Social Science & Medicine 366 (2025) 117718

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Trajectories of health-related quality of life across age cohorts: A longitudinal analysis of the German population over 16 years

C. Kasinger [a,b,*], L. Kriechel [a,c], S. Hahm [d,e], A. Reinwarth [a,f], B. Strauss [b], M. Beutel [a], E. Brähler [a,g], L. Altweck [d,e]

[a] Department of Psychosomatic Medicine and Psychotherapy, University Medical Center, Johannes Gutenberg University Mainz, Germany
[b] Jena University Hospital, Institute of Psychosocial Medicine and Psychotherapy, Jena, Germany
[c] Department of Family and Fertility, Federal Institute for Population Research, Wiesbaden, Germany
[d] Department Health and Prevention, Institute of Psychology, University of Greifswald, Germany
[e] German Center for Child and Adolescent Health (DZKJ), partner site Greifswald/Rostock, Greifswald, Germany
[f] Department of Psychiatry and Psychotherapy, University Medical Center, Johannes Gutenberg University Mainz, Germany
[g] Department of Psychiatry and Psychotherapy, Leipzig University Hospital, Leipzig, Germany

A B S T R A C T

Background: Understanding the trajectories of health-related quality of life (HRQoL) across different age cohorts and sociodemographic factors is crucial for promoting healthy aging. This study aims to examine the course of physical and mental HRQoL over a 16-year period in a nationwide sample of the German population.
Methods: Data from the German Socio-Economic Panel spanning from 2002 to 2018 (N = 4111; female = 52.0%; age range = 18–81 years; age_{mean} in 2002 = 45.65 years) was analyzed using latent growth curve modeling. Measures of mental and physical HRQoL were assessed using the SF-12 questionnaire. Sociodemographic variables including age, gender, region, income, education were examined as predictors of HRQoL trajectories.
Findings: The analysis revealed distinct trajectories for mental and physical HRQoL. Mental HRQoL showed a non-linear trend, peaking between the ages of 62–72, while physical HRQoL exhibited a linear decline with increasing age. Women consistently reported lower starting values for both mental and physical HRQoL across age cohorts. East Germans reported lower starting values for both dimensions of HRQoL compared to West Germans, although the gap in mental HRQoL narrowed over time. Higher income and education were associated with better HRQoL outcomes, particularly for physical HRQoL.
Interpretation: This study highlights the importance of considering age, gender, region, income, and education in understanding the trajectories of HRQoL. Target interventions for individuals with certain risk factors can contribute to enhance overall well-being in the population.

1. Introduction

In an era of an aging population, where longevity and good health are increasingly important, public health policies must adapt (World Health Organisation, 2021). Consequently, there is a growing need to understand the individual characteristics that influence health and well-being. This understanding is crucial to effectively address the health and social care needs of this aging population. Age effects on the trajectories on health-related quality of life (HRQoL) are underrepresented in previous research. Therefore, this article aims to address this shortcoming by exploring the implications of age on HRQoL in more detail.

In recent decades, the prevailing pathological concept of health has been superseded by a holistic biopsychosocial approach. Accordingly, the World Health Organisation (2021) has defined health as one's physical, mental, and social well-being and not just the absence of disease. Research has demonstrated a growing interest in positive aspects and self-evaluations of health, such as HRQoL. The construct of HRQoL has gained importance due to the evolving recognition of subjective health factors in medicine.

A mounting body of research has demonstrated a correlation between low HRQoL and adverse health outcomes, including higher mortality risk in the general population, coronary diseases, pulmonary diseases, and cancer (Phyo et al., 2020; Rodriguez-Artalejo et al., 2005; Domingo-Salvany et al., 2002; Sehlen et al., 2012). The important role of HRQoL for public health and longevity has been further demonstrated by an emerging body of research that showed its additional use in monitoring efficacy of health services and treatment success (Bullinger et al., 2015).

Empirical research has demonstrated that, in general, HRQoL

* Corresponding author. Department for Psychosomatic Medicine and Psychotherapy, University Medical Center of Johannes Gutenberg University of Mainz, Untere Zahlbacher Str. 8, 55131, Mainz, Germany.
E-mail address: Christoph.kasinger@unimedizin-mainz.de (C. Kasinger).

https://doi.org/10.1016/j.socscimed.2025.117718
Received 1 August 2024; Received in revised form 14 January 2025; Accepted 15 January 2025
Available online 18 January 2025

experiences a decline with the progression of age (Gobbens and Remmen, 2019; Zaninotto et al., 2009). Furthermore, the discrepancy in HRQoL between younger and older individuals increases with age, as HRQoL deteriorates more rapidly among older compared to younger individuals (Zaninotto et al., 2009). However, examining mental and physical HRQoL separately, an increase of mental HRQoL in young seniors (age 65–78) was identified (Klar et al., 2021). Since mental and physical dimensions of HRQoL may exhibit distinct trajectories as individuals age, a nuanced approach to differentiate between these dimensions is necessary (Reinwarth et al., 2023).

Life-course epidemiology posits that this age-related decline may result from the cumulative impact of early adversity, chronic stressors, environmental exposures, and risky health behaviors (Ben-Shlomo and Kuh, 2002; Hertzman and Power, 2003; Elder and Shanahan, 2007). Life-course frameworks draw on the notion that exposure to specific factors at particular stages in life leads to specific health outcomes in later life (Mayer, 2009; Plagnol and Scott, 2011). This for instance pertains to the exposure to major life events, such as economic crises or wars (Hertzman and Power, 2003; Elder et al., 2003). However, on a more fundamental level this exposure can also relates to how we lead our life on a daily basis in relation to different life domains, such as employment, partnership, or fertility (Giudici and Morselli, 2019; Mariani et al., 2017). Consequently, the life course can be conceptualized as a succession of events and social roles that an individual adopts throughout their life (Giele and Elder, 1998). While life courses are becoming increasingly individualized and less uniform, cultural and institutional norms continue to exert a significant influence on an individual level (Huinink and Kohli, 2014).

Evidence suggests that HRQoL varies with sociodemographic characteristics in adulthood. Specifically, the female sex has been found to be negatively associated with the physical domain of HRQoL. Furthermore, higher income and wealth are positively associated with physical and mental quality of life (Gobbens and Remmen, 2019; Zaninotto et al., 2009). Education and employment are also positively associated with HRQoL (Zaninotto et al., 2009).

The present study focuses on the German context. Hahm et al. (2024) examined life satisfaction typologies in a German sample. They found that four typologies – stable, improvement, decline followed by improvement, and declining – were seen both short-term (5 years) and long-term (30 years) following the reunification. Becoming unemployed, divorce/separation, and a lower household income were related to a lower likelihood of stable satisfaction with life trajectories. In a separate study, Altweck et al. (2023) examined employment and family life courses in Germany, identifying distinct types of life courses, including singledom, family formation and marital separation, as well as entering, continuous or leaving employment. This study revealed differential associations with sociodemographic background and HRQoL, with the life course denoted by marital separation or leaving employment being associated with a steeper decline in HRQoL.

Another important sociodemographic predictor of health in Germany is region, as the former Eastern and Western states exhibit disparities in terms of, for instance, wealth, income and the unemployment rate. For example, East Germans report experiencing greater deprivation than West Germans, both in absolute terms and relative to their peers (Heyder and Gaßner, 2012). Additionally, East Germans exhibit lower levels of life satisfaction compared to West Germans and significant disparities in mental health variables such as depression, anxiety, and somatic symptoms, are observed between these two groups (Kasinger et al., 2023; Beutel et al., 2021). Previous studies identified divergent trajectories for mental health and subjective well-being outcomes between East and West Germans following unification (Altweck et al., 2021). Consequently, it is important to examine the trajectories of HRQoL for East and West Germans separately. Furthermore, examining the disparities between East and West Germany may facilitate the identification of implications concerning the consequences of differing sociopolitical and socioeconomical backgrounds on HRQoL.

In sum, previous research has demonstrated that age, income, education, region, and sex are influential sociodemographic predictors of subjective mental and physical health. To the best of our knowledge, this paper is the first to examine age cohort and sociodemographic factors on physical and mental HRQoL trajectories in a German population sample.

2. Method

2.1. Dataset and sample

Data from the Core-Study of the German Socio-Economic Panel (GSOEP) was used. This is an annual representative longitudinal study of private households from 1984 until the present (Liebig et al., 2019). The waves that measured HRQoL (i.e., 2002–2018; every two years) were used, resulting in nine measurement points. Complete case analysis was performed, and only participants who consistently responded to every item of the SF-12 questionnaire across all waves and had complete data on all relevant covariates were included in the analysis. Participants who relocated between East and West Germany were excluded from the analysis. This resulted in a final sample of N = 4111 participants. Compared with the size of the originally recruited sample in 2002 with $N = 19{,}442$ participants the dropout rate is 78.85 %.

2.2. Ethical considerations

The primary study was approved by the appropriate ethics committee and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This approval also includes national laws (i.e., in alignment with the General Data Protection Regulation. Written informed consent was obtained from each subject (Siegers et al., 2024). The current study protocols were approved by the German Institute for Economic Research. The data can be accessed following an application to the German Institute for Socioeconomic research: https://www.diw.de/en/diw_01.c.618953.en/the_institute.html. As this study was a secondary data analysis of publicly available data sets no additional ethical approval was required.

2.3. Measures

Mental and physical health related quality of life was measured using the GSOEP-SF-12 which has been questioned every two years since 2002 (Nübling et al., 2006). The SF-36 and its short-form, the SF-12, is one of the most frequently used measurement instruments worldwide to assess HRQoL (Drixler et al., 2020). The mental HRQoL subscale includes six items that evaluate mental health, emotional role functioning, social functioning, and vitality. The physical HRQoL subscale contains six items that assess general health, physical fitness, bodily pain, and physical role functioning. General health was assessed on a 5-point Likert scale (1 = very good to 5 = bad), the physical fitness items were assessed on a 3-point Likert scale (1 = greatly to 3 = not at all), and all other items were measured on a 5-point Likert scale (1 = always to 5 = never). Examples of items include: "Please think about the last four weeks. How often did it occur within this period of time, that due to mental or emotional problems you carried out your work or everyday tasks less thoroughly than usual?" (subjective mental health) and "… that you had strong physical pains?" (bodily pain). Several studies have reported good psychometric properties of the SF-12 (Drixler et al., 2020; Wirtz et al., 2018; Ware et al., 1996). The items of the subscales utilize different answering formats. Therefore, we performed a transformation in accordance with the instructions of Andersen et al. (2007). This transformation assigned values of 50 to the mean scores of 2004, with every increment of ten representing one standard deviation. Higher scores indicate better HRQoL.

Sociodemographic variables. The baseline values (i.e., 2002) were utilized to categorize the age cohort spanning an age period of 16 years

(18–33 years, 34–49 years, etc.), sex by self-report (0 = male, 1 = female), and the equivalized household income. The equivalized household income was computed by dividing the total household income by the root square of the number of people living in the household. Household income refers to the sum of money all people living in the household earn. For education we coded a dummy variable of the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) -classification of the end values in 2018 identifying people with a tertiary education level certificate (1) and below (0). Tertiary educational facilities are institutions of formal learning that follow secondary education, typically provided by universities, colleges, vocational institutions, and other specialized post-secondary schools. Participants who were residing in West Germany prior to the unification in 1989 and who were residing in West Germany at all specified time points were designated as West Germans (0), while the analogous approach was employed for East Germans (1).

2.4. Statistical analysis

Descriptive statistics. The analysis data set was examined through the calculation of mean values, standard deviations for continuous variables, and absolute and relative frequencies for categorical variables. The results are displayed in Table 1. To visualize possible age-period-cohort effects, lexis-plots were created for the mental and physical component summary scale of the SF-12 (see Figs. 2 and 3). These graphs plot year against age with the scores of mental and physical HRQoL. The values are visualized through different coloring: darker grey indicates smaller values, and brighter grey indicates higher values. Age cohorts are represented by "blocks" moving upwards each year. Line graphs of mental and physical HRQoL for every time point for the different age cohorts were also created (see Figs. 4 and 5).

Latent growth curve modelling (LGCM). In order to address the current research question, LGCM was conducted using the lavaan package (version 0.6–7) in R (version 4.0·3) (Rosseel, 2012). Growth analysis "attempt[s] to estimate between-person differences in within-person change" (Curran et al., 2010). Recently, LGCM has been drawing on confirmatory factor analysis and structural equation modelling methods in a two-stage process. First, measurement points of the outcome are fitted to the latent variables *intercept* (i.e., baseline value) and *slope* (i.e., growth). Subsequently, additional – for instance., inter-person – variables are entered as predictors of the intercept and slope variables (Curran et al., 2010). Thedata requirements for the LGCM approach were met: a substantial sample size was provided, a minimum of three measurement points were examined, and the repeated measures (i.e., mental and physical HRQoL) were both continuous. Given the non-normal distribution of the data, the robust maximum likelihood parameter estimation (MLR) method was employed (see Fig. 1 for a visual representation of the current statistical models). The mental and physical HRQoL aspects were modelled concurrently, yet with two distinct intercept and slope variables respectively. In a first step, a LGCM was modelled on the entire sample, with age and age squared serving as predictors. In a second step, age cohorts were incorporated as grouping variables. The control variables were regressed on intercepts and slopes in both steps.

To evaluate the models, Hu and Bentler's guidelines for model fit indices were used: Root Mean Squared Error of Approximation (RMSEA) < 0.06, Comparative Fit Index (CFI) > 0.95 and Standardized Root Mean Square Residual (SRMR) < 0.08 (Hu and Bentler, 1999).

Table 1
Sociodemographic characteristics of the sample.

Variable	Total (*N* = 4111)	Age cohort			
		18–33 (*N* = 804)	**34–49** (*N* = 1653)	**50–65** (*N* = 1394)	**66–81** (*N* = 260)
Female; *N* (%)	2136 (52.0)	443 (55.1)	864 (52.3)	699 (50.1)	130 (50.0)
East Germany; *N* (%)	1177 (28.6)	239 (29.7)	453 (27.4)	410 (29.4)	75 (28.8)
Age in 2002; *M* (SD)	45.65 (13.26)	26.54 (4.95)	41.69 (4.49)	57.08 (4.64)	68.57 (2.27)
EHI in 2002; *M* (SD)	1796.57 (1257.24)	1520.00 (901.66)	1720.75 (1081.49)	2052.58 (1494.73)	1761.23 (1567.65)
Holding tertiary educational degree in 2018; *N* (%)	1266 (30.8)	273 (34.0)	489 (29.6)	430 (30.8)	74 (28.5)

Note. EHI = Equivalized Household Income.

3. Results

1. Descriptive Analyses

The lexis-plot for the mental and physical component summary scale of the SF-12 are shown in Figs. 2 and 3. For the mental health component a brighter corridor, approximately between the ages of 62 and 72, signifies enhanced mental HRQoL. This phenomenon occurs independently from cohorts and is observed in every period, indicating a robust age effect. This suggests that mental HRQoL experiences a pronounced enhancement around the age of 60 and beyond. Another notable observation is the increased variability in the bright and dark grey blocks among older age groups compared to younger ones. This indicates that the distribution of individuals reporting higher values of mental HRQoL is wider in older age groups compared to younger ones. The plot further reveals a period effect for the mental health component in 2016, with a brighter scale observed across nearly every age cohort.

The lexis-plot for the physical health component demonstrates a linear age effect of deterioration in physical HRQoL, consistent across all time points and reflecting the aggregate development of the age cohorts over time. No discernible cohort or period effects are apparent, but a pronounced negative age effect on physical HRQoL is evident.

These results are supported by the line graphs for the mental HRQoL (Fig. 4) and the physical HRQoL summary scale (Fig. 5) which demonstrate analogous trends across various age cohorts.

2. Latent Growth Curve Model

The primary analyses of the total sample concentrated on relevant trajectories for mental and physical HRQoL, with an emphasis on age. The results are presented in Table 2. Additionally, detailed information of the outcomes of the latent growth curve analyses (e.g. actual p-levels, unstandardized estimates and 95%-CI) are provided in the supplement materials (Tables 5–14).

3.1. Age effects

The model's fit for the total sample was assessed using the CFI, RMSEA, and SRMR, with a value of .980, .035, and .023, respectively, indicating a good model fit. The results of the LGCM analysis revealed a non-linear trend for the effects of age on the mental HRQoL intercept and slope (Table 2). However, a linear trend for age on the physical HRQoL was observed, with older participants reporting lower physical HRQoL-scores. It is noteworthy that age demonstrated no significant impact on the slope of the physical HRQoL-scores, indicating a steady and stable decline across all age cohorts. However, dynamic age effects were observed in the mental HRQoL scores, with individuals experiencing varied courses of mental HRQoL depending on their age. A notable increase and peak in mental HRQoL was observed around the age of 62–72.

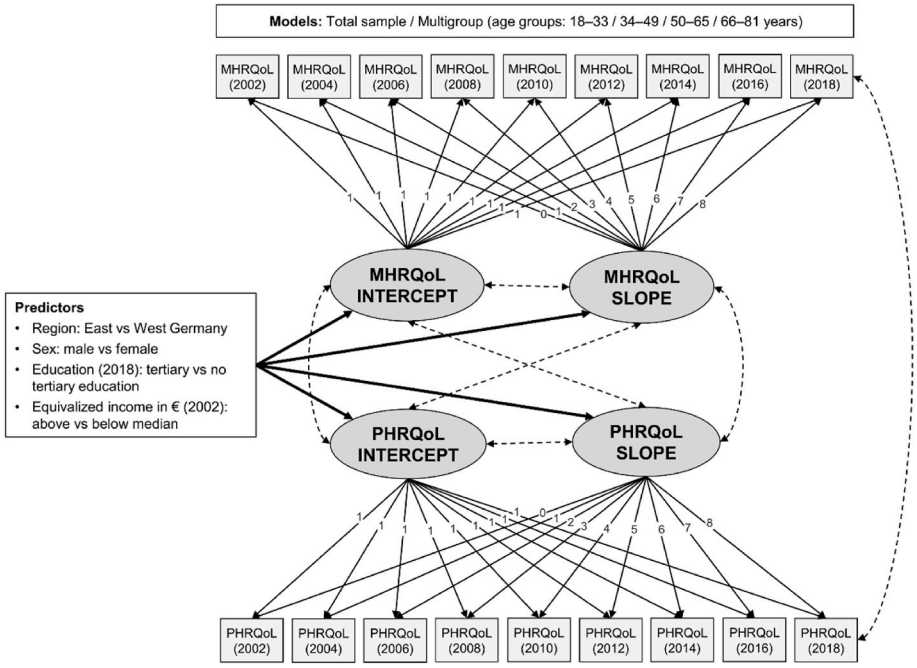

Fig. 1. Statistical model.
Note. MHRQoL = Mental health-related quality of life, PHRQoL = Physical health-related quality of life. Covariance between SF-12 scores within each wave; exemplarily shown for 2018.

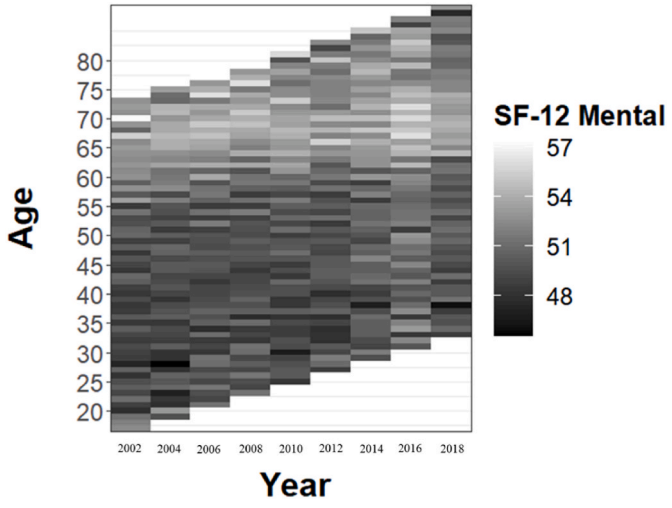

Fig. 2. Lexis-plot of the mental HRQoL summary scale (N = 4111).
Note. Darker colors represent lower levels of mental HRQoL compared to brighter colors, which indicate higher levels of mental HRQoL within the observed range. Every tile represents one age group at one measurement point. E.g. people in our sample, who were 18 at the beginning of the measurement were 33 at the end. Therefore, the lowest tile in 2018 represents the same people as the lowest tile in 2002 and so forth.

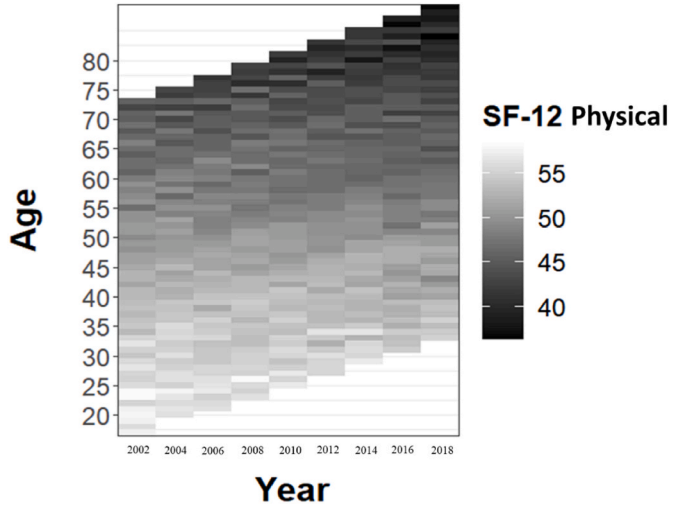

Fig. 3. Lexis-plot of the physical HRQoL summary scale (N = 4111).
Note. Darker colors represent lower levels of physical HRQoL compared to brighter colors, which indicate higher levels of physical HRQoL within the observed range. Every tile represents one age group at one measurement point. E.g. people in our sample, who were 18 at the beginning of the measurement were 33 at the end. Therefore, the lowest tile in 2018 represents the same people as the lowest tile in 2002 and so forth.

3.2. Regional effects

The analysis also revealed regional disparities, with individuals in East Germany exhibiting initial mental and physical HRQoL scores that were lower than those observed in West Germany ($p < .001$). While the effect of place of residence on physical HRQoL was not significant, East Germans demonstrated a more positive trajectory for mental HRQoL ($p = .024$). Consequently, the disparity in mental HRQoL between East and West Germans diminished during the observed time period.

A more detailed examination of the age cohorts indicated that regional effects for the mental and physical HRQoL intercepts were only observed among individuals aged 34–81 years and 34–65 years, respectively. Furthermore, regional effects for the slope of the mental and physical HRQoL-values were identified, specifically for the slope of physical HRQoL in the 34 to 49 age group ($p = .021$). However, no significant effects concerning region were observed in the youngest age group.

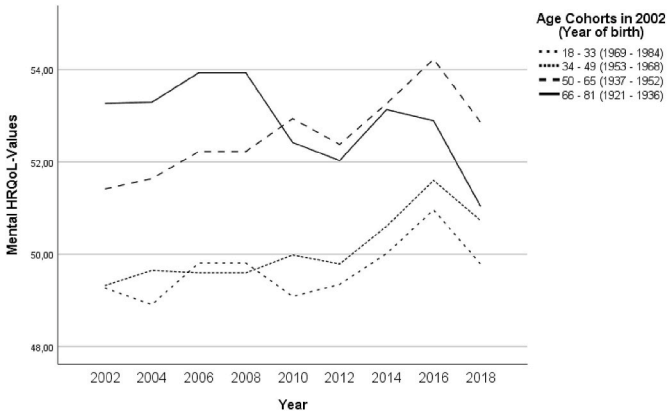

Fig. 4. Line-graph of the mental HRQoL-values for different age cohorts (N = 4111).

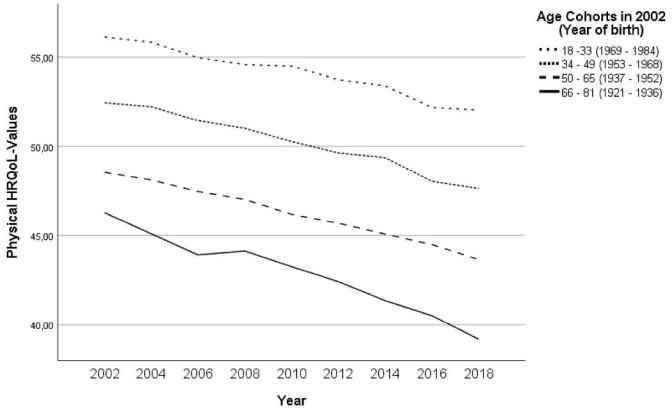

Fig. 5. Line-graph of the physical HRQoL-values for different age cohorts (N = 4111).

3.3. Sex effects

The analysis revealed that women reported worse mental and physical HRQoL starting values ($p < .001$). However, the course of physical and mental HRQoL trajectories did not differ significantly between men and women.

The analysis of the age cohorts indicated an interaction effect for age and sex, with women's starting values differing significantly for mental HRQoL in the youngest age cohort, ($p < .001$). In women aged 34 to 65, the intercepts for mental and physical HRQoL were significantly lower (all $p < .024$). We did not find sex differences in the individual age cohorts regarding the slope of mental and physical HRQoL.

3.4. Income effects

Income was found to have a significant impact on the reported levels of mental and physical HRQoL, with individuals who reported higher incomes also reporting higher values of mental and physical HRQoL ($p < .001$). However, income was not found to be significantly associated with HRQoL trajectory. The relevance of income varied by age cohorts. While no effect of income on the HRQoL was shown for the youngest age cohort, it played a significant role for the starting values ($p < .001$) and the trajectories of mental HRQoL ($p = .020$) for people aged 34 to 49. People with higher income report higher starting values, but the decline of mental HRQoL is stronger compared to people with lower income ($p = .021$). For participants aged 50–81 years old, individuals with higher income levels also exhibit higher starting values for the physical HRQoL component ($p < .001$). Interestingly, the trajectory of physical HRQoL was found to be independent by income.

Table 2
Results of the latent growth curve models for mental HRQoL and physical HRQoL (standardized β-values) (N = 4111).

	Mental HRQoL		*Physical HRQoL*	
	Intercept	*Slope*	*Intercept*	*Slope*
Total Sample ($N = 4111$)				
Age	**−0.627**	**1.062**	**−0.307**	−0.205
Age squared	**0.808**	**−1.111**	−0.165	0.126
Region (ref = West Germans)	**−0.095**	0.052	−0.066	−0.029
Sex (ref = female)	**0.117**	−0.020	**0.062**	−0.033
EHI	**0.116**	−0.026	**0.086**	0.020
Tertiary Education (ref = no tertiary certificate)	0.023	0.036	**0.127**	0.047
Age cohort (18–33 y; $N = 804$)				
Intercept/Slope mean	**47.423**	0.273	**55.491**	**−0.633**
Region	−0.034	0.063	0.001	0.026
Sex	0.187	−0.094	0.020	0.019
EHI	0.036	−0.041	−0.018	0.055
Tertiary Education	0.062	−0.051	**0.269**	0.075
Age cohort (34–49 y; $N = 1653$)				
Intercepts/Slope mean	**47.334**	**0.268**	**51.411**	**−0.622**
Region	−0.070	0.022	−0.058	−0.083
Sex	**0.102**	0.010	**0.088**	−0.053
EHI	**0.126**	−0.073	0.033	0.012
Tertiary Education	.031	.048	**0.161**	**0.136**
Age cohort (50–65 y; $N = 1395$)				
Intercept/Slope mean	**50.363**	0.185	**46.592**	**−0.562**
Region	**−0.142**	0.037	**−0.110**	0.006
Sex	0.097	0.007	0.065	−0.040
EHI	**0.130**	−0.009	**0.151**	0.012
Tertiary Education	−0.016	0.112	**0.112**	−0.047
Age cohort (66–81 y; $N = 260$)				
Intercept/Slope mean	**51.787**	−0.076	**45.140**	**−0.782**
Region	−0.174	0.137	−0.131	−0.160
Sex	0.184	−0.152	0.061	0.106
EHI	0.102	−0.019	0.088	−0.032
Tertiary Education	0.119	−0.082	0.106	0.020

Note. ***bold****:* $p < .001$, *underlined:* $p < .05$, EHI = equivalized household income. Fit indices: Model for age cohort 18–33: CFI = .950, RMSEA = .038, SRMR = .034; Model for age cohort 34–49: CFI = .965, RMSEA = .041, SRMR = .033; Model for age cohort 50–65: CFI = .969, RMSEA = .039, SRMR = .029; Model for age cohort 66–81: CFI = .973, RMSEA = .034, SRMR = .047. Intercept/Slope means are unstandardized.

3.5. Education effects

Education showed no significant effects on either the intercept or the slope of mental HRQoL. For physical HRQoL, a significant positive effect on the intercept ($p < .001$) and the slope ($p = .034$), was observed. These findings suggest that individuals with higher levels of education experience a more favorable physical HRQoL and a less precipitous decline.

The observation of the age cohorts revealed a similar pattern to the overall model regarding the intercept and the slope of mental HRQoL, with the exception of the age cohort 50 to 65, whose course trajectories differed significantly between levels of education ($r = .005$). While the initial values of physical HRQoL varied significantly across all age cohorts, the trajectory of the physical HRQoL differed significantly only for individuals aged 34 to 49 ($p < .001$). This finding suggests that the significant outcomes concerning the course of physical HRQoL identified in the overall model were predominantly influenced by this particular age group.

3.6. Correlation effects

The results of the correlation matrix of the LGCM are shown in

Table 3
Correlation Matrix of the mental and physical HRQoL intercepts and slopes.

	Mental-HRQoL-Intercept	Mental-HRQoL-Slope	Physical-HRQoL-Intercept
Mental-HRQoL-Slope	**−0.449**	–	
p	**<0.001**		
Physical-HRQoL-Intercept	**0.160**	−0.005	–
p	<0.001	0.850	
Physical-HRQoL-Slope	0.034	0.054	**−0.279**
p	0.207	0.121	<0.001

Note. **Bold** = p < 0.001, N = 4111.

Table 3. The mental HRQoL-intercept correlated negatively with the mental HRQoL-slope ($r = -.449$), indicating that individuals with higher initial values of mental HRQoL experienced a worse trajectory of mental HRQoL. A similar correlation was observed between the physical HRQoL-intercept and the physical HRQoL-slope ($r = -.279$). A modest positive correlation ($r = .160$) was identified between mental HRQoL and physical HRQoL, suggesting an intercorrelation between these two concepts. Notably, despite this intercorrelation, no correlation was observed between the mental HRQoL-intercept and the physical HRQoL-slope, between the physical HRQoL-intercept and the mental HRQoL-Slope and between the physical HRQoL-slope and the mental HRQoL-slope. The course of mental HRQoL was not influenced by the trajectory of physical HRQoL and vice versa.

4. Discussion

The aim of the present study was to examine the trajectory of physical and mental HRQoL over a period of 16 years in men and women across various age cohorts within the general German population. In an aging population, assessing trajectories and potential influences of health becomes a crucial aspect in promoting healthy aging. The findings revealed several significant results that contribute to our understanding of the factors influencing HRQoL. While numerous associations were identified between individual sociodemographic variables and HRQoL, it is acknowledged that these rarely occur in isolation. For instance, unemployment frequently follows a decline in household income, potentially exacerbating familial stress, which can subsequently lead to significant life events such as divorce or relocation. From a life-course perspective, the interplay of sociodemographic variables is of importance (Ben-Shlomo and Kuh, 2002; Hertzman and Power, 2003; Elder and Shanahan, 2007). However, this was beyond the scope of the current study and should be examined in the future. Next, we discuss individual associations with HRQoL, posing interconnecting explanations:

With respect to the impact of age, the analysis revealed a non-linear trend for the mental HRQoL and a linear trend for the physical HRQoL. The observed peak in mental HRQoL-values between the ages of 62–72 indicates a period of enhanced mental HRQoL during this phase of life. This effect remained consistent across various age cohorts and periods, indicating a robust age effect. In contrast, the physical HRQoL exhibited a stable decline with increasing age, indicating a linear age effect on physical HRQoL. Consistent with prior studies, mental HRQoL demonstrated an increase with age, while physical HRQoL exhibited a decrease with age (Tseng et al., 2020). However, these results do not support the finding, that the decline in physical HRQoL accelerates with age (Zaninotto et al., 2009). These findings indicate a strong beneficial retirement effect on mental HRQoL and corroborates and extends previous findings that show a positive retirement effect on subjective well-being (Clark and Zhu, 2024; Henning et al., 2022). Retirement marks a significant transition from a work-centred lifestyle to one characterized by greater personal freedom and reduced occupational stress. The reduction in daily work-related stressors may be a key factor in improving mental HRQoL. Retirees often find more time to engage in leisure activities, pursue hobbies, and relax, contributing to a better mental state. Along with more personal freedom retirees experience an enhanced sense of internal control over their life which is positively associated with subjective health and well-being (Clark and Zhu, 2024; Henning et al., 2022). An additional explanation for these findings is provided by the theory of response shift (Barclay-Goddard et al., 2009). This theory posits that individuals' internal frames of reference, including their values, expectations, and conceptualizations of health, undergo changes over time. Such adjustments for older people may involve redefining how they define good health, often placing less emphasis on physical prowess and more on other aspects of well-being. Furthermore, our research highlights a critical aspect of HRQoL research: the divergent trajectories of mental and physical HRQoL. While physical and mental HRQoL are sometimes reported in a combined sum score, our results demonstrate that treating these components as a unified metric may obscure significant, distinct trends in each domain. The different trajectories highlight the importance of evaluating physical and mental HRQoL as separate entities to accurately understand and address the multifaceted aspects of HRQoL.

Women between the age of 34–65 reported worse initial values for both mental and physical HRQoL. However, the trajectories of the physical and mental HRQoL did not differ significantly between sexes. The analysis of different age cohorts revealed interaction effects between age and sex, indicating differential patterns across age cohorts. One potential explanation for these observed differences, is the persistent gender disparity in care work distribution, with women disproportionately bearing the majority of domestic and familial responsibilities, including childcare and eldercare (Sullivan, 2019). These care related stressors may contribute to the observed differences in HRQoL intercepts. Additionally, these disparities between men and women may be a consequence of a reporting bias, as individuals, especially men, have been observed to overrate their health and well-being (Brown et al., 2018).

One notable finding is the significant regional effect observed between East and West Germans. East Germans reported smaller initial values for both mental and physical HRQoL, suggesting a comparatively inferior HRQoL in comparison to West Germans. This observation aligns with prior research that identified regional disparities in life expectancy and mortality due to cardiovascular circulatory diseases (Lampert et al., 2019; Nowossadeck et al., 2019). However, during the observed time period, the mental HRQoL disparity between East and West Germans narrowed, as East Germans showed a more positive trajectory of mental HRQoL. This finding suggests some improvement in mental HRQoL among East Germans, although the initial disadvantage persists. These regional differences may be attributed to the unequal economic conditions that emerged after the reunification of Germany. East Germans exhibit higher unemployment rates, lower incomes, and reduced wealth compared to West Germans, which partially explains their poorer subjective well-being (Kasinger et al., 2023; Altweck et al., 2021). The present findings highlight the enduring impact of these economic disparities on the HRQoL of individuals, even after the passage of several decades. The absence of significant differences in HRQoL between East and West Germans among participants younger than 34 years may stem from the fact that individuals in this age group were less impacted by the turbulences of the reunification compared to older cohorts.

Income was also found to play a significant role in reported levels of mental and physical HRQoL, with higher income corresponding to higher physical and mental HRQoL values. However, income did not show a significant effect on the trajectories of HRQoL. Notably, the influence of income on HRQoL varied across different age cohorts. In the youngest age cohort, income did not have a significant effect on HRQoL, suggesting that other factors may be more influential during early adulthood. However, in the age cohort of 34–49, higher income was associated with higher initial values for the mental HRQoL, although the

trajectory of the mental HRQoL was worse compared to those with lower income. These findings underscore the significance of socioeconomic factors, such as income, on HRQoL outcomes.

The findings of this study indicated that education exerts a significant influence on the intercept and slope of the physical HRQoL, indicating that individuals with higher levels of education experience better physical HRQoL and a less steep decline over time. However, the study did not demonstrate a significant association between education and the intercept or slope of the mental HRQoL values. In contrast to previous research (Burdine et al., 2000; Kivits et al., 2013), our study did not demonstrate significant associations between higher educational attainment and enhanced mental HRQoL. However, it is noteworthy that the operationalization of income as a covariate in our study differed from that employed in previous research, which may serve as a potential explanation for the observed discrepancy. This assumption stems from the finding of Euteneuer et al. (2021) who also controlled for equivalent household income and did not find a significant relation between the mental component of health-related quality of life and education. Therefore, multicollinearity might be an explanation for this disparate finding. These results suggest that educational attainment primarily influences physical HRQoL outcomes and might be explained by different working conditions. Individuals with lower educational attainment tend to be employed in blue collar jobs more often than individuals with higher educational attainment. These jobs are physically more demanding and affect physical HRQoL more negatively than white collar jobs (Kajitani, 2015).

4.1. Strengths and limitations

A notable strength of our study is the large nationwide overall sample size and the longitudinal design, which spans over 16 years. This design offers the opportunity to gain insight into the temporal dynamics of HRQoL. Furthermore, HRQoL was assessed using a well-established, widely used and extensively validated measure. However, interpretation of our findings is limited by the representativeness of the sample. In longitudinal studies, such as the German Socioeconomic Panel, panel attrition effects are a concern, as higher educated people, women and older people, are more likely to continue to participate in longitudinal surveys (Liebig et al., 2019). In our sample the proportion of individuals from East Germany and women are overrepresented. Consequently, our results may lack representativeness for the general population and may be distorted due to the panel attrition effects. Additionally, the underrepresentation of individuals with elevated risk for diminished health-related quality of life (HRQoL) may be a consequence of this distortion. Considering the large dropout rate of 78.85 % among the originally recruited sample in 2002 the possible distortion by the panel attrition effects represent the most significant limitation to the representativeness of our findings. As indicated in previous research, the associations of sociodemographic factors and quality of life vary depending on the instruments used to assess quality of life (Grieve et al., 2009; Gobbens and Remmen, 2019; Lubetkin and Gold, 2003). Another salient aspect pertains to the SF-12's exclusion of measures pertaining to the social dimensions of health, which have been identified as pivotal components of an individual's HRQoL (Michel et al., 2009; Berra et al., 2024).

5. Conclusions

In conclusion, the present study sheds light on the trajectories of mental and physical HRQoL in a German population sample. The findings underscore the impact of age, regional disparities, sex, income, and education on HRQoL outcomes. The results evidently demonstrate an age effect on mental and physical HRQoL. Moreover, we distinctly illustrate divergent trajectories of mental and physical HRQoL over the course of life contingent on disparate sociodemographic characteristics. The identification of salient sociodemographic variables offers potential targets for interventions aimed at enhancing HRQoL and at identifying groups that may be susceptible to diminished mental and physical HRQoL.

CRediT authorship contribution statement

C. Kasinger: Writing – original draft, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **L. Kriechel:** Writing – original draft, Conceptualization. **S. Hahm:** Writing – original draft, Visualization, Methodology, Conceptualization. **A. Reinwarth:** Writing – original draft, Conceptualization. **B. Strauss:** Writing – review & editing, Supervision, Conceptualization. **M. Beutel:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **E. Brähler:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **L. Altweck:** Writing – original draft, Visualization, Methodology, Investigation, Conceptualization.

Ethical considerations

The primary study was approved by the appropriate ethics committee and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This approval also includes national laws (i.e., in alignment with the GDPR); written informed consent was obtained from each subject. The current study protocols were approved by the German Institute for Economic Research. The data can be accessed following an application to the German Institute for Socioeconomic research: https://www.diw.de/en/diw_01.c.618953.en/the_institute.htmlAs this study was a secondary data analysis of publicly a vailable data sets no additional ethical approval was required.

Conflict of interests

The authors declare no conflict of interests.

Acknowledgements

Funding: This research was supported by the German Federal Ministry of Education and Research (grant number 01UJ1911AY). The funding source had no other role other than financial support.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2025.117718.

Data availability

Data will be made available on request.

References

Altweck, L., Hahm, S., Muehlan, H., et al., 2021. The interplay of gender, social context, and long-term unemployment effects on subjective health trajectories. BMC Publ. Health 21 (1). https://doi.org/10.1186/s12889-021-10324-8.

Altweck, L., Hahm, S., Schmidt, S., et al., 2023. Even now women focus on family, men on work: an analysis of employment, marital, and reproductive life-course typologies in relation to change in health-related quality of life. Applied Research in Quality of Life 18, 1205–1223. https://doi.org/10.1007/s11482-022-10130-3.

Andersen, H.H., Mühlbacher, A., Nübling, M., Schupp, J., Wagner, G.G., 2007. Computation of standard values for physical and mental health scale scores using the SOEP version of SF-12v2. Journal of Contextual Economics 127 (1), 171–182. https://doi.org/10.3790/schm.127.1.171.

Barclay-Goddard, R., Epstein, J.D., Mayo, N.E., 2009. Response shift: a brief overview and proposed research priorities. Qual. Life Res. 18 (3), 335–346. https://doi.org/10.1007/s11136-009-9450-x.

Ben-Shlomo, Y., Kuh, D., 2002. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges, and interdisciplinary perspectives. Int. J. Epidemiol. 31 (2), 285–293. https://doi.org/10.1093/ije/31.2.285.

Beutel, M.E., Krakau, L., Schmutzer, G., Brähler, E., 2021. Somatic symptoms in the Eastern and Western states of Germany 30 years after unification: population-based survey analyses. J. Psychosom. Res. 147, 110535. https://doi.org/10.1016/j.jpsychores.2021.110535.

Berra, S., Bernaschini, M.E., Mamondi, V., et al., 2024. Gender differences in trajectories of health-related quality of life from childhood to adolescence in a 7-year follow-up study in an urban socially disadvantaged sample from Argentina. Qual. Life Res. 33 (1), 183–193.

Brown, S., Harris, M.N., Srivastava, P., Taylor, K.B., 2018. Mental health and reporting bias: analysis of the GHQ-12. SSRN Electron. J. https://doi.org/10.2139/ssrn.3249885.

Bullinger, M., Blome, C., Sommer, R., Lohrberg, D., Augustin, M., 2015. Health-related quality of life: a pivotal endpoint in benefit assessment of medical procedures. Bundesgesundheitsblatt - Gesundheitsforsch. - Gesundheitsschutz 58 (3), 283–290. https://doi.org/10.1007/s00103-014-2107-0.

Burdine, J.N., Felix, M.R., Abel, A.L., Wiltraut, C., Musselman, Y., 2000. The SF-12 as a population health measure: an exploratory examination of potential for application. Health Serv. Res. 35 (4), 885.

Clark, A.E., Zhu, R., 2024. Taking back control? Quasi-experimental evidence on the impact of retirement on locus of control. Econ. J. 134 (660), 1465–1493. https://doi.org/10.1093/ej/uead118.

Curran, P.J., Obeidat, K., Losardo, D., 2010. Twelve frequently asked questions about growth curve modeling. Journal of Cognitive Development 11 (2), 121–136. https://doi.org/10.1080/15248371003699969.

Drixler, K., Morfeld, M., Glaesmer, H., Brähler, E., Wirtz, M.A., 2020. Validierung der Messung gesundheitsbezogener Lebensqualität mittels des Short-Form-Health-Survey-12 (SF-12 Version 2.0) in einer deutschen Normstichprobe. Z. Psychosom. Med. Psychother. 66 (3), 272–286. https://doi.org/10.13109/zptm.2020.66.3.272.

Domingo-Salvany, A., Lamarca, R., Ferrer, M., Garcia-Aymerich, J., Alonso, J., Félez, M., et al., 2002. Health-related quality of life and mortality in male patients with chronic obstructive pulmonary disease. Am. J. Respir. Crit. Care Med. 166 (5), 680–685. https://doi.org/10.1164/rccm.2112043.

Elder Jr., G.H., Johnson, M.K., Crosnoe, R., 2003. The emergence and development of life course theory. In: Mortimer, J.T., Shanahan, M.J. (Eds.), Handbook of the Life Course. Springer, New York, pp. 3–19. https://doi.org/10.1007/978-0-306-48247-2_1.

Elder Jr., G.H., Shanahan, M.J., 2007. The life course and human development. In: Damon, W., Lerner, R.M. (Eds.), Handbook of Child Psychology. John Wiley & Sons, Inc, Hoboken, NJ, p. 1149.

Euteneuer, F., Schäfer, S.J., Neubert, M., Rief, W., Süssenbach, P., 2021. Subjective social status and health-related quality of life—a cross-lagged panel analysis. Health Psychol. 40 (1), 71.

Giele, J.Z., Elder, G.H. (Eds.), 1998. Methods of Life Course Research: Qualitative and Quantitative Approaches. SAGE Publications, Thousand Oaks, CA. https://doi.org/10.4135/9781483348919.

Giudici, F., Morselli, D., 2019. 20 years in the world of work: a study of (nonstandard) occupational trajectories and health. Soc. Sci. Med. 224, 138–148. https://doi.org/10.1016/j.socscimed.2019.02.002.

Gobbens, R.J.J., Remmen, R., 2019. The effects of sociodemographic factors on quality of life among people aged 50 years or older are not unequivocal: comparing SF-12, WHOQOL-BREF, and WHOQOL-OLD. Clin. Interv. Aging 14, 231–239. https://doi.org/10.2147/cia.s189560.

Grieve, R., Grishchenko, M., Cairns, J., 2009. SF-6D versus EQ-5D: reasons for differences in utility scores and impact on reported cost-utility. Eur. J. Health Econ. 10 (1), 15–23.

Hahm, S., Altweck, L., Schmidt, S., et al., 2024. Trajectories of satisfaction with life following a collective, critical life event and their relationship with sociodemographic factors and internal migration: the example of the German reunification 1989/90. Applied Research in Quality of Life 19, 2309–2329. https://doi.org/10.1007/s11482-024-10337-6.

Henning, G., Segel-Karpas, D., Stenling, A., Huxhold, O., 2022. Subjective well-being across the retirement transition—historical differences and the role of perceived control. Psychol. Aging 37 (3), 388.

Hertzman, C., Power, C., 2003. Health and human development: understandings from life-course research. Dev. Neuropsychol. 24 (2–3), 719–744.

Heyder, A., Gaßner, A., 2012. Anomia, Deprivation und Werteorientierung zur Vorhersage rechtsextremistischer Einstellungen – Eine empirische Studie mit Repräsentativdaten aus Deutschland. https://doi.org/10.15203/OZP.18.VOL41ISS3.

Hu, L.-T., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model. 6 (1), 1–55. https://doi.org/10.1080/10705519909540118.

Huinink, J., Kohli, M., 2014. A life-course approach to fertility. Demogr. Res. 30, 1293–1326. https://doi.org/10.4054/DemRes.2014.30.45.

Kajitani, S., 2015. Which is worse for your long-term health, a white-collar or a blue-collar job? J. Jpn. Int. Econ. 38, 228–243. https://doi.org/10.1016/j.jjie.2015.09.002.

Kasinger, C., Braunheim, L., Beutel, M., Brähler, E., 2023. Closing the "happiness gap" by closing the wealth gap: the role of wealth on life satisfaction between East and West-Germans. J. Publ. Health 31 (9), 1433–1442. https://doi.org/10.1007/s10389-022-01716-0.

Kivits, J., Erpelding, M.-L., Guillemin, F., 2013. Social determinants of health-related quality of life. Revue d'Épidémiologie et de Santé Publique 61 (Suppl. l).

Klar, M.K., Geyer, S., Safieddine, B., Tetzlaff, F., Tetzlaff, J., Sperlich, S., 2021. Trends in healthy life expectancy between 2002 and 2018 in Germany - compression or expansion of health-related quality of life (HRQOL)? SSM - Population Health 13 (100758). https://doi.org/10.1016/j.ssmph.2021.100758.

Lampert, T., Müters, S., Kuntz, B., Dahm, S., Nowossadeck, E., 2019. Beschreibung der gesundheitlichen Lage in Ost und West sowie deren Entwicklung in den letzten 30 Jahren. https://doi.org/10.25646/6076.

Liebig, S., Goebel, J., Schröder, C., Grabka, M., Richter, D., Schupp, J., et al., 2019. Sozio-oekonomisches Panel (SOEP), Daten der Jahre 1984-2018. SOEP Socio-Economic Panel Study.

Lubetkin, E.I., Gold, M.R., 2003. Areas of decrement in health-related quality of life (HRQL): comparing the SF-12, EQ-5D, and HUI 3. Qual. Life Res. 12 (9), 1059–1067.

Mariani, E., Özcan, B., Goisis, A., 2017. Family trajectories and well-being of children born to lone mothers in the UK. Eur. J. Popul. 33 (2), 185–215. https://doi.org/10.1007/s10680-017-9420-x.

Mayer, K.U., 2009. New directions in life course research. Annu. Rev. Sociol. 35 (1), 413–433.

Michel, G., Bisegger, C., Fuhr, D.C., Abel, T., KIDSCREEN Group, 2009. Age and gender differences in health-related quality of life of children and adolescents in Europe: a multilevel analysis. Qual. Life Res. 18 (8), 1147.

Nowossadeck, E., von der Lippe, E., Lampert, T., 2019. Entwicklung der Lebenserwartung in Deutschland – aktuelle Trends. Robert Koch-Institut. https://doi.org/10.25646/5869.

Nübling, M., Andersen, H.H., Mühlbacher, A., 2006. Entwicklung eines Verfahrens zur Berechnung der körperlichen und psychischen Summenskalen auf Basis der SOEP-Version des SF-12 (Algorithmus). www.econstor.eu. https://hdl.handle.net/10419/129225.

Phyo, A.Z.Z., Freak-Poli, R., Craig, H., et al., 2020. Quality of life and mortality in the general population: a systematic review and meta-analysis. BMC Publ. Health 20 (1). https://doi.org/10.1186/s12889-020-09639-9.

Plagnol, A.C., Scott, J., 2011. What matters for well-being: individual perceptions of quality of life before and after important life events. Applied Research in Quality of Life 6 (2), 115–137. https://doi.org/10.1007/s11482-010-9119-1.

Reinwarth, A.C., Wicke, F.S., Hettich, N., et al., 2023. Self-rated physical health predicts mortality in aging persons beyond objective health risks. Sci. Rep. 13 (1). https://doi.org/10.1038/s41598-023-46882-7.

Rodriguez-Artalejo, F., Guallar-Castillón, P., Pascual, C.R., et al., 2005. Health-related quality of life as a predictor of hospital readmission and death among patients with heart failure. Arch. Intern. Med. 165 (11), 1274–1279. https://doi.org/10.1001/archinte.165.11.1274.

Rosseel, Y., 2012. Lavaan: an R package for structural equation modeling. J. Stat. Software 48 (2). https://doi.org/10.18637/jss.v048.i02.

Sehlen, S., Marten-Mittag, B., Herschbach, P., et al., 2012. Health-related quality of life supersedes other psychosocial predictors of long-term survival in cancer patients undergoing radiotherapy. Acta Oncol. 51 (8), 1020–1028. https://doi.org/10.3109/0284186x.2012.683879.

Siegers, R., Belcheva, V., Silbermann, T., 2024. SOEP survey papers series C - data documentation SOEP-core v35 - documentation of sample sizes and panel attrition in the German socio-economic panel (SOEP) (1984 until 2018). https://www.diw.de/documents/publikationen/73/diw_01.c.745900.de/diw_ssp0826.pdf.

Sullivan, O., 2019. Gender inequality in work-family balance. Nat. Human Behav. 3 (3), 201–203. https://doi.org/10.1038/s41562-019-0536-3.

Tseng, H.-Y., Löckenhoff, C., Lee, C.-Y., et al., 2020. The paradox of aging and health-related quality of life in Asian Chinese: results from the healthy aging longitudinal study in Taiwan. BMC Geriatr. 20 (1). https://doi.org/10.1186/s12877-020-1446-y.

Ware Jr., J.E., Kosinski, M., Keller, S.D., 1996. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. Med. Care 34 (3), 220–233.

Wirtz, M.A., Morfeld, M., Glaesmer, H., Brähler, E., 2018. Konfirmatorische Prüfung der Skalenstruktur des SF-12 Version 2.0 in einer deutschen bevölkerungs-repräsentativen Stichprobe. Diagnostica 64 (2), 84–96.

World Health Organisation, 2021. Decade of Healthy Ageing. World Health Organisation.

Zaninotto, P., Falaschetti, E., Sacker, A., 2009. Age trajectories of quality of life among older adults: results from the English Longitudinal Study of Ageing. Qual. Life Res. 18 (10), 1301–1309. https://doi.org/10.1007/s11136-009-9543-6.