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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study (GSOEP)

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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study

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#### Abstract

#### Introduction

Research on time trends in educational inequalities in health is scarce, in particular for Germany. The aim of this study is to analyse how educational inequalities in health evolved 21 years in the middle-aged population in Germany and whether the trends differ by gender.

# Methods

Data were obtained from the German Socio-Economic Panel (GSOEP) covering 1994-2014. In total, n= 16.339 participants (10.6221 person years) aged 30-49 years were included. Educational level was measured based on the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) classification. Health outcomes were self-rated health (SRH) as well as mental and physical health related quality of life (HRQOL, SF-12). Absolute (SII) and relative (RII) Indexes of inequalities were calculated using logistic and linear regression analysis with robust standard errors.

#### Results

Educational inequalities in SRH and physical HRQOL were found for almost every survey year from 1994 to 2014. Relative inequalities in SRH ranged from 1.50-2.10 in men and 1.25-1.87 in women (RII). For educational inequalities in physical HRQOL, a difference between 4.5-6.6 points in men and 3.3-6.1 points in women was observed to the disadvantage of the lowest educational level. Although educational level increased over time, health inequalities remained largely stable over the last 20 years. For mental HRQOL few educational inequalities were found.

#### Discussion

This study found persistent educational inequalities in SRH and physical HRQOL among adults in Germany from 1994-2014. Our findings highlight the need to intensify efforts in social and health policy to tackle these persistent inequalities.

# Words: 247

- This is among the first study to examine trends in educational inequalities in self-rated health and mental and physical health related quality of life in Germany
- We used a large sample size representing the German population and offering the opportunity for a trend analysis covering 21 years (1994-2014) regarding different measures of health
- The current study describes trends in educational inequalities in health, but did not explain the relationship
- It is unclear, why no educational inequalities could be found for mental health

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#### INTRODUCTION

The existence of socioeconomic inequalities in health in Europe is well established,[1, 2] for a variety of health indicators such as premature mortality,[3, 4], morbidity,[2] and subjective health,[5–7]. Most studies reveal that socioeconomic inequalities in adult health are stable or have increased over the last decades;,[2, 5, 8–13] the same applies among young people,[14, 15]. However, variations exist and the extent of inequalities depends on gender, health measures, and indicators of socioeconomic status or on relative or absolute measures of inequalities. For example, educational inequalities in self-rated health (SRH) increased in Swedish women from 2000 to 2008, but remained stable in Swedish men,[5]. Another study showed that in many European countries relative inequalities in mortality increased while absolute inequalities in mortality decreased,[3]. Furthermore, Dalstra et al.,[16] analysing trends from the 1980s to 1990s, found that inequalities in SRH were more pronounced for income than for education. Additionally, different results were observed for different health outcomes. While social inequalities in SRH increased over time, other outcomes (e.g., short- and long-term health problems and chronic diseases) remained stable.

In the last decades, several large societal changes have occurred in Germany. After the reunification of West and East Germany in 1990, the government faced slow economic growth, rising unemployment, and debts,[17, 18]. Current research shows that income inequality increased in Germany from 1994 to 2013,[19]. Only a few studies have analysed trends in health inequalities in Germany, but these studies found stable,[20] or increasing inequalities,[18, 21]. For example, inequalities in SRH by employment status increased from 1994 to 2008 in women and, particularly, in men aged 30-59 years,[18]. Another study revealed that income-related inequalities in SRH roughly doubled from 1994 to 2011,[21].

The majority of studies focused on occupational or income-related inequalities in SRH in Germany. Less attention has been paid to educational inequalities and different health measures. Analyzing trends in health inequalities is essential for investigating whether differences in health have changed and whether policy strategies have been successful in tackling inequalities,[12, 13]. To date, existing studies on trends have focused on adolescents,[14, 15] or taken a wide age range into account,[17, 21]. This study pays special attention to the middle-aged group of men and women (aged 30 to 49). The middle-aged group represents a highly important life period where work demands (e.g., consolidation in the labor market) and private demands (e.g., having children) are very high. However, only limited information is available for this specific age group. Therefore, the aim of this study is (1) to analyse whether educational inequalities exist in three measures of subjective health (SRH, mental and physical health-related quality of life) among early middle-aged adults in Germany between 1994 and 2014, (2) whether they have changed over 20 years, and (3) whether the observed trends are consistent for both genders and all three health outcomes, that is, SRH and mental and physical health-related quality of life (HRQoL).

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#### METHODS

#### Data

The German Socio-Economic Panel (GSOEP) is the largest and longest-running household panel in Germany, starting in 1984. It surveys about 20,000 individuals yearly from more than 10,000 households and represents the residential population of Germany. Each participating household member aged 18 years and older is invited to fill out a personal questionnaire every year. The GSOEP includes a wide range of socio-economic questions relevant to health. The longitudinal design and annual follow-up of the GSOEP allow for analyzing social trends and dynamics,[22]. Detailed information about the GSOEP can be found elsewhere,[23].

The analyses were based on 21 waves of the study covering 1994 through 2014. A weighting variable was used to facilitate the comparability over time with respect to age, gender, state of residence, and refreshments of the survey participants over time,[18]. For our analyses, we focused on the age group between 30 and 49 years ( $n_{paticipants}$ =16339) because most people complete their educational training by the late 20s and it can be assumed that their occupational status is stabilized 10 years later. To avoid bias from the educational effects of including two generations (cohort effect), we limited our age group to 30-49. Cases with missing values on the outcome and/or educational level were excluded. In total, we used 106,221 observations for our analyses based on self-rated health. As physical and mental health was surveyed only between 2002 and 2014, and only every two years, fewer participants ( $n_{participants}$ =13099 /  $n_{observation}$ =39541) were included than for self-rated health.

#### Measures

#### Educational level

Educational level was based on the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) educational classification system and recoded into "low," "medium," and "high" educational level,[20, 24]. The CASMIN classification distinguishes between hierarchically structured educational qualifications and provides international comparability. The high educational group is defined as all persons with low or high tertiary degrees, the medium group consists of those with a vocational degree (intermediate general qualification, intermediate vocational, general maturity certificate, vocational maturity certificate), and the lowest group includes all respondents with inadequately completed general education, general elementary education or basic vocational qualification.

### Self-rated health

SRH was assessed with the question "How would you describe your current health". The response options of "very good," "good," "satisfactory," "not so good," and "bad" were dichotomized as "rather good" (first two categories) and "rather poor" (last three categories),[25]. SRH has been shown to be a robust indicator for different health outcomes and a reliable predictor for mortality,[26–28]. Data on SRH have been collected For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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annually in the GSOEP since 1994.

Health-related quality of life (HRQOL, SF 12v2) in mental and physical health

The Short Form 12 Health Survey (SF-12) was developed to measure health status based on 12 health-related questions. It is a subset of the SF-36v2 and considered a reliable measure of overall health status covering two superordinate dimensions of physical and mental health,[29]. Both scales were included in the GSOEP after 2002 and related data were collected every two years until 2014. The Mental Component Summary Scale (MCS) measures episodes of emotional problems, melancholy, and social limitations due to mental health problems within the last four weeks of the interview. The Physical Component Summary Scale (PCS) summarizes different aspects of physical health (e.g., physical functioning, bodily pain, general health). The MCS and PCS range from 0 to 100, with higher values indicating better health. The mean value of the GSOEP 2004 population is set to 50 with a standard deviation of 10,[29, 30].

#### **Statistical analysis**

Analyses were stratified by gender. Age was categorized into four groups: 30-34 (1), 35-39 (2), 40-44 (3), and 45-49 (4). Bivariate analyses were used to describe trends in SRH and mental and physical health, as well as in educational level, from 1994 to 2014 (supplementary figure 3-6). In the analysis of educational inequalities in SRH, we used generalized linear regression models for binomial data with a logarithmic link function to calculate the Relative Index of Inequality (RII) and with an identity link function to compute the Slope Index of Inequality (SII),[31–33]. The RII (SII) can be interpreted as the estimated relative rate ratio (absolute rate difference) for poor SRH between people with the lowest and highest level of education. These two measures take into account the entire distribution of educational groups and are frequently used when comparing socioeconomic inequalities in health over time or between countries, [1, 8, 15, 20, 34, 35]. To calculate RII and SII, the educational groups were transformed into cumulative rank probabilities (ridit score) ranging from 0 (highest) to 1 (lowest), [15, 36]. Furthermore, linear regression models were calculated for the association of mental health (MCS) and physical health (PCS) and educational level. In the analysis of educational inequalities in mental (MCS) and physical (PCS) health-related guality of life, linear regression models were used with logarithmic and identity link functions to compute the RII and SII, respectively. All presented models were adjusted for family structure (with or without partner), migration background (with or without migration background), and residence (East or West Germany). All analyses were carried out with STATA 14 MP.

#### RESULTS

Study characteristics and trends in self-rated health and educational level

Table 1 presents the study population by age, gender, educational level, SRH, and mental and physical HRQOL.

In total, 41% reported rather poor health. About one quarter of the participants had a high or low educational For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 1	Sample characteristics,	GSOEP 1994-2014,
$n_{obs.} = 10$	06,221	

	%	n
Year of the study		
1994-2014 (persons)		3,782-7,376
Total participants		16,339
Total observations		106,221
Age		
30-34	22.4	23,817
35-39	24.4	25,902
40-44	26.8	28,464
44-49	26.4	28,038
Sex	4	
women	49.6	52,657
men	50.4	53,564
Educational level		
high	22.0	23,411
medium	45.4	48,207
low	32.6	34,603
Self-rated health (SRH)		~
Rather good	56.6	60,114
Rather poor	43.4	46,107
Mental Health (MCS)		
Mean	48.8	39,541
SD*	9.9	
Physical Health (PCS)		
Mean	52.2	39,541
SD*	8.3	

\* SD = standard deviation, obs. = observations

The percentage of poor SRH remained stable between 1994 and 2014. In contrast, MCS slightly increased and PCS slightly decreased (supplementary files, figure 5 and 6). Regarding educational level, there were noticeable changes in the educational groups (supplementary files, figure 3 and 4). For men, in the mid-1990s, 40% were classified as low educated, whereas 30% belonged to that group starting from 2010. From 1994 to 2014, more study participants fell into in the high and medium educational groups. In women, the trend was similar, although with greater changes in the medium and high educational levels.

#### Educational inequalities in self-rated health

**Error! Reference source not found.** presents educational inequalities in poor SRH for men and women. Between 1994 and 2014, significant absolute (SII) and relative (RII) educational inequalities in self-rated health were observed. Relative inequalities ranged from 1.50 -2.10 in men and 1.25-1.87 in women (RII) (Table 2). Trend analyses showed no significant increase or decrease over time in either gender. However, educational inequalities in men were slightly higher than in women.

		MEN				WOMEN		
	RII	CI	SII	CI	RII	CI	SII	CI
1994	1,66***	1,29-2,14	0,20***	0,10-0,31	1,37**	1,10-1,70	0,17**	0,06-0,27
1995	1,95***	1,52-2,49	0,28***	0,17-0,38	1,71***	1,35-2,18	0,25***	0,14-0,35
1996	2,04***	1,64-2,54	0,32***	0,22-0,42	1,87***	1,49-2,34	0,28***	0,17-0,38
1997	2,05***	1,59-2,64	0,29***	0,19-0,39	1,52**	1,18-1,96	0,19***	0,08-0,30
1998	1,67***	1,28-2,18	0,21***	0,10-0,31	1,43**	1,10-1,84	0,16**	0,04-0,27
1999	2,01***	1,53-2,63	0,29***	0,18-0,39	1,21	0,93-1,57	0,10	-0,02-0,21
2000	1,98***	1,65-2,37	0,26***	0,19-0,33	1,45***	1,22-1,72	0,15***	0,08-0,23
2001	1,94***	1,49-2,52	0,31***	0,20-0,42	1,48**	1,13-1,95	0,19**	0,07-0,31
2002	1,79***	1,48-2,16	0,24***	0,16-0,31	1,39***	1,16-1,66	0,14***	0,07-0,22
2003	1,50***	1,23-1,84	0,17***	0,09-0,26	1,25*	1,02-1,54	0,11*	0,02-0,19
2004	1,48***	1,19-1,84	0,17***	0,09-0,26	1,34**	1,10-1,65	0,14**	0,05-0,23
2005	1,52***	1,23-1,88	0,20***	0,11-0,29	1,26*	1,02-1,54	0,11*	0,02-0,20
2006	1,78***	1,45-2,19	0,26***	0,17-0,34	1,45***	1,18-1,78	0,16***	0,08-0,25
2007	1,76***	1,37-2,26	0,23***	0,13-0,33	1,64***	1,31-2,05	0,23***	0,13-0,33
2008	1,55***	1,22-1,97	0,20***	0,10-0,30	1,58***	1,26-2,00	0,20***	0,10-0,30
2009	1,62***	1,29-2,04	0,25***	0,15-0,36	1,55***	1,25-1,93	0,21***	0,10-0,31
2010	1,53**	1,17-2,00	0,21***	0,09-0,34	1,44**	1,11-1,88	0,17**	0,05-0,29
2011	1,61**	1,20-2,16	0,22***	0,10-0,34	1,64***	1,23-2,18	0,22***	0,10-0,35
2012	2,10***	1,59-2,65	0,30	0,20-0,40	1,73***	1,36-2,18	0,24***	0,14-0,34
2013	1,61**	1,21-2,14	0,20***	0,10-0,31	1,55***	1,21-1,99	0,18***	0,08-0,29
2014	1,98***	1,46-2,68	0,25	0,15-0,36	1,58***	1,24-2,01	0,20***	0,10-0,31
Trend	0,88	0,65-1,18	-0,03	-0,16-0,09	1,07	0,82-1,40	0,02	-0,01-0,14

Note: adjusted for age, migration, family structure and residence; RII = relative index of inequalities, SII = slope index of inequalities; CI = Confidence Interval, SRH = self-rated health; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001; obs. = observations

# Educational inequalities in mental and physical health HRQOL

Regarding the mental component scale of health-related quality of life, the results do not show significant inequalities by education in contrast to the physical component scale (Figure 2). Men with the lowest educational level rated their physical health between 4.5 and 6.6 points lower than those with the highest educational level (SII, absolute difference). A difference of 3.3-6.1 points in physical health between the lowest and the highest educational group was also observed in women to the disadvantage of the lowest educational group. For women, educational inequalities in physical health increased over time (p<0.10), whereas men showed stable inequalities (Table 3), that failed to reach significance levels.

Table 3 Relative and absolute educational inequalities in health related quality of life in mental (MCS) and physical (PCS)



health	nealth and educational level, RII and SII, GSOEP, n <sub>obs.</sub> = 39,541								
		M	len			Wo	men		
				RII				RII	
MCS	SII	СІ	RII	СІ	SII	СІ	RII	CI	
2002	-0,53	-2,15; 1,08	0,99	0,96; 1.02	-0,81	-2,57; 0,96	0,98	0,95; 1,02	
2004	-0,64	-2,48; 1,19	0,99	0,95; 1,02	0,28	-1,80; 2,36	1,01	0,96; 1,05	
2006	0,24	-1,65; 2,12	1,00	0,97; 1,04	0,05	-2,05; 2,15	1,00	0,96; 1,04	
2008	0,13	-1,89; 2,14	1,00	0,96; 1,04	-1,73	-4,16; 0,70	0,96	0,92; 1,01	
2010	-0,99	-3,23; 1,24	0,98	0,94; 1,03	-0,87	-3,51; 1,76	0,98	0,93; 1,04	
2012	-1,64	-3,81; 0,54	0,97	0,93; 1,01	-2,39*	-4,43; -0,35	0,95*	0,91; 0,99	
2014	-2,00	-4,12; 0,12	0,96	0,92; 1,00	-1,30	-3,42; 0,81	0,97	0,93; 1,02	
Trend	-1,4	-3,86-1,05	0,97	0,92-1,02	-1,75	-4,18-0,67	0,96	0,92-1,01	
PCS									
2002	-5,70***	-6,85; -4,55	0,90***	0,88; 0,92	-3,26***	-4,68; -1,84	0,94***	0,92; 0,97	
2004	-4,50***	-5,93; -3,07	0,92***	0,89; 0,94	-4,77***	-6,47; -3,06	0,91***	0,88; 0,94	
2006	-6,09***	-7,42; -4,76	0,89***	0,87; 0,91	-4,68***	-6,22; -3,14	0,92***	0,89; 0,94	
2008	-5,91***	-7,51; -4,30	0,89***	0,87; 0,92	-5,33***	-7,05; -0,36	0,90***	0,87; 0,93	
2010	-5,91***	-7,93; -3,90	0,89***	0,86; 0,93	-5,06***	-7,29; -2,83	0,91***	0,87; 0,95	
2012	-6,39***	-8,03; -4,74	0,89***	0,86; 0,91	-5,29***	-7,09; -3,49	0,90***	0,87; 0,94	
2014	-6,63***	-8,59; -4,67	0,88***	0,85; 0,92	-6,12***	-7,95; -4,28	0,89***	0,86; 0,92	
Trend	-1,19	-3,18-0,81	0,98	0,94-1,01	-2,08+	-4,22-0,07	0.96+	0,92-1,00	

Note: adjusted for age, migration, family structure and residence; RII = relative index of inequalities, SII = slope index of inequalities; CI = Confidence Interval, MCS=mental component scale, PCS = physical component scale; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001, obs. = observations

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#### DISCUSSION

#### Summary of the results

This study is among the first to analyse educational inequalities in self-rated health and, mental and physical health in the middle-aged population over a time period up to 21 years. Our results indicate a significant social gradient for self-rated health and health-related quality of life in physical health among 30 to 49-year-old men and women to the disadvantage of lower educated people in almost every survey year. These inequalities remained stable over time. Exceptions were educational inequalities with respect to the physical components of HRQoL in women, which increased significantly from 2002 to 2014. However, no educational inequalities were found in health-related quality of life regarding mental health for men and women. We found a decline in poor self-rated health and an increase in educational level over time, in particular among women.

# Comparing and explaining the results

In accordance with other studies, we found persistent health inequalities over time, [5–7, 17, 37]. The few previous studies examining trends in educational inequalities in self-rated health among adults in Germany also found rather stable inequalities between 1994 and 2006,[38, 39]. Consistent with our results, Pförtner et al., [20] found rather stable inequalities by material deprivation in self-rated health. To date, no studies have analyzed trends in educational inequalities in health-related quality of life in Germany. However, some studies have shown that health inequalities by income and occupational status increased over the last decades, [17, 21]. Similar results were found for educational inequalities in life expectancy, [40] and health behaviors such as smoking and leisure-time physical activity, [33, 35]. The persistence of health inequalities over time highlights how strongly health inequalities are embedded in Western societies, [16, 34]. Trend studies often illustrate social inequalities in health over time, but they rarely try to explain why these inequalities persist by including mediating determinants. However, Granström et al., [5] showed that the lower educated group reported poor self-rated health associated with lack of financial resources, smoking, and low optimism in all survey waves in a cross-sectional survey in 2000, 2004, and 2008 in Sweden. These results suggest that the same explanations found for cross-sectional studies, namely, unequal distribution of material/structural, psychosocial, and behavioural factors, [5, 41–45] have not changed much over time and persist in producing health inequalities. However, future studies need to concentrate on explaining the persistence of education-related health inequalities. People with lower socioeconomic status tend to live and work in rather health-detrimental circumstances, have fewer psychosocial resources and more hazards, and engage in more risk behavior, such as substance use and less physical activity. Furthermore, the results show that health inequalities persist, even though efforts have been made to attenuate the consequences of social disadvantages. Therefore, one can assume, that policy makers need to find alternative ways to enhance health for the less privileged.

In accordance with other studies, our results showed that the distribution of educational level changed over the last decades. The group of people with a higher educational level increased while the low educational For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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group decreased,[5]. However, self-rated health did not increase over time. Although educational level increased, educational inequalities in health did not; they remained stable over time. Our results using RII and SII show that the difference between the lowest and highest educational group still did not narrow, but remained stable.

No educational inequalities were found for health-related quality of life in mental health. Only a few studies have analysed health-related quality of life in mental and physical health domains separately and apart from self-rated health, in particular over time. Although for specific mental disorders a social gradient is often reported (e.g.,[46]), other studies have provided heterogeneous results. For example, Lahelma et al.,[47] found no occupational class inequalities in mental health but did find them in physical health. Others found inequalities for mental health and still other studies found weak, no, or reversed inequalities in mental health. An explanation for the absence of health inequalities in association with education in our study might be due to the specific study population. It may be that a higher socioeconomic position based on educational level or high occupational position is mentally demanding, which results in fewer or no inequalities,[47]. This might be even more important for men and women between 30 and 49 who are building their career and might, especially in the beginning, be struggling with financial burdens due to raising young children. Since this development is evident in all social positions, it does not affect single positions, especially with respect to educational level. This assumption is highlighted by the design of the MCS and PCS, which measure health-related quality of life instead of mental or physical health itself.

# Limitations

The strength of this study is the large sample size representing the German population and offering the opportunity for a trend analysis covering 21 years. However, the study also has some limitations that need to be considered. First, rather modest effect sizes in the extent of social inequalities in self-rated health were observed. Effect size might differ between studies due to the cut-off point "less than good" in the measurement of self-rated health. Also, variation exists in the categorization of SRH, with some categorizing SRH as we did,[5, 37, 41, 48] and others including "satisfactory" in the good health group,[17, 20, 42, 43]. Comparing the two extreme categories would probably show greater effect sizes. However, we do not assume a severe bias as the studies mentioned found similar trends in health inequalities. Second, no clear trend is evident in our results, potentially the results of outlier values in some years. This might be due to sample refreshments in the respective years. However, as we used a weighting variable controlling for the study participants, we do not expect a strong bias.

# Conclusion

A need exists for further investment in strategies that are effective in tackling health inequalities as previous efforts have not been able to reduce health inequalities. Such strategies should be based on determinants For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

contributing to the inequalities, such as investment in education, material and structural living conditions, psychosocial resources, and healthier lifestyles. Further studies should focus on explaining why these inequalities persist over time and what strategies might be more effective in tackling educational inequalities in subjective health. The results would help policy makers develop and implement more adequate strategies for tackling socioeconomic inequalities in health.

#### Contributors

IM designed the study, led the writing and the interpretation of the data and wrote the first draft of the article. SG performed the statistical analyses in collaboration with IM. MR contributed to the conception of the study, supervised the data analyses and provided critical comments on the manuscript. SG, AK, JH, TKP and TL assisted with data interpretation and editing of the article. All authors read and approved the final manuscript.

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# Data sharing statement

Supplementary figure 3-6 can be found online or accessed via the corresponding author. GSOEP data are available free of charge for scientific use from the German Institute for Economic Research (DIW).

#### Provenance and peer review

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#### **Competing interests**

None declared.

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RII



Note: adjusted for age, migration, family structure and residence; obs. = observations SII = Slope Index of Inequality, RII = Relative Index of Inequality

168x149mm (150 x 150 DPI)



2012

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185x74mm (150 x 150 DPI)

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Figure 5 Trends in rather poor self-rated health in men and women, GSOEP, nobs. = 106,221 (supplementary figure)

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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study (GSOEP)

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Keywords:	health inequalities, socioeconomic status, self-rated health, SF 12, SOEP

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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study (GSOEP)

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# Abstract

#### Introduction

As trend studies have shown, health inequalities by income and occupation have widened or remained stable. However, research on time trends in educational inequalities in health in Germany is scarce. The aim of this study is to analyse how educational inequalities in health evolved over a period of 21 years in the middle-aged population in Germany and whether the trends differ by gender.

# Methods

Data were obtained from the German Socio-Economic Panel (GSOEP) covering the period 1994-2014. In total, n= 16,339 participants (106,221 person years) aged 30-49 years were included in the study sample. Educational level was measured based on the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) classification. Health outcomes were self-rated health (SRH) as well as mental and physical health related quality of life (HRQOL, SF-12). Absolute (SII) and relative (RII) Indexes of inequalities were calculated using linear and logarithmic regression analysis with robust standard errors.

# Results

Significant educational inequalities in SRH and physical HRQOL were found for almost every survey year from 1994 to 2014. Relative inequalities in SRH ranged from 1.50 to 2.10 in men and 1.25 to 1.87 in women (RII). For educational inequalities in physical HRQOL, a difference between 4.5 to 6.6 points in men and 3.3 to 6.1 points in women was observed to the disadvantage of the lowest educational level. Although educational level increased over time, absolute and relative health inequalities remained largely stable over the last 21 years. For mental HRQOL few educational inequalities were found.

# Discussion

This study found persistent educational inequalities in SRH and physical HRQOL among adults in Germany from 1994 to2014. Our findings highlight the need to intensify efforts in social and health policies to tackle these persistent inequalities.

# Words: 281

# Strengths and limitations of this study

- This is among the first study to examine trends in educational inequalities in self-rated health and mental and physical health-related quality of life in Germany
- We used a large sample size representing the German population and offering the opportunity for a trend analysis covering 21 years (1994-2014) regarding different measures of health

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- No clear trend is evident in our results, potentially because of outlier values in some years.

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#### INTRODUCTION

The existence of socioeconomic inequalities in health in Europe is well established[1, 2] for a variety of health indicators such as premature mortality[3, 4], morbidity[2] and self-rated health[5–7]. Most studies have revealed that socioeconomic inequalities in adult health are stable or have increased over the last few decades; [2, 5, 8–13] the same applies among young people[14, 15]. However, variations exist and the extent of inequalities depends on gender, health measures, and indicators of socioeconomic status or on relative or absolute measures of inequalities. For example, educational inequalities in self-rated health (SRH) increased in Swedish women between 2000 to 2008, but remained stable in Swedish men,[5]. Another study showed that in many European countries relative inequalities in mortality increased while absolute inequalities in mortality decreased[3]. Furthermore, Dalstra et al.[16] analysing trends from the 1980s to the 1990s in the Netherlands and found that inequalities in SRH were more pronounced according to income level than for education. Additionally, different results were observed for different health outcomes. While social inequalities in SRH increased over time, other outcomes (e.g., short- and long-term health problems and chronic diseases) remained stable.

In the last few decades, several large societal changes have occurred in Germany. After the reunification of West and East Germany in 1990, the government faced slow economic growth, rising unemployment, and debt[17, 18]. Current research shows that income inequality increased in Germany from 1994 to 2013[19]. Only a few studies have analysed trends in health inequalities in Germany, but these studies found stable,[20] or increasing inequalities[18, 21]. For example, inequalities in SRH by employment status increased between 1994 to 2008 in women in general and specifically in men aged 30-59 years[18]. Another study revealed that income-related inequalities in SRH roughly doubled from 1994 to 2011[21].

The majority of studies on this topic have focused on occupational or income-related inequalities in SRH in Germany. Less attention has been paid to educational inequalities and different health measures. However, educational level is strongly related to social origin [22] and can be considered as the foundation that determines the opportunities for occupational status and income level and therefore also for the standard of living and quality of life [23]. Since the 1950s there has been an increased participation in higher education which has resulted in an educational expansion in Germany. While the lowest educational track (lower secondary school) is increasingly less pronounced in Germany, the participation in the highest educational track rose during that time [24]. A declining share of low educated people in a population has been suggested to increase negative selection into this group, which may contribute to widening educational inequalities in health [25–27] Besides the general increase in the number of higher educational degrees, a gender-specific development was also visible. While men showed higher educational attainment for a long time period, women started approaching them starting in the late 1950s, with education degrees being almost equal currently. Therefore, gender needs to be taken into account when studying trends in education [24].

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A higher educational level is often associated with better health and health behaviour. However, the link between education and health is complex. Studies have found that different mechanisms mediate this relationship. Evidence shows that education is associated with different material, psychosocial and behavioural factors which in turn affect self-rated health [23, 28, 29]. Well-educated people have more advantages in these factors e.g. healthier lifestyle which results in better health (mediation). However, moderating effects were also found implying that the effects of lifestyle factors on health are at least partially dependent upon educational level [30]. In addition cognitive ability was found to be important for educational attainment and to enhance personal care of one's own health and well-being, e.g., regarding a better understanding of education's messages and prevention. Further education increases a person's sense of control over their life, including better analytic and communication skills. A lack of personal control can be perceived as a stressor with negative physiological consequences [22, 31].

Analyzing trends in health inequalities is essential for investigations into whether differences in health have changed and whether policy strategies have been successful in tackling inequalities that affect health[12, 13]. To date, existing studies on trends have focused on adolescents[14, 15] or have taken a wide age range into account[17, 21]. This study pays special attention to the middle-aged group of men and women (aged 30 to 49). This age group represents a highly important life period where work demands (e.g., consolidation in the labor market) and private demands (e.g., having children) are very high. However, only limited information is available for this specific age group. Therefore, the aim of this study is (1) to analyse whether educational inequalities exist in three measures of subjective health (SRH and mental and physical health-related quality of life (HRQOL)) among early middle-aged adults in Germany between 1994 and 2014, (2) whether they have changed over the 21 years, and (3) whether the observed trends are consistent for both genders and SRH and HRQOL. We hypothesise (a) that educational inequalities will be found in all three health outcomes; (b) that these health inequalities either widened or remained stable and (c) that there will be gender differences in the trends of educational inequalities in health.

# METHODS

#### Data

The German Socio-Economic Panel (GSOEP) is the largest and longest-running household panel in Germany, having been established in 1984. The GSOEP surveys about 20,000 individuals yearly from more than 10,000 households and represents the residential population of Germany. Each participating household member aged 18 years and older is invited to fill out a personal questionnaire every year that includes a wide range of socio-economic questions relevant to health. The longitudinal design and annual follow-up of the GSOEP survey allows for analyzing social trends and dynamics[32]. Detailed information about the GSOEP can be found elsewhere[33].

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was used to facilitate the comparability over time with respect to age, gender, state of residence, and refreshments of the survey participants over time[18]. For our analyses, we focused on the age group between 30 and 49 years ( $n_{paticipants}$ =16,339), because most people complete their educational training in the middle of their 20s and it can be assumed that their occupational status stabilizes when they reach the age of 30. To avoid bias from the educational effects of including two generations (cohort effect), we therefore limited our age group to 30-49. Cases with missing values on the outcome (203 observations) and/or educational level (27,355 observations) and the further independent variables (2,484 observations) at annual level were excluded. In total, our analyses on self-rated health are based on the data from 16,339 individual persons and 106,221 observations of these persons, respectively, resulting from repeated participation over the whole time period. As physical and mental health was surveyed only between 2002 and 2014, and only every two years, fewer participants ( $n_{participants}$ =13,099 /  $n_{observation}$ =39,541) were included in this data than for self-rated health. For the purposes of this study "participants" means a single person and "observations" is the number of person years we used.

#### Measures

#### Educational level

Educational level was based on the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) educational classification system and was recoded into "low," "medium," and "high" educational levels[20, 34]. The CASMIN classification distinguishes between hierarchically structured educational qualifications and provides international comparability. The high educational group is defined as all persons with low or high tertiary degrees, the medium group consists of those with a vocational degree (intermediate general qualification, intermediate vocational, general maturity certificate, vocational maturity certificate), and the lowest group includes all respondents with inadequately completed general education, general elementary education, or basic vocational qualification.

#### Self-rated health

SRH was assessed with the question "How would you describe your current health?". The response options were "very good," "good," "satisfactory," "poor," and "bad" and were dichotomized as "rather good" (first two categories) and "rather poor" (last three categories) [35]. SRH has been shown to be a robust indicator for different health outcomes and a reliable predictor for mortality[36–38]. Data on SRH have been collected annually in the GSOEP since 1994.

Health-related quality of life (HRQOL, SF 12v2) in mental and physical health The Short Form 12 Health Survey (SF-12) was developed to measure health status based on 12 health-related questions. It is a subset of the SF-36v2 and is considered a reliable measure of overall health status covering two superordinate dimensions of physical and mental health[39]. Both scales have been included in the GSOEP For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

since 2002, and related data were collected every two years until 2014. The Mental Component Summary Scale (MCS) measures episodes of emotional problems, melancholy, and social limitations due to mental health problems within the last four weeks of the interview. The Physical Component Summary Scale (PCS) summarizes different aspects of physical health (e.g., physical functioning, bodily pain, general health). The MCS and PCS range from 0 to 100, with higher values indicating better health. The mean value of the GSOEP 2004 population is set to 50 with a standard deviation of 10[39, 40]. We used the raw data of the subscales and transformed them using the algorithm from Andersen et al. [39] separately for all years.

# Confounder

All presented models were adjusted for family structure (no partner, married, living with partner), migration background (with or without migration background), and residence (East or West Germany). These sociodemographic determinants were known to be associated with socioeconomic status and/or to self-rated health. For example, residence in Germany is important, as there are higher rates of unemployment and poverty in East Germany compared to West Germany (Statistisches Bundesamt 2015). Furthermore, migration background is associated with educational attainment, often resulting in lower educational degrees for men and women who have a migration background [41]. Additionally, family structure correlates with SRH as well as with physical and mental health problems [42].

# **Statistical analysis**

Analyses were stratified by gender. Bivariate analyses were used to describe trends in SRH, mental and physical health, as well as in educational level from 1994 to 2014 (figures 1-4). In the analysis of educational inequalities in SRH, we used generalized linear regression models for binomial data with a logarithmic link function to calculate the Relative Index of Inequality (RII) and with an identity link function to compute the Slope Index of Inequality (SII)[43-45]. The RII (SII) can be interpreted as the estimated relative rate ratio (absolute rate difference) for poor SRH between people with the lowest and highest levels of education. These two measures take into account the entire distribution of educational groups and are frequently used when comparing socioeconomic inequalities in health over time or between countries[1, 8, 15, 20, 46, 47]. To calculate RII and SII, the educational groups were transformed into cumulative rank probabilities (ridit score) ranging from 0 (highest) to 1 (lowest)[15, 48]. Therefore, the weighted ridits were generated for each year separately via the Stata wridit function [48, 49]. Though the educational groups were ordered from highest to lowest, as high education was our reference category, and each group was assigned a so-called ridit-score. Furthermore, linear regression models were calculated for the association of mental health (MCS), and physical health (PCS), and educational level. In the analysis of educational inequalities in mental (MCS) and physical (PCS) health-related quality of life, generalized linear regression models were used with logarithmic link functions to compute the RII and an identity link function to compute SII, respectively. In both cases, a Gaussian distribution family of MCS and PCS was set. Trend analyses were derived using multivariate models For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

that tested the main effects and interactions of dummy variables for education (ridit scores) and a continuous time trend variable. This trend variable was generated by recoding the calendar year in values from 0=1994 to 1=2014 implying for example 0,95 for 2013 [18, 48]. Sensitivity analyses were also performed with different cut-off points for SRH. All analyses were carried out using STATA 14 MP.

#### Ethics

Ethical approval for this study was not required, as the data were extracted from the GSOEP set, which did not contain any personally identifiable information.

# RESULTS

# Study characteristics and trends in self-rated health and educational level

Table 1 presents the study population by age, gender, educational level, SRH, and mental and physical HRQOL. In total, 43.4% of participants reported rather poor health. Regarding educational level, 22% of the participants had a high and about one third had a low educational level, whereas 45.4% of the participants were part of the medium educational group.

Table 1	Sample characteristics,	GSOEP	1994-2014,
$n_{obs} = 10$	06,221		

	%	n
Year of the study		•
1994-2014 (persons)		3,782-7,376
Total participants		16,339
Total observations		106,221
Sex		
women	49.6	52,657
men	50.4	53,564
Educational level		
high	22.0	23,411
medium	45.4	48,207
low	32.6	34,603
Self-rated health (SRH)		
Rather good	56.6	60,114
Rather poor	43.4	46,107
Mental Health (MCS) <sup>a</sup>		
Mean	48.8	39,541
SD*	9.9	
Physical Health (PCS) <sup>a</sup>		
Mean	52.2	39,541
SD*	8.3	

\* SD = standard deviation, obs. = observations, men and women aged 30-49

<sup>a</sup> The MCS and PCS range from 0 to 100, with higher values indicating better health. 50 represents the mean value, values above 50 indicate better health.

There were noticeable changes in educational level for the educational groups (figures 1 and 2). In the mid-

1990s, 40% of men were classified as low educated, whereas 30% of men belonged to that group starting from For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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2010. From 1994 to 2014, more study participants fell into in the high and medium educational groups. For women, the trend was similar, although with greater changes in the medium and high educational levels. The percentage of poor SRH remained stable between 1994 and 2014 (figure 3). In contrast, MCS slightly increased and PCS slightly decreased (figure 4).

# Educational inequalities in self-rated health

Figure 5 presents educational inequalities in poor SRH for men and women. Between 1994 and 2014, significant absolute (SII) and relative (RII) educational inequalities in self-rated health were observed. Relative inequalities ranged from 1.50 -2.10 in men and 1.25-1.87 in women (RII) (Table 2). Trend analyses showed no significant increase or decrease over time for either gender. However, educational inequalities in men were slightly higher than in women.

		MEN				WOMEN		
	RII	СІ	SII	CI	RII	СІ	SII	СІ
1994	1.66***	1.29-2.14	0.20***	0.10 to 0.31	1.37**	1.10 to1.70	0.17**	0.06 to 0.27
1995	1.95***	1.52 to 2.49	0.28***	0.17 to 0.38	1.71***	1.35 to2.18	0.25***	0.14 to 0.35
1996	2.04***	1.64 to 2.54	0.32***	0.22 to 0.42	1.87***	1.49 to2.34	0.28***	0.17 to 0.38
1997	2.05***	1.59 to 2.64	0.29***	0.19 to 0.39	1.52**	1.18 to 1.96	0.19***	0.08 to 0.30
1998	1.67***	1.28 to 2.18	0.21***	0.10 to 0.31	1.43**	1.10 to 1.84	0.16**	0.04 to 0.27
1999	2.01***	1.53 to 2.63	0.29***	0.18 to 0.39	1.21	0.93 to 1.57	0.10	-0.02 to 0.21
2000	1.98***	1.65 to 2.37	0.26***	0.19 to 0.33	1.45***	1.22 to 1.72	0.15***	0.08 to 0.23
2001	1.94***	1.49 to 2.52	0.31***	0.20 to 0.42	1.48**	1.13 to 1.95	0.19**	0.07 to 0.31
2002	1.79***	1.48 to 2.16	0.24***	0.16 to 0.31	1.39***	1.16 to 1.66	0.14***	0.07 to 0.22
2003	1.50***	1.23 to 1.84	0.17***	0.09 to 0.26	1.25*	1.02 to 1.54	0.11*	0.02 to 0.19
2004	1.48***	1.19 to 1.84	0.17***	0.09 to 0.26	1.34**	1.10 to 1.65	0.14**	0.05 to 0.23
2005	1.52***	1.23 to 1.88	0.20***	0.11 to 0.29	1.26*	1.02 to 1.54	0.11*	0.02 to 0.20
2006	1.78***	1.45 to 2.19	0.26***	0.17 to 0.34	1.45***	1.18 to 1.78	0.16***	0.08 to 0.25
2007	1.76***	1.37 to 2.26	0.23***	0.13 to 0.33	1.64***	1.31 to 2.05	0.23***	0.13 to 0.33
2008	1.55***	1.22 to 1.97	0.20***	0.10 to 0.30	1.58***	1.26 to 2.00	0.20***	0.10 to 0.30
2009	1.62***	1.29 to 2.04	0.25***	0.15 to 0.36	1.55***	1.25 to 1.93	0.21***	0.10 to 0.31
2010	1.53**	1.17 to 2.00	0.21***	0.09 to 0.34	1.44**	1.11 to 1.88	0.17**	0.05 to 0.29
2011	1.61**	1.20 to 2.16	0.22***	0.10 to 0.34	1.64***	1.23 to 2.18	0.22***	0.10 to 0.35
2012	2.10***	1.59 to 2.65	0.30	0.20 to 0.40	1.73***	1.36 to 2.18	0.24***	0.14 to 0.34
2013	1.61**	1.21 to 2.14	0.20***	0.10 to 0.31	1.55***	1.21 to 1.99	0.18***	0.08 to 0.29
2014	1.98***	1.46 to 2.68	0.25	0.15 to 0.36	1.58***	1.24 to 2.01	0.20***	0.10 to 0.31
Trend	0.88	0.65 to 1.18	-0.03	-0.16 to 0.09	1.07	0.82 to 1.40	0.02	-0.01 to 0.14

Note: adjusted for age, migration, family structure and residence; RII = relative index of inequalities, SII = slope index of inequalities; CI = Confidence Interval, SRH = self-rated health; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001; obs. = observations, men and women aged 30-49

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# Educational inequalities in mental and physical health HRQOL

Regarding the mental component scale of health-related quality of life, the results do not show significant inequalities by education in contrast to the physical component scale (figure 6). Men with the lowest educational level rated their physical health between 4.5 and 6.6 points lower than those with the highest educational level (SII, absolute difference). A difference of 3.3-6.1 points in physical health between the lowest and the highest educational groups was also observed in women, to the disadvantage of the lowest educational group. For women, educational inequalities in physical health increased over time (p<0.10); whereas, men showed stable inequalities (Table 3) that failed to reach significance levels.

	Men				Women			
MCS	RII	СІ	SII	СІ	RII	СІ	SII	CI
2002	0.99	0.96 to 1.02	-0.53	-2.15 to 1.08	0.98	0.95 to 1.02	-0.81	-2.57 to 0.96
2004	0.99	0.95 to 1.02	-0.64	-2.48 to 1.19	1.01	0.96 to 1.05	0.28	-1.80 to 2.36
2006	1.00	0.97 to 1.04	0.24	-1.65 to 2.12	1.00	0.96 to 1.04	0.05	-2.05 to 2.15
2008	1.00	0.96 to 1.04	0.13	-1.89 to 2.14	0.96	0.92 to 1.01	-1.73	-4.16 to 0.70
2010	0.98	0.94 to 1.03	-0.99	-3.23 to 1.24	0.98	0.93 to 1.04	-0.87	-3.51 to 1.76
2012	0.97	0.93 to 1.01	-1.64	-3.81 to 0.54	0.95*	0.91 to 0.99	-2.39*	-4.43 to -0.35
2014	0.96	0.92 to 1.00	-2.00	-4.12 to 0.12	0.97	0.93 to 1.02	-1.30	-3.42 to 0.81
Trend	0.97	0.92 to 1.02	-1.4	-3.86 to 1.05	0.96	0.92 to 1.01	-1.75	-4.18 to 0.67
PCS								
2002	0.90***	0.88 to 0.92	-5.70***	-6.85 to -4.55	0.94***	0.92 to 0.97	-3.26***	-4.68 to -1.84
2004	0.92***	0.89 to 0.94	-4.50***	-5.93 to -3.07	0.91***	0.88 to 0.94	-4.77***	-6.47 to -3.06
2006	0.89***	0.87 to 0.91	-6.09***	-7.42 to -4.76	0.92***	0.89 to 0.94	-4.68***	-6.22 to -3.14
2008	0.89***	0.87 to 0.92	-5.91***	-7.51 to -4.30	0.90***	0.87 to 0.93	-5.33***	-7.05 to -0.36
2010	0.89***	0.86 to 0.93	-5.91***	-7.93 to -3.90	0.91***	0.87 to 0.95	-5.06***	-7.29 to -2.83
2012	0.89***	0.86 to 0.91	-6.39***	-8.03 to -4.74	0.90***	0.87 to 0.94	-5.29***	-7.09 to -3.49
2014	0.88***	0.85 to 0.92	-6.63***	-8.59 to -4.67	0.89***	0.86 to 0.92	-6.12***	-7.95 to -4.28
Trend	0.98	0.94 to 1.01	-1.19	-3.18 to 0.81	0.96+	0.92 to 1.00	-2.08+	-4.22 to 0.07

Note: adjusted for age, migration, family structure and residence; RII = relative index of inequalities, SII = slope index of inequalities; CI = Confidence Interval, MCS=mental component scale, PCS = physical component scale; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001, obs. = observations, men and women aged 30-49

#### DISCUSSION

#### Summary of the results

This study is among the first to analyse time trends in educational inequalities in self-rated health and mental and physical health in the middle-aged population over a time period of up to 21 years in Germany. Our results indicate that our first hypotheses can be largely confirmed. A significant social gradient for self-rated health and health-related quality of life in physical health among 30 to 49-year-old men and women to the For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

disadvantage of lower educated people in almost every survey year. However, no educational inequalities were found in the health-related quality of life regarding mental health for men and women. The second hypothesis can also be confirmed as the existing inequalities in health remained stable over time. Exceptions were educational inequalities with respect to the physical components of HRQOL in women, which increased significantly from 2002 to 2014. Therefore, our third hypothesis is partially true as there are gender-differences e.g. in educational level or in the extent of educational inequalities in health and. We found a decline in poor self-rated health and an increase in educational level over time, most notably among women.

#### Comparing and explaining the results

In accordance with other studies, we found persistent health inequalities over time[5–7, 17, 50]. The few previous studies that examined trends in educational inequalities in self-rated health among adults in Germany also found rather stable inequalities between 1994 and 2006[51, 52]. Consistent with our results, Pförtner et al. [20] found rather stable inequalities by material deprivation in self-rated health. To date, no studies have analyzed trends in educational inequalities in health-related guality of life in Germany. However, some studies have shown that health inequalities by income and occupational status increased over the last few decades[17, 21]. Similar results were found for educational inequalities in life expectancy,[53] and health behaviors, such as smoking and leisure-time physical activity[45, 47]. The persistence of health inequalities over time highlights how strongly health inequalities are embedded in Western societies[16, 46]. Trend studies often illustrate social inequalities in health over time, but they rarely try to explain why these inequalities persist by including mediating determinants. However, Granström et al. [5] showed that the lower educated group reported poor self-rated health associated with lack of financial resources, smoking, and low optimism in all survey waves in a cross-sectional survey in 2000, 2004, and 2008 in Sweden. Their results suggest that the same explanations found for cross-sectional studies, namely unequal distribution of material/structural, psychosocial, and behavioural factors[5, 23, 54–57], have not changed much over time and persist in producing health inequalities. However, future studies need to concentrate on explaining the persistence of education-related health inequalities. People with lower socioeconomic status tend to live and work in rather health-detrimental circumstances, have fewer psychosocial resources, more hazards, and engage in more risky behavior, such as substance use and less physical activity. Furthermore, the results show that health inequalities persist, even though efforts have been made to attenuate the consequences of social disadvantages. Therefore, one can assume, that policy makers should find alternative ways to enhance health for the less privileged.

In accordance with other studies, our results showed that the distribution of educational level changed over the last few decades. The groups of people with a higher educational level increased while the low educational group decreased[5]. However, self-rated health did not increase over time. Although educational level increased, educational inequalities in health did not; they remained stable over time. As all socioeconomic For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

groups (to different degrees) benefit from educational expansion [24], it can be assumed that the social gap remains and continues to result in educational inequalities in health. Results from a study in 18 european countries show that widening educational inequaliites (here in mortality) can be partly be attributed to educational expansion [27]. Our results, using RII and SII in SRH, support these studies and confirm that the difference between the lowest and highest educational group still did not narrow.

Our study found no educational inequalities for health-related quality of life in mental health. Only a few studies have analysed health-related quality of life in mental and physical health domains, either separately or apart from self-rated health, or in particular over time. Although, for specific mental disorders, a social gradient is often reported (e.g., for depression [58]), other studies have provided heterogeneous results. For example, Lahelma et al.[59] found no occupational class inequalities in mental health but did find them in physical health. Others did find inequalities for mental health and still other studies found weak, no, or reversed inequalities in mental health. An explanation for the absence of health inequalities in association with education in our study might be due to the specific study population. It may be that a higher socioeconomic status based on educational level or high occupational position is mentally demanding, which results in fewer or no inequalities,[59]. This might be even more important for men and women between the ages of 30 and 49, as they are more likely to be building their career and might, especially in the beginning, be struggling with financial burdens due to raising young children. Since this development is evident in all social positions, it does not affect single positions, especially with respect to educational level. This assumption is highlighted by the design of the MCS and PCS, which measure health-related quality of life instead of mental or physical health itself.

#### Strengths and limitations

The strength of this study is the large sample size representing the German population and offering the opportunity for a trend analysis covering a 21 year time span. In addition, as the GSOEP represents the residential population of Germany, we believe that the results can be generalized for Germany. However, the study also has some limitations that need to be considered. First, rather modest effect sizes in the extent of social inequalities in self-rated health were observed. Effect size might differ between studies due to the cut-off point of "less than good" in the measurement of self-rated health. Also, variation exists in the categorization of SRH, with some categorizing SRH as we did[5, 50, 54, 60] and others including "satisfactory" in the good health group[17, 20, 23, 55]. We have therefore conducted a sensitivity analysis, in which "satisfactory" was part of the reference category "good health". As we anticipated, the relative index of inequality increased, while the slope index of inequality decreased. So, the relative risk for people with low education to assess their own health as only poor or bad is even higher, but the absolute difference of people with poor self-rated health in the lower and upper educational groups (ridit-scores) is smaller. Second, no clear trend is evident in our results, potentially the results of outlier values in some years might be due to sample refreshments in the respective years. However, as we used a weighting variable controlling for the study *For peer review only - http://bmjopen.bmj.com/site/about/quidelines.xhtml*
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participants, we do not expect a strong bias. Third, although we found increased educational inequalities in the physical component of HRQOL in women between 2002 and 2014, the p value was significant only at the 10 percent level. Therefore, the results might be interpreted with caution. Fourth, the results might also be biased because of the subjective measure of self-rated health. Studies have found that the predictive ability of SRH for mortality weakens with increasing socioeconomic advantage among middle-aged individuals in the short-term and over a follow-up period [61].

#### Conclusion

The current study contributes to overcoming the lack of research on time trends in educational inequalities in different health outcomes in Germany over the last few decades. The findings suggest that educational inequalities in self-rated health as well as in mental and physical health related quality of life among the 30-49 year-old population were persistent and did not largely change.

Although there was no increase in educational inequalities in health found in our study, the public health problem remains that these inequalities also did not decrease. Therefore, it can be assumed that previous efforts have not been able to reduce health inequalities. Further studies should focus on explaining why these inequalities persist over time and what strategies might be more effective in tackling educational inequalities in subjective health and health-related quality of life. The results would help policy makers develop and implement more adequate strategies for tackling socioeconomic inequalities in health.

#### Contributors

IM designed the study, led the writing and the interpretation of the data and wrote the first draft of the article. SG performed the statistical analyses in collaboration with IM. MR contributed to the conception of the study, supervised the data analyses and provided critical comments on the manuscript. SG, AK, JH, TKP and TL assisted with data interpretation and editing of the article. All authors read and approved the final manuscript.

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#### Data sharing statement

Supplementary figure 3-6 can be found online or accessed via the corresponding author. GSOEP data are available free of charge for scientific use from the German Institute for Economic Research (DIW).

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## **Competing interests**

None declared.

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	<ul> <li>2005;59(3):214–20.</li> <li>Lorant V, Deliège D, Eaton W, et al. Socioeconomic Inequalities in Depression: A Meta-Analysis. <i>American Journal of Epidemiology</i> 2003;157(2):98–112.</li> <li>Lahelma E, Martikainen P, Rahkonen O, et al. Occupational class inequalities across key domains of health: results from the Helsinki Health Study. <i>Eur J Public Health</i> 2005;15(5):504–10.</li> <li>Hiyoshi A, Fukuda Y, Shipley MJ, et al. Health inequalities in Japan: the role of material, psychosocial, social relational and behavioural factors. <i>Soc Sci Med</i> 2014;104:201–09.</li> <li>Singh-Manoux A, Dugravot A, Shipley MJ, et al. The association between self-rated health and mortality in different socioeconomic groups in the GAZEL cohort study. <i>International Journal of Epidemiology</i> 2007;36(6):1222–28.</li> </ul>

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Figure 2 Trends in educational level in women, GSOEP, nobs. = 106,221

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= observations; SII = Slope Index of Inequality, RII = Relative Index of Inequality

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Figure 6 Absolute and relative educational inequalities mental and physical health-related quality of life in men and women, GSOEP 2002-2014, nobs. = 39,541!! + !! + Note: adjusted for age, migration, family structure and residence, obs. = observations; SII = Slope Index of Inequality, RII = Relative Index of Inequality, MCS = Mental Component Summary Scale, PCS = Physical Component Summary Scale

360x256mm (300 x 300 DPI)

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	Item No	Recommendation	Page (marked copy)
Title and abstract	1	( <i>a</i> ) Indicate the study's design with a commonly used	1-2
			2
		(b) Provide in the abstract an informative and balanced	2
		summary of what was done and what was found	
Introduction			2.4
Background/rationale	2	investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified	4, hypotheses were adde
Methods		hypotheses	
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting locations, and relevant dates.	5-7
		including periods of recruitment exposure follow-up	
		and data collection	
Participants	6	(a) Give the eligibility criteria and the sources and	5-6
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Variables	7	Clearly define all outcomes exposures predictors	6-7 confounder were
Vullubies	,	notential confounders, and effect modifiers. Give	now described in more
		diagnostic criteria, if applicable	detail
Data sources/	<u></u> 8*	For each variable of interest, give sources of data and	6-7
masurement	0	details of methods of assessment (measurement)	0-7
measurement		Describe comparability of assessment methods if there is	
		more than one group	
Bias	9	Describe any efforts to address potential sources of bias	7 sensitivity analyses
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how die study size was arrived at	6-7
Quantitative variables	11	analyses. If annlicable, describe which groupings were	0-7
		chosen and why	
Statistical methods	12	(a) Describe all statistical methods including those used	6-8
Statistical methods	12	(a) Deserve an statistical methods, meruding those used	
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		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking	na
		account of sampling strategy	na
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		completing follow up, and applyced	
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		(c) Consider use of a flow diagram	na

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	demographic, clinical, social) and information on	characteristics)
	exposures and potential confounders	
	(b) Indicate number of participants with missing data for	6
	each variable of interest	
15*	Report numbers of outcome events or summary measures	8, Table 1
16	(a) Give unadjusted estimates and, if applicable,	7 (methods section),
	confounder-adjusted estimates and their precision (eg,	unadjusted estimates can
	95% confidence interval). Make clear which confounders	be given by interest
	were adjusted for and why they were included	
	(b) Report category boundaries when continuous	6-7 (MCS/PCS=0-100)
	variables were categorized	
	(c) If relevant, consider translating estimates of relative	We used absolute and
	risk into absolute risk for a meaningful time period	relative measures (RII
		and SII)
17	Report other analyses done-eg analyses of subgroups	7
	and interactions, and sensitivity analyses	
18	Summarise key results with reference to study objectives	11
19	Discuss limitations of the study, taking into account	12
	sources of potential bias or imprecision. Discuss both	
	direction and magnitude of any potential bias	
20	Give a cautious overall interpretation of results	11-13
	considering objectives, limitations, multiplicity of	
	analyses, results from similar studies, and other relevant	
	evidence	
21	Discuss the generalisability (external validity) of the	12
	study results	
22	Give the source of funding and the role of the funders for	13
	the present study and, if applicable, for the original study	
	on which the present article is based	
	15*         16         17         17         18         19         20         21         22	demographic, clinical, social) and information on         exposures and potential confounders         (b) Indicate number of participants with missing data for         each variable of interest         15*         Report numbers of outcome events or summary measures         16       (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included         (b) Report category boundaries when continuous variables were categorized         (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period         17       Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses         18       Summarise key results with reference to study objectives         19       Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias         20       Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence         21       Discuss the generalisability (external validity) of the study results         22       Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study (GSOEP)

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Secondary Subject Heading:	Global health, Health policy
Keywords:	health inequalities, socioeconomic status, self-rated health, SF 12, SOEP

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search, and Rehabilitation Science, Faculty of Hu
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# Educational inequalities in subjective health in Germany from 1994 to 2014: A trend analysis using the German Socio-Economic Panel study (GSOEP)

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#### Abstract

#### Introduction

As trend studies have shown, health inequalities by income and occupation have widened or remained stable. However, research on time trends in educational inequalities in health in Germany is scarce. The aim of this study is to analyse how educational inequalities in health evolved over a period of 21 years in the middle-aged population in Germany and whether the trends differ by gender.

#### Methods

Data were obtained from the German Socio-Economic Panel (GSOEP) covering the period from 1994 to 2014. In total, n= 16,339 participants (106,221 person years) aged 30-49 years were included in the study sample. Educational level was measured based on the "Comparative Analysis of Social Mobility in Industrial Nations (CASMIN)" classification. Health outcomes were self-rated health (SRH) as well as mental and physical healthrelated quality of life (HRQOL, SF-12v2). Absolute (SII) and relative (RII) Indexes of inequalities were calculated using linear and logarithmic regression analysis with robust standard errors.

#### Results

Significant educational inequalities in SRH and physical HRQOL were found for almost every survey year from 1994 to 2014. Relative inequalities in SRH ranged from 1.50 to 2.10 in men and 1.25 to 1.87 in women (RII). Regarding physical HRQOL the lowest educational group yielded 4.5 to 6.6 points (men) and 3.3. to 6.1 points (women) lower scores. Although educational level increased over time, absolute and relative health inequalities remained largely stable over the last 21 years. For mental HRQOL only few educational inequalities were found.

#### Discussion

This study found persistent educational inequalities in SRH and physical HRQOL among adults in Germany from 1994 to 2014. Our findings highlight the need to intensify efforts in social and health policies to tackle these persistent inequalities.

#### Words: 278

## Strengths and limitations of this study

- This is among the first study examining trends in educational inequalities in SRH and mental and physical HRQOL in Germany
- We used a large sample size representing the German population and offering the opportunity for a trend analysis covering 21 years (1994-2014) regarding different measures of health
- No clear trend is evident in our results, which might be explained by outlier values in some years.

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# INTRODUCTION

The existence of socioeconomic inequalities in health in Europe is well established[1, 2] for a variety of health indicators, such as premature mortality[3, 4], morbidity[2] and self-rated health (SRH)[5–7]. Most studies have revealed that these inequalities are stable or have increased over the last few decades[2, 5, 8–13]. This applies for adult as well as adolescents' health [14, 15]. However, variations exist and the extent of inequalities depends on gender, health measures, and indicators of socioeconomic status or on relative or absolute measures of inequalities. For example, educational inequalities in SRH increased in Swedish women between 2000 and 2008, but remained stable in Swedish men[5]. Another study showed that in many European countries relative inequalities in mortality increased, while absolute inequalities in mortality decreased[3]. Furthermore, Dalstra et al.[16], analysing trends from the 1980s to the 1990s in the Netherlands, found that inequalities in SRH were more pronounced for income than for educational level. Additionally, different results were observed for different health outcomes. While social inequalities in SRH increased over time, other outcomes (e.g., short- and long-term health problems and chronic diseases) remained stable.

In the last few decades, several large societal changes have occurred in Germany. After the reunification of West and East Germany in 1990, the government faced slow economic growth, rising unemployment, and debt[17, 18]. Current research shows that income inequality increased in Germany from 1994 to 2013[19]. Only a few studies have analysed trends in health inequalities in Germany, reporting stable[20], or increasing inequalities[18, 21]. For example, inequalities in SRH by employment status increased between 1994 and 2008 in women in general and in men aged 30-59 years[18]. Another study revealed that income-related inequalities in SRH roughly doubled from 1994 to 2011[21].

Furthermore, the majority of studies on this topic have focused on occupational or income-related inequalities in SRH in Germany. Less attention has been paid to educational inequalities. However, educational level is strongly related to social origin [22] and can be considered as the foundation that determines the opportunities for occupational status and income level and therefore also for the standard of living and quality of life [23]. Since the 1950s there has been an increased participation in higher education, which has resulted in an educational expansion in Germany. While the lowest educational track (lower secondary school) is now less pronounced, the participation in the highest educational track rose during that time [24]. A declining share of low educated people in a population has been suggested to increase negative selection into this group, which may contribute to widening educational inequalities in health [25–27]. Besides the general increase in the number of higher educational degrees, a gender-specific development was also visible. While men showed higher educational attainment for a long period of time, women started approaching them beginning in the late 1950s, with education degrees being almost equal now. Therefore, gender needs to be taken into account when studying trends in education [24].

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A higher educational level is often associated with better health and health behaviour. However, the link between education and health is complex. Studies have found that different mechanisms mediate this relationship. Evidence shows that education is associated with different material, psychosocial and behavioural factors which in turn affect SRH [23, 28, 29]. Well-educated people have more advantages regarding these factors e.g. a healthier lifestyle which in turn results in better health (mediation). However, moderating effects were also found implying that the effects of lifestyle factors on health are at least partially dependent upon educational level [30]. In addition, cognitive ability was found to be important for educational attainment and to enhance personal care of one's own health and well-being, e.g., regarding a better understanding of education's messages and prevention. Further education increases a person's sense of control over their life, including better analytic and communication skills. A lack of personal control can be perceived as a stressor with negative physiological consequences [22, 31].

Analyzing trends in health inequalities is essential for investigations into whether differences in health have changed and whether policy strategies have been successful in tackling inequalities affecting health[12, 13]. To date, existing studies on trends have either focused on adolescents[14, 15] or have taken a wide age range into account[17, 21]. This study pays special attention to the middle-aged group of men and women (aged 30 to 49). This age group represents a highly important life period where work (e.g., consolidation in the labor market) and private responsibilities (e.g., having children) are very demanding. However, only limited information is available for this specific age group. Therefore, the aim of this study is (1) to analyse whether educational inequalities exist in three measures of subjective health (SRH and mental and physical HRQOL) among early middle-aged adults in Germany between 1994 and 2014, (2) whether they have changed over 21 years, and (3) whether the observed trends are consistent for both genders and SRH and HRQOL. We hypothesise (a) that educational inequalities will be found in all three health outcomes; (b) that these health inequalities either widened or remained stable and (c) that there will be gender differences in the trends of educational inequalities in health.

#### METHODS

The paper follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies [32].

#### Data

The German Socio-Economic Panel (GSOEP) is the largest and longest-running household panel in Germany, having been established in 1984. The GSOEP surveys about 20,000 individuals yearly from more than 10,000 households and represents the residential population of Germany. Each participating household member aged 18 years and older is invited to fill out a personal questionnaire every year that includes a wide range of socio-economic questions relevant to health. The longitudinal design and annual follow-up of the GSOEP survey offers the possibility to analyse social trends and dynamics[33]. Detailed information about the GSOEP can be For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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#### found elsewhere[34].

The analyses were based on 21 waves of the study covering the years 1994 through 2014. A weighting variable was used to facilitate the comparability over time with respect to age, gender, state of residence, and refreshments of the survey participants over time[18]. For our analyses, we focused on the age group between 30 and 49 years (n<sub>paticipants</sub>=16,339), because most people complete their educational training in the middle of their 20s and it can be assumed that their occupational status stabilizes when they reach the age of 30. To avoid bias from the educational effects of including two generations (cohort effect), we therefore limited our age group to 30-49. Cases with missing values on the outcome (203 observations) and/or educational level (27,355 observations) and the further independent variables (2,484 observations) at annual level were excluded. In total, our analyses on SRH are based on the data from 16,339 individual persons and 106,221 observations of these persons, respectively, resulting from repeated participation over the whole time period. As physical and mental HRQOL was surveyed only between 2002 and 2014, and only every two years, fewer participants (n<sub>participants</sub>=13,099 / n<sub>observation</sub>=39,541) were included than for SRH. For the purposes of this study "participants" means a single person and "observations" is the number of person years we used.

#### Patient and public involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design or implementation of the study. No patients were asked to advise on interpretation or writing up of results. There are no plans to disseminate the results of the research to study participants or the relevant patient community.

#### Measures

#### **Educational level**

Educational level was based on the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) educational classification system and was recoded into "low," "medium," and "high" educational levels[20, 35]. The CASMIN classification distinguishes between hierarchically structured educational qualifications and provides international comparability. The high educational group is defined as all persons with low or high tertiary degrees, the medium group consists of those with a vocational degree (intermediate general qualification, intermediate vocational, general maturity certificate, vocational maturity certificate), and the lowest group includes all respondents with inadequately completed general education, general elementary education, or basic vocational qualification.

#### SRH

SRH was assessed using the question "How would you describe your current health?". The response options were "very good," "good," "satisfactory," "poor," and "bad" and were dichotomized as "rather good" (first two For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml Page 7 of 30

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categories) and "rather poor" (last three categories) [36]. SRH has been shown to be a robust indicator for different health outcomes and a reliable predictor for mortality[37–39]. Data on SRH have been collected annually in the GSOEP since 1994.

#### HRQOL (SF 12v2) in mental and physical health

The Short Form 12 Health Survey (SF-12) was developed to measure health status based on 12 health-related questions. It is a subset of the SF-36v2 and is considered a reliable measure of overall health status covering two superordinate dimensions of physical and mental health[40]. Both scales have been included in the GSOEP since 2002, and related data were collected every two years until 2014. The Mental Component Summary Scale (MCS) measures episodes of emotional problems, melancholy, and social limitations due to mental health problems within the last four weeks of the interview. The Physical Component Summary Scale (PCS) summarizes different aspects of physical health (e.g., physical functioning, bodily pain, general health). The MCS and PCS range from 0 to 100, with higher values indicating better health. The mean value of the GSOEP 2004 population is set to 50 with a standard deviation of 10[40, 41]. We used the raw data of the subscales and transformed them using the algorithm from Andersen et al. [40] separately for all years.

#### Confounder

All presented models were adjusted for family structure (no partner, married, living with partner), migration background (with or without migration background), and residence (East or West Germany). These sociodemographic determinants were known to be associated with socioeconomic status and/or with SRH. For example, residence in Germany is important, as there are higher rates of unemployment and poverty in East Germany compared to West Germany (Statistisches Bundesamt 2015). Furthermore, migration background is associated with educational attainment, often resulting in lower educational degrees for men and women who have a migration background [42]. Additionally, family structure correlates with SRH as well as with physical and mental health problems [43].

#### **Statistical analysis**

Analyses were stratified by gender. Bivariate analyses were used to describe trends in SRH, MCS and PCS, as well as in educational level from 1994 to 2014 (figures 1-4). In the analysis of educational inequalities in SRH, we used generalized linear regression models for binomial data with a logarithmic link function to calculate the Relative Index of Inequality (RII) and with an identity link function to compute the Slope Index of Inequality (SII)[44–46]. The RII (SII) can be interpreted as the estimated relative rate ratio (absolute rate difference) for poor SRH between people with the lowest and highest levels of education. These two measures take into account the entire distribution of educational groups and are frequently used when comparing socioeconomic inequalities in health over time or between countries[1, 8, 15, 20, 47, 48]. To calculate RII and SII, the educational groups were transformed into cumulative rank probabilities (ridit score) ranging from 0 (highest) For peer review only - http://bmjopen.bmj.com/site/about/quidelines.xhtml

to 1 (lowest)[15, 49]. The weighted ridits were generated for each year separately via the Stata wridit function [49, 50]. The educational groups were sorted from highest to lowest, as high education was our reference category, and each group was assigned a so-called ridit-score.

Furthermore, linear regression models were calculated for the association of MCS and PCS, and educational level. In the analysis of educational inequalities in MCS and PCS, generalized linear regression models were used with logarithmic link functions to compute the RII and an identity link function to compute SII, respectively. In both cases, a Gaussian distribution family of MCS and PCS was set. Trend analyses were derived using multivariate models that tested the main effects and interactions of dummy variables for education (ridit scores) and a continuous time trend variable. This trend variable was generated by recoding the calendar year in values from 0=1994 to 1=2014 implying for example 0,95 for 2013 [18, 49]. As the study did not focus on intra-individual changes and within difference in the outcome and the variables of control, all trend analysis were based on pooled data of the considered panel waves. The year-specific coefficients refer to cross-sectional data. Sensitivity analyses were also performed with different cut-off points for SRH. All analyses were carried out using STATA 14 MP.

#### Ethics

Ethical approval for this study was not required, as the data were extracted from the GSOEP set, which did not contain any personally identifiable information.

#### RESULTS

#### Study characteristics and trends in SRH and educational level

Table 1 presents the study population by age, gender, educational level, SRH, and mental and physical HRQOL. In total, 43.4% of participants reported rather poor health. Regarding educational level, 22% of the participants had a high and about one third had a low educational level, whereas 45.4% of the participants were part of the medium educational group.

	%	n
Year of the study		
1994-2014 (persons)		3,782-7,376
Total participants		16,339
Total observations		106,221
Sex		
women	49.6	52,657
men	50.4	53,564
Educational level		
high	22.0	23,411
medium	45.4	48,207
low	32.6	34,603

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Rather poor	43.4	46,107
MCS <sup>a</sup>		
Mean	48.8	39,541
SD*	9.9	
PCS <sup>a</sup>		
Mean	52.2	39,541
SD*	8.3	

\* SD = standard deviation, obs. = observations, men and women aged 30-49

<sup>a</sup> The MCS and PCS range from 0 to 100, with higher values indicating better health. 50 represents the mean value, values above 50 indicate better health.

There were noticeable changes in educational level for the educational groups (figures 1 and 2). In the mid-1990s, 40% of men were classified as low educated, whereas 30% of men belonged to that group starting from 2010. From 1994 to 2014, more study participants fell into in the high and medium educational groups. For women, the trend was similar, although with greater changes in the medium and high educational levels. The percentage of poor SRH remained stable between 1994 and 2014 (figure 3). In contrast, MCS slightly increased and PCS decreased to a small degree (figure 4).

#### **Educational inequalities in SRH**

Figure 5 and 6 presents educational inequalities in poor SRH for men and women. Between 1994 and 2014 significant absolute (SII) and relative (RII) educational inequalities in SRH were observed. Relative inequalities ranged from 1.502.10 in men and 1.251.87 in women (RII) (Table 2). Trend analyses showed no significant increase or decrease over time for either gender. However, educational inequalities in men were slightly higher than in women.

Table 2       Relative and absolute inequalities in SRH, RII and SII, GSOEP, nobs. = 106,221								
		MEN				WOMEN		
	RII	СІ	SII	СІ	RII	СІ	SII	CI
1994	1.66***	1.29 to 2.14	0.20***	0.10 to 0.31	1.37**	1.10 to1.70	0.17**	0.06 to 0.27
1995	1.95***	1.52 to 2.49	0.28***	0.17 to 0.38	1.71***	1.35 to2.18	0.25***	0.14 to 0.35
1996	2.04***	1.64 to 2.54	0.32***	0.22 to 0.42	1.87***	1.49 to2.34	0.28***	0.17 to 0.38
1997	2.05***	1.59 to 2.64	0.29***	0.19 to 0.39	1.52**	1.18 to 1.96	0.19***	0.08 to 0.30
1998	1.67***	1.28 to 2.18	0.21***	0.10 to 0.31	1.43**	1.10 to 1.84	0.16**	0.04 to 0.27
1999	2.01***	1.53 to 2.63	0.29***	0.18 to 0.39	1.21	0.93 to 1.57	0.10	-0.02 to 0.21
2000	1.98***	1.65 to 2.37	0.26***	0.19 to 0.33	1.45***	1.22 to 1.72	0.15***	0.08 to 0.23
2001	1.94***	1.49 to 2.52	0.31***	0.20 to 0.42	1.48**	1.13 to 1.95	0.19**	0.07 to 0.31
2002	1.79***	1.48 to 2.16	0.24***	0.16 to 0.31	1.39***	1.16 to 1.66	0.14***	0.07 to 0.22
2003	1.50***	1.23 to 1.84	0.17***	0.09 to 0.26	1.25*	1.02 to 1.54	0.11*	0.02 to 0.19
2004	1.48***	1.19 to 1.84	0.17***	0.09 to 0.26	1.34**	1.10 to 1.65	0.14**	0.05 to 0.23
2005	1.52***	1.23 to 1.88	0.20***	0.11 to 0.29	1.26*	1.02 to 1.54	0.11*	0.02 to 0.20
2006	1.78***	1.45 to 2.19	0.26***	0.17 to 0.34	1.45***	1.18 to 1.78	0.16***	0.08 to 0.25
2007	1.76*≇*år	നല്പുദ്ദുക്കുള്ളുക or		nio8ക്ഷർമങ്ങ്റാന	/di:64/**ho	ut/ha31it0e21005ess	htr0,23***	0.13 to 0.33

2008	1.55***	1.22 to 1.97	0.20***	0.10 to 0.30	1.58***	1.26 to 2.00	0.20***	0.10 to 0.30
2009	1.62***	1.29 to 2.04	0.25***	0.15 to 0.36	1.55***	1.25 to 1.93	0.21***	0.10 to 0.31
2010	1.53**	1.17 to 2.00	0.21***	0.09 to 0.34	1.44**	1.11 to 1.88	0.17**	0.05 to 0.29
2011	1.61**	1.20 to 2.16	0.22***	0.10 to 0.34	1.64***	1.23 to 2.18	0.22***	0.10 to 0.35
2012	2.10***	1.59 to 2.65	0.30***	0.20 to 0.40	1.73***	1.36 to 2.18	0.24***	0.14 to 0.34
2013	1.61**	1.21 to 2.14	0.20***	0.10 to 0.31	1.55***	1.21 to 1.99	0.18***	0.08 to 0.29
2014	1.98***	1.46 to 2.68	0.25	0.15 to 0.36	1.58***	1.24 to 2.01	0.20***	0.10 to 0.31
Trend	0.88	0.65 to 1.18	-0.03	-0.16 to 0.09	1.07	0.82 to 1.40	0.02	-0.01 to 0.14

Note: adjusted for age, migration, family structure and residence; RII = relative index of inequalities, SII = slope index of inequalities; CI = Confidence Interval, SRH = self-rated health; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001; obs. = observations, men and women aged 30-49

#### Educational inequalities in mental and physical HRQOL

Regarding the mental component scale of HRQOL, the results do not show significant inequalities by education in contrast to the physical component scale (figure 7 and 8). Men with the lowest educational level rated their physical health between 4.5 and 6.6 points lower than those with the highest educational level (SII, absolute difference) (figure 9). A difference of 3.3-6.1 points in physical health between the lowest and the highest educational groups was also observed in women, to the disadvantage of the lowest educational group (figure 10). For women, educational inequalities in physical health increased over time (p<0.10), whereas men showed stable inequalities (Table 3) that failed to reach significance levels.

			Men			v	Vomen	men	
MCS	RII	CI	SII	CI	RII	CI	SII	CI	
2002	0.99	0.96 to 1.02	-0.53	-2.15 to 1.08	0.98	0.95 to 1.02	-0.81	-2.57 to 0.96	
2004	0.99	0.95 to 1.02	-0.64	-2.48 to 1.19	1.01	0.96 to 1.05	0.28	-1.80 to 2.36	
2006	1.00	0.97 to 1.04	0.24	-1.65 to 2.12	1.00	0.96 to 1.04	0.05	-2.05 to 2.15	
2008	1.00	0.96 to 1.04	0.13	-1.89 to 2.14	0.96	0.92 to 1.01	-1.73	-4.16 to 0.70	
2010	0.98	0.94 to 1.03	-0.99	-3.23 to 1.24	0.98	0.93 to 1.04	-0.87	-3.51 to 1.76	
2012	0.97	0.93 to 1.01	-1.64	-3.81 to 0.54	0.95*	0.91 to 0.99	-2.39*	-4.43 to -0.35	
2014	0.96	0.92 to 1.00	-2.00	-4.12 to 0.12	0.97	0.93 to 1.02	-1.30	-3.42 to 0.81	
Trend	0.97	0.92 to 1.02	-1.40	-3.86 to 1.05	0.96	0.92 to 1.01	-1.75	-4.18 to 0.67	
PCS									
2002	0.90***	0.88 to 0.92	-5.70***	-6.85 to -4.55	0.94***	0.92 to 0.97	-3.26***	-4.68 to -1.84	
2004	0.92***	0.89 to 0.94	-4.50***	-5.93 to -3.07	0.91***	0.88 to 0.94	-4.77***	-6.47 to -3.06	
2006	0.89***	0.87 to 0.91	-6.09***	-7.42 to -4.76	0.92***	0.89 to 0.94	-4.68***	-6.22 to -3.14	
2008	0.89***	0.87 to 0.92	-5.91***	-7.51 to -4.30	0.90***	0.87 to 0.93	-5.33***	-7.05 to -3.61	
2010	0.89***	0.86 to 0.93	-5.91***	-7.93 to -3.90	0.91***	0.87 to 0.95	-5.06***	-7.29 to -2.83	
2012	0.89***	0.86 to 0.91	-6.39***	-8.03 to -4.74	0.90***	0.87 to 0.94	-5.29***	-7.09 to -3.49	
2014	0.88***	0.85 to 0.92	-6.63***	-8.59 to -4.67	0.89***	0.86 to 0.92	-6.12***	-7.95 to -4.28	

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Trend	0.98	0.94 to 1.01	-1.19	-3.18 to 0.81	0.96+	0.92 to 1.00	-2.08+	-4.22 to 0.07
Note: adjusted for a	- age, migratio	n. family structure and	residence	: RII = relative index of inec	ualities.	SII = slope index of ine	equalities:	CI = Confidence

Interval, MCS=mental component scale, PCS = physical component scale; + p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001, obs. = observations, men and women aged 30-49

#### DISCUSSION

#### Summary of the results

This study is among the first to analyse time trends in educational inequalities in SRH and mental and physical HRQOL in the middle-aged population over a time period of up to 21 years in Germany. Our results indicate that our first hypothesis can be largely confirmed. A significant social gradient for SRH and HRQOL in physical health among 30 to 49-year-old men and women to the disadvantage of lower educated people in almost every survey year was observed. However, no educational inequalities were found in the HRQOL regarding mental health for men and women. The second hypothesis can also be confirmed as the existing inequalities in health remained stable over time. Exceptions were educational inequalities with respect to the physical components of HRQOL in women, which increased significantly from 2002 to 2014. Therefore, our third hypothesis is partially true as there are gender-differences e.g. in educational level or in the extent of educational inequalities in health. We found a decline in poor SRH and an increase in educational level over time, most notably among women.

#### Comparing and explaining the results

In accordance with other studies, we found persistent health inequalities over time[5-7, 17, 51]. The few previous studies that examined trends in educational inequalities in SRH among adults in Germany also found rather stable inequalities between 1994 and 2006[52, 53]. Consistent with our results, Pförtner et al.[20] found constant inequalities by material deprivation in SRH. To date, no studies have analyzed trends in educational inequalities in HRQOL in Germany. However, previous research has shown that health inequalities by income and occupational status increased over the last few decades [17, 21]. Similar results were found for educational inequalities in life expectancy[54] and health behaviors, such as smoking and leisure-time physical activity[46, 48]. The persistence of health inequalities over time highlights how strongly health inequalities are embedded in Western societies[16, 47]. Trend studies often illustrate social inequalities in health over time, but they rarely try to explain why these inequalities persist by including mediating determinants. However, Granström et al. [5] showed that the lower educated group reported poor SRH, which was associated with lack of financial resources, smoking, and low optimism in all survey waves in a cross-sectional survey in 2000, 2004 and 2008 in Sweden. Their results suggest that the same explanations found for cross-sectional studies, namely unequal distribution of material/structural, psychosocial, and behavioural factors[5, 23, 55-58], have not changed much over time and persist in producing health inequalities. However, future studies need to concentrate on explaining the persistence of education-related health inequalities. People with lower socioeconomic status tend to live and work in rather health-detrimental circumstances, have fewer psychosocial resources, more For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

hazards and engage in more risky behavior, such as substance use and less physical activity. Furthermore, the results show that health inequalities persist, even though efforts have been made to attenuate the consequences of social disadvantages. Therefore, one can assume that policy makers should find alternative ways to enhance health for the less privileged.

In accordance with other studies, our results showed that the distribution of educational level changed over the last few decades. The group of people with a higher educational level increased while the low educational group decreased[5]. However, SRH did not increase over time. Although educational level increased, educational inequalities in health did not; they remained stable over time. As all socioeconomic groups (to different degrees) benefit from educational expansion [24], it can be assumed that the social gap remains and continues to result in educational inequalities in health. Results from a study in 18 European countries show that widening educational inequalities (here in mortality) can partly be attributed to educational expansion [27]. Our results, using RII and SII in SRH, support these assumptions and confirm that the difference between the lowest and highest educational group still did not narrow.

Our study found no educational inequalities for HRQOL in mental health. Only a few studies have analysed HRQOL in mental and physical health domains, either separately or apart from SRH or over time. Although, for specific mental disorders, a social gradient was often reported (e.g., for depression [59]), other studies have provided heterogeneous results. For example, Lahelma et al.[60] have found no occupational class inequalities in mental health, but have reported them in physical health. Others have found inequalities in mental health and additional studies have found weak, no, or reversed inequalities in mental health. An explanation for the absence of health inequalities in association with education in our study might be due to the specific study population. It may be that a higher socioeconomic status based on educational level or high occupational position is mentally demanding, which results in fewer or no inequalities[60]. This might be even more important for men and women between the ages of 30 and 49, as they are more likely to be building their career and might, especially in the beginning, be struggling with financial burdens due to raising young children. Since this development is evident in all social positions, it does not affect single positions, especially with respect to educational level. This assumption is highlighted by the design of the MCS and PCS, which measure HRQOL instead of mental or physical health itself.

#### Strengths and limitations

The strength of this study is the large sample size representing the German population and offering the opportunity for a trend analysis covering a 21 year time span. In addition, as the GSOEP represents the residential population of Germany, we believe that the results can be generalized for Germany. However, the study also has some limitations that need to be considered. First, rather modest effect sizes in the extent of social inequalities in SRH were observed. Effect size might differ between studies due to the cut-off point of "less than good" in the measurement of SRH. Also, variation exists in the categorization of SRH, with some For peer review only - http://bmjopen.bmj.com/site/about/quidelines.xhtml

categorizing SRH as we did[5, 51, 55, 61] and others including "satisfactory" in the good health group[17, 20, 23, 56]. We have therefor conducted a sensitivity analysis, in which "satisfactory" was part of the reference category "good health". As we anticipated, the relative index of inequality increased, while the slope index decreased. Consequently, the relative risk for people with low education to assess their own health as only poor or bad is even higher, but the absolute difference of people with poor SRH in the lower and upper educational groups (ridit-scores) is smaller. Second, no clear trend is evident in our results, potentially the results of outlier values in some years, which might be due to sample refreshments in the respective years. However, as we used a weighting variable controlling for the study participants, we do not expect a strong bias. Third, although we found increased educational inequalities in the physical component of HRQOL in women between 2002 and 2014, the p value was significant only at the 10 percent level. Therefore, the results might be interpreted with caution. Fourth, the results might also be biased because of the subjective measure of SRH. Studies have found that the predictive ability of SRH for mortality weakens with increasing socioeconomic advantage among middle-aged individuals in the short-term and over a follow-up period [62]. There are studies showing that groups may differ in their use of response categories, e.g. lower and higher educated people rate their health differently (response category differential item functioning - DIF). A method to consider such differences is to create anchoring vignettes to adjust for self-rated health item. For instance, one study found that those with a higher education rate their health more positively than lower educated people but that this relationship weakened when DIF was considered [63]. However, the evidence is heterogeneous [64] and further studies are needed taking these differences in rating styles into account to prevent misestimating of the effect strength.

#### Conclusion

The current study contributes to overcoming the lack of research on time trends in educational inequalities in different health outcomes in Germany over the last few decades. The findings suggest that educational inequalities in SRH as well as in mental and physical HRQOL among the 30-49 year-old population were persistent and did not largely change.

Although there was no increase in educational inequalities in health found in our study, the public health problem remains that these inequalities also did not decrease. Therefore, it can be assumed that previous efforts have not been successful in reducing health inequalities. Further studies should focus on explaining why these inequalities persist over time and what strategies might be more effective in tackling educational inequalities in SRH and HRQOL. The results would help policy makers develop and implement more adequate strategies for tackling socioeconomic inequalities in health.

#### Contributors

IM designed the study, led the writing and the interpretation of the data and wrote the first draft of the article. SG performed the statistical analyses-interplation with any with any with a study,

supervised the data analyses and provided critical comments on the manuscript. SG, AK, JH, TKP and TL assisted with data interpretation and editing of the article. All authors read and approved the final manuscript.

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#### Data sharing statement

Supplementary figure 3-6 can be found online or accessed via the corresponding author. GSOEP data are available free of charge for scientific use from the German Institute for Economic Research (DIW).

#### Provenance and peer review

Not commissioned; externally peer reviewed.

#### **Competing interests**

None declared.

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Figure 2 Trends in educational level in women, GSOEP, nobs. = 106,221

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Figure 6 Absolute and relative educational inequalities in self-rated health SRH in women, GSOEP 1994-2014, nobs. = 106,221



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Figure 8 Absolute and relative educational inequalities in mental health-related quality of life in women, GSOEP 2002-2014, nobs. = 39,541

Men





Figure 9 Absolute and relative educational inequalities in physical health-related quality of life in men, GSOEP 2002-2014, nobs. = 39,541

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Figure 10 Absolute and relative educational inequalities in physical health-related quality of life in women, GSOEP 2002-2014, nobs. = 39,541

	Item No	Recommendation	Page (marked copy)
Title and abstract	1	( <i>a</i> ) Indicate the study's design with a commonly used	1-2
		term in the title or the abstract	
		(b) Provide in the abstract an informative and balanced	2
		summary of what was done and what was found	
Introduction	1	T	
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4, hypotheses were adde
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates,	5-7
		including periods of recruitment, exposure, follow-up, and data collection	
Participants	6	(a) Give the eligibility criteria, and the sources and	5-6
		methods of selection of participants	
Variables	7	Clearly define all outcomes, exposures, predictors,	6-7, confounder were
		potential confounders, and effect modifiers. Give	now described in more
		diagnostic criteria, if applicable	detail
Data sources/	8*	For each variable of interest, give sources of data and	6-7
measurement		details of methods of assessment (measurement).	
		Describe comparability of assessment methods if there is	
		more than one group	
Bias	9	Describe any efforts to address potential sources of bias	7, sensitivity analyses
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the	6-7
		analyses. If applicable, describe which groupings were	
		chosen and why	
Statistical methods	12	(a) Describe all statistical methods, including those used	6-8
		to control for confounding	
		(b) Describe any methods used to examine subgroups and	na
		interactions	
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking	na
		account of sampling strategy	
		(e) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of	6
		study—eg numbers potentially eligible, examined for	
		eligibility, confirmed eligible, included in the study.	
		completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	na (secondary data)
		(c) Consider use of a flow diagram	na
Degemintizza data	1/*	(a) Give characteristics of study participants (as	8 Table 1 (comple

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		1
	demographic, clinical, social) and information on	characteristics)
	exposures and potential confounders	
	(b) Indicate number of participants with missing data for	6
	each variable of interest	
15*	Report numbers of outcome events or summary measures	8, Table 1
16	(a) Give unadjusted estimates and, if applicable,	7 (methods section),
	confounder-adjusted estimates and their precision (eg,	unadjusted estimates can
	95% confidence interval). Make clear which confounders	be given by interest
	were adjusted for and why they were included	
	(b) Report category boundaries when continuous	6-7 (MCS/PCS=0-100)
	variables were categorized	
	(c) If relevant, consider translating estimates of relative	We used absolute and
	risk into absolute risk for a meaningful time period	relative measures (RII
		and SII)
17	Report other analyses done-eg analyses of subgroups	7
	and interactions, and sensitivity analyses	
	6	
18	Summarise key results with reference to study objectives	11
19	Discuss limitations of the study, taking into account	12
	sources of potential bias or imprecision. Discuss both	
	direction and magnitude of any potential bias	
20	Give a cautious overall interpretation of results	11-13
	considering objectives, limitations, multiplicity of	
	analyses, results from similar studies, and other relevant	
	evidence	
21	Discuss the generalisability (external validity) of the	12
	study results	
	· 4	
22	Give the source of funding and the role of the funders for	13
	the present study and, if applicable, for the original study	
	on which the present article is based	
	15*   16   17   17   18   19   20   21   22	demographic, clinical, social) and information on   exposures and potential confounders   (b) Indicate number of participants with missing data for   each variable of interest   15*   Report numbers of outcome events or summary measures   16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included   (b) Report category boundaries when continuous variables were categorized   (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   18 Summarise key results with reference to study objectives   19 Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias   20 Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence   21 Discuss the generalisability (external validity) of the study results

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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