The changing meaning of education for health: the role of compositional changes

Abstract According to many studies educational disparities in health have increased in the United States during recent decades. However, two interrelated factors have not been fully taken into account in the analyses so far: the role of educational expansion in shaping educational differences in health and consequently the compositional change within various educational groups. First, the goal of this analysis is to understand how the relationship between height and education changes over time. Indeed, shorter height could be considered as a proxy measure for disadvantaged conditions during the childhood. Is the mechanism of selection into various educational categories changing after the educational expansion? Secondly, we examine changes in the relationship between education and health after the educational expansion. We use height in order to understand whether compositional differences within educational groups has a role in explaining educational differences in health. Data are from 39 pooled National Health Interview Surveys (NHIS) containing information about health of US citizens from 1976 to 2014. First, using ordinal logit models we examine whether height is associated differently to the membership in various educational groups over time and over age. Second, we analyze whether the association between health and height within various educational groups varies over time. Finally, we examine what is the role of within-groups height composition on the health gap between low and high educated individuals over time.

Introduction

According to recent studies educational disparities in health are widening in the United States (Elo and Preston 1996; Montez et al. 2011; Olshansky et al. 2012). For instance, the gap in life expectancy between low and high educated groups has grown over recent decades. Some authors have explained these increasing disparities by looking at the differences in smoking and obesity trends, increasing income inequality, and differential access to healthcare for the lowest strata of the population (Ho and Fenelon 2015; Meara et al. 2008; Montez and Zajacova 2013). However, these widening differences might also be explained by changing group compositions over time. Can we compare people attending higher education institutions nowadays, after decades of educational expansion, to higher educated people in the 1920s and 1930s birth cohorts?

Some scholars have argued that the consequences of educational expansion on individuals outcomes have not been carefully examined (Horowitz 2015; Rosenbaum 2001). In particular, the role of compositional differences within educational groups over time has not been exhaustively explored in the literature (Dowd and Hamoudi 2014). Moreover, the effect of this changing composition on the socioeconomic gradient in health has not been adequately analyzed, although some have suggested it (Hendi 2015; Ho and Fenelon 2015; Sasson 2016). We examine to what extent widening educational differences in health in the US can be attributed to changes in the composition of the low and high educated groups across the 20th century. Our innovation is to measure heterogeneity within educational groups by height at different ages, since adult height can be considered a proxy for early childhood circumstances. Height is an underutilized measure for predicting health outcomes and is considered a good predictors for early-life biological health.

Does the lower educated group increasingly consist of negatively selected individuals (i.e. people with disadvantageous childhood circumstances and poor childhood health)? And can this selection mechanism explain widening trends in adult health mortality for these cohorts?

First, we test the changing association between height and education. We want to map this relationship over time for different age groups. In this part we investigate the existence of a possible changing mechanism of selection into education by height. Therefore, through ordinal logit models we study how the probability of achieving different educational levels changes over time given the relative height position in the birth cohort. Second, we assess the contribution of changes in height distribution within educational groups to trends in educational differences in health for different cohorts. We use self-reported health for assessing the health status. The influence of the changing composition on health disparities is studied through Oaxaca-Blinder decomposition method. This method breaks down how much of the observed difference in health outcomes is attributable to changing height composition and to differential effect of height on health.

Background

Changing composition of educational groups and educational expansion

A number of scholars have pointed towards the importance of compositional differences of socioeconomic groups when studying trends in health inequalities (Goesling 2007; Hendi 2015; Mackenbach et al. 2015), but very few empirical studies have actually addressed this issue. Dowd and Hamoudi (2014) have underlined the fact that the dynamics of selection into educational groups have changed greatly over time. They propose lagged selection bias—which is a phenomenon arising when "stable differences between non-comparable subgroups are being mistaken for time trends in a broader group"—as possible explanation for the observed differences (Dowd and Hamoudi 2014 p. 983). Their analysis through simulations have demonstrated that even if there were stable socioeconomic differences in health an artificial increase in period age-standardized mortality would be observable in the low educational category. This is the result of compositional changes in low education groups, which increasingly include negatively selected individuals.

Educational expansion in the 20th century had an important role for shaping social fluidity even if the effect appears to be non-homogeneous in different contexts (Breen 2010; Pfeffer and Hertel 2015). Pfeffer and Hertel (2015) present an interesting picture concerning cohort trends in education in the United States. By using the year in which individuals turned 30 they found a significant increasing trend in bachelor's degree holders between the 1913-1951 and 1976-1987 cohorts. During this period the percentage with a completed college degree in the cohorts grew from 12.9 to 30.9. Conversely, the percentage of people with less than a high-school education decreased from 44.9 to 11. Therefore, over time we observe a considerable change in the educational distribution of different cohorts. This transition has important implications not only for social fluidity, but also for other life domains such as health. However, the increase in access to education did not occur randomly in the population. This leads us to hypothesize that before the educational expansion the least educated group was much more heterogeneous than the highest educated group since more people would belong to it and selectivity into it was weak. Conversely, in the oldest cohorts the highest educated group was a much more selected group since only a small percentage reached university education.

In conclusion, the least educated individuals are possibly a more selected group after the educational expansion. As suggested by Sasson (2016) the selection could originate from family social background. Therefore, height could be a valid tool for understanding the compositional change in the population due to diverging family social environment for low and high educated individuals. Scholars have already pointed out the diverging destinies of American children coming from different social environments (Mclanahan 2004). The physical and psychosocial environment of childhood poverty almost unavoidably leads to low developmental outcomes and poor health consequences. More disadvantaged children have greater likelihood of family instability and abuse; they live in more hazardous areas, crowded households and unhealthy environments (Evans 2004). Moreover, increasing income insecurity for children is posing additional challenges to an already unstable outlook (Western et al. 2016).

Childhood disadvantage and height

"A principle underlying anthropometric history is that adult stature is a powerful proxy for childhood living conditions with adverse conditions leading to impaired growth" (Cole 2003 p. 162). Many scholars have pointed out the influence of childhood circumstances on height both during childhood and adulthood (Li et al. 2007; Silventoinen 2003; Whitley et al. 2008). They conclude that height can be considered a valuable biomarker for childhood circumstances not only in developing countries, but also in developed countries (Li et al. 2007; Silventoinen 2003). Two main factors can be considered responsible for this association: nutrition and diseases. First, poor childhood circumstances are associated with a worst nutritional intake which conversely leads to shorter stature (Shrimpton et al. 2001). Several elements of the diet—such as protein, minerals and vitamins—seem to be important for postnatal growth (Silventoinen 2003). Second, diseases during the childhood might impair growth through under nutrition, medical treatments and inflammatory nature of the diseases (Silventoinen 2003). However, in developed countries these associations between disease and height do not seem to hold. There is only consistent evidence for the effect of serious disease on growth (Power and Manor 1995). In addition, other factors such as overcrowding at home, family size and income, social housing and parent's socioeconomic position are associated with shorter height (D. L. Kuh et al. 1991; D. Kuh and Wadsworth 1989; Li et al. 2007; Peck and Lundberg 1995; Rona and Chinn 1987), although the mechanisms through which they might impair growth are not clear. Therefore, environmental conditions could lead to poor growth in childhood which would imply shorter height in adulthood. In addition, the exposure to multiple phases with poor growth during childhood increases the risk of being short (Karlberg and Luo 2000). In conclusion, height is considered a good marker for childhood disadvantage, since the association between different poor childhood conditions and short stature is well-documented in the literature.

Childhood disadvantage, education and health

Poor childhood conditions—in terms of health and social circumstances—are reflected in adult health and earnings partially through educational attainment (Case et al. 2003). Different type of childhood circumstances, such as family income, parental education and father's social status, are correlated with educational attainment. In particular, advantageous family conditions are associated with greater probability of educational attainment (Case et al. 2003). Therefore, the link between childhood circumstances and educational attainment is well established in the literature. For example, poor childhood socioeconomic status measured in terms of parental education, financial strain and recipient of welfare benefits is associated among other outcomes also with lower educational attainment in adulthood (Ferraro et al. 2016). However, the trend over time in this association between childhood poor conditions and education is not adequately studied. We could expect that in the last century the effect of childhood circumstances on educational attainment might have changed because of the increasing opportunities given by the educational expansion.

In conclusion, poor health and economic circumstances in childhood affect adult health both through the limitation of educational attainment and through biological imprint (D. J. Kuh and Wadsworth 1993; Montez and Hayward 2014). Disadvantaged childhood experiences are found to be associated with a decrease in active and total life expectancy in later life, although education does not emerge as positive moderating effect for these specific indicators (Montez and Hayward 2014). Other studies which consider mortality as main outcome have found that education, family income, household wealth, and occupation are positive mediators for disadvantaged childhood socioeconomic circumstances (Hayward and Gorman 2004). Therefore, there is evidence for independent effect of childhood circumstances on health as well as for social pathway through educational attainment (Blackwell et al. 2001).

Why height?

Already more than 30 years ago, Vaupel, Manton, and Stallard (1979) have introduced the frailty theory according to which the population is composed by different individuals with heterogeneous endowment of longevity. Individual differences in frailty are important factors in mortality studies that might lead to biased results if they are overlooked (Vaupel et al. 1979). While the measurement of frailty remains difficult, the idea of an heterogeneous endowment of health shaped by childhood social circumstances might help to explain health differences over time in various educational groups.

In this analysis height is used to measure poor childhood conditions both in terms of socioeconomic status and illness. Evidence for height effect on health in later life are limited, since tall individuals have a higher risk of cancer but short ones are more likely to suffer from cardiovascular diseases (Blackwell et al. 2001). Despite this we believe there are several advantages in measuring the changing composition of the population through height. First, height can be a useful indicator for measuring the degree of embodiment of negative childhood circumstances without incurring in the problem of recall bias. Previous research has shown that the underreporting of negative childhood circumstances could be significantly biased for the analysis of early life conditions on later life health especially for black and low educated adults (Haas 2007). Likewise, height could be a good measure for exposure to multiple domains of disadvantage. As noted by Evans (2004), "cumulative rather than singular exposure to a confluence of psychosocial and physical environmental risk factors is a potentially critical aspect of the environment of childhood poverty". Second, since height is fixed at the beginning of the life-course, endogeneity problems are limited. Height can influence health in later life but not the other way around.

Research Design and Hypotheses

The aim of this work is to look at the relationship between education and health in the last century. What are we doing when we are comparing individuals from different time periods? What are we doing when we are looking the effect of education on health over time? First, this work looks at the selection into education and consequently the composition of each educational group; second, we analyze the consequences of these changes on the association between education and health. Trends over cohorts are considered. However, it is not possible to distinguish between period and cohort effect in this analysis, and consequently the trends over time need to be considered as a mixture of both effects.

Education and Health over time

First, we look at the composition of the educational groups over time. *How do people select themselves into education over time? Is there a difference in the height composition of various educational groups? Is the probability of achieving different educational levels changing over time given the relative height position in the birth cohort?*

This first question is important to understand subsequently how the relationship between education and health changes. More diverse people are able to attend higher education thanks to the educational expansion. Therefore, the association between height and education is expected to decrease over birth cohorts.

Question 1: What is the predictive power of height for the access to educational categories? Does it change over birth cohorts?

Hypothesis 1: We expect that the predictive power of height for education becomes weaker over cohorts.

Second, we examine how this differential selection in various educational groups influence the results on health disparities over time. Indeed, the differential selection into educational groups could lead to composition's changes. *What is the role for this composition changes in the increase of health disparities over time?* The method that we are going to use is the Oaxaca-Blinder decomposition. Oaxaca-Blinder decomposition is widely used in the demographic literature (Barber, Yarger, & Gatny, 2013; Hayford, 2013; Maurer, 2011). However, the application to socioeconomic differences in health is limited (Sen 2014). Mandel and Semyonov (2014) showed that it can be an interesting method for decomposing socioeconomic differences over birth cohorts.

The analytic strategy is to decompose the difference between low and high educated group for different birth cohorts. The analysis is carried out in different age groups.

$$Health_{low} = \beta_{0,low} + \beta_{1,low} quintile_{low} + \varepsilon_{low}$$

$$Health_{high} = \beta_{0,high} + \beta_{1,high} quintile_{high} + \varepsilon_{high}$$

$$Health_{high} - Health_{low} = (E(quintile_{high}) - E(quintile_{low}))'\beta_{1,low} + (E(quintile_{low}))'(\beta_{1,high} - \beta_{1,low}) + (\beta_{0,high} - \beta_{0,low})$$

$(E(quintile_{high}) - E(quintile_{low}))'\beta_{1,low}$ is the explained part which represents the difference in average height quintile between low and high educated keeping fixed the effect of height on health as the low educated. This term tells us how much the different structure of the low and high educated groups accounts for the observed difference in health.

$(E(quintile_{low}))'(\beta_{1,high} - \beta_{1,low})$ is the unexplained part due to the different effect of height quintile on health between low and high educated after fixing the average quintile at the low educated level. This term represents the contribution of differing return to height between low and high educated individuals.

$(\beta_{0,high} - \beta_{0,low})$ is the unexplained gap due to group membership.

The goal is to quantify the effect of height composition in the educational differences in health and the role of the unexplained part over time.

Question 2: How does the changing group composition influence the health disparities over time?

Hypothesis 2: The increased selectivity on the basis of height in the low educated group would be partially responsible for the increasing health disparities.

Data

We use 39 pooled National Health Interview Surveys (NHIS), which are annual cross-sectional surveys concerning the health of people living in the United States. NHIS data contains height and other information of individuals from 1976 to 2014. We limit our analysis to non-Hispanic white and blacks in order to limit the confounding effect of migration in the Hispanic population. Over this period there are some changes in the bottom and top codes for height. These long time series are extremely useful to learn about the composition of several socioeconomic groups and the differential selection processes into educational categories over time. In order to adjust for possible time trends in height we calculate quintile of height for each cohort. These thresholds are used for calculating the relative height position of each individual within each 5-year birth cohort. Then, people are classified in their height quintile looking at the height distribution for their cohort when they were between 25 and 35. Individuals in this age range are expected to have completed education and should not be positively selected. Our final analytical sample includes 1,134,420 individuals of which 47 percent are male and 53 percent are female. We divided the self-reported highest attained education in four groups. The education variable is 1 if the individual has less than high-school education, 2 if high-school completed, 3 if some years of college and 4 college and higher.

Health is measured with self-reported health. Since there are changes in scale after 1982, we created four categories for health: 1 excellent or very good, 2 good, 3 fair and 4 poor health. Similar solution has been adopted by Goesling (2007) and Liu and Umberson (2008).

<TABLE 1 with descriptive statistics to include>

Educational expansion in the last century has greatly changed the educational distribution in the US population. Figures 1 presents the percentage of individuals in three educational categories (less than high school, high school, and some college or more). An increasing number of people accessed higher education over birth cohorts. Although the trend is similar among race and gender, there are some differences in the timing of the educational expansion. White men are the first ones to benefit from the increasing access to education, followed by white women, black women and black men.

<FIGURE 1>

Simultaneously, an increase in health inequality for men over cohort for 40-50, 50-60, and 60-70 age groups is observable in Figures 2. Not only the health differences between less-than-high-school and college educated individuals increases over cohorts, but also it increases over the life-course as Figure 3 shows. These trends are consistent both for men and women suggesting the presence of some mechanism independent from gender.

<FIGURE 2-3>

Results

Selection into education by height

The first step of the analysis aims to understand how height predicts educational attainment over cohorts. In particular, we examine whether shorter stature is associated with lower likelihood of higher education. In addition, the goal is to see how this relationship changes over cohorts. The predicted probabilities from ordinal logit model for being in various educational groups are presented in Figure 4 to 7. We present the predicted probabilities from the model including height quintile, cohort, age and the interaction between quintile and cohort. The age range included is 30 to 60 years old. For sake of clarity, we present the predicted probabilities of the two extreme quintiles over cohorts. The effect of educational expansion over cohorts is observable in the declining probability of less-than-high-school and high-school education and the increasing probability of some college or more. However, being in the first height quintile represents always a disadvantage in terms of educational attainment. Therefore, those at the bottom of the distribution are less likely to have college or high-school education. Over cohort this height disadvantage seems to diminish only for the probability of less-than-high-school and some college. Despite this shrinking gap, the differences between those at the top of height distribution and those at the bottom remain evident in the predicted probabilities.

The disadvantage for educational attainment associated with shorter stature holds true by gender and race, but there are differences in the magnitude of the effect. For example, men seem to suffer more from shorter height, since the differential in the predicted probability of college education for those in the first and fifth quintile is larger than in the female sample. Likewise, white individuals have more extensive differences compared to blacks. The analysis does not seem to support the idea that the low educated group is becoming more selected in terms of height relative to other individuals in the cohort.

Oaxaca-Blinder Decomposition Results

Table 2 presents the results from the Oaxaca-Blinder decomposition using less-than-high-school and college completed as categories to calculate the differences. The model predicts health status only using height quintile as explanatory variable for different age groups where we observe rising health inequalities (40-50, 50-60, 60-70). The results in the 40-50 age group suggest that the explained effect for different height distribution between low and high educated individuals increases for men over cohort with the exception of 1962. For women the increasing important role of height is less evident over cohorts. Moreover, in the other age groups differential height distributions do not seem to increasingly explain health differences between low and high educated groups. The part unexplained by height represents the differing return to height for low and high educated individuals. Higher height is associated with better self-reported health more for the less-than-high-school educated than college educated in the 40-50 age group. Being tall in a low educated group represents over time more an advantage than having the same stature in the college educated group. These results seem to hold only in the 40-50 age group. This increasing discrepancy in health in the middle age is evident also in Table 3 where the decomposition is applied within different educational groups. College educated individuals experience improving health between 1962 and 1937, but people with less than high-school education have worsening selg-reported health. In the least educated group height distribution explain 6 % for men and 3 % for women of this increasing disadvantage.

Conclusions

This analysis studies how the selection into education based on height changed over cohorts. We hypothesized a weaker predictive power of height for education over cohorts. The results suggest that height does not seem to be an important determinant of less-than-high-school and some college education, since the gap between first and fifth height quintile disappears over cohorts. However, substantial differences remain in the probability of achieving high-school and college education. Therefore, height is not becoming a weaker predictor of education for achieving high-school and college degree. The second question examines how the changing group composition in terms of height influences the rising health disparities in health. In particular, shorter height is considered as a proxy for disadvantaged childhood conditions. We find weak evidence in support of this hypothesis, since height distribution seems to increasingly account for rising health inequalities only in 40-50 age group. In the other age groups height does not increasingly predict health differences over cohorts. However, height is imprecise measure of childhood circumstances since we cannot control for confounding genetic factors. Moreover, improvements in the environment in terms of improved nutrition and fewer infective disease in the second part of last century could outweigh the disadvantages experienced at the family level. It is important to continue researching on how differential selection might influence results on trends over time.

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Tables and Figures

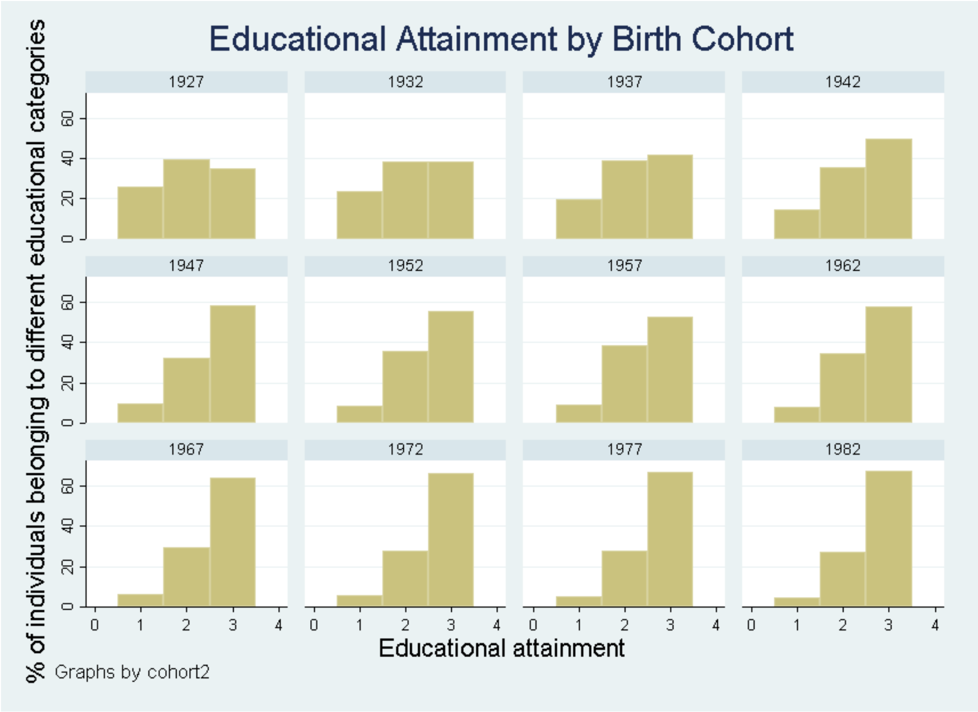

Fig 1 Proportion of non-Hispanic white men with less-than-high-school (1), high-school (2) and some-college-or-more education (3) (authors' calculations using NHIS data)

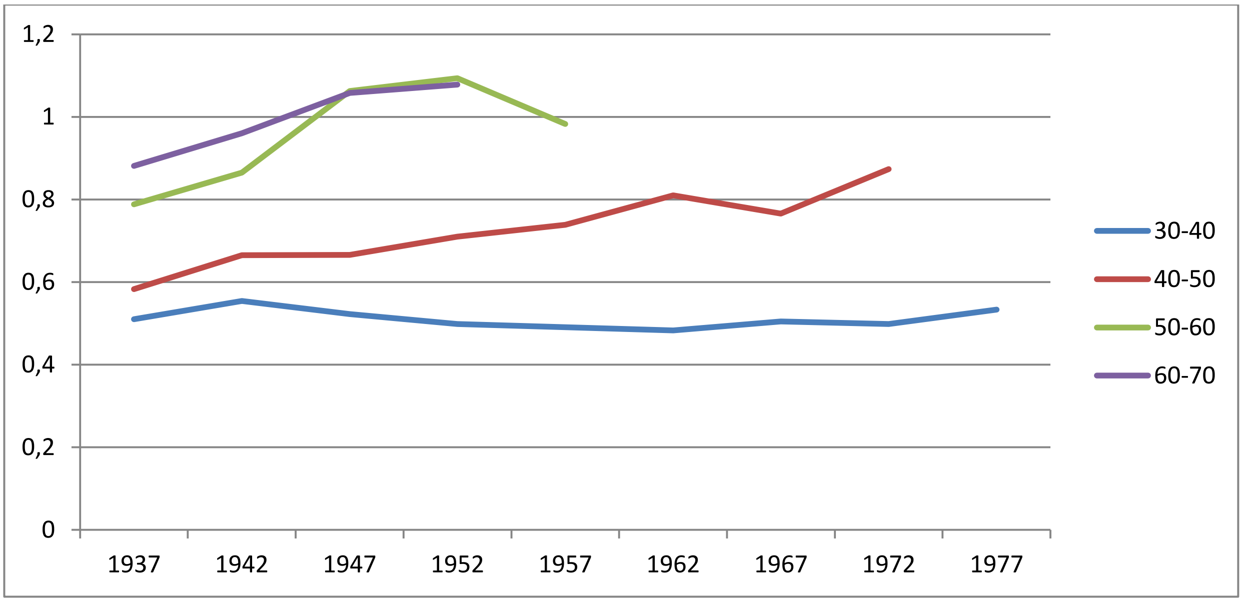

Fig 2 Health difference between low and high educated individuals over cohort for different age groups for non-Hispanic white men

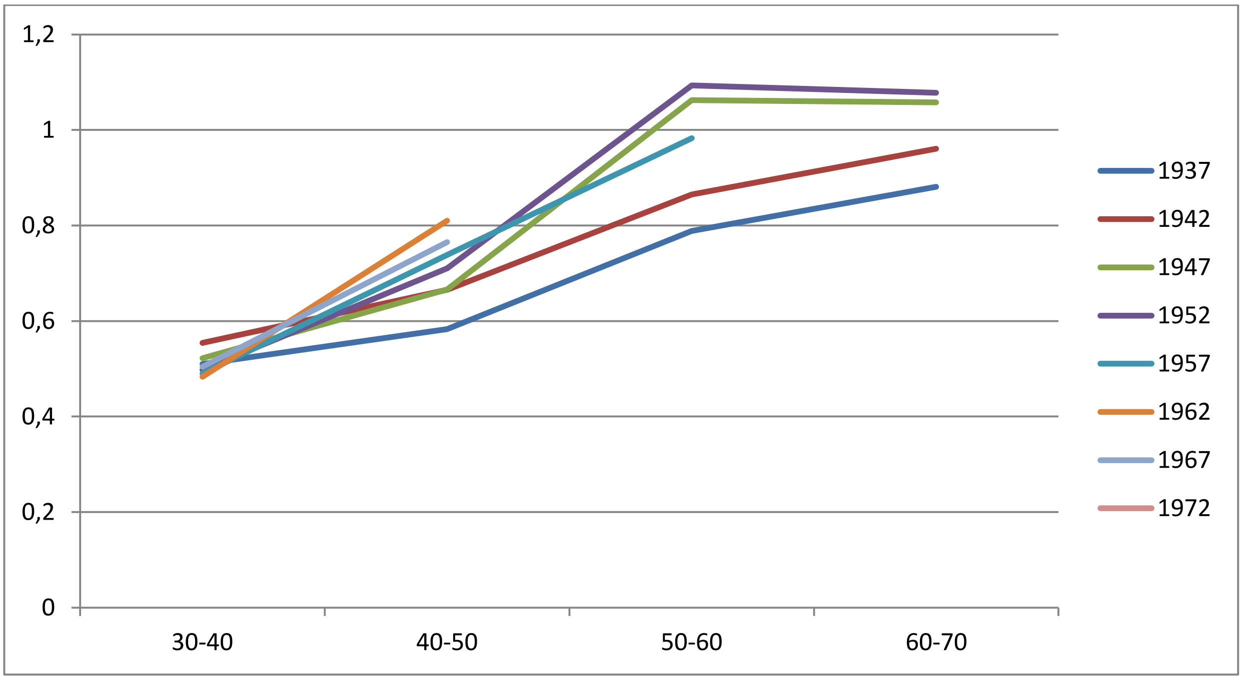

Fig 3 Health difference between low and high educated individuals over age for different cohorts for non-Hispanic white men

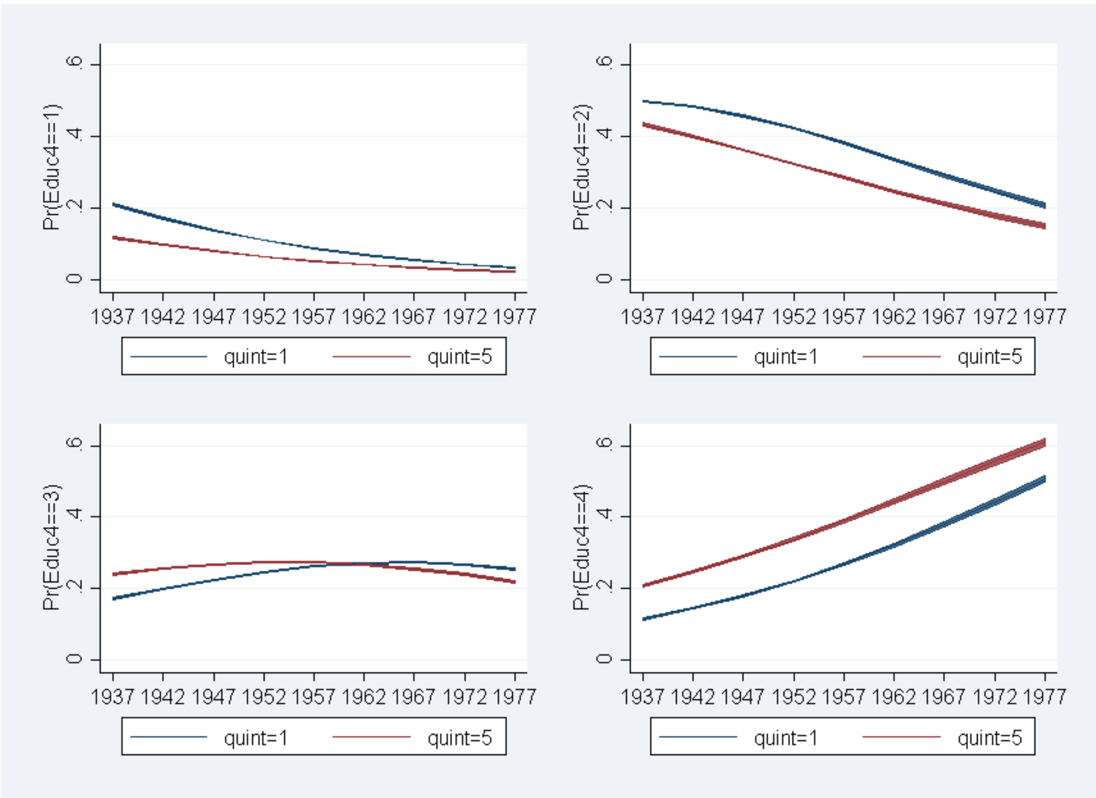

Fig 4 Predicted probability of achieving less than high school(educ4=1), high-school (=2), some college (=3) and college (=4) for non-Hispanic white men in the first and fifth quintile (age 30-60)

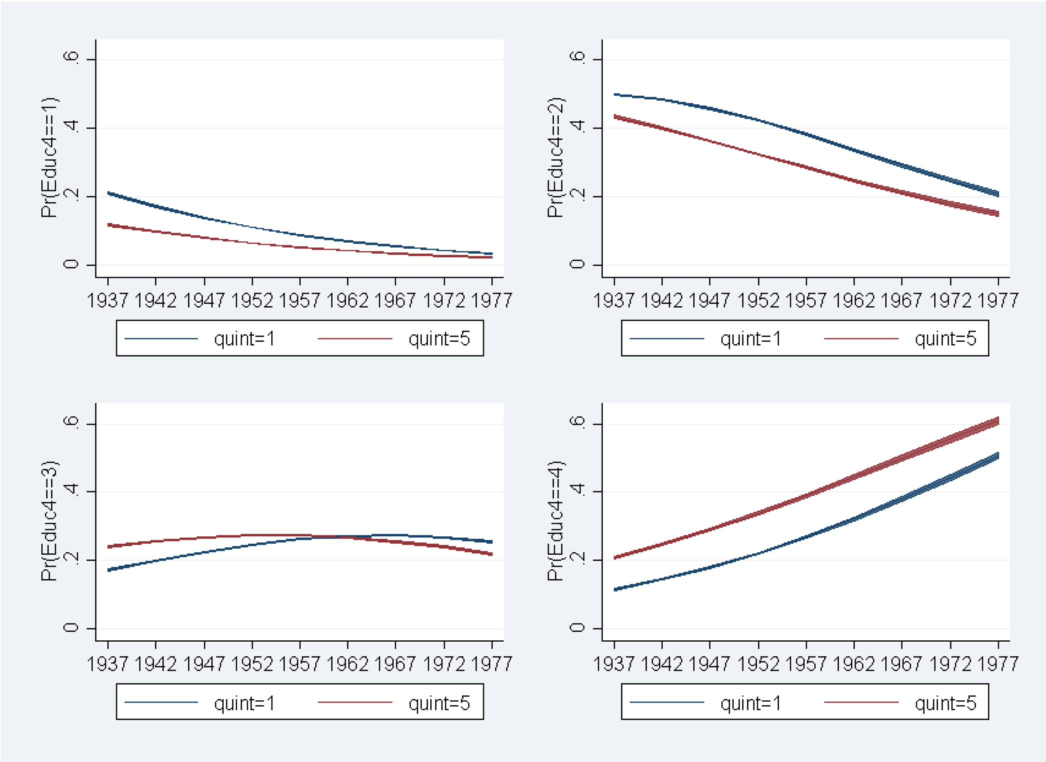

Fig 5 Predicted probability of achieving less than high school(educ4=1), high-school (=2), some college (=3) and college (=4) for non-Hispanic white women in the first and fifth quintile (age 30-60)

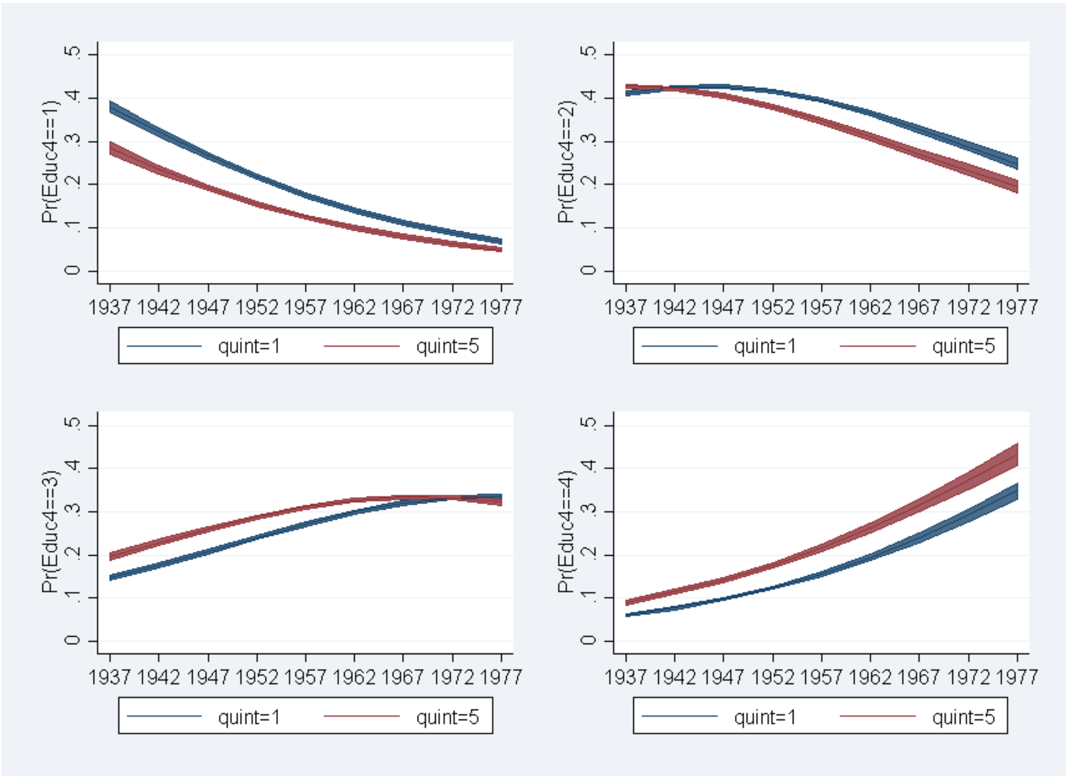

Fig 6 Predicted probability of achieving less than high school(educ4=1), high-school (=2), some college (=3) and college (=4) for non-Hispanic black men in the first and fifth quintile (age 30-60)

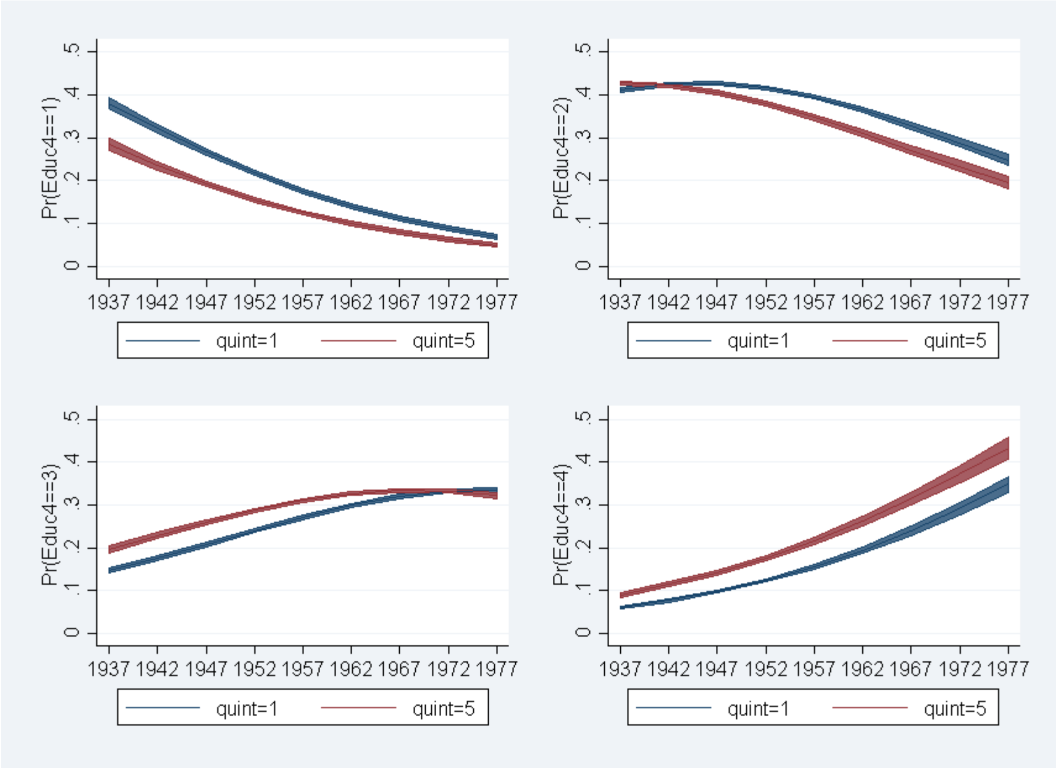

Fig 7 Predicted probability of achieving less than high school(educ4=1), high-school (=2), some college (=3) and college (=4) for non-Hispanic black men in the first and fifth quintile (age 30-60)

Table 2 Oaxaca-Blinder decomposition: explained and unexplained part

	White men		White Women	
	40-50		**40-50**	
Birth cohort	Explained by height quintile	Unexplained by height quintile	Explained by height quintile	Unexplained by height quintile
1937	1%	-2%	1%	-7%
1942	2%	-15%	0%	4%
1947	2%	-7%	-1%	6%
1952	5%	-27%	2%	-5%
1957	5%	-18%	3%	-11%
1962	1%	-9%	4%	-23%
	50-60		**50-60**	
1937	2%	-5%	0%	1%
1942	-1%	7%	1%	-6%
1947	3%	-12%	-1%	10%
1952	2%	-5%	1%	2%
1957	3%	-11%	1%	-3%
	60-70		**60-70**	
1937	0%	8%	-1%	13%
1942	2%	-7%	4%	-14%
1947	-1%	14%	0%	2%

Table 3 Oaxaca-Blinder decomposition between two different periods for different educational groups (age 40-50): explained and unexplained part

	College	Less than high-school	College	Less than high-school
1937 to 1962	Men		Women	
Health gap	-0.0062239	0.2205677	-0.03215	0.23841
Explained by height quint	0.00346	0.0130351	0.00341	0.007225
Explained by age	-0.0036443	-0.00076	-0.00409	0.011829
Unexplained by quint	-0.0083725	-0.138213	-0.05027	-0.16366
Unexplained by age	0.7118421	1.634337	0.951713	2.357963
Unexplained by constant	-0.7095092	-1.287831	-0.93291	-1.97494

Appendix

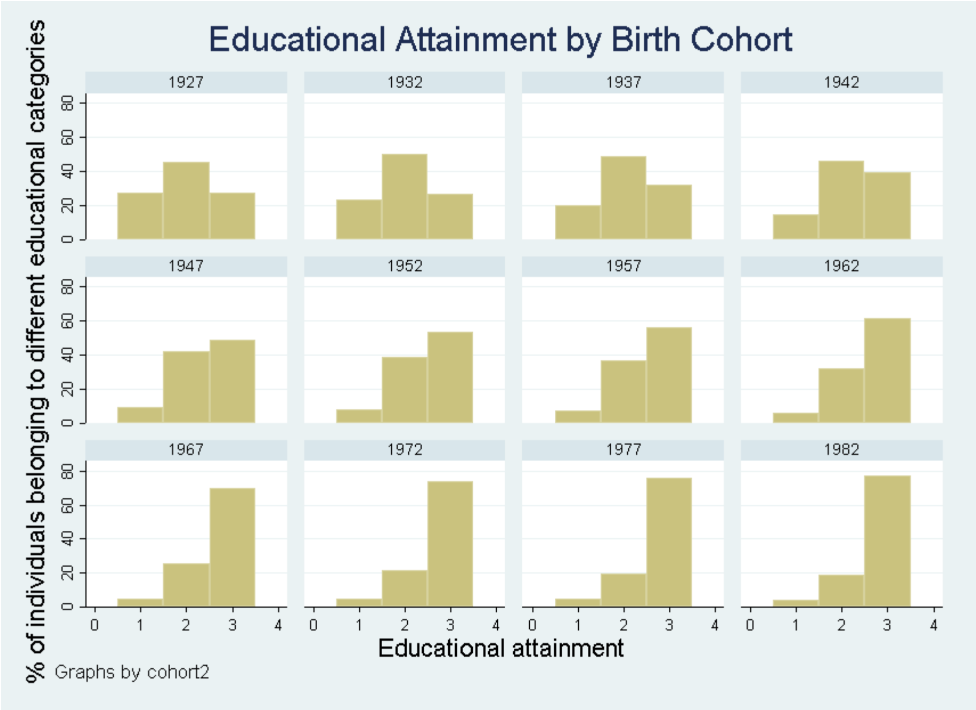

Fig 2 Proportion of non-Hispanic white women with less-than-high-school (1), high-school (2) and some-college-or-more education (3) (authors' calculations using NHIS data)

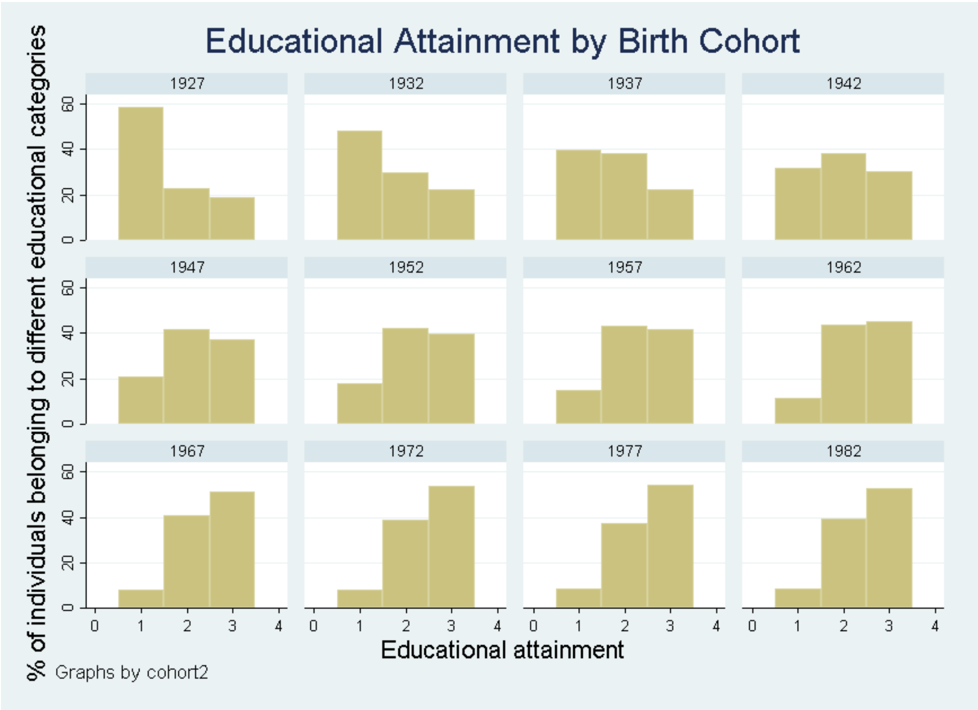

Fig 3 Proportion of non-Hispanic black men with less-than-high-school (1), high-school (2) and some-college-or-more education (3) (authors' calculations using NHIS data)

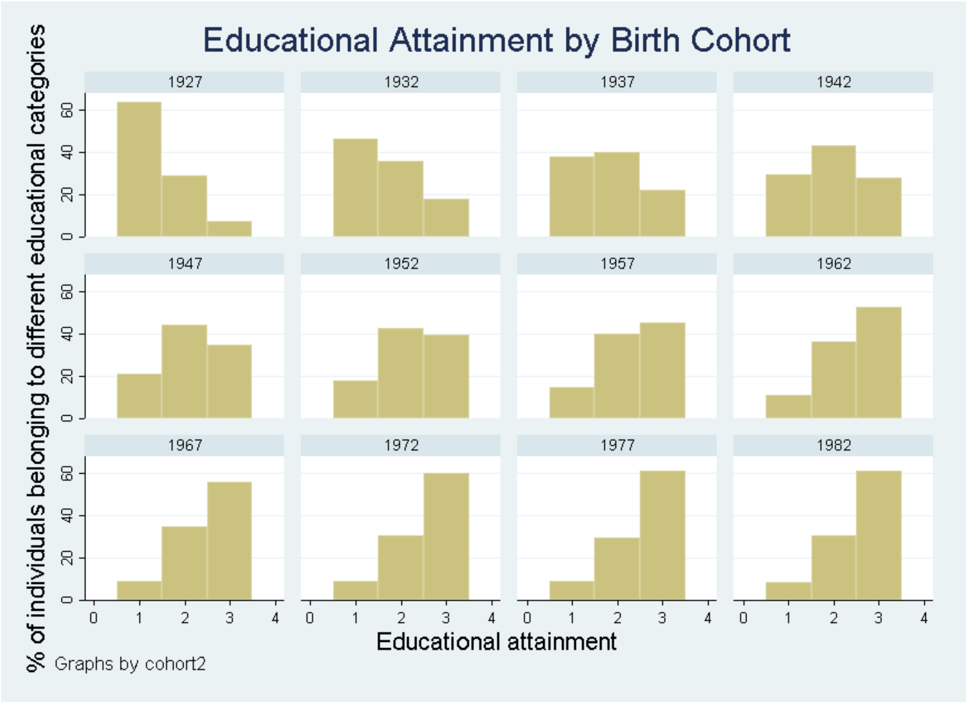

Fig 4 Proportion of non-Hispanic black women with less-than-high-school (1), high-school (2) and some-college-or-more education (3) (authors' calculations using NHIS data)

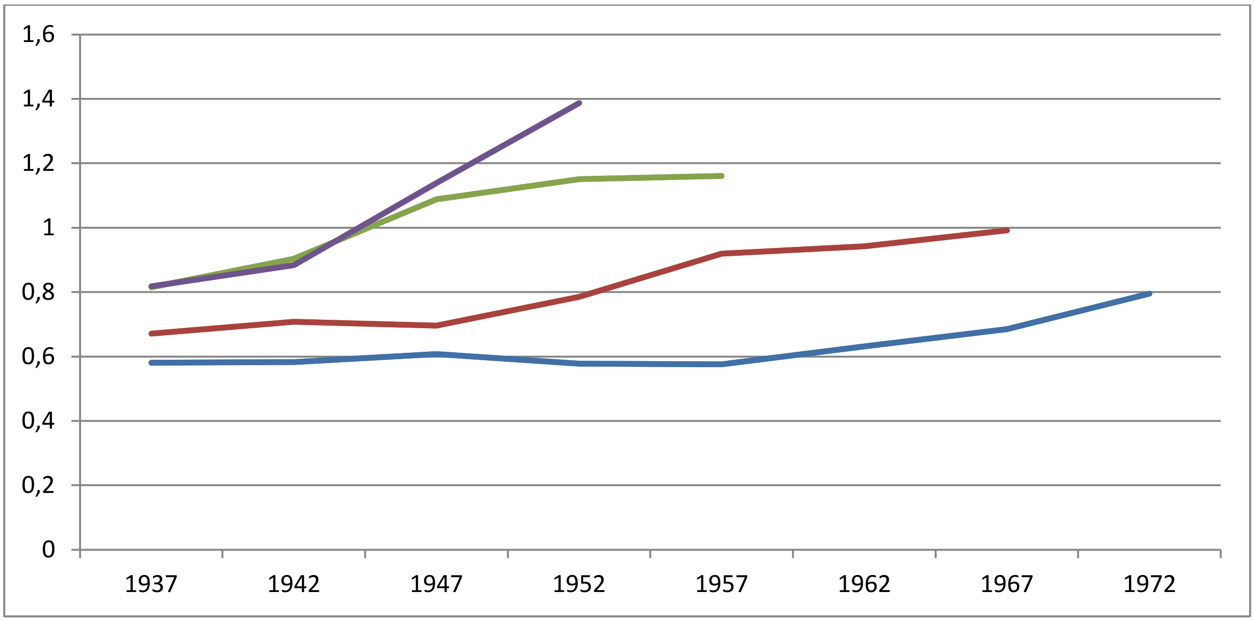

Fig 5b Health difference between low and high educated individuals over cohort for different age groups for non-Hispanic white women

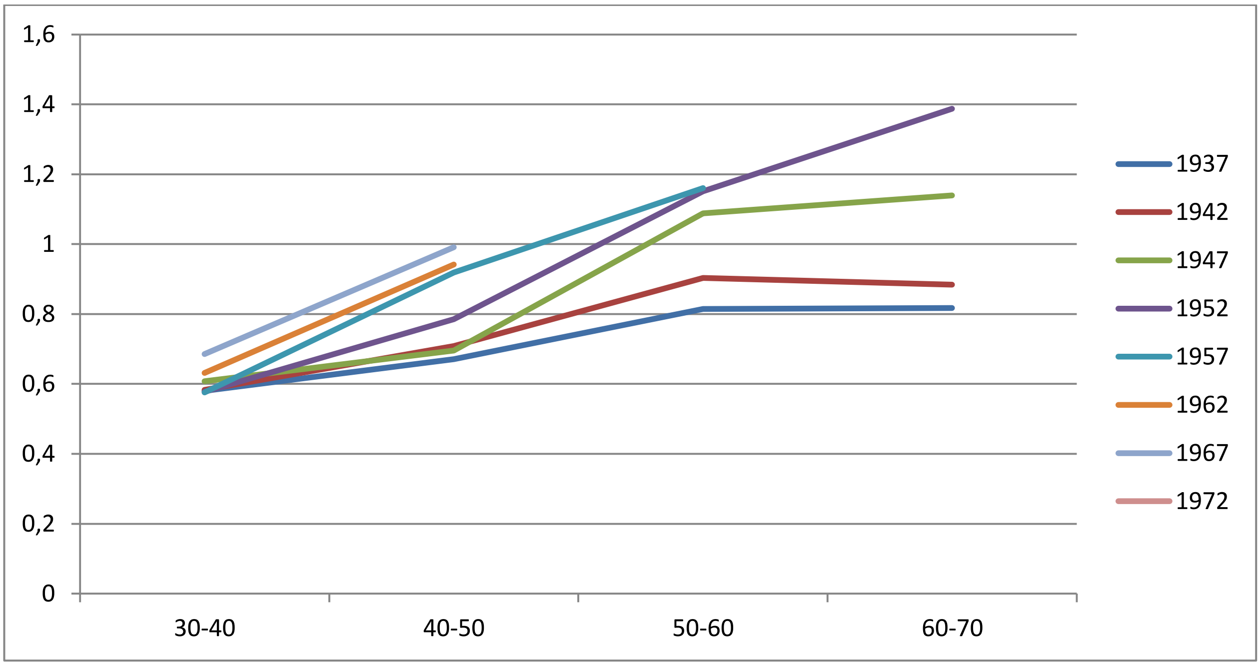

Fig 6b Health difference between low and high educated individuals over age for different cohorts for non-Hispanic white women