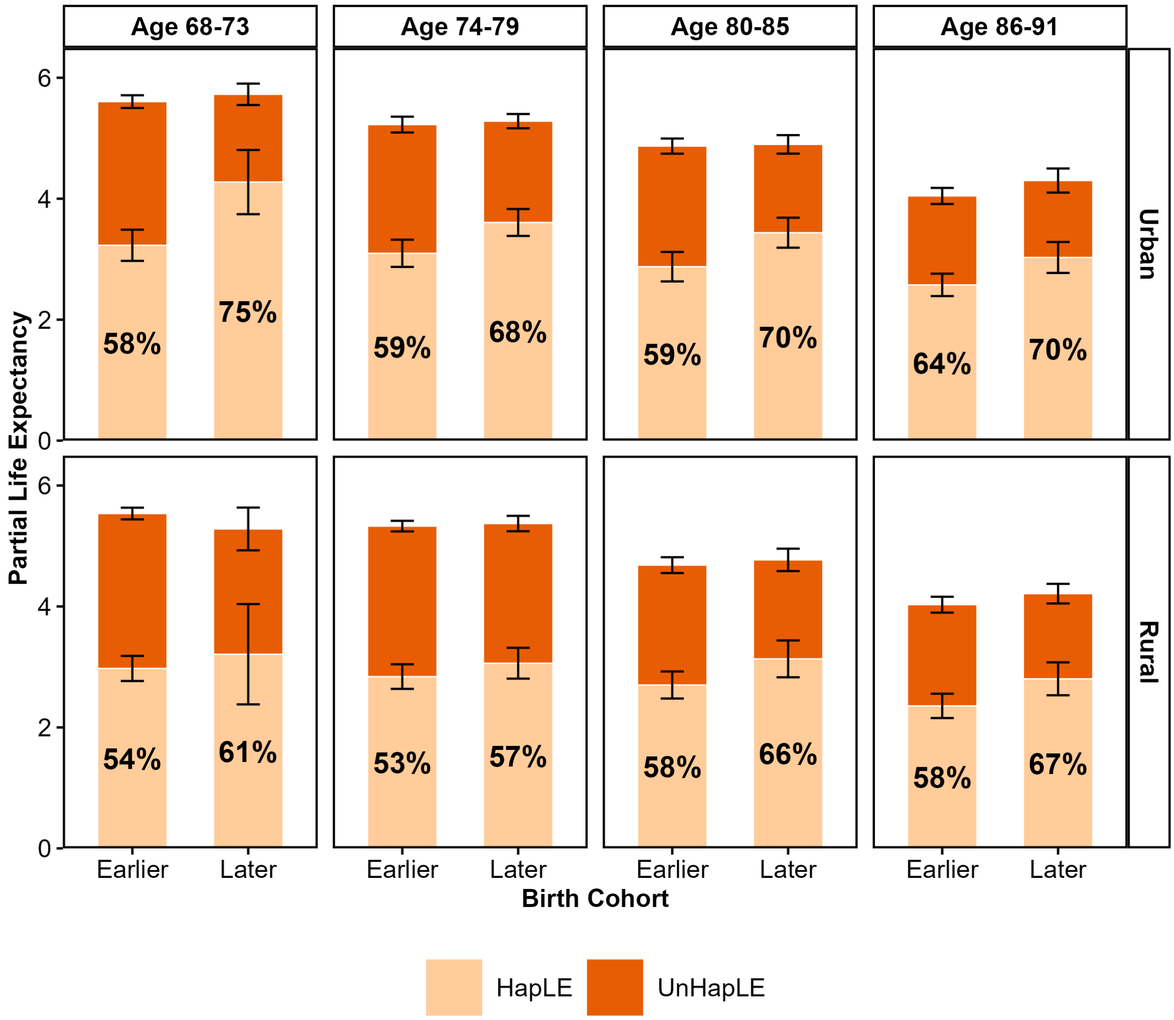

Figure 5. Estimated PC-LE, PC-HapLE and PC-UnHapLE across birth cohorts by age range and residence. The black vertical lines denote the 95% CI around each point estimate. The percentage figure in each bar shows HapLE%.

adult population. Our use of a cohort design provides stronger evidence that this is a generational phenomenon rather than a simple period effect (Payne, 2022). This optimistic cohort trend also offers a nuanced counterpoint to the "Easterlin paradox," which posited that China's rapid economic growth during the 1990s and early 2000s did not uniformly translate into greater life satisfaction (Easterlin et al., 2012). Our results align more closely with recent studies indicating that Chinese happiness levels have been rising since the early 2000s, as the benefits of development became more widespread (H. Cai et al., 2023; P. Wang, 2023). Several key factors likely contributed to the observed gains in happy life expectancy across the cohorts in our study. The observation periods of our analysis coincide with a period of maturation in China's social and economic systems. The older adults in our study were direct beneficiaries of the substantial expansion and consolidation of China's social security programs. The nationwide rollout of near-universal pension systems and health insurance schemes, including the New Rural Cooperative Medical System and the Urban Resident Basic Medical Insurance, provided a crucial buffer against economic and health-related shocks (Liu et al., 2019). This enhanced security, alongside improvements in public infrastructure and the continued, albeit changing, role of family support, has likely contributed to a more favorable environment for well-being in later life.

An interesting finding is the significant gender disparity in cohort differences, with older women experiencing substantially larger and more consistent gains in happy life expectancy (HapLE) than men. This finding contrasts with previous period-based evidence from China, which suggested that while women had a longer HapLE, this advantage was primarily driven by their lower mortality rather than a higher prevalence of happiness in later life (Duan & Chen, 2020). Our study reveals a fundamental shift: the gains in HapLE for women are driven by a "compression of unhappiness," indicating an improvement in the quality, not just the quantity, of later-life years. One possible explanation for this phenomenon is that the trend is driven less by women's objective conditions improving faster than men's (the composition effect), and more by women deriving greater subjective well-being from the same life improvements (the coefficient effect) (J. Yang et al., 2024). Furthermore, women's deeper embeddedness in family and community life means they likely gained more from improvements in community environments and social support systems, which are central to their daily routines and well-being (Feng & Zheng, 2024).

Perhaps the most critical finding of this study is the widening socioeconomic gap in happy life expectancy, particularly between urban and rural residents. While previous research confirmed static inequalities at a single time point (Wan & Jiang, 2024), our cohort analysis reveals a more troubling dynamic: the disparity is actively growing, creating a deepening "happiness gap." This growing urban-rural divide is likely rooted in

China's dualistic socioeconomic structure, which has long favored urban areas in resource allocation. Urban older adults have consistently benefited from more generous pensions, higher-quality healthcare, and better-developed community infrastructure (Liu et al., 2019). Although rural social security has improved, the level of protection remains substantially lower, leaving rural older adults less able to translate national development into personal well-being. Similarly, the education gap reflects disparities in the capacity to leverage resources. As a key determinant of socioeconomic status (Payne, 2022; Shen & Payne, 2023), education equips individuals to better navigate complex healthcare and social welfare systems, an advantage that allows them to more effectively convert available opportunities into longer and happier lives (Wan & Jiang, 2024). It is important to acknowledge that these two dimensions of inequality were analyzed in separate models due to the limitation of sample size. Given that urban populations in China are, on average, more educated, the effects we attribute to each factor are not fully disentangled. However, the fact that both show an independent predictive effect underscores that socioeconomic disadvantage is a multifaceted force. This suggests that while intertwined, the structural resource disparities and differences in individual capacity driving these gaps represent distinct mechanisms that warrant separate consideration.

Several limitations should be considered when interpreting the findings. First, our measurement of happiness relies on a single-item life satisfaction question, which, although widely validated and used in large-scale surveys, cannot capture the full multidimensional nature of well-being (George, 2010). Additionally, the dichotomization of the five-point scale into "happy" and "unhappy" categories, while facilitating model estimation, may result in a loss of information about the gradual differences in satisfaction levels (Wan & Jiang, 2024). Second, our analysis focuses on partial-cohort happy life expectancy within bounded age ranges rather than complete life-course measures. While this approach enables the examination of living cohorts, the results should not be directly extrapolated to full lifetime happiness trajectories, particularly given the potential for major social or policy disruptions that could alter later-life patterns (Payne, 2022). Third, the multistate life table model employed in this study is based on a first-order Markov assumption, meaning that happiness transitions depend only on the current state and not on the duration spent in that state or past emotional trajectories. This simplifies the complex psychological dynamics of well-being in reality (Payne, 2022; Shen & Payne, 2023). Related to this, the panel nature of CLHLS data, with surveys conducted every three or four years, assumes only annual transitions between waves, potentially missing short-term fluctuations or multiple transitions in happiness states that may occur between survey periods.

One of the main strengths of this study is its focus on understanding changes in happy life expectancy across birth cohorts, rather than relying solely on period-based comparisons. Though period-based approach may be useful for monitoring aggregate trends in population-level happiness, these results do not easily translate to the experience of any given cohort of individuals (Payne, 2022). Our cohort-based approach provides results that match more closely with the lived experience of individuals within the population and offers clearer insights into generational changes in happy longevity. A second strength lies in our comprehensive examination of socioeconomic disparities in HapLE trends. While previous studies have documented static inequalities in HapLE at single time points (Wan & Jiang, 2024), our analysis reveals the dynamic patterns of how these disparities evolve across cohorts, thus providing new evidence on whether the benefits of China's socioeconomic development are being equitably distributed across different population subgroups. Additionally, our analysis uses CLHLS, one of the largest and most comprehensive longitudinal datasets of older adults worldwide, providing a unique opportunity to examine happiness trajectories among a substantial portion of the global aging population. The combination of this data source with the multistate life table method enables robust estimation of HapLE across cohorts and subgroups, supporting the reliability and generalizability of our findings.

5. Conclusion

In conclusion, this study provides evidence that older adults in China are indeed living longer happy years across generations, largely driven by a significant "compression of unhappiness" rather than an extension of total lifespan. This optimistic aggregate trend, however, conceals a crucial and troubling counter-narrative: the profound widening of a "happiness gap." The benefits of China's rapid socioeconomic development have not been equitably distributed, disproportionately favoring urban, educated, and female older adults. While these advantaged groups are experiencing accelerated gains in happiness, their rural and less-educated counterparts are being left behind, creating a deepening divide in the quality of later life. These findings challenge policymakers to look beyond extending longevity and to urgently address the structural inequalities that prevent the gains of national progress from translating into universal well-being. To foster a truly equitable aging society, future policy must pivot from simply adding years to life, to ensuring that those added years are happy ones for all.

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Appendix

Table S1. Descriptive statistics of the sample by age range and cohort

Age Range	**68–73**		**74–79**		**80–85**		**86–91**	
Cohort	**1932–37**	**1942–47**	**1926–31**	**1936–41**	**1920–25**	**1930–35**	**1914–19**	**1924–29**
N	1643	754	1677	1370	1763	1194	1288	903
Gender (%)								
Men	51.7	56.0	50.4	53.2	51.4	51.8	53.3	52.9
Women	48.3	44.0	49.6	46.8	48.6	48.2	46.7	47.1
Education (%)								
Literate	57.6	72.7	49.3	60.2	43.6	48.0	46.6	40.4
Illiterate	42.4	27.3	50.7	39.8	56.4	52.0	53.4	59.6
Residence (%)								
Urban	41.3	41.9	40.9	51.0	43.4	49.8	51.0	46.6
Rural	58.7	58.1	59.1	49.0	56.6	50.2	49.0	53.4
Happiness (%)								
Happy	56.7	58.6	57.1	56.9	58.4	60.1	59.1	56.0
Unhappy	43.3	41.4	42.9	43.1	41.6	39.9	40.9	44.0
Disability (%)								
0 ADL	96.3	95.8	93.4	92.8	86.2	88.4	77.3	82.2
1+ ADL	3.7	4.2	6.6	7.2	13.8	11.6	22.7	17.8

Table S2. Estimated PC-LE, PC-HapLE, PC-UnHapLE, HapLE% and UnHapLE% and their differences across birth cohorts by age range and sex. The differences were calculated as the difference between the later cohort and the earlier cohort. The 95% CI around each point estimate is shown in parentheses. Significance of difference: * p<0.05, ** p<0.01, *** p<0.001.

Age Range	Sex	Cohort	PC-LE	PC-HapLE	HapLE%	PC-UnHapLE	UnHapLE%
68-73	**All**	Earlier	5.56 (5.48, 5.64)	3.08 (2.91, 3.24)	55.3 (52.5, 58.1)	2.49 (2.33, 2.65)	44.7 (41.9, 47.5)
		Later	5.51 (5.28, 5.73)	3.68 (3.09, 4.26)	66.8 (57.4, 76.3)	1.83 (1.33, 2.32)	33.2 (23.7, 42.6)
		Diff.	*-0.06 (-0.30, 0.18)*	*0.60 (-0.00, 1.21)*	*11.5 (1.7, 21.4)**	*-0.66 (-1.18, -0.14)**	*-11.5 (-21.4, -1.7)**
	Men	Earlier	5.52 (5.41, 5.62)	3.03 (2.79, 3.27)	54.9 (50.8, 58.9)	2.49 (2.27, 2.71)	45.1 (41.1, 49.2)
		Later	5.37 (5.04, 5.71)	3.36 (2.62, 4.11)	62.6 (50.3, 74.9)	2.01 (1.36, 2.66)	37.4 (25.1, 49.7)
		Diff.	*-0.14 (-0.50, 0.21)*	*0.34 (-0.45, 1.12)*	*7.7 (-5.2, 20.6)*	*-0.48 (-1.16, 0.21)*	*-7.7 (-20.6, 5.2)*
	Women	Earlier	5.60 (5.51, 5.70)	3.12 (2.88, 3.35)	55.6 (51.4, 59.8)	2.49 (2.24, 2.73)	44.4 (40.2, 48.6)
		Later	5.66 (5.41, 5.92)	4.01 (3.29, 4.73)	70.8 (59.4, 82.2)	1.65 (1.03, 2.27)	29.2 (17.8, 40.6)
		Diff.	*0.06 (-0.21, 0.33)*	*0.89 (0.14, 1.65)**	*15.2 (3.1, 27.3)**	*-0.83 (-1.50, -0.17)**	*-15.2 (-27.3, -3.1)**
74-79	**All**	Earlier	5.30 (5.22, 5.37)	2.93 (2.76, 3.10)	55.3 (52.3, 58.3)	2.37 (2.21, 2.53)	44.7 (41.7, 47.7)
		Later	5.34 (5.25, 5.43)	3.33 (3.14, 3.52)	62.4 (58.9, 65.9)	2.01 (1.82, 2.20)	37.6 (34.1, 41.1)
		Diff.	*0.04 (-0.08, 0.16)*	*0.40 (0.15, 0.65)***	*7.1 (2.5, 11.7)***	*-0.36 (-0.61, -0.11)***	*-7.1 (-11.7, -2.5)***
	Men	Earlier	5.23 (5.12, 5.34)	3.03 (2.83, 3.23)	57.9 (54.3, 61.5)	2.20 (2.01, 2.40)	42.1 (38.5, 45.7)
		Later	5.15 (5.01, 5.29)	3.13 (2.90, 3.36)	60.7 (56.3, 65.1)	2.02 (1.78, 2.27)	39.3 (34.9, 43.7)
		Diff.	*-0.08 (-0.26, 0.10)*	*0.10 (-0.20, 0.40)*	*2.8 (-2.9, 8.5)*	*-0.18 (-0.49, 0.13)*	*-2.8 (-8.5, 2.9)*
	Women	Earlier	5.36 (5.25, 5.46)	2.84 (2.63, 3.06)	53.0 (49.2, 56.9)	2.52 (2.30, 2.73)	47.0 (43.1, 50.8)
		Later	5.52 (5.43, 5.61)	3.49 (3.22, 3.76)	63.2 (58.5, 67.9)	2.03 (1.77, 2.29)	36.8 (32.1, 41.5)
		Diff.	*0.16 (0.02, 0.30)**	*0.65 (0.30, 0.99)****	*10.2 (4.1, 16.3)***	*-0.48 (-0.82, -0.15)***	*-10.2 (-16.3, -4.1)***
80-85	**All**	Earlier	4.74 (4.64, 4.85)	2.76 (2.57, 2.94)	58.1 (54.7, 61.6)	1.98 (1.82, 2.15)	41.9 (38.4, 45.3)
		Later	4.84 (4.71, 4.96)	3.28 (3.05, 3.50)	67.7 (63.9, 71.5)	1.56 (1.38, 1.74)	32.3 (28.5, 36.1)
		Diff.	*0.09 (-0.07, 0.25)*	*0.52 (0.23, 0.81)****	*9.6 (4.4, 14.7)****	*-0.42 (-0.67, -0.18)****	*-9.6 (-14.7, -4.4)****
	Men	Earlier	4.60 (4.47, 4.74)	2.75 (2.51, 2.98)	59.7 (55.0, 64.3)	1.86 (1.64, 2.07)	40.3 (35.7, 45.0)
		Later	4.70 (4.53, 4.88)	3.10 (2.81, 3.38)	65.9 (60.8, 71.0)	1.60 (1.37, 1.84)	34.1 (29.0, 39.2)
		Diff.	*0.10 (-0.12, 0.32)*	*0.35 (-0.02, 0.72)*	*6.2 (-0.7, 13.2)*	*-0.25 (-0.57, 0.07)*	*-6.2 (-13.2, 0.7)*
	Women	Earlier	4.86 (4.72, 4.99)	2.77 (2.54, 3.00)	57.0 (52.6, 61.3)	2.09 (1.88, 2.30)	43.0 (38.7, 47.4)
		Later	4.95 (4.78, 5.11)	3.42 (3.12, 3.72)	69.1 (64.0, 74.1)	1.53 (1.29, 1.77)	30.9 (25.9, 36.0)
		Diff.	*0.09 (-0.12, 0.30)*	*0.65 (0.27, 1.03)****	*12.1 (5.5, 18.8)****	*-0.56 (-0.88, -0.24)****	*-12.1 (-18.8, -5.5)****
86-91	**All**	Earlier	4.04 (3.93, 4.14)	2.43 (2.27, 2.59)	60.2 (56.8, 63.6)	1.61 (1.47, 1.74)	39.8 (36.4, 43.2)
		Later	4.24 (4.11, 4.37)	2.90 (2.70, 3.10)	68.3 (64.3, 72.2)	1.35 (1.18, 1.51)	31.7 (27.8, 35.7)
		Diff.	*0.21 (0.04, 0.37)**	*0.47 (0.21, 0.73)****	*8.1 (2.9, 13.3)***	*-0.26 (-0.48, -0.05)**	*-8.1 (-13.3, -2.9)***
	Men	Earlier	3.80 (3.67, 3.92)	2.30 (2.13, 2.46)	60.5 (56.4, 64.6)	1.50 (1.33, 1.67)	39.5 (35.4, 43.6)
		Later	4.00 (3.81, 4.18)	2.73 (2.49, 2.97)	68.3 (63.4, 73.2)	1.27 (1.07, 1.47)	31.7 (26.8, 36.6)
		Diff.	*0.20 (-0.02, 0.42)*	*0.43 (0.14, 0.72)***	*7.8 (1.4, 14.2)**	*-0.23 (-0.49, 0.03)*	*-7.8 (-14.2, -1.4)**
	Women	Earlier	4.18 (4.05, 4.31)	2.49 (2.28, 2.70)	59.6 (55.3, 64.0)	1.69 (1.51, 1.87)	40.4 (36.0, 44.7)
		Later	4.39 (4.22, 4.57)	3.00 (2.73, 3.28)	68.4 (63.1, 73.6)	1.39 (1.16, 1.62)	31.6 (26.4, 36.9)
		Diff.	*0.22 (-0.00, 0.44)*	*0.51 (0.17, 0.86)***	*8.7 (1.9, 15.6)**	*-0.30 (-0.59, -0.00)**	*-8.7 (-15.6, -1.9)**

Table S3. Estimated PC-LE, PC-HapLE, PC-UnHapLE, HapLE% and UnHapLE% and their differences across birth cohorts by age range and education for both sex. The differences were calculated as the difference between the later cohort and the earlier cohort. The 95% CI around each point estimate is shown in parentheses. Significance of difference: * p<0.05, ** p<0.01, *** p<0.001.

Age Range	Education	Cohort	PC-LE	PC-HapLE	HapLE%	PC-UnHapLE	UnHapLE%
68-73	**Literate**	Earlier	5.60 (5.50, 5.69)	3.23 (3.01, 3.44)	57.7 (54.0, 61.4)	2.37 (2.16, 2.58)	42.3 (38.6, 46.0)
		Later	5.52 (5.26, 5.78)	3.80 (3.20, 4.40)	68.9 (59.2, 78.6)	1.72 (1.19, 2.24)	31.1 (21.4, 40.8)
		Diff.	*-0.08 (-0.35, 0.20)*	*0.58 (-0.06, 1.21)*	*11.2 (0.8, 21.6)**	*-0.65 (-1.22, -0.08)**	*-11.2 (-21.6, -0.8)**
	Illiterate	Earlier	5.46 (5.29, 5.63)	2.86 (2.57, 3.15)	52.4 (47.3, 57.6)	2.60 (2.30, 2.89)	47.6 (42.4, 52.7)
		Later	5.32 (4.93, 5.71)	3.28 (2.31, 4.24)	61.6 (46.8, 76.4)	2.04 (1.34, 2.75)	38.4 (23.6, 53.2)
		Diff.	*-0.14 (-0.56, 0.29)*	*0.42 (-0.59, 1.43)*	*9.2 (-6.5, 24.9)*	*-0.55 (-1.32, 0.21)*	*-9.2 (-24.9, 6.5)*
74-79	**Literate**	Earlier	5.34 (5.23, 5.44)	3.00 (2.81, 3.19)	56.2 (52.6, 59.9)	2.34 (2.12, 2.55)	43.8 (40.1, 47.4)
		Later	5.36 (5.24, 5.48)	3.47 (3.22, 3.73)	64.8 (60.2, 69.4)	1.89 (1.64, 2.14)	35.2 (30.6, 39.8)
		Diff.	*0.02 (-0.14, 0.18)*	*0.47 (0.15, 0.79)***	*8.6 (2.7, 14.5)***	*-0.45 (-0.78, -0.12)***	*-8.6 (-14.5, -2.7)***
	Illiterate	Earlier	5.28 (5.15, 5.40)	2.78 (2.53, 3.03)	52.7 (48.2, 57.1)	2.50 (2.26, 2.73)	47.3 (42.9, 51.8)
		Later	5.31 (5.16, 5.46)	2.97 (2.65, 3.28)	55.8 (50.1, 61.6)	2.35 (2.04, 2.66)	44.2 (38.4, 49.9)
		Diff.	*0.04 (-0.16, 0.23)*	*0.19 (-0.22, 0.59)*	*3.2 (-4.0, 10.4)*	*-0.15 (-0.54, 0.24)*	*-3.2 (-10.4, 4.0)*
80-85	**Literate**	Earlier	4.80 (4.63, 4.98)	2.72 (2.45, 3.00)	56.7 (51.2, 62.3)	2.08 (1.79, 2.37)	43.3 (37.7, 48.8)
		Later	4.85 (4.66, 5.03)	3.42 (3.09, 3.76)	70.6 (64.9, 76.3)	1.43 (1.16, 1.69)	29.4 (23.7, 35.1)
		Diff.	*0.04 (-0.22, 0.30)*	*0.70 (0.26, 1.13)***	*13.9 (5.9, 21.8)****	*-0.65 (-1.05, -0.26)***	*-13.9 (-21.8, -5.9)****
	Illiterate	Earlier	4.72 (4.57, 4.87)	2.79 (2.55, 3.03)	59.1 (54.7, 63.5)	1.93 (1.73, 2.13)	40.9 (36.5, 45.3)
		Later	4.84 (4.67, 5.01)	3.17 (2.89, 3.45)	65.6 (60.5, 70.6)	1.67 (1.42, 1.91)	34.4 (29.4, 39.5)
		Diff.	*0.12 (-0.11, 0.34)*	*0.38 (0.01, 0.75)**	*6.5 (-0.2, 13.2)*	*-0.26 (-0.58, 0.05)*	*-6.5 (-13.2, 0.2)*
86-91	**Literate**	Earlier	4.00 (3.79, 4.22)	2.44 (2.13, 2.74)	60.8 (54.0, 67.7)	1.57 (1.29, 1.85)	39.2 (32.3, 46.0)
		Later	4.49 (4.29, 4.70)	3.14 (2.77, 3.50)	69.8 (62.5, 77.1)	1.36 (1.03, 1.69)	30.2 (22.9, 37.5)
		Diff.	*0.49 (0.19, 0.79)***	*0.70 (0.22, 1.18)***	*9.0 (-1.0, 19.0)*	*-0.21 (-0.65, 0.22)*	*-9.0 (-19.0, 1.0)*
	Illiterate	Earlier	4.08 (3.95, 4.21)	2.41 (2.22, 2.60)	59.1 (55.1, 63.2)	1.67 (1.50, 1.83)	40.9 (36.8, 44.9)
		Later	4.11 (3.96, 4.27)	2.76 (2.55, 2.97)	67.1 (62.5, 71.6)	1.36 (1.16, 1.55)	32.9 (28.4, 37.5)
		Diff.	*0.04 (-0.17, 0.24)*	*0.35 (0.06, 0.63)**	*7.9 (1.8, 14.1)**	*-0.31 (-0.57, -0.05)**	*-7.9 (-14.1, -1.8)**

Table S4. Estimated PC-LE, PC-HapLE, PC-UnHapLE, HapLE% and UnHapLE% and their differences across birth cohorts by age range and residence. The differences were calculated as the difference between the later cohort and the earlier cohort. The 95% CI around each point estimate is shown in parentheses. Significance of difference: * p<0.05, ** p<0.01, *** p<0.001.

Age Range	Residence	Cohort	PC-LE	PC-HapLE	HapLE%	PC-UnHapLE	UnHapLE%
68-73	Urban	Earlier	5.61 (5.50, 5.71)	3.23 (2.97, 3.49)	57.6 (53.0, 62.2)	2.38 (2.11, 2.64)	42.4 (37.8, 47.0)
		Later	5.73 (5.55, 5.90)	4.28 (3.74, 4.81)	74.7 (65.4, 83.9)	1.45 (0.92, 1.98)	25.3 (16.1, 34.6)
		Diff.	*0.12 (-0.09, 0.33)*	*1.05 (0.45, 1.64)****	*17.0 (6.7, 27.4)***	*-0.92 (-1.52, -0.33)***	*-17.0 (-27.4, -6.7)***
	Rural	Earlier	5.54 (5.44, 5.63)	2.98 (2.77, 3.18)	53.7 (50.1, 57.4)	2.56 (2.36, 2.77)	46.3 (42.6, 49.9)
		Later	5.28 (4.93, 5.64)	3.21 (2.38, 4.04)	60.8 (47.2, 74.3)	2.07 (1.40, 2.74)	39.2 (25.7, 52.8)
		Diff.	*-0.25 (-0.62, 0.11)*	*0.24 (-0.62, 1.09)*	*7.0 (-7.0, 21.1)*	*-0.49 (-1.19, 0.21)*	*-7.0 (-21.1, 7.0)*
74-79	Urban	Earlier	5.23 (5.09, 5.36)	3.10 (2.87, 3.32)	59.3 (55.3, 63.3)	2.13 (1.91, 2.34)	40.7 (36.7, 44.7)
		Later	5.28 (5.16, 5.40)	3.61 (3.38, 3.83)	68.3 (64.4, 72.2)	1.67 (1.46, 1.89)	31.7 (27.8, 35.6)
		Diff.	*0.06 (-0.12, 0.23)*	*0.51 (0.19, 0.83)***	*9.0 (3.4, 14.6)***	*-0.45 (-0.75, -0.15)***	*-9.0 (-14.6, -3.4)***
	Rural	Earlier	5.33 (5.24, 5.42)	2.84 (2.64, 3.04)	53.3 (49.7, 56.9)	2.49 (2.30, 2.68)	46.7 (43.1, 50.3)
		Later	5.37 (5.24, 5.50)	3.06 (2.81, 3.32)	57.0 (52.4, 61.6)	2.31 (2.06, 2.56)	43.0 (38.4, 47.6)
		Diff.	*0.04 (-0.11, 0.20)*	*0.22 (-0.10, 0.55)*	*3.7 (-2.1, 9.5)*	*-0.18 (-0.49, 0.14)*	*-3.7 (-9.5, 2.1)*
80-85	Urban	Earlier	4.87 (4.74, 5.00)	2.88 (2.63, 3.12)	59.1 (54.3, 63.8)	1.99 (1.76, 2.23)	40.9 (36.2, 45.7)
		Later	4.90 (4.75, 5.05)	3.44 (3.19, 3.69)	70.2 (65.8, 74.6)	1.46 (1.24, 1.68)	29.8 (25.4, 34.2)
		Diff.	*0.03 (-0.17, 0.23)*	*0.56 (0.21, 0.91)***	*11.1 (4.7, 17.6)****	*-0.53 (-0.85, -0.22)***	*-11.1 (-17.6, -4.7)****
	Rural	Earlier	4.68 (4.55, 4.81)	2.70 (2.48, 2.93)	57.7 (53.4, 62.0)	1.98 (1.78, 2.19)	42.3 (38.0, 46.6)
		Later	4.77 (4.59, 4.96)	3.13 (2.83, 3.44)	65.7 (60.3, 71.0)	1.64 (1.39, 1.89)	34.3 (29.0, 39.7)
		Diff.	*0.09 (-0.14, 0.31)*	*0.43 (0.05, 0.81)**	*8.0 (1.1, 14.9)**	*-0.35 (-0.67, -0.02)**	*-8.0 (-14.9, -1.1)**
86-91	Urban	Earlier	4.05 (3.91, 4.18)	2.58 (2.39, 2.76)	63.7 (59.7, 67.6)	1.47 (1.31, 1.63)	36.3 (32.4, 40.3)
		Later	4.30 (4.10, 4.50)	3.03 (2.77, 3.28)	70.4 (65.9, 75.0)	1.27 (1.07, 1.47)	29.6 (25.0, 34.1)
		Diff.	*0.25 (0.02, 0.49)**	*0.45 (0.14, 0.77)***	*6.8 (0.8, 12.8)**	*-0.20 (-0.45, 0.06)*	*-6.8 (-12.8, -0.8)**
	Rural	Earlier	4.03 (3.90, 4.16)	2.36 (2.16, 2.56)	58.5 (54.2, 62.7)	1.67 (1.51, 1.84)	41.5 (37.3, 45.8)
		Later	4.21 (4.05, 4.37)	2.80 (2.53, 3.08)	66.6 (60.9, 72.2)	1.41 (1.17, 1.65)	33.4 (27.8, 39.1)
		Diff.	*0.18 (-0.03, 0.39)*	*0.45 (0.11, 0.79)***	*8.1 (1.0, 15.1)**	*-0.26 (-0.55, 0.02)*	*-8.1 (-15.1, -1.0)**