Educational expansion and the education gradient in health:

A hierarchical age-period-cohort analysis

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Abstract

Researchers have recently been investigating the temporal variation in the educational gradient in health. While there is abundant literature concerning age trajectories, theoretical knowledge about cohort differences is relatively limited. Therefore, in analogy with the life course perspective, we introduce two contrasting cohort-specific hypotheses. The diminishing health returns hypothesis predicts a decrease in educational disparities in health across cohorts. By contrast, the cohort accretion hypothesis suggests that the education-health gap will be more pronounced among younger cohorts. To shed light on this, we perform a hierarchical age-period-cohort analysis (HAPC), using data from a subsample of individuals between 25 and 85 years of age (N = 232,573*) from 32 countries in the European Social Survey (six waves: 2002–2012). The analysis leads to three important conclusions. First, we observe a widening health gap between different educational levels over the life course. Second, we find that these educational differences in the age trajectories of health seem to strengthen with each successive birth cohort. However, the two age-related effects disappear when we control for employment status, household income, and family characteristics. Last, when adjusting for these mediators, we reveal evidence to support the diminishing health returns hypothesis, implying that it is primarily the direct association between education and health that decreases across cohorts. This finding raises concerns about potential barriers to education being a vehicle for empowerment and the promotion of health.*

INTRODUCTION

The relationship between health and education is well established. Higher-educated people generally have better health than the lower educated (Bracke et al., 2013; Groot & van den Brink, 2006; Mirowsky & Ross, 2005). A substantial body of literature pinpoints the key pathways by which education is linked positively to health (Groot & van den Brink, 2007; Mirowsky & Ross, 2005, 1999; Ross & Wu, 1996).

First, higher-educated people face a lower risk of unemployment and are more likely to have access to high-status and well-paid work (*the allocation function of education*). Therefore, the higher educated tend to have lower exposure to stress related to economic hardship (Mirowsky & Ross, 2005; Ross & Van Willigen, 1997). Furthermore, the lower educated are at a greater risk of being employed in occupations demanding physical labor, have less work autonomy, and are likely to be engaged in labor that is more routine. All of these factors are negatively related to health (Ross & Reskin, 1992). Second, compared with those who have little schooling, the better educated have more resources to build supportive and equitable relationships (Huijts et al., 2010; Ross & Mirowsky, 1999; Ross & Van

Willigen, 1997) and have a greater sense of personal control (*the socialization function of education*) (Ross & Mirowsky, 1999; Ross & Wu, 1996). These are well-known stress buffers (Ross & Mirowsky, 2013; Thoits, 2011). Third, well-educated people are more likely to adopt healthy behaviors, such as exercising, not smoking, drinking in moderation, and maintaining a healthy body weight (Montez & Zajacova, 2013; Reynolds & Ross, 1998).

More recently, researchers have advanced this line of investigation to a more complex level, by paying attention to the roles of age and cohort patterns in the association between education and health. While there is extensive literature concerning life course trajectories (Dupre, 2007; Mirowsky & Ross, 2005; Ross & Wu, 1996; Willson et al., 2007), researchers know much less about the impact of cohort experiences on the education-health gap. The inclusion of an interaction between birth cohort and education has principally been justified as a methodological necessity. An accurate understanding of how life course patterns affect the educational gradient in health requires the modeling of cohort changes (Lauderdale, 2001; Lynch, 2003). Furthermore, this interaction has been handled as a lower-order term in the examination of how cohort membership affects age trajectories in the relationship between education and health (Leopold & Leopold, 2013; Mirowsky & Ross, 2008). However, in the context of educational expansion, we argue that it may also be fruitful to develop theoretical and empirical knowledge on the education-health gap across cohorts, irrespective of life course dynamics.

In this study, we start by summarizing age-related theories concerning the educational gradient in health (the age-as-leveler hypothesis and the cumulative advantage hypothesis). Next, we develop two cohort-specific hypotheses that are of primary interest in the present paper (the diminishing health returns hypothesis and the cohort accretion hypothesis). Last, we pay attention to complex intersection processes between life course patterns and cohort patterns. This paper aims to add to the existing literature on temporal variation in the relationship between education and health, by offering a structured overview of possible outcomes, first in a theoretical way and then in an empirical one. To achieve this, data from six cross-sectional waves (2002–2012) of the European Social Survey (ESS) is analyzed by applying hierarchical age-period-cohort analysis, under the assumption of certain period effect restrictions (Bell & Jones, 2013b).

LITERATURE

1. Life course patterns

Two micro-level hypotheses can be distinguished in existing literature on age effects: the *age-as-leveler hypothesis* (Figure 1) (Dupre, 2007; Willson et al., 2007) and the *cumulative advantage hypothesis* (Figure 2) (Leopold & Leopold, 2013; Mirowsky & Ross, 2005; Ross & Wu, 1996; Willson et al., 2007).

Figure 1: Age-as-leveler hypothesis

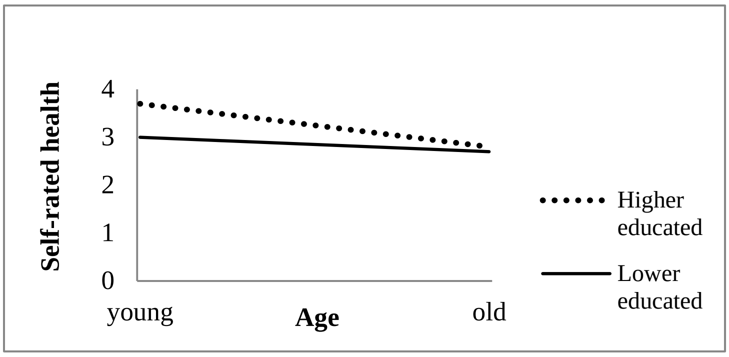
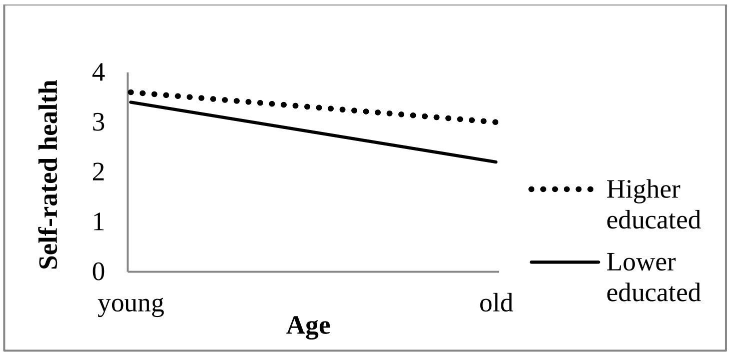


Figure 2: Cumulative advantage hypothesis



The *age-as-leveler hypothesis* predicts that educational differences in health decrease at older ages (Dupre, 2007). There are different reasons to assume converging trajectories with age. First, mortality selection might be an important explanation (Dupre, 2007; Masters et al., 2012; Ross & Wu, 1996). Because of the higher rates of mortality at younger ages among the less educated, selection leads to a decrease in heterogeneity at older ages. Only a more robust group of less-educated individuals survive, who are not representative of the total population of lower-educated older individuals (Leopold & Leopold, 2013). Second, convergence with age can be attributed to age-targeted social policies (Dupre, 2007; Ross & Wu, 1996; Willson et al., 2007). Old-age social security programs can counter the accumulation of education-related disadvantages throughout the life course, equalizing health differences among the older population. Third, the effect of education on health differences may be greater at younger ages, because of decreasing dependency on the level of education across the life course (Lynch, 2003, 2006). Among older people, changes in health are more closely associated with age itself than with educational differences.

By contrast, the *cumulative advantage hypothesis* predicts an increase in educational disparities in health with age (Mirowsky & Ross, 2005; Ross & Wu, 1996; Willson et al., 2007). According to the theory of learned effectiveness, education contributes to the development of values, skills, traits, habits, and abilities which increase effective agency. Consequently, the better educated are more likely to think in a rational and flexible way and to experience feelings of competence and self-efficacy, enabling them to solve a wide range of problems. These advantages grow over time, almost without limit, and interact with other educational returns (e.g. economic factors and health behaviors). Accordingly, not only the positive effects, but also the negative effects accumulate across the life course, resulting in the educational gap in health widening with age (Lynch, 2003).

2. Cohort patterns

Ryder (1965) was among the first to stress the importance of cohorts as time units for analysis. He argued (p. 845) that “each cohort has a distinctive composition and character reflecting the circumstances of its unique origination and history”. This distinct character results in differentiated cohort experiences, irrespective of age dynamics. Following this line of thinking, we believe that it is necessary to study cohort differences in the education-health association. To address this, we develop two contrasting hypotheses: the *diminishing health returns hypothesis* (Figure 3) and the *cohort accretion hypothesis* (Figure 4).

Figure 3: Diminishing health returns hypothesis

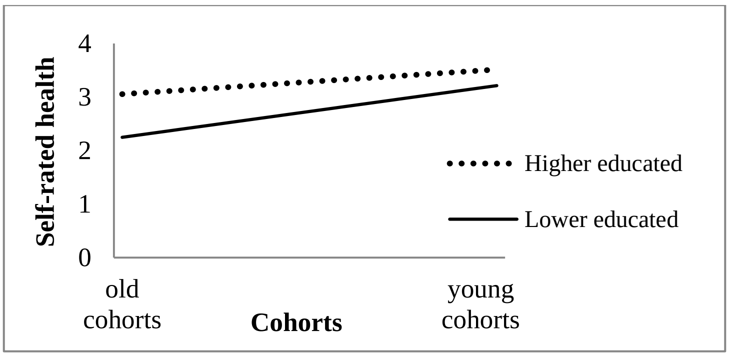
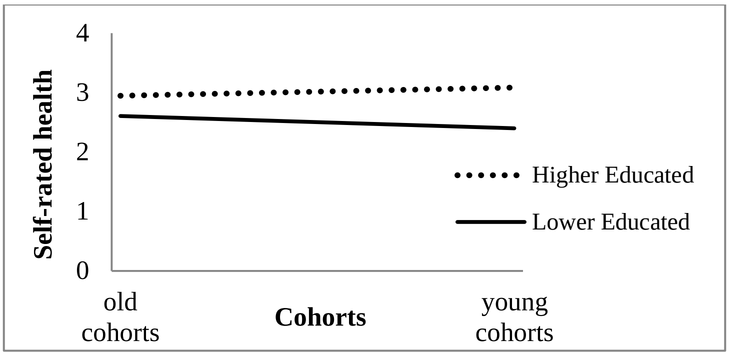


Figure 4: Cohort accretion hypothesis



The *diminishing health returns hypothesis* predicts that the relationship between education and health will be weaker among younger cohorts. A first explanation suggests that the educational expansion process has watered down both the aforementioned allocation and socialization functions of education. From the 1960s onward, participation in higher education has increased substantially (Groot & Van den Brink, 2000). In many European countries, this massive growth in tertiary education has not been accompanied by an equivalent upgrade to the labor market (Bracke et al., 2013; Bracke et al., 2014). The discrepancy between the supply of and demand for highly-qualified workers has led to the phenomenon of 'over-education' (Freeman, 1976); a situation in which individuals cannot fully reap the economic benefits of their educational attainment. In times of intensified job competition, a substantial number of highly-educated employees end up in jobs that actually require lower qualifications, and hence receive limited health returns (Bracke et al., 2013; Bracke et al., 2014). According to Sicherman and Galor (1990), over-education at the individual level is only a temporary situation. At the beginning of their career, over-qualified workers are expected to compensate for wage penalties by having better prospects for promotion. This finding suggests a relatively small decrease in health benefits among the higher educated. Empirical evidence, however, does not univocally support this individualistic perspective (e.g. Baert et al., 2013). At early stages, over-education can be a stumbling block instead of a stepping stone.

By contrast, some consensus exists on the health implications of over-education at the societal level. The misfit between the labor market and education is generally considered a structural problem (Gesthuizen & Wolbers, 2010) that adversely affects all people with a similar level of education, irrespective of their own level of job-education mismatch (Bracke et al., 2014). Slightly falling returns on education in the labor market may have reduced the health benefits it provides. Furthermore, over-education has gone hand in hand with the devaluation of educational credentials (Chevalier, 2003; Van de Werfhorst & Andersen, 2005). The worldwide process of educational expansion has resulted in people valuing educational degrees, irrespective of the skills and knowledge acquired, because of the institutionalization of education as a system of legitimation (Meyer, 1977). Consequently, the relationship between formal education and learned effectiveness has weakened (Bracke et al., 2013). This observation fits in with Collin's view (1979) of education as an artificial good. The credential model questions the assumption that education produces the necessarily competencies and skills to function effectively in a society (Ross & Mirowsky, 1999; Walters, 2004).

A second explanation concerns compositional changes in the group of the higher educated. Given the expansion of democracy and human rights, higher education is no longer an elite enterprise (Kamens & Benavot, 2007; Schofer & Meyer, 2005). From one birth cohort to another, lower-status groups have become increasingly represented in tertiary education. As family background is an important determinant of health outcomes (Koivusilta et al., 2006), it could be argued that the general health status among the higher educated may have deteriorated across cohorts. Nonetheless, some studies have demonstrated that the effect of education on health for a person is not mediated by parental education (Laaksonen et al., 2005; Ross & Mirowsky, 2011; Ross & Wu, 1995).

A last explanation points to a possible spillover effect. Smits (2003, 2009) revealed a significant relationship between educational expansion and societal openness. The larger the proportion of highly-skilled individuals, the less likely the higher educated are to marry within their own levels. Additionally, drawing on social capital theories, Huijts and colleagues (2010) argued that the lower educated benefit the most from a high level of educational heterogamy. In countries with permeable educational boundaries, the low educated may compensate for their lack of education by the abundant presence of bridging social ties. In fact, social cohesion facilitates access to resources conducive to health. In line with these two arguments, we may expect educational inequalities in health to converge across cohorts.

By contrast, the *cohort accretion hypothesis* points to an increasing education-health gap from one cohort to another. A general explanation has been provided by the modernization theory (Blau & Duncan, 1967), which states that social stratification has become increasingly based on achieved properties (e.g. educational attainment) and decreasingly on ascribed characteristics (e.g. social class background). Therefore, a post-industrial society is by its nature a meritocracy (Bell, 1974), in which lack of education is a major barrier to good health.

More-detailed explanations focus on the widening economic gap between education levels. In most of the European countries investigated, disparities in labor-market success and wages have increased across cohorts (Gesthuizen, 2004; Leopold & Leopold, 2013). One explanation refers to the 'crowding-out hypothesis' (Gesthuizen & Wolbers, 2010; Wolbers, 2011), which is related to the previously described phenomenon of over-education at the societal level. Along with skill-biased technological change, intensified job competition has forced highly-educated employees into jobs that were previously carried out by intermediately educated workers, and the latter have put the low educated at a disproportionally higher risk of being pushed out of the labor market entirely.

An alternative sociological explanation–the 'discredit' argument–suggests that in addition to displacement, a stigma effect might also be at play (Gesthuizen et al., 2011; Solga, 2002). In the context of educational expansion, the group of the low educated is constantly shrinking (Schofer & Meyer, 2005). Exposed to a social minority position, they are more likely to be labeled as 'deviating from the norm' (Solga, 2002). A lack of education seems to indicate an 'individual failure to succeed'. Accordingly, particularly in meritocratic societies, employers are less willing to hire low-skilled individuals.

Last, employers prefer employees with higher credentials, as they reduce a company's costs for job training (Hirsch, 2005). The 'negative cognitive competence selection' argument posits that the low educated have become a homogeneous group with regard to (non-)cognitive abilities and social capital (Gesthuizen et al., 2005; Gesthuizen et al., 2011), and hence, are perceived as having a low trainability (Gesthuizen et al., 2011; Solga, 2002).

3. Life course and cohort patterns: an intersection

Recent studies on time-related changes in the education-health association have drawn attention to intersection processes (Goesling, 2007; Lauderdale, 2001; Lynch, 2003; Mirowsky & Ross, 2008). Firstly, age and cohort patterns can either enhance or suppress each other. In this regard, researchers have discussed the impact of model misspecification. While a substantial body of evidence supports the age-as-leveler hypothesis (e.g. Beckett, 2000; House et al., 1994; Kitagawa & Hauser, 1973; Knesebeck et al., 2003; Schmidt et al., 2012), Lauderdale (2001) and Lynch (2003) have convincingly questioned this. According to them, this pattern is an artifact of ignoring cohort effects. Studies that simultaneously recognize the life course and the socio-historical context in which the education-health relationship unfolds, are likely to yield support for the cumulative advantage hypothesis (Leopold & Leopold, 2013; Lynch, 2003; Mirowsky & Ross, 2008). At the same time, it has been shown that this is not necessarily an 'either or' question (Reiter et al., 2009; Yang, 2008). Life course patterns and birth-cohort differences may concurrently affect the relationship between education and health, independent of each other.

Apart from their additional effects, life course and cohort experiences can be interwoven (Goesling, 2007; Mirowsky & Ross, 2008). Age and historical context intersect, so the cumulative relationship between educational returns and health might differ from one cohort to another (Chen et al., 2010; Willson et al., 2007). The body of social epidemiological literature is currently one-sided in this regard. There is fragmentary evidence for *the rising importance hypothesis* (Goesling, 2007; Mirowsky & Ross, 2008), which predicts that the cumulative advantage pattern will become stronger with each successive birth cohort. This hypothesis presumes an interaction between the cumulative advantage theory and the cohort accretion theory. However, following the above-developed theoretical framework, other possible intersections can be assumed. For instance, the spillover effect described in the cohort patterns section may attenuate the reinforcing effect of age. In more recent cohorts, the low educated can compensate for the accumulation of education-related disadvantages through increased access to resources, facilitated by the higher educated. Hierarchical age-period-cohort models lend themselves to unraveling these complex intersection processes (Bell & Jones, 2014a).

METHODS

Data

Our analysis is based on data from six waves (2002–2012) of the European Social Survey (ESS). The ESS is a biennial repeated cross-sectional survey, in which an independent sample is collected in each wave. The number of participating countries varies over the different waves between 22 (2002) and 31 (2008). In each participating country, a random sample of respondents, aged 15 and above, were surveyed using face-to-face interviews. Although all the countries hoped to obtain a response rate of at least 70%, there is some variation in response rates by countries and waves: from 33.4% in Switzerland in 2002, to 81.4% in Bulgaria in 2010. Our sample is restricted to the population aged 25-85. Respondents from Albania, Kosovo, Romania, and Latvia are excluded from the analysis, as data for these countries is only available for one wave. In addition, respondents with data lacking on self-rated health, education, gender, employment, and marital status are omitted from the sample (7.69%, N =19,366). The final sample we use, contains 232,573 respondents.

Measurements

Dependent variable

Health is measured by the question ‘How good is your health in general?’ Respondents could indicate one of the following answer categories: very good, good, fair, bad, or very bad. Previous research supports the use of self-reported health measurements (Ferraro & Farmer, 1999; Idler & Benyamini, 1997). The dependent variable ranges from 0 to 4, with higher scores pointing to better health.

<u>*Independent variables*</u>

Education is measured by years of full-time education completed, rather than highest educational level attained, as this indicator enhances the comparability of education systems between countries (Berigan & Irwin, 2011; Bracke et al., 2014). In addition, to reduce the influence of outliers, cases who score higher than the country-year specific mean plus three standard deviations are removed (Bracke et al., 2013). *Age* is measured in years. *Birth cohort* is entered as a continuous characteristic, coded as described in the analysis section. Exploratory curve-fitting analyses suggest a linear relationship between age and cohort on the one hand, and self-rated health on the other.

<u>*Control variables and mediating factors*</u>

We control for gender and parental educational attainment. For *gender*, men form the reference category. *Parental education* is measured as the highest level of education completed, and is divided into categories derived from the European survey version of ISCED-97: less than lower-secondary education (ISCED 1)(reference category), lower-secondary education (ISCED 2), upper-secondary and post-secondary non-tertiary education (ISCED 3-5), and to tertiary education (ISCED 6-7). An extra category was added for respondents who had not provided information about either of their parents' educational attainment. Employment status, household income, and family characteristics are considered as mediators, as they have been found to be correlated to both education and health (Lynch, 2006; Montez & Berkman, 2014; Ross & Van Willigen, 1997; Ross & Wu, 1996). *Employment status* is coded into eight categories: employed (reference category); student; unemployed, looking for work; unemployed, not looking for work; permanently sick or disabled; retired; housework; and a remaining category for community or military services and 'other'. *Household income* is used as an indicator of economic hardship. The net household income is weighted based on the modified OECD scale, which gives a weight of 1 to the first adult in the household, 0.5 to all other adults (>14 years old), and 0.3 to children (<14 years old) (OECD, 2013). To improve the comparability of the weighted household incomes between countries, this control variable is coded into five categories: lowest income (<50% of the median income [reference category]), modest income (>50% and <80% of the median), high income (>80% and <120% of the median), highest income (>120% of the median), and missing values. Last, we enter some family characteristics (Ross & Van Willigen, 1997). *Marital status* indicates whether the respondent was married or in a civil partnership (reference category), divorced or separated, widowed, or single. We also add the *number of children under the age of 12* and the *number of children between 12 and 21 years of age* living in the household.

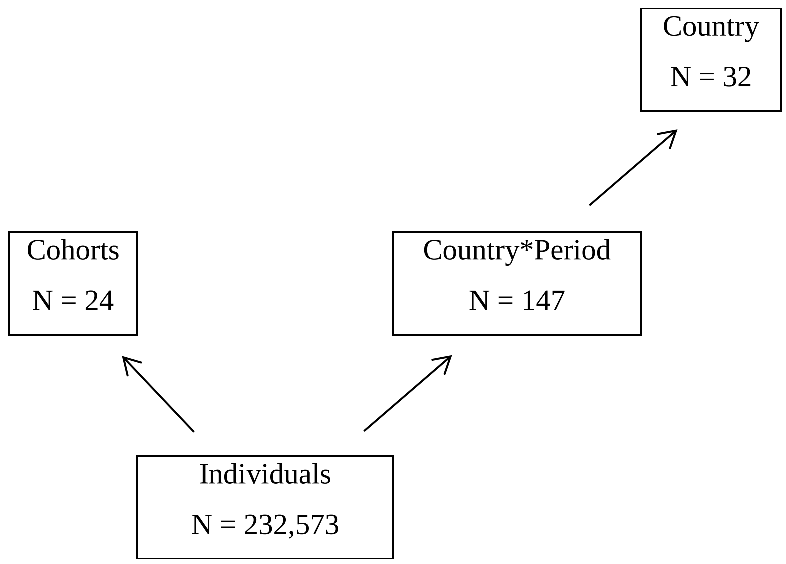
Analysis

We use what is termed Hierarchical Age-Period-Cohort (HAPC) analysis, in order to fully understand the time changes in the education-health relationship. This model was developed by Yang and Land (2006, 2008, 2013) as a solution to the ‘identification problem’, induced by the exact linear relationship of the age, period, and cohort categories (Period = Age + Cohort) (Bell & Jones, 2014a). The HAPC model acknowledges individuals as simultaneously nested in periods and cohorts. Accordingly, cohort and period are considered as contextual effects, and age is entered at the individual level.

Although HAPC analysis has gained popularity among epidemiological and social researchers in recent years (see, e.g. Clarke et al., 2009; Reiter et al., 2009; Stegmueller, 2014; Tawfik et al., 2012), Bell and Jones (2013a, 2013b, 2014a) questioned the validity of this approach. They asserted that it is impossible to assess the net effects of time-related changes accurately, without making the assumption that at least one of the age-period-cohort effects is equal to zero. To decide which one of the three must be left out of the model, theoretical grounds are needed (Bell & Jones, 2014b). Due to the limited time span available, theoretically it is unlikely to assume any substantial linear (or higher polynomial) period effect in the education-health association, with the exception of an economic crisis effect. However, by using an informative prior for age, we tested whether or not the recent economic crisis has had an influence on self-rated health. As we did not find significant differences between the pre- and post-crisis years, we removed period effect from the model.

In order to test our hypotheses, we make use of a cross-classified model, in which individuals are nested in three levels (Figure 5). First, individuals are nested within cohorts. 24 different cohorts with a length of three years are defined, with the exception of the youngest birth cohort, which has an interval of two years. Therefore, birth cohorts range between 1917–1919 and 1986–1987. Simulation studies have shown that the application of Bayesian analysis allows us to produce reliable estimates in the presence of even fewer than 15 higher-level units (Stegmueller, 2013), thus at the cohort level, there is no problem. Second, individuals are nested within periods. Since there are only six periods of observation available, there is a more substantial problem at this level (Van der Bracht & Van de Putte, 2014). As a solution, we examine the different periods as clustered within countries. This method of clustering was proposed by Fairbrother (2014) to create a sufficient number of second-level units. Given that not every country participated in every ESS round, 147 different country-periods are calculated. It should be noted that–unlike period effects–we do take into account the country-period level for methodological reasons (i.e. to control for similarities among respondents interviewed in the same survey year and in the same country). Third, the country-periods are again nested in 32 countries.

Figure 5: Multilevel analysis design



To conduct the multilevel analysis, we use MLwiN version 2.31. The Markov Chain Monte Carlo (MCMC) estimation procedure is used to take into account the cross-classified structure (Browne, 2012; Leckie, 2013). Models were run for 200,000 iterations, following a 2,000 iteration burn-in. In order to facilitate the interpretation of the regression coefficients, age, cohort, and education effects are grand-mean centered and divided by ten. Design weights are used, but we decided not to include population weights. The analysis is built up stepwise, with complexity being increased in every successive model. The first model is the baseline model, containing only the main effects. The second model includes the two-way interactions, controlling for temporal variation. In the third model, the three-way interaction term is entered. Finally, the last model adds possible mediators. The Deviance Information Criterion (DIC) gives an indicator of the overall goodness of the model fit, with lower scores indicating a better model (Spiegelhalter et al., 2002).

RESULTS

Descriptive statistics of the dependent and independent variables are shown in Appendix A. We see that the mean self-reported health score of the whole sample is 2.69 (SD = 0.94), indicating that individuals on average reported being in good health.

With regard to the variance decomposition analysis (not shown, but available upon request), we see that 33.6% (i.e. $\rho = [\sigma^2_{country}+\sigma^2_{country*period} +\sigma^2_{cohort}] / [\sigma^2_{country}+\sigma^2_{country*period} +\sigma^2_{cohort} + \sigma^2_{individual}]$) of the variance in self-rated health is at higher levels. This is relatively large, which underscores the feasibility of multilevel modelling. The greater part of the higher-level variation (22.4%) derives from between-cohort differences. This finding is in accordance with previous research (Reiter et al., 2009; Ryder, 1965) and supports the conceptual relevance of using cohort as a contextual variable.

Table 1 shows the results of the cross-classified multilevel analysis for self-reported health. All models are controled for gender and parental education. We find higher self-rated health scores among men and among respondents with higher-educated parents. Our main results are described as follows: Model 1 in Table 1 clearly shows a positive influence of educational attainment on self-rated health (b = 0.334; SD = 0.005). The higher educated appear to have better health. Furthermore, we observe a significant age effect. Other things being equal, younger people report higher self-rated health scores than older people do (b = -0.172; SD = 0.013). With regard to cohort effects, we note no significant differences in health.

As can be seen in Model 2 in Table 1, there are significant age differences in the education-health association. The coefficient of the interaction between age and education is significantly positive, which provides support for the cumulative advantage hypothesis, that is, that educational differences in health increase at older ages. By contrast, we do not observe significant cohort differences in the education-health gap, net of age differences.

Adding the three-fold interaction to the equation (Table 1, Model 3), attenuates the diverging educational inequalities over the life course. Subsequently, this cumulative pattern is found to be more pronounced among the youngest cohorts (b = 0.030; SD = 0.005), which is in line with the rising importance hypothesis.

Table 1: Self-rated health regressed on education, age, and cohort. Total population aged 25-85 ($N_{cohorts}$ = 24; $N_{individuals}$ = 232,573, weighted sample)[(a)]

	Model 1		Model 2		Model 3		Model 4[(b)]	
	b (SE)		b (SE)		b (SE)		b (SE)	
Intercept	2.716 (0.054)	***	2.722 (0.056)	***	2.725 (0.055)	***	2.917 (0.054)	***
Education (/10)	0.334 (0.005)	***	0.335 (0.005)	***	0.359 (0.007)	***	0.225 (0.007)	***
Age (/10)	- 0.172 (0.013)	***	-0.172 (0.012)	***	-0.173 (0.012)	***	-0.134 (0.011)	***
Cohort (/10)	0.041 (0.039)		0.035 (0.039)		0.041 (0.038)		0.001 (0.035)	
Education x Age (/100)			0.027 (0.013)	*	0.032 (0.014)	*	0.009 (0.013)	
Education x Cohort (/100)			-0.051 (0.040)		-0.053 (0.040)		-0.114 (0.038)	**
Age x Cohort (/100)			-0.005 (0.007)		-0.005 (0.006)		-0.039 (0.006)	***
Education x Age x Cohort (/1000)					0.030 (0.005)	***	-0.005 (0.005)	
Variance								
Country	0.094 (0.026)		0.094 (0.026)		0.094 (0.026)		0.088 (0.025)	
Country x Period	0.003 (0.000)		0.003 (0.000)		0.003 (0.000)		0.002 (0.000)	
Cohort	0.000 (0.000)		0.001 (0.000)		0.001 (0.000)		0.001 (0.000)	
Individual	0.641 (0.002)		0.640 (0.002)		0.640 (0.002)		0.592 (0.002)	
DIC	556587.89		556349.59		556318.89		538040.91	

*p < .05; **p < .01; *** p < .001 (two-tailed test).
[(a)] Gender and parental education are included in all the models.
[(b)] This model contains all mediators.
All continuous variables are centered on their grand mean.

Finally, all mediators are significant and in the expected direction (See appendix B for the full models): we find higher self-rated health scores among employed people, married people, people with higher household income, and with each additional child living in the household. Controlling for these predictors does affect the results (See Table 1, Model 4). First, after adjusting for the mediators, the age-related interaction effects in the prediction of self-rated health are no longer significant. All of the revealed life course patterns–both the overall and the cohort-specific–are explained by the addition of the mediators. Second, a notable interaction is observed between age and cohort. This indicates that the effect of age on health is steeper among more recent cohorts. Third and most importantly, we now observe significant cohort differences in the effect of education on health. Across the mean age group, health inequalities between education levels diminish from older to more recent cohorts in a linear fashion. Additional analyses (not shown, but available upon request) indicate that this finding holds across all ages. To enable the interpretation of this coefficient, we depict the across-cohort trend in Figure 6.

Figure 6: Educational health differences across cohorts, controlling for employment status, household income, and family characteristics

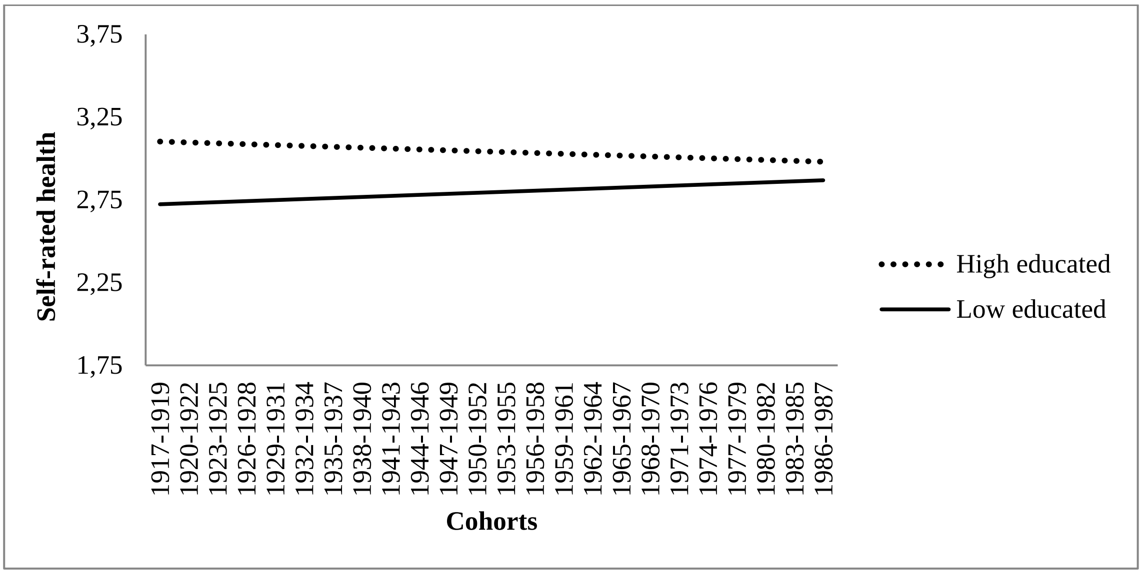


Figure 6 shows the predicted self-rated health scores of different cohorts by educational level (based on Model 4). The range of self-rated health is the overall mean plus or minus one standard deviation. As can be seen, the educational gradient in health is a robust finding among all cohorts. However, the relative benefits of higher education are smaller among younger cohorts. Consistent with the diminishing health returns hypothesis, this figure illustrates that direct health benefits from higher education decrease slightly in absolute terms.

To give more substance to this finding, we perform additional analyses. First, we are aware of the fact that cohort differences are, to a certain extent, related to age differences. Due to the short time span of our measurements, the oldest cohorts only contain older people, whereas the youngest cohorts only comprise younger people. Therefore, we test whether or not the steep increase among the lower educated is caused by the fact that younger people are generally healthier than older people. Additional analysis on the middle cohorts, in which individuals have comparable ages, reveals an upward trend among the less educated (Appendix C). This supports the general form of the graph presented above. Second, we recognize that this finding may be subject to a ceiling effect. If younger cohorts are healthier than their earlier counterparts, an increasing proportion of the higher-educated respondents may rate their health as very good. As a consequence, the higher educated may have less room for improvement compared with the lower educated. We therefore need to control the degree to which the revealed pattern of diminishing health returns among the higher educated is an artifact of measurement. Sensitivity checks, however, refute the hypothesis of a ceiling effect (results not shown, but available upon request).

CONCLUSION

The results from our analyses support the cumulative advantage hypothesis, the diminishing health returns hypothesis, and the rising importance hypothesis. Before discussing these findings in greater depth, some limitations of the study need to be highlighted.

First, as self-reported assessments are contingent on social experiences, the validity of the answers can be somewhat questionable, particularly among the lower educated (Subramanian et al., 2010). Nevertheless, several studies have underscored the reliability of self-rated health measurements in a general population sample (Zajacova et al., 2012, e.g.). Second, the results of the age and cohort trends depend on the assumption of restricted period effects. However, as stated before, additional analyses reveal it is highly probable that no significant period effects exist. Third, some limitations are characteristic to the analysis design. Cross-sectional data hinders causal interpretation, as we cannot exclude the possible existence of selection effects. For example, lower-educated individuals may report having worse health due to social causation or health selection. Nevertheless, we consider selection less likely, because previous studies (Chandola et al., 2003; Chevalier, 2003) have illustrated that lower education causes worse health, to a greater extent than vice versa. Last, this study could suffer from mortality selection. Selective mortality is especially relevant in the exploration of age differences in the educational gradient (Ross & Wu, 1996). However, as already noted, the observed cohorts partly overlap with age groups. In our case, it follows that mortality selection processes would be likely to result in conservative estimates of the converging health gap across cohorts.

Notwithstanding the limitations, our findings extend the understanding of the education-health relationship. First, similar to prior single-country studies (Leopold & Leopold, 2013; Lynch, 2003; Mirowsky & Ross, 2008), we find a widening health gap between the higher and the lower educated over the life course. The interaction between and the accumulation of educational returns seem to be the dominant mechanism behind the divergent pattern. The second, and probably most striking finding, justifies our plea for the investigation of cohort effects. We observe clear evidence to support the diminishing health returns hypothesis. All else being equal, health disparities between educational levels are smaller among more recent cohorts. The significance of this finding becomes clear after adjusting for mediators, implying that it is mainly the direct relationship between education and health that decreases across cohorts. This is not to say that the educational gradient in health among younger cohorts has become a myth. Highly-educated people still report better health on average than lower-educated individuals do. The evidence instead shows that–in relation to health–individuals in older cohorts seem to benefit more from an additional year of education compared with individuals in younger cohorts. Since we controled for parental education and allocation variables, the converging pattern is likely to be explained by a combination of a spillover effect and the phenomenon of 'credential inflation'. The latter is especially worrisome. It seems that in the context of educational expansion and over-education, the direct benefits of education for health have reached their limits. Therefore, we are concerned about potential barriers to education in terms of being a vehicle for empowerment and for the promotion of population health.

It is beyond the scope of our study to explore the diminishing health returns hypothesis in a country-comparative perspective. Nonetheless, the need for comparative research is obvious with regard to this time-related change. The general trend of slightly falling health returns on education could be counterbalanced by country-specific dynamics (Bracke et al., 2014), as European countries might substantially differ with regard to the expansion of tertiary education (Croce & Ghignoni, 2012) and occupational upgrading (Fernández-Macías & Hurley, 2008). Hence, further research could aim to explain the between-cohort variation by introducing country- and cohort-specific characteristics (e.g. changes in mandatory schooling laws and the expansion of compulsory education).

We could also point to other socio-historical transformations that heavily encourage cohort-based approaches, such as the gendered expansion of tertiary education. During recent decades, women have realized significant gains in educational achievement and now earn the majority of tertiary degrees (Wood & Eagly, 2012). Therefore, it would be interesting to examine all of the outlined changes in a gender-specific way.

Third, we find cohort-specific changes in the age trajectories in the education-health association, a result that corroborates previous observations (Chen et al., 2010; Leopold & Leopold, 2013; Lynch, 2003). More precisely, the analysis provides support for the rising importance hypothesis; the cumulative impact of education on health is more pronounced among younger cohorts. As this result holds only when we do not control for employment status, household income, and family characteristics, this observation could point to an increase in the importance of education for health-relevant life chances and opportunities. This interpretation merits additional study.

In summary, this paper extends the understanding of time-related changes in the educational gradient in health. It provides the first effort to develop theoretical and empirical knowledge about the education-health gap across cohorts, irrespective of life course dynamics. We are convinced that future research would benefit from considering across-cohort patterns not only as a methodological or statistical issue, but also as a theoretical underpinning.

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APPENDIX

Appendix A: Descriptive statistics (N = 232,573)

	Range	Mean	SD
Health	0-4	2.69	0.94
Years of education	0-30	12.1	4.1
Age (in years)	25-85	51	15.6
Cohort (birth year)	1917-1987	1957	15.9
		%	N
Gender (men)		45.5%	105779
Parental education			
Less than lower education		16.1%	37541
Lower secondary education		9.8%	22865
Upper- and postsecondary and nontertiary education		20.7%	48093
Tertiary education		6.9%	16105
Missing values		46.4%	107969
Employment			
Employed		52.5%	122021
Student		1.3%	2950
Unemployed, looking for work		3.8%	8892
Unemployed, not looking for work		1.6%	3803
Permanently sick or disabled		2.6%	6123
Retired		26.5%	61723
Household		10.7%	24882
Others		0.9%	2179
Household income			
< 50% of median income		12.5%	29124
50-80% of median income		15.4%	35887
80-120% of median income		20.9%	48558
> 120% of median income		32.7%	76069
Missing values household income		18.5%	42935
Marital status			
Married or civil partnership		60.8%	141426
Divorced or separated		10.9%	25273
Widowed		10.8%	25198
Single		17.5%	40676
Number of children, aged below 12			
0		84.8%	197123
1		8.5%	19842
2+		6.7%	15608
Number of children, aged between 12 and 21			
0		86.4%	200975
1		9.0%	20819
2+		4.6%	10779

Appendix B: Self-rated health regressed on education, age, and cohort. Total population aged 25-85 ($N_{cohorts}$ = 24; $N_{individuals}$ = 232,573, weighted sample)(full models)

	Model 1		Model 2		Model 3		Model 4[(b)]	
	b (SE)		b (SE)		b (SE)		b (SE)	
Intercept	2.716	***	2.722	***	2.725	***	2.917	***
	(0.054)		(0.056)		(0.055)		(0.054)	
Education (/10)	0.344	***	0.335	***	0.359	***	0.225	***
	(0.005)		(0.005)		(0.007)		(0.007)	
Age (/10)	-0.172	***	-0.172	***	-0.173	***	-0.134	***
	(0.013)		(0.012)		(0.012)		(0.011)	
Cohort (/10)	0.041		0.035		0.041		0.001	
	(0.039)		(0.039)		(0.038)		(0.035)	
Education x Age (/100)			0.027	*	0.032	*	0.009	
			(0.013)		(0.014)		(0.013)	
Education x Cohort (/100)			-0.051		-0.053		-0.114	**
			(0.040)		(0.040)		(0.038)	
Age x Cohort (/100)			-0.005		-0.005		-0.039	***
			(0.007)		(0.006)		(0.006)	
Education x Age x Cohort (/1000)					0.030	***	-0.005	
					(0.005)		(0.005)	
Gender	-0.081	***	-0.078	***	-0.078	***	-0.057	***
	(0.003)		(0.003)		(0.003)		(0.003)	
Parental education (less than lower education = reference)								
Lower secondary education	0.015		0.012		0.012		0.005	
	(0.007)		(0.007)		(0.007)		(0.007)	
Upper- and postsecondary and nontertiary education	0.068 (0.007)	***	0.067 (0.007)	***	0.067 (0.007)	***	0.040 (0.006)	***
Tertiary education	0.068	***	0.075	***	0.075	***	0.047	***
	(0.008)		(0.008)		(0.009)		(0.008)	
Missing values	-0.017	*	-0.018	*	-0.018	*	-0.018	*
	(0.007)		(0.007)		(0.007)		(0.007)	
Employment status (employed = reference)								
Student							-0.034	*
							(0.014)	
Unemployed, looking for work							-0.126	***
							(0.009)	
Unemployed, not looking for work							-0.214	***
							(0.013)	
Permanently sick or disabled							-1.223	***
							(0.010)	
Retired							-0.303	***
							(0.006)	
Housework							-0.129	***
							(0.006)	
Others							-0.192	***
							(0.017)	

Marital status (married = reference)					
Divorced or separated				-0.064	***
				(0.005)	
Widowed				-0.103	***
				(0.006)	
Single – never married/civil partnership				-0.066	***
				(0.005)	
Household income (>120% of median income = reference)					
< 50% of median income				-0.207	***
				(0.006)	
50%–80% of median income				-0.140	***
				(0.005)	
80%–120% of median income				-0.082	***
				(0.005)	
Missing values				-0.044	***
				(0.005)	
Number of children, aged below 12				0.027	***
				(0.003)	
Number of children, aged between 12 and 21				0.031	***
				(0.003)	
Variance					
Country	0.094	0.094	0.094	0.088	
	(0.026)	(0.026)	(0.026)	(0.025)	
Country x Period	0.003	0.003	0.003	0.002	
	(0.003)	(0.000)	(0.000)	(0.000)	
Cohort	0.000	0.001	0.001	0.001	
	(0.000)	(0.000)	(0.000)	(0.000)	
Individual	0.641	0.640	0.640	0.592	
	(0.002)	(0.002)	(0.002)	(0.002)	
DIC	556598.89	556349.59	556318.89	538040.91	

*p < .05; **p < .01; *** p < .001 (two-tailed test)
All continuous variables are centered on their grand mean.

Appendix C: Diminishing health returns hypothesis – middle cohorts