

# BMJ Open Life stage-specific trends in educational inequalities in health-related quality of life and self-rated health between 2002 and 2016 in Germany: findings from the German Socio-Economic Panel Study (GSOEP)

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## ABSTRACT

**Objectives** While evidence suggests persisting health inequalities, research on whether these trends may vary according to different stages of life has rarely been considered. Against this backdrop, we analysed life stage-specific trends in educational inequalities in health-related quality of life (HRQOL) and poor self-rated health (SRH) for individuals in 'later working life' (50–64 years), 'young seniors' (65–79 years) and persons of 'old age' (80+ years).

**Methods** We used survey data from the German Socio-Economic Panel Study comprising the period from 2002 to 2016. The sample consists of 26 074 respondents (160 888 person-years) aged 50 years and older. Health was assessed using the mental and physical component summary scale (MCS/PCS) of the HRQOL questionnaire (12-Item Short Form Health Survey V.2) and the single item SRH. To estimate educational health inequalities, we calculated the regression-based Slope Index of Inequality (SII) and Relative Index of Inequality (RII). Time trends in inequalities were assessed by the inclusion of a two-way interaction term between school education and time.

**Results** With increasing age, educational inequalities in PCS and poor SRH decreased whereas they rose in MCS. Over time, health inequalities decreased in men aged 65–79 years ( $MCS_{SII} = 2.76$ , 95% CI 0.41 to 5.11;  $MCS_{RII} = 1.05$ , 95% CI 1.01 to 1.10;  $PCS_{SII} = 2.12$ , 95% CI  $-0.27$  to 4.51;  $PCS_{RII} = 1.05$ , 95% CI 1.00 to 1.11; poor  $SRH_{SII} = -0.10$ , 95% CI  $-0.19$  to 0.01; poor  $SRH_{RII} = 0.73$ , 95% CI 0.48 to 1.13) and among women of that age for MCS ( $MCS_{SII} = 2.82$ , 95% CI 0.16 to 5.50;  $MCS_{RII} = 1.06$ , 95% CI 1.01 to 1.12). In contrast, health inequalities widened in the 'later working life' among women ( $PCS_{SII} = -2.98$ , 95% CI  $-4.86$  to  $-1.11$ ;  $PCS_{RII} = 0.94$ , 95% CI 0.90 to 0.98; poor  $SRH_{SII} = 0.07$ , 95% CI 0.00 to 0.14) while remained largely stable at old age for both genders.

**Conclusions** We found distinctive patterns of health inequality trends depending on gender and life stage. Our findings suggest to adopt a differentiated view on health inequality trends and to pursue research that explores their underlying determinants.

## Strengths and limitations of this study

- This is one of the first studies investigating trends in educational inequalities in health-related quality of life (HRQOL) and poor self-rated health according to different stages of life.
- We used data from a large nationally representative survey, and our study considered trends over a period of 15 years using a validated measure of HRQOL.
- The key findings of life stage-specific trends in educational inequality in health are open to different interpretation and might be the result of cohort as well as period effects.
- Further studies are warranted in order to replicate our findings and to provide clues to the drivers behind the life stage-specific trends.

## INTRODUCTION

Indicators of subjective health like self-rated health (SRH) and health-related quality of life (HRQOL) complement mortality and morbidity as measures used in tracking trends in population health.<sup>1</sup> Previous studies on temporal change in subjective health have shown conflicting results indicating both improvements<sup>2–4</sup> as well as stable trends or even deterioration of SRH over time.<sup>5–7</sup> Similarly, recent studies in Germany revealed heterogeneous findings with some suggesting that the prevalence of poor SRH did not change substantially over time<sup>8,9</sup> while others pointing towards enhancements in HRQOL and functional health.<sup>10,11</sup>

The existence of socioeconomic inequalities in mortality and morbidity is well documented<sup>12–14</sup> and the social gradient in health has also been shown to be present for SRH and HRQOL.<sup>15,16</sup> Recent studies from Europe

and other western countries indicate that the SRH gap between lower and higher socioeconomic status (SES) groups remained largely the same or has even widened over time. For instance, Hu *et al*,<sup>17</sup> who analysed trends in socioeconomic inequalities in 17 European countries, found that absolute inequalities in SRH remained unchanged while relative inequalities increased between 1990 and 2010. Lahelma *et al*<sup>18</sup> reported that educational inequalities in SRH in Finland largely remained constant between 1979 and 2014. Similarly, the study by Hanibuchi *et al*<sup>19</sup> revealed stable trends in socioeconomic inequalities in SRH in Japan between 2000 and 2010. Analysing trends in quality-adjusted life expectancy between 2001 and 2011 for the Netherlands, Gheorghe *et al*<sup>20</sup> summarised that the largest increases were found for higher educated individuals, which resulted in a widening health gap by education. A similar pattern was observed for Germany where Lampert *et al*<sup>16</sup> found increasing income inequalities in the prevalence of poor SRH between 1994 and 2014. Based on the data of repeated cross-sectional surveys between 2003 and 2012, the study by Wachtler *et al*<sup>9</sup> revealed stable absolute and relative inequalities in SRH between 2003 and 2012.

The life-course perspective on social inequalities in health suggests that while social disparities persist across the life course, the magnitude of these differences may vary according to the stage in the life phase. Three opposing theoretical perspectives have been proposed about the way in which health inequality may evolve across the life course. The cumulative advantage/disadvantage hypothesis claims that the positive effect of SES on health increases over the life course and therefore health inequality would widen at older ages.<sup>21</sup> In contrast, the status maintenance hypothesis states that the social health gradient remains largely constant across the life course since the social positions attained in early adulthood do not substantially change in later life.<sup>22</sup> Finally, the age-as-leveler hypothesis posits that health inequality decreases at older ages due to different factors such as the selection of more healthy people due to mortality.<sup>23</sup> Previous studies revealed contradictory findings supporting the cumulative advantage/disadvantage hypothesis,<sup>24 25</sup> as well as the status maintenance<sup>25 26</sup> and the age-as-leveler<sup>27</sup> assumptions.

Whereas numerous studies on social inequalities in health have adopted a life course approach,<sup>28 29</sup> a life stage-specific perspective on determinants of health inequalities has so far been neglected. In one of the few existing studies, San Sebastian *et al*<sup>30</sup> analysed the effects of social determinants in health at four different life stages. They found that the effects of specific adversities depend on the life course stage and concluded that life course needs to be taken into consideration for tackling health inequalities. In a similar vein, recent studies suggest that the temporal trends in SRH and functional disability also differ according to the life stage considered.<sup>31–35</sup>

In medical sociological research, it has been established to distinguish between material, psychosocial and

behavioural pathways in explaining social inequalities in health.<sup>36–38</sup> While the material explanation refers to structural living conditions, the psychosocial pathway includes a wide range of social and personal resources as well as psychosocial stressors. Finally, the behavioural explanation considers a variety of health-related behaviours that are strongly linked with the material and psychosocial pathway.<sup>39</sup> In order to explain trends in health inequality, a dynamic perspective on these explanations needs to be employed that take medical, demographic, social and economic change into account. This approach represents a substantial challenge since health inequalities are the result of a number of interacting factors. In addition, a life stage-specific approach would appear appropriate as the consequences of medical and social change may have different implications according to people's phase in life. However, research on whether trends in health inequalities may vary according to different stages of life is still rare. Using this as a starting point, the aim of this study was to analyse life stage-specific time trends in educational inequalities in HRQOL and poor SRH for individuals in 'later working life' (50–64 years), among 'young seniors' (65–79 years) and persons of 'old age' (80+ years). We focused on life stage-specific rather than age-specific effects in order to emphasise that social and demographic change may have altered people's living conditions differently depending on their stage in the life course and the specific psychosocial resources and burdens associated therewith. In more detail, the study was guided by the following research questions:

1. Does the extent of educational inequalities in HRQOL and poor SRH vary between different life stages?
2. How are HRQOL and poor SRH evolving over time in each of the life stages according to educational level?
3. Are there diverging trends of educational inequalities in health for the different life stages?

## METHODS

Our paper follows the 'Strengthening the Reporting of Observational Studies in Epidemiology' guidelines.<sup>40</sup>

## Data source

This study is based on data from the German Socio-Economic Panel Study (GSOEP V.31). The GSOEP is the largest representative annual survey of German individuals based on a random sample of private households. Conducted from 1984 onwards the study covers nearly 11 000 households and 30 000 individuals each year. The GSOEP population is regularly updated with new survey samples to account for changes in the German population and for compensating lost to follow-up. Data were collected using different questionnaires for individuals, households or specific subgroups by face-to-face interviews. Further information on GSOEP can be derived from Frick *et al*.<sup>41</sup> The information used for this study includes school education, income, marital status, nationality as well as SRH and HRQOL as health outcomes. While SRH

was assessed annually, HRQOL has been measured every 2 years since 2002. We focused on men and women aged 50 and above since limitations in physical well-being are rare in younger subjects.

For the physical and the mental components of HRQOL, in total 23 878 respondents (11 553 men/12 325 women) were observed 81 676 times (39 159 men/42 517 women) between 2002 and 2016, corresponding to an average participation in 3.4 waves (min.=1/max.=8). With respect to SRH, a total of 26 074 respondents (12 665 men/13 409 women) were observed 160 888 times (77 028 men/83 860 women), corresponding to an average participation in 6.1 waves in men and 6.3 in women (min.=1/max.=15). We used cross-sectional weights which are assumed to produce a nationally representative sample.<sup>42</sup> The proportion of missing values varied between 0% and 2.6%. Respondents with missing information were excluded from analysis (table 1).

### Life stage-approach

According to our life stage approach, we assigned the population to three different life stages, namely 'later working life' (50–64 years), 'young seniors' (65–79 years) and 'old age' (80+ years).

### Patient and public involvement

The study is based on anonymised data from the GSOEP that is conducted by the German Institute for Economic Research (DIW). No patients were involved in the design of the study, nor were they involved in the recruitment to and the conduct of the study. In addition, no consent to participate was required and there are no plans to disseminate the results of the research to study participants.

### Measures

#### Self-rated health

SRH is one of the most frequently used health measures in public health and has been proved to be a reliable indicator of healthcare services utilisation,<sup>43</sup> functional limitations<sup>44</sup> and mortality.<sup>43 45</sup> In our study, SRH was measured by the question "How would you assess your current state of health?" comprising the five response categories: 'very good', 'good', 'satisfactory', 'poor' and 'bad'. The responses were dichotomised into 'poor health' (last two categories) and better health (first three categories).

#### Health-related quality of life

HRQOL is a multidimensional concept that incorporates physical, emotional and social dimensions of health.<sup>46</sup> In this study, HRQOL was assessed using a slightly modified version of the second version of the 12-Item Short Form Health Survey (SF-12 V.2).<sup>47</sup> The SF-12 V.2 includes 12 items making up eight scales: physical functioning, role limitations due to physical problems, bodily pain, general health, vitality, social functioning, role limitation due to emotional problems and perceived mental health. Based on these items a physical component summary (PCS) score and a mental component summary (MCS) score were calculated. Values are standardised to a national

**Table 1** Weighted sample characteristics in % by time period, GSOEP 2002–2016, no observations=170 317

	2002–2006 (n=54 244)	2007–2011 (n=56 299)	2012–2016 (n=59 774)
<b>Sex</b>	%	%	%
Women	54.2	53.7	53.2
Men	45.8	46.3	46.8
Missings (n)	0	0	0
<b>Age groups in years</b>			
50–64	49.2	48.2	50.0
65–79	40.2	40.0	38.7
80+	10.6	11.8	11.3
Missing (n)	0	0	0
<b>School education</b>			
Primary/no education	58.5	51.3	43.9
Secondary	19.5	23.4	26.2
Tertiary	14.6	17.0	19.6
Other qualification	7.4	8.3	10.3
Missing (n)	1689	1262	1212
<b>Income</b>			
<60%	14.5	15.8	15.3
60% to <150%	67.5	65.9	65.6
≥150%	18.0	18.3	19.1
Missing (n)	16	13	31
<b>Living with partner</b>			
Yes	67.8	66.7	66.6
No	32.2	33.3	33.4
Missing (n)	0	0	1
<b>Nationality</b>			
German	93.6	92.8	92.8
Others	6.4	7.2	7.2
Missing (n)	0	0	1

n=number of observations (maximum sample size of annually surveys 2002–2016), income: equivalised net income. GSOEP, German Socio-Economic Panel.

norm (GSOEP population in 2004) ranging from 0 to 100 points with a mean of 50 points and an SD of 10 points. A higher score corresponds to a better health status.

#### Education

Educational level was classified into 'low', 'intermediate' and 'high' according to the number of years of schooling. All individuals with a maximum of 9 years of schooling (secondary education) were assigned to the low educational group that includes also subjects without a school leaving certificate due to early school leaving. The intermediate education group consists of those with 10 years of schooling corresponding to a comprehensive school certificate. Subjects with at least 12 years' schooling were



assigned to the high educational group corresponding to German secondary school leaving certificate. For analysing time trends, these educational groups were transformed into cumulative rank probabilities (ridit scores).

### Time trend

Changes in SRH and HRQOL between 2002 and 2016 were assessed by a continuous time trend variable with a range of 0–1 for the entire study period. The first year of observation (2002) is coded as 0 and the last year (2016) as 1, with the years in between getting fractional values according to the following formula:  $[(\text{year}-2002)/(\text{2016}-2002)]$ .

### Confounders

Sociodemographic characteristics such as migration background, marital status and income level might be correlated with health outcomes as well as educational level. Shift in the compositions of these factors due to selective panel attrition might be a possible source of bias for the magnitude of health trends observed. Hence, in all analyses, we adjusted for nationality, marital status and equivalised net income. To take account of possible shifts in age composition over time within the three life stages, we additionally adjusted for age in each of the models.

### Statistical analysis

We performed logistic and linear regression models to test for time effects on poor SRH and HRQOL, respectively. We accommodated the statistical dependence among the repeated observations by calculating population-averaged effects using generalised equation estimating for logistic and linear regression.<sup>48</sup> We used this regression technique since our aim was to analyse population-averaged and not subject-specific time effects which would be more accurately estimated by random-effect models.<sup>49</sup> In addition to OR we reported predicted means and probabilities (margins at means) giving the time trends a more substantial interpretation.

We calculated the Relative Index of Inequality (RII) and the Slope Index of Inequality (SII) as recommended by Mackenbach and Kunst.<sup>50</sup> These indices are both regression based and take the entire distribution of a socioeconomic variable as well as the size of the socioeconomic groups into account. In our study, the RII can be interpreted as the estimated ratio (poor SRH: prevalence ratio, HRQOL: ratio of mean values) between subjects with the lowest and those with the highest educational level. In contrast, the SII quantifies the magnitude of absolute health inequality and can be interpreted as the difference in the prevalence (poor SRH) or in the mean (HRQOL) between individuals at the top and bottom of the educational hierarchy. In order to calculate RII and SII, the educational groups of each survey year and for each stage of life (separated for men and women) were transformed into cumulative rank probabilities ('ridit scores') ranging from 0 (highest level of education) to 1 (lowest level of

education). For computing the ridit scores, population weights were employed to match the official population statistics. As proposed, we used a logarithmic link function to calculate the RII and an identity link function to calculate the SII by using clustered variance estimators.<sup>50</sup> Temporal trends in educational inequalities were assessed by the inclusion of a two-way interaction term between educational levels (ridit score) and the time trend variable. The models were adjusted for possible confounders (see above) and the main effects of education and time. For MCS and PCS where higher scores reflect better health, values of RII <1 and SII <0 indicate widening educational inequalities while RII >1 and SII >0 point to decreasing inequalities over time. The opposite interpretation applies for poor SRH where RII >1 and SII >0 indicate increasing health inequality over time. All analyses were performed with STATA V.13.1.

## RESULTS

The weighted sample characteristics, separated by time periods, are presented in [table 1](#). Between 2002 and 2016, the proportion of subjects with low educational attainment decreased while the proportions of those with higher educational levels increased. The distribution of age, gender, income, nationality and cohabitation remained largely stable over time.

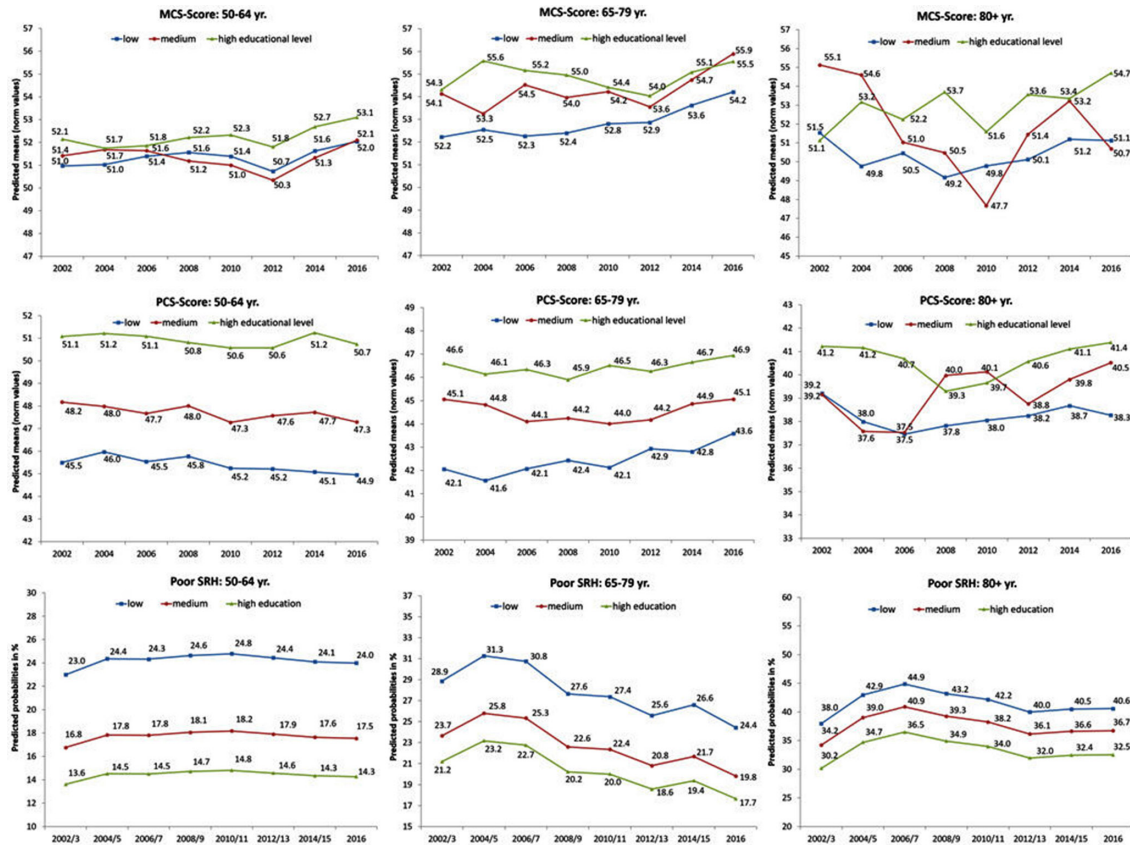
Women as compared with men reported consistently lower levels of MCS and PCS as well as higher proportions of poor SRH at almost each time point ([figures 1 and 2](#)). Men and women in the later working life both showed the highest levels of PCS and lowest proportions of poor SRH. Health status for these indicators gradually declined in the subsequent life stages with poorest subjective health observed at old age. For both genders, in contrast, levels of MCS were lowest in the later working life and tended to improve with age.

### The extent of educational inequalities in HRQOL and SRH according to life stages

Educational inequalities in mean scores of PCS and proportions of poor SRH to the disadvantage of lower educated subjects were observed for both genders and all life stages considered. These inequalities were most pronounced in later working life and declined with age. In contrast, for both men and women, educational disparities in MCS were not significant in later working life but widened with age ([table 2](#)).

### Health trends in different life stages according to educational level

Among men in the later working life hardly any significant temporal health change was observed in any of the educational groups. The only exception was that MCS significantly improved by 1.01 points (95% CI 0.04 to 1.98,  $p<0.05$ ) among highly educated men ([table 3](#) and [figure 1](#)). Stronger temporal fluctuations in MCS and PCS were observed in the life stage of old age, however,



**Figure 1** Trends in HRQOL (MCS/PCS) and poor SRH (predicted means and probabilities) by life stages among men. HRQOL, health-related quality of life; MCS, mental component summary; PCS, physical component summary; SRH, self-rated health.

no systematic linear health trend was found in any of the educational groups. By contrast, health in the life stage of young seniors improved more strongly in low educated as compared with highly educated men. This was observed for all of the three health indicators considered. For example, among low educated men MCS and PCS increased by 1.82 points (95% CI 0.80 to 2.85,  $p < 0.001$ ) and 1.56 points (95% CI 0.56 to 2.56,  $p < 0.01$ ), respectively, while no significant improvements for MCS and PCS were found among highly educated men (table 3). Similar, in men with low educational level, odds of poor SRH reduced by 31% (OR 0.69, 95% CI 0.57 to 0.83,  $p < 0.001$ ) while declined only by 26% (OR 0.74, 95% CI 0.53 to 1.08,  $p < 0.10$ ) in their high educated counterparts.

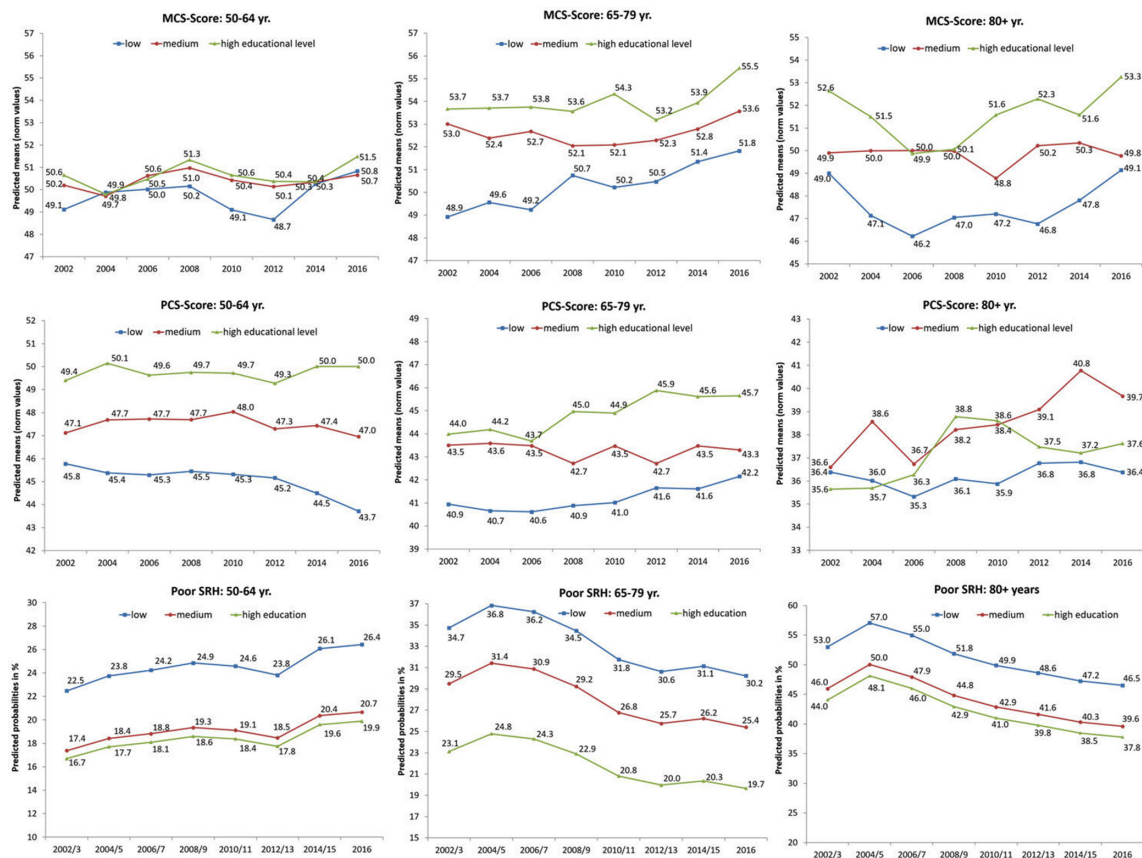
Among women, a similar pattern was found, indicating that subjective health in young seniors increased more pronounced in those with low as compared with higher educational attainment (table 3). In later working life, by contrast, PCS and SRH deteriorated among low educated women while remained largely stable for the higher educated ones. At this life stage, PCS declined by 1.65 points (95% CI -2.65 to -0.66,  $p < 0.001$ ) in low educated women while slightly improved by 0.36 points (95% CI -0.78 to 1.49,  $p > 0.10$ ) in women with high education. In addition, odds of poor SRH increased by 33% (OR 1.33; 95% CI 1.12 to 1.59,  $p < 0.05$ ) in low educated women while marginally decreased by 3% (OR 0.97; 95% CI 0.75 to 1.27,  $p > 0.10$ ) for the high educated ones. Similarly

to the results of their male counterparts, no systematic linear health trend was found among old age women in any of the educational groups.

### Life stage-specific trends in relative (RII) and absolute (SII) educational inequalities

In terms of relative (RII) and absolute (SII) educational inequalities, no significant temporal change in HRQOL and SRH was found among men in later working life as well as in old age (table 4). In contrast, educational inequalities decreased over time among male young seniors. As indicated by the significant interaction terms ( $MCS_{RII} = 1.05$ , 95% CI 1.01 to 1.10,  $p < 0.05$ / $PCS_{RII} = 1.05$ , 95% CI 1.00 to 1.11,  $p < 0.10$ ), HRQOL improved more strongly in the lowest as compared with the highest educational group. Expressed in absolute terms (SII), educational inequalities between low and highly educated men were reduced by 2.76 points (95% CI 0.41 to 5.11,  $p < 0.05$ ) for MCS and 2.12 points (95% CI -0.27 to 4.51,  $p < 0.10$ ) for PCS. The same pattern was found for poor SRH where the opposite interpretation applies (RII  $< 1$  and SII  $< 0$  indicating reduction of health inequality), reaching statistical significance for SII only.

Educational inequalities among ‘young seniors’ also decreased in women. However, this was restricted to MCS where absolute differences between the highest and lowest educational group were reduced over time by 2.82 points (95% CI 0.16 to 5.50,  $p < 0.05$ ). The contrary



**Figure 2** Trends in HRQOL (MCS/PCS) and poor SRH (predicted means and probabilities) by life stages among women. HRQOL, health-related quality of life; MCS, mental component summary; PCS, physical component summary; SRH, self-rated health.

pattern was found in the life stage of ‘later working life’ where educational inequality in women increased in relative and absolute terms for PCS and poor SRH. Similar to men, no significant change in educational inequalities was observed for the life stage of ‘old age’.

## DISCUSSION

The aim of this study was to analyse trends in educational inequalities in HRQOL and poor SRH between 2002 and 2016 in the life stages of ‘later working life’ (50–64 years), ‘young seniors’ (65–79 years) and ‘old age’ (80+ years). First, we found that educational inequalities in poor SRH and in the physical component of HRQOL decreased with subsequent life stages while the opposite applied to the mental component of HRQOL. Our findings suggest that the way in which health inequality evolves across the life stages depend on the health indicator considered. This corresponds to previous studies who found different patterns of health inequalities across ages for different health indicators.<sup>25 51 52</sup> Our main finding was that the temporal development of health inequality differed according to the stage of life. While among young seniors health inequalities declined for both genders, a significant increase was found among women in later working life.

## The extent of educational inequalities in HRQOL and SRH according to different life stages

In the life stage of ‘later working life’ no educational inequalities were found for MCS in both genders. This is in line with the finding by Moor *et al*<sup>8</sup> who likewise found no social gradient in MCS among subjects aged 30–49 years. They supposed that this may due to the specific life phase in which career building coincide with family demands, affecting subjects of all educational levels and thus equalising educational differences in HRQOL with respect to mental health. Our findings indicate that educational inequalities in MCS to the disadvantage of lower educated subjects first emerged at retirement age, supporting the assumption that during working life, the mental health component of HRQOL is strongly influenced by work-related demands and time constraints acting independently of educational attainment. Furthermore, our results suggest that high educated women may benefit more from retirement age which supports the cumulative advantage/disadvantage hypothesis claiming that the positive effect of SES on health increases over the life course. In contrast, we found educational inequalities in the physical health component of HRQOL as well as in poor SRH to be strongest in the later working life and declining with age. This finding supports the age-as-leveller hypothesis positing that health inequality

**Table 2** Educational inequalities in HRQOL (MCS/PCS) and poor SRH in men and women, stratified by life stage, GSOEP 2002–2016

Life stage	Education	MCS			PCS		Poor SRH		
		n	Coef.	95% CI	Coef.	95% CI	OR	n	95% CI
<b>Men</b>									
All ages	Low	13902	<b>-0.85***</b>	-1.31 to -0.40	<b>-4.07***</b>	-4.53 to -3.61	<b>1.66***</b>	30102	1.50 to 1.84
	Medium	6857	<b>-0.48*</b>	-0.98 to 0.02	<b>-2.40***</b>	-2.88 to -1.92	<b>1.21**</b>	14604	1.08 to 1.37
	High	8578	1		1		1	17640	
Later working life (50–64 years)	Low	6050	-0.40	-0.99 to 0.19	<b>-4.59***</b>	-5.17 to -4.00	<b>1.90***</b>	13042	1.65 to 2.17
	Medium	4501	-0.42	-1.01 to 0.18	<b>-2.70***</b>	-3.26 to -2.15	<b>1.28**</b>	9590	1.11 to 1.48
	High	5008	1		1		1	10411	
Young seniors (65–79 years)	Low	6727	<b>-1.23***</b>	-1.89 to -0.57	<b>-3.49***</b>	-4.19 to -2.79	<b>1.51***</b>	14484	1.30 to 1.75
	Medium	2031	-0.25	-1.05 to 0.55	<b>-1.89***</b>	-2.76 to -1.03	1.15	4278	0.96 to 1.39
	High	3140	1		1		1	6244	
Old age (80+ yr)	Low	1125	<b>-2.25*</b>	-4.14 to -0.36	<b>-2.29**</b>	-4.01 to -0.57	<b>1.42*</b>	2576	1.05 to 1.11
	Medium	325	-1.42	-3.40 to 0.55	-1.31	-3.42 to 0.79	1.20	736	0.83 to 1.74
	High	430	1		1		1	985	
<b>Women</b>									
All ages	Low	16251	<b>-1.10***</b>	-1.64 to -0.57	<b>-3.31***</b>	-3.84 to -2.77	<b>1.56***</b>	35521	1.40 to 1.75
	Medium	9544	-0.21	-0.74 to 0.33	<b>-1.76***</b>	-2.29 to -1.22	<b>1.19**</b>	20149	1.06 to 1.34
	High	5970	1		1		1	12599	
Later working life (50–64 year)	Low	6347	-0.50	-1.16 to 0.17	<b>-3.67***</b>	-4.32 to -3.02	<b>1.54***</b>	13665	1.34 to 1.76
	Medium	6494	0.50	-0.57 to 0.67	<b>-1.91***</b>	-2.52 to -1.32	1.10	13609	0.96 to 1.26
	High	4103	1		1		1	8561	
Young seniors (65–79 years)	Low	7880	<b>-2.64***</b>	-3.47 to -1.80	<b>-3.16***</b>	-4.08 to -2.24	<b>1.77***</b>	17176	1.48 to 2.12
	Medium	2590	<b>-1.04*</b>	-1.97 to -0.12	<b>-1.81**</b>	-2.83 to -0.78	<b>1.39**</b>	5519	1.14 to 1.70
	High	1615	1		1		1	3422	
Old age (80+ years)	Low	2024	<b>-3.87***</b>	-5.99 to -1.74	-1.02	-3.00 to 0.96	<b>1.43*</b>	4680	1.04 to 1.08
	Medium	460	-1.65	-4.08 to -0.77	1.54	-0.74 to 3.82	1.08	1021	0.76 to 6.21
	High	252	1		1		1	616	

Adjusted for age, nationality, living with partner and equivalised net income.

Significant values are written in bold.

\*P&lt;0.05, \*\*p&lt;0.01, \*\*\*p&lt;0.001.

Coef., coefficient; GSOEP, German Socio-Economic Panel; HRQOL, health-related quality of life; MCS, mental component summary; PCS, physical component summary; SRH, self-rated health.

decreases at older ages. One possible explanation for declining educational inequalities over the life stages in physical health could be that biological frailty in older age may contribute to an intensified health decline of individuals with high SES leading to a reduction of health inequalities. In addition, retirement might bring an end to inequalities in the work context with respect to work-related physical strain. Finally, with age increasing mortality selection in the general population as well as selective panel attrition may have contributed to the selection of more healthy individuals with the consequence that the association between education and health appeared to be weaker at older ages.

### Life stage-specific trends in educational health inequalities

Previous research on trends in health inequalities has mainly focused on the entire adult population and has not adequately taken into consideration that health trends may vary across different stages of life. In line with this research, we found educational inequalities in health to be largely stable over time when considering individuals of all ages. However, the differentiated analysis according to life stages revealed distinctive patterns of health inequality trends. The study conducted by Gransström *et al.*<sup>53</sup> is one of the few that adopted a life stage-specific view on health inequality trends. Their findings indicate that the increase in health inequality among



**Table 3** Time trends in HRQOL (MCS/PCS) and poor SRH in men and women, stratified by life stage and level of education, GSOEP 2002–2016

Time trend	MCS			PCS		Poor SRH		
	n	Coeff.	95% CI	Coeff.	95% CI	n	OR	95% CI
<b>Men</b>								
Later working life (50–64 years)								
Education low	6050	0.79	–0.16 to 1.74	–0.68	–1.63 to 0.27	13042	1.06	0.89 to 1.26
Medium	4501	0.21	–0.90 to 1.33	–0.75	–1.79 to 0.30	9590	1.12	0.89 to 1.44
High	5008	<b>1.01*</b>	0.04 to 1.98	–0.32	–1.20 to 0.56	10411	1.00	0.77 to 1.30
Young seniors (65–79 years)								
Education low	6727	<b>1.82***</b>	0.80 to 2.85	<b>1.56**</b>	0.56 to 2.56	14484	<b>0.69***</b>	0.57 to 0.83
Medium	2031	<b>1.85*</b>	0.19 to 3.50	0.33	–1.33 to 2.00	4278	1.16	0.77 to 1.62
High	3140	0.47	–0.89 to 1.83	0.53	–0.87 to 1.93	6244	<b>0.74*</b>	0.53 to 1.08
Old age (80+ years)								
Education low	1125	0.63	–2.31 to 3.57	0.05	–2.42 to 2.53	2576	0.91	0.61 to 1.35
Medium	325	–2.63	–7.05 to 1.80	2.07	–2.97 to 7.10	736	1.22	0.56 to 2.65
High	430	2.59	–1.57 to 6.75	0.89	–2.79 to 4.57	985	0.56	0.26 to 1.21
<b>Women</b>								
Later working life (50–64 years)								
Education low	6347	0.90	–0.10 to 1.89	<b>–1.65**</b>	–2.65 to 0.66	13665	<b>1.33*</b>	1.12 to 1.59
Medium	6494	0.36	–0.60 to 1.32	–0.34	–1.25 to 0.57	13609	1.04	0.84 to 1.28
High	4103	0.78	–0.39 to 1.95	0.36	–0.78 to 1.49	8561	0.97	0.75 to 1.27
Young seniors (65–79 years)								
Education low	7880	<b>2.75***</b>	1.74 to 3.76	<b>1.30**</b>	0.39 to 2.21	17176	<b>0.73***</b>	0.62 to 0.89
Medium	2590	0.78	–0.78 to 2.34	–0.13	–1.83 to 1.57	5519	0.83	0.61 to 1.13
High	1615	1.44	–0.58 to 3.45	<b>1.97*</b>	–0.01 to 3.94	3422	<b>0.67*</b>	0.43 to 1.03
Old age (80+ years)								
Education low	2024	0.77	–1.33 to 2.87	0.61	–1.01 to 2.22	4680	0.70	0.53 to 0.94
Medium	460	0.04	–4.62 to 4.71	<b>3.35*</b>	–0.04 to 6.74	1021	0.75	0.41 to 1.36
High	252	1.57	–2.80 to 5.95	1.59	–3.97 to 7.15	616	0.88	0.41 to 1.90

Adjusted for age, nationality, living with partner and equivalised net income.

Significant values are written in bold.

\* $P < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

GSOEP, German Socio-Economic Panel; HRQOL, health-related quality of life; MCS, mental component summary; PCS, physical component summary; SRH, self-rated health.

women was mainly due to growing inequalities in early adulthood between 25 and 34 years of age. The findings of our study on subjects ageing 50 years and older revealed a reduction of educational health inequality in the life stage of young seniors, holding for both genders. In contrast, health inequalities in later working life widened among women and remained largely stable for both genders at old age. These findings support the assumption that the consequences of medical and social change may have different implications according to people's phase in life. For example, the decline in health inequality among young seniors as found in our study might be attributed to medical progress in the prevention and treatment of diseases that appears to be particularly relevant at this life stage where chronic conditions

gained in importance. While medical advances bring benefit to all educational groups, lower educated persons may benefit more as they are more vulnerable to chronic conditions what might partly explain the reduction of health inequality at this age. In the same way, the increase in work-related stress in recent years in Germany<sup>33</sup> does not apply to retired persons, which might partly explain the greater health improvement among young seniors as found in a previous study.<sup>34</sup> The same reasoning may apply to the reduction of the educational health gap among young seniors found in this study. Seen from that perspective, educational differences in subjective health may decrease at this age as retirement bring an end to the unequal work-related burden caused by socially stratified working conditions that might have become even



**Table 4** Trends in relative (RII) and absolute (SII) educational inequalities in HRQOL (MCS/PCS) and poor SRH, stratified by gender and life stage, GSEOP 2002–2016

		N	RII	95% CI	SII	95% CI
<b>Men</b>						
All ages	MCS	35 208	1.01	0.98 to 1.04	0.52	−0.84 to 1.87
	PCS	35 208	1.02	0.99 to 1.05	0.91	−0.38 to 2.20
	Poor SRH	69 095	0.88	0.69 to 1.12	−0.03	−0.08 to 0.03
Later working life (50–64 years)	MCS	18 947	1.00	0.96 to 1.03	−0.20	−2.04 to 1.64
	PCS	18 947	0.99	0.95 to 1.03	−0.56	−2.39 to 1.23
	Poor SRH	37 316	1.16	0.80 to 1.67	0.03	−0.04 to 0.10
Young seniors (65–79 years)	MCS	13 840	<b>1.05*</b>	1.01 to 1.10	<b>2.76*</b>	0.41 to 5.11
	PCS	13 840	<b>1.05*</b>	1.00 to 1.11	<b>2.12*</b>	−0.27 to 4.51
	Poor SRH	27 028	0.73	0.48 to 1.13	<b>−0.10*</b>	−0.19 to 0.01
Old age (80+ years)	MCS	2 421	1.03	0.91 to 1.17	1.44	−5.20 to 5.09
	PCS	2 421	0.89	0.77 to 1.04	−4.71	−10.58 to 1.16
	Poor SRH	4 751	1.08	0.52 to 2.26	0.06	−0.23 to 0.34
<b>Women</b>						
All ages	MCS	38 229	<b>1.03*</b>	1.00 to 1.06	<b>1.41*</b>	−0.03 to 2.86
	PCS	38 229	0.98	0.95 to 1.01	−0.59	−1.95 to 0.76
	Poor SRH	75 142	0.99	0.80 to 1.23	0.01	−0.04 to 0.06
Later working life (50–64 years)	MCS	20 412	1.00	0.97 to 1.04	0.27	−1.61 to 2.15
	PCS	20 412	<b>0.94**</b>	0.90 to 0.98	<b>−2.98**</b>	−4.86 to −1.11
	Poor SRH	40 074	1.29	0.94 to 1.78	<b>0.07*</b>	0.00 to 0.14
Young seniors (65–79 years)	MCS	14 371	<b>1.06*</b>	1.01 to 1.12	<b>2.82*</b>	0.16 to 5.50
	PCS	14 371	1.02	0.96 to 1.09	0.85	−1.82 to 3.52
	Poor SRH	28 179	1.10	0.74 to 1.63	−0.04	−0.14 to 0.07
Old age (80+ years)	MCS	3 446	1.03	0.91 to 1.17	1.19	−5.25 to 7.63
	PCS	3 446	0.97	0.84 to 1.13	−0.96	−6.63 to 4.72
	Poor SRH	6 889	1.02	0.57 to 1.22	−0.02	−0.28 to 0.23

Adjusted for age, nationality, living with partner and equivalised net income.

Displayed are the interaction effects between educational level and the time trend variable.

Significant values are written in bold.

\* $P < 0.05$ , \*\* $p < 0.01$ .

GSOEP, German Socio-Economic Panel; MCS, mental component summary; PCS, physical component summary; RII, Relative Index of Inequality; SII, Slope Index of inequality; SRH, self-rated health.

harder for low educated individuals. In contrast, changes in employment rates over the last decades might have contributed to the increasing health inequalities among women in later working life. In a previous study, we found an overall increase in women's perceived rates of good SRH at this age that was more pronounced as compared with men.<sup>34</sup> Following the idea by Guilar-Palacio *et al*,<sup>54</sup> it was postulated that the increasing presence of women in the labour force might have contributed to the reduction of the gender gap in SRH. The finding of this study suggests that not all women benefited equally from the increase in employment rates. It might be possible that higher educated women have benefited more as their working activities provide higher levels of autonomy and rewards which proved to be significant health-promoting resources.<sup>55 56</sup> Conversely, employment may pose higher

burdens to low educated women that would explain the rise in health inequalities found among women of later working life. In addition to these explanations, different trends in health-related behaviours might have contributed to the life stage-specific trends in health inequality. For example, recent findings suggest that probability of obesity increased particularly for younger cohorts while the rise was less pronounced among older ones.<sup>57 58</sup> Future studies are needed to examine whether educational inequality in obesity has also increased in this life stage. Finally, it is worth noting that while the educational expansion over the past decades has affected all ages, the implications might have been very different depending on the life stage. While today low educated individuals in Germany represent a minority among younger cohorts, they are still forming the majority of older cohorts.<sup>59</sup>



Hence, low educated individuals in younger ages may increasingly form a vulnerable subgroup with a high health risk which is not the case for the elderly. These varying implications of the educational expansion for different cohorts need to be considered when exploring life stage-specific trends in health inequality.

### Strength and limitations

The strength of this study is the large sample size representing the German population allowing for stratification according to gender and different stages of life. We used different indicators of subjective health giving the findings a more substantial interpretation. In addition, we used established instruments to ensure high construct validity for measuring subjective health. We enhanced the validity of trend analysis by using measures of both absolute and relative health inequalities. We performed further time trend analyses not adjusting for potential confounders and found the time trends determined to be very robust.

However, this study has also limitations worth noting. Even though sampling weights were used, the existence of sampling bias cannot be completely ruled out since a full match of the official population statistics is not absolutely guaranteed. Selection bias could be due to the exclusion of the institutionalised population as well as persons who could not take part in the survey for health reasons. Furthermore, there is a possible existence of a reporting bias since the outcome and the independent variables are self-reported.

As Moor *et al*<sup>8</sup> pointed out, the effect size in the extent of health inequalities depends on the cut-off point chosen for the categorisation of poor health. They conducted a sensitivity analysis, in which 'satisfactory' was part of the reference category 'good health' as it was in this study. Compared with the alternative in which 'satisfactory' was part of the category 'rather poor health', they found the relative risk in low educated people to assess their health as poor to be higher while the absolute difference revealed to be smaller. This finding suggests that the results obtained depend on the way of classification poor health, indicating that the generalisability of our study results may be limited.

In addition, our key finding of life stage-specific trends in educational health inequality cannot be clearly attributed to either cohort or period effects. While sociological literature considers a cohort effect as the sum of all unique exposures experienced by the cohort from birth, a period effect result from external factors that equally affect all age groups at a particular calendar time.<sup>60</sup> In our study, we found subjective health steadily improving particularly among lower educated young seniors not fitting in with the idea of an exclusive cohort or period effect. Instead, our results speak in favour of a gradual transition that might be better described with the continuing progress of social and economic change that may have different implications depending on the stage of people's lives.

Lastly, conclusions about the further development of health inequality in different life stages cannot be derived from our findings. In particular, it is not foreseeable whether the positive trend of narrowed health inequality among young seniors, if confirmed in further studies will continue in the future.

### CONCLUSIONS

We found distinctive patterns of health inequality trends in HRQOL and SRH for different life stages and according to gender. While educational disparities declined among young seniors in both genders, they widened in later working life exclusively among women. The results emphasise the need for a life stage approach when analysing health inequality trends in order to capture varying effects of social change on different life stages. In addition, our findings suggest that social change may have different implications for men and women, indicating that gender is another core inequality dimension that may interact with life stage and social status. Moving from the description to the explanation of health trends would be an important next step to develop targeted political interventions aiming at tackling inequality in health. For this purpose, it would be beneficial to adopt an intersectional framework that includes age, gender and social status as interconnected and time-varying dimensions of health inequalities.

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