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Amplified disparities: The association between spousal education and own health

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ABSTRACT

Positive associations between own educational attainment and own health have been extensively documented. Studies have also shown spousal educational attainment to be associated with own health. This paper investigates the extent to which spousal education contributes to the social gradient in health, net of own education; and whether parts of a seeming spousal education effect are attributable to differences in early-life human capital, as measured by respondents' height and childhood living standard. Furthermore, we investigate the relative contribution of predictors in the regression analysis by use of Shapley value decomposition. We use data from a comprehensive health survey from Northern Norway (conducted in 2015/16, N = 21,083, aged 40 and above). We apply three alternative health outcome measures: the EQ-5D-5L index, a visual analogue scale (EQ-VAS) and self-rated health. In all models considered, spousal education is generally positively significant for both men and women. The results also suggest that spousal education is generally more important for men than women. In the sub-sample of individuals having a spouse, decomposition analyses showed that the relative contribution of spousal education to the goodness-of-fit in men's (women's) health was 13% (14%) with the EQ-5D-5L; 25% (20%) with the EQ-VAS and; 30% (21%) with self-rated health. Heterogeneity analyses showed stronger spousal education effects in younger age groups. In conclusion, we have provided empirical evidence that spousal education may contribute to explaining the amplified health gradient in an egalitarian country like Norway.

1. Introduction

In the literature on social inequalities in health, educational attainment is a widely used indicator of individuals' socioeconomic position. Studies evidenced the consistent positive association between educational attainment and health, commonly referred to as the education gradient in health. Compared to less educated people, the more educated have better self-rated health (Mirowsky and Ross, 2008; Zajacova et al., 2012); fewer chronic conditions (Johnson-Lawrence et al., 2017; Quiñones et al., 2016), and; less functional limitations and disability (Schoeni et al., 2005; Tsai, 2017; Zajacova and Montez, 2017). The education-health gradient is evident in both men and women (Zajacova, 2006).

Three theoretical perspectives have been suggested in the literature for the educational gradient in health: The *fundamental cause theory* (Link and Phelan, 1995) seeks to explain why the association between socioeconomic status and health disparities has persisted over time. The theory posits that social factors such as education are 'fundamental' causes of health and disease, because they embody an array of resources, such as income, knowledge, and prestige (Cutler and Lleras-Muney, 2006; Zajacova and Lawrence, 2018), healthier lifestyles (Zajacova and Lawrence, 2018), or beneficial social connections (Clouston and Link, 2021; Ross and Wu, 1995) and therefore protect or improve health. The *human capital theory* considers education as a highly instrumental and necessary investment that yields returns via increased productivity (Becker, 1993). Hence, education improves individuals' knowledge and skills that can ultimately shape health and wellbeing (Mirowsky and Ross, 2003; Ross and Mirowsky, 1999). Third, the *credentialing perspective* (Collins et al., 2019; Spence, 1973) emphasizes that it is the credential (i.e., college degree) that gives an individual an opportunity

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to get good jobs with better pay (Ross and Mirowsky, 1999), meanwhile, quality and better-paid jobs are generally beneficial for health and wellbeing (Grzywacz and Dooley, 2003; Henseke, 2018; Hobson, 2007). Thus, all three perspectives postulate a causal relationship between education and health, and identify several, and partly overlapping, mechanisms through which education influences health.

There is also growing evidence of the existence of reverse causation: healthier children and adolescents are more likely to complete higher levels of education (Case et al., 2005; Haas, 2006; Jackson, 2009). Good health increases subjective life expectancy, which can increase future orientation and long-term investments such as higher education (Cutler and Lleras-Muney, 2008). This mechanism that health predicts educational attainment does not necessarily mean that health affects educational attainment, rather it could imply that health is *correlated with other early life advantages* that affect educational attainment (Lynch and von Hippel, 2016). For example, parents with a higher socioeconomic position tend to have children who are *both* healthy *and* have strong cognitive and academic skills (Hayward and Gorman, 2004; Lynch, 2011; Palloni, 2006).

In addition to these positive associations between *own* educational attainment and health, several studies have documented a positive association between *spousal* educational attainment and own health, both in terms of self-rated health (Brown et al., 2014; Guo et al., 2020; Halpern-Manners et al., 2022; Huijts et al., 2010; Li et al., 2013; Monden et al., 2003; Nilsen et al., 2012), and life expectancy (Bosma et al., 1995; Egeland et al., 2002; Jaffe et al., 2005, 2006; Kravdal, 2008; Saito et al., 2020; Skalická and Kunst, 2008; Spoerri et al., 2014). Gender differences in this relationship are mixed depending on the institutional context and which health indicators are considered. Studies from the US and the Netherlands, using self-rated health as an outcome, suggest that women benefit more from having a highly educated husband than men do from their wives' education (Brown et al., 2014; Halpern-Manners et al., 2022; Monden et al., 2003). Studies from the Netherlands, Norway and Sweden, using mortality and risk of coronary heart disease as outcomes, all showed a protective effect of wives' education (Bosma et al., 1995; Egeland et al., 2002; Skalická and Kunst, 2008; Torssander and Erikson, 2009). A study from Finland found that having a partner with basic education was particularly strongly associated with long-term fatality in women (Kilpi et al., 2018). Lastly, a Chinese survey of identical twins, showed that wives' education reduces husbands' chronic diseases, while husbands' education was less important for wives' health (Guo et al., 2020).

When seeking to explain a *causal* mechanism for the observed associations between spousal education on own health, some overlapping concepts are used, such as 'crossover effects' (Halpern-Manners et al., 2022), and 'spillover influence' (Kilpi et al., 2018). Couples enforce habits and norms, thereby creating externalities on each other. To the extent that higher education is associated with more healthy habits, there are *protective effects* of having a highly educated spouse. Furthermore, having a partner with higher education improves material wellbeing through pooled resources, which in turn affects health behaviour and health (Monden et al., 2003; Umberson, 1992).

However, beyond such *protective effects*, the education level of the spouse may also serve as an indicator for unobserved heterogeneity in *pre-union health*, i.e., before the choice of partner. This is based on a matching selection argument, that your attraction in the *marriage market* depends on your aggregate human capital, which includes your prior health capital and socio-economic background, in addition to your educational capital. Thus, the higher your pre-union human capital, the more likely you match a partner with high education. Having a higher educated spouse might therefore be a signal of having *initially* better health, as caused by fortunate childhood conditions, i.e., a *selection effect* (Guner et al., 2018). If healthier and highly educated individuals seek out and marry individuals who are also healthier and highly educated – spouse resemblance in health and education through mate selection (Monden, 2007; Schwartz, 2013) then partners' education and health outcomes would be *correlated* and not necessarily explained by causal mechanisms.

Although research has consistently documented a strong association between spousal education and various health outcomes, few studies have considered the influence of pre-union human capital variables in this relationship. A recent study from the US included some 'pre-union characteristics' related to cognitive ability and individuals' health and health behaviours prior to marriage, in the relationship between education and self-rated health among married couples (Halpern-Manners et al., 2022). A Norwegian study included mothers' and fathers' education on the association between education and mortality (Kravdal, 2008). However, we have not found other studies that have adjusted for early life circumstances that impact adult health.

The current paper extends the literature in several important ways: First, rather than showing yet another association between spousal education and own health, we focus on the extent to which the additional contribution from spousal education is *amplifying* the social gradient in health. Second, by use of two variables that are theoretically linked to variations in early-life human capital, we show that parts of a seeming spousal education effect can be explained by differences in pre-union health. Third, in addition to the widely used self-rated health measure, we apply two alternative health-related quality of life (HRQoL) measures: the five-dimensional generic preference-based descriptive system; EQ-5D-5L, as well as respondents' direct valuation of overall health using a visual analogue scale; EQ-VAS.

By use of a comprehensive dataset, we investigate the degree to which the education-health gradient is amplified when accounting for the contribution of spousal education level. More specifically, this paper aims to answer the following key questions: i) What is the sex-specific effect of spousal education on health, net of own education and two indicators of variations in pre-union human capital? ii) What is the relative contribution of own education, spouse's education and pre-union human capital, for the overall explained variation in health?

2. Materials and methods

2.1. Data

We used data from the seventh wave of a prospective cohort study of the population residing in the largest city in Northern Norway (conducted in 2015/16). The study population (N = 21,083, aged 40 and above) is considered broadly representative of the Norwegian adult population, with individuals holding a university degree being slightly overrepresented. The design of this Tromsø Study is described in detail elsewhere (Jacobsen et al., 2012). The study was approved by the Regional Committee for Medical and Health Research Ethics (ID, 2016/607). All participants gave written informed consent before admission.

Given the small amount of missing data, the analysis was performed using complete data, and no imputation was performed. The largest missing value was observed on one of the key outcomes (EQ-5D-5L, with <4% missing values).

2.2. Variables

2.2.1. Outcome variables

Health was measured by use of three alternative variables: i) a multi-item descriptive system (EQ-5D-5L); ii) a numerical rating scale (EQ-VAS), and; iii) a single-item descriptive rating scale (self-rated health). The EQ-5D-5L is a generic preference-based descriptive system that includes five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, each with five severity levels (*no problems*, *slight problems*, *moderate problems*, *severe problems,* or *unable to/extreme problems*) (Herdman et al., 2011). It defines 3125 possible health state profiles, which are scored using a preference-based value set. The EQ-5D-5L index is anchored on a [0 to 1] scale, with 1 indicating 'full health' and 0 representing being dead. Negative values are allowed for health state combinations that are considered worse than being dead. In the absence of a Norwegian value set, we applied an amalgam value set based on four Western countries' preference pattern (WePP), including Canada, England, the Netherlands, and Spain (Olsen et al., 2018).

The EQ-VAS score is based on respondents' direct valuations of their overall health on a vertical visual analogue scale that ranges from 0 (*worst imaginable health*) to 100 (*best imaginable health*). To ease the comparison of the coefficients with the EQ-5D-5L index, we rescaled the EQ-VAS scores to [0–1].

Self-rated health is a widely used indicator of subjective health, based on the single item question: 'How do you in general consider your own health to be?', with five response levels: *Very bad*, Bad, *Neither good* nor *bad*, *Good*, *Excellent*. We dichotomised the five response options by collapsing them into two categories: those that reported Very bad, Bad, Neither good nor bad = 0, for Not good health, *vs* those that reported Good, Excellent = 1, for Good health.

2.2.2. Explanatory variables

The main variables of interest are the educational attainments of the respondent and the spouse, categorized in line with the International Standard Classification of Education (ISCED). Respondents were asked to report the highest education completed along with four levels: 1) primary (including lower secondary); 2) secondary (including vocational); 3) tertiary low (less than 4 years of university study); and 4) tertiary high (4 years or more of university study). Spousal education was initially measured based on the same four levels. We further included *not having a spouse* and set it as the reference level, such that all four-level of spousal education were estimated. Thus, this reference category includes all respondents who for whatever reason do not have a *current* partner, i.e., they might be single, widowed, separated, or divorced.

We adjust for two indicators of pre-union human capital that affect adult health. Height is a proxy for birth size (Jelenkovic et al., 2018; Sorensen et al., 1999), and a marker of variation in early nutrition (Perkins et al., 2016). Because height varies with sex and age, the height variable was estimated separately for men and women by five-years age cohorts. Eventually, those with heights at the 20th percentile and below were defined as 'short' and those at the 80th percentile and above as 'tall'. The remaining 60% (medium height) is used as a reference category.

Childhood living standard was measured by the question: "How was your family's financial situation during childhood?", with response options: *very good*, *good*, *difficult*, *very difficult*. Due to few respondents in the lowest category (<2%), 'very difficult' was merged with 'difficult'. We used 'good' as the reference group, and trace the health effects of having experienced deprived or privileged material circumstances in early life. Similar indicators have been used to proxy childhood socioeconomic circumstances in a range of epidemiological studies (Listl et al., 2018; Straughen et al., 2013).

2.3. Statistical analyses

Fig. 1 illustrates our analytical framework. Respondents report their *current* health by use of three different measures, and provide information on key predictors that refer to their past. Model-1 is denoted by arrow ① to explain the association between own education and health, i.e., the simple reference case model. Model-2 further includes arrow ② showing the extent to which the additional contribution of spousal education is amplifying disparities in health. Finally, the full Model-3 includes arrows ③ to capture the lasting impacts of early-life human capital on adult health. The three dotted arrows ④, ⑤ and ⑥ suggest that individuals' *pre-union* human capital, as revealed by their height, childhood living standard and own educational attainment, contribute to explaining spouses' educational attainments.

Regression analyses were firstly conducted for all three models using the full sample. To better present the spousal education level effect, we further conducted regression analyses based on model specification 3 and using a subsample of respondents who have spouse denoted by Model-3HS. Consequently, the reference group of spousal education become the lowest level of primary education in this subsample analyses.

In all models, ordinary least squares regression was applied when EQ-5D-5L and EQ-VAS were used as health outcomes, whereas a binary logistic regression was employed when self-rated health was used as the outcome. Eventually, we apply Shapley value decomposition to quantify the relative contribution of each explanatory variable in the model (Lamu and Olsen, 2016; Shorrocks, 2013).

Binary logistic regression models were applied to estimate the probability of having a spouse with tertiary education depending on the two indicators of early-life human capital (relative height and childhood living standard) and own education levels. This enables us to identify any influence of a selection effect of a spouse's education on own health; i.e., by comparing estimations from Models 2 and 3, we can identify the degree to which some of the seeming spouse effects stem from selection mechanisms.

In the regression analyses we initially explored the potential heterogeneity by testing interaction effects between education and sex (detailed results are not reported). The effects of both own- and spousal-education levels on HRQoL are significantly different for men and women ($p < 0.01$). Thus, alternative linear regression models were estimated separately for men and women (in which age was consistently included).

Acknowledging the cohort differences in the distribution across education levels, particularly so for women, we conducted regression analyses by two age groups (40–59 years and 60+ years) for the full model, separately for men and women.

3. Results

3.1. Descriptive statistics

Characteristics of the study sample by sex are shown in Table 1. More

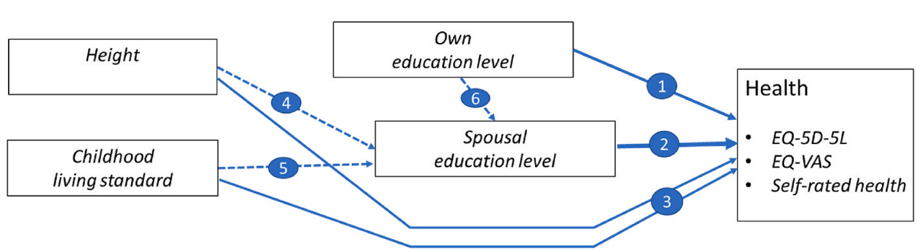

Fig. 1. Analytical framework Arow ① denotes a base model with only own education as a predictor of health (Model-1); Arrow ② shows the extent to which spousal education is widening the health gap (Model-2); Arrows ③ capture the lasting impacts of early life human capital on adult health. The three dotted arrows – ④, ⑤, and ⑥ – control for individuals' *pre-union* human capital in the association between spouses' educational attainments and health.

Table 1
Sample characteristics by sex.

Variable	Men		Women	
	N	Mean (SD)/%	N	Mean (SD)/%
Own education (%)				
Primary	2179	22.2	2617	24.1
Secondary	2997	30.5	2759	25.4
Tertiary low	2091	21.3	1917	17.6
Tertiary high	2564	26.1	3581	32.9
Spouse education (%)				
No spouse	1363	14.3	2153	20.1
Primary	1633	17.1	1784	16.6
Secondary	2481	26.0	2892	26.9
Tertiary low	1689	17.7	1630	15.2
Tertiary high	2386	25.0	2279	21.2
Height[a] (%)				
Short	2015	20.2	2223	20.1
Medium	5947	59.6	6584	59.6
Tall	2021	20.2	2233	20.2
Childhood living standard (%)				
Difficult	2569	26.3	2667	24.6
Good	6659	68.2	7491	69.2
Very Good	530	5.4	667	6.2
Self-rated health (%)				
Good	6855	68.9	7435	67.8
Not good	3088	32.1	3525	32.2
EQ-5D-5L index	9631	0.90 (0.10)	10,648	0.88 (0.11)
EQ-VAS score	9827	0.76 (0.16)	10,840	0.76 (0.17)
Age, range [40–93]	10,009	57.4 (11.4)	11,074	57.2 (11.5)

Self-rated health, was converted to a binary variable (from its original five levels; 0 = Very bad, Bad, Neither good nor bad *vs* 1 = Good, Excellent).
EQ-5D-5L: Five-level EQ-5D, based on the WePP value set (Western Preference Pattern, hybrid of four Western countries' value sets); *VAS*: Visual Analogue Scale, converted to [0–1] scale.
[a] Short refers to the shortest 20%, and Tall, the tallest 20%, within each subgroup split by sex*5-years age cohort, with the remaining 60% as the reference group.

women than men had 'tertiary high' education (32.9 vs 26.1%), which reflects a general trend of increasingly high education levels among women. Nearly a quarter of both men and women reported difficult childhood living standards. The mean age was 57 years for both sexes. On average, men reported significantly higher EQ-5D-5L index than women ($p < 0.05$). For the EQ-VAS and self-rated health, sex differences were negligible.

Appendix Table A1 provides a cross-tabulation on educational homogamy and heterogamy. Within each education level, educational homogamy accounts for the highest proportion, with the only exception of females with tertiary low education. Overall, the highest educational homogamy was observed among those with a tertiary high in both men and women.

Fig. 2 presents the age-adjusted mean HRQoL scores by own and spousal education, split by sex. Generally, the largest disparities are observed between those who have primary education without a spouse, and those with the highest education levels in both self and spouse (see more details in Table A2). For example, consider the mean *EQ-VAS* for *men*: The black solid line shows disparities based on own educational attainment only, i.e., without considering any spousal influence, indicating a gap in mean EQ-VAS between the highest and the lowest education levels of 0.056 (= 0.792–0.736), on a 0–1 scale. Then, by including spousal education, the gap between the highest (high tertiary education for both self and spouse), and the lowest (own primary education and no spouse) becomes 0.089 (= 0.799–0.710). The corresponding gaps in EQ-5D-5L are 0.030 and 0.054. For men, it appears to be relatively more important for their health to have a spouse, see Fig. 2 that shows large consistent differences between not having a spouse vs the lowest education level of the spouse. While Fig. 2 seeks to illustrate how disparities are amplified when accounting for differences in spousal education, Figs A1 and A2 illustrate the incremental health gains associated with increasing levels of spousal education.

3.2. Regression results

Table 2 presents results for linear regression models explaining variations in EQ-5D-5L. Model-1 shows the age-adjusted (own-)education-health gradient. For instance, compared to primary education, having the highest education level was associated with better health by 0.030 for men and 0.038 for women. Model-2 further includes spousal education, suggesting significant positive effects on EQ-5D-5L. When accounting for pre-union human capital in Model-3, these associations were slightly attenuated.

For men, the difference between *No-spouse* and having a spouse with the *lowest* education level is twice as high as it is for women (0.020 vs 0.009). The remaining difference in the coefficients between the lowest spouse education (primary) *vs* the highest spouse education (tertiary high) appeared quite similar for men and women. These effects were largely maintained in Model-3, after adjusting for relative height and childhood living standards. Childhood living standard was significantly associated with EQ-5D-5L in both men and women, but more strongly in women. For example, experiencing childhood financial *difficulty* reduced HRQoL by 0.020 in men and 0.029 in women compared with having *good childhood* financial circumstances. Height was only marginally significant for men. The results based on a sub-sample of respondents who have spouse, Model-3HS, are quite similar to Model-3 that uses the full sample, except for spouse education: only tertiary high spouse education significantly influences EQ-5D-5L in Model-3HS.

Tables 3 and 4 provide parallel regression estimates when health is measured by EQ-VAS and self-rated health, respectively. The coefficients for own education levels were slightly attenuated when we move from Model-1 to Model-2; when we move from Model-2 to Model-3, both own- and spousal-education coefficients were slightly attenuated. Interestingly, the results from the full sample (Model-3) and a sub-sample of respondents having spouse (Model-3HS) were consistent, i.e., spouse education is positively associated with health net of own education in both men and women. Thus, the general findings from Tables 2–4 imply the presence of a significant spousal education gradient in health.

Table 5 presents the relative contributions of each explanatory variable in the explained overall variance of health. In the full sample, spousal education appears to be twice as important for men than for women: For men, the spouse's education contributed 29% of the EQ-5D-5L; 34% of EQ-VAS and; 31% of self-rated health, while, for women, the relative contributions of the spouse's education were 15%, 15% and 16%, respectively. In the sub-sample of individuals having a spouse, spousal education was still generally more important for men than for women: its relative contribution to the goodness-of-fit in men's (women's) health was 13% (14%) for the EQ-5D-5L; 25% (20%) for the EQ-VAS and; 30% (21%) for self-rated health.

3.3. Cohort differences

Table A3 shows the distributions of education attainments by two age groups. The most contrasting proportions were women with primary education only: 12% in the younger (40–59) age group and 42% in the older (60+) group. Thus, we further investigated heterogeneity by two age groups and sex for the full model, based on the total sample as well as the sub-sample of those having spouse (see Tables A4-A6 in the appendix). The general finding from these heterogeneity regressions is that spousal education is much more important in the younger age group, in that the coefficients are generally larger and more statistically significant, than those presented in our main analyses (Tables 2–4).

3.4. Potential selection effect

Table 6 shows the average marginal effects from logistic regression

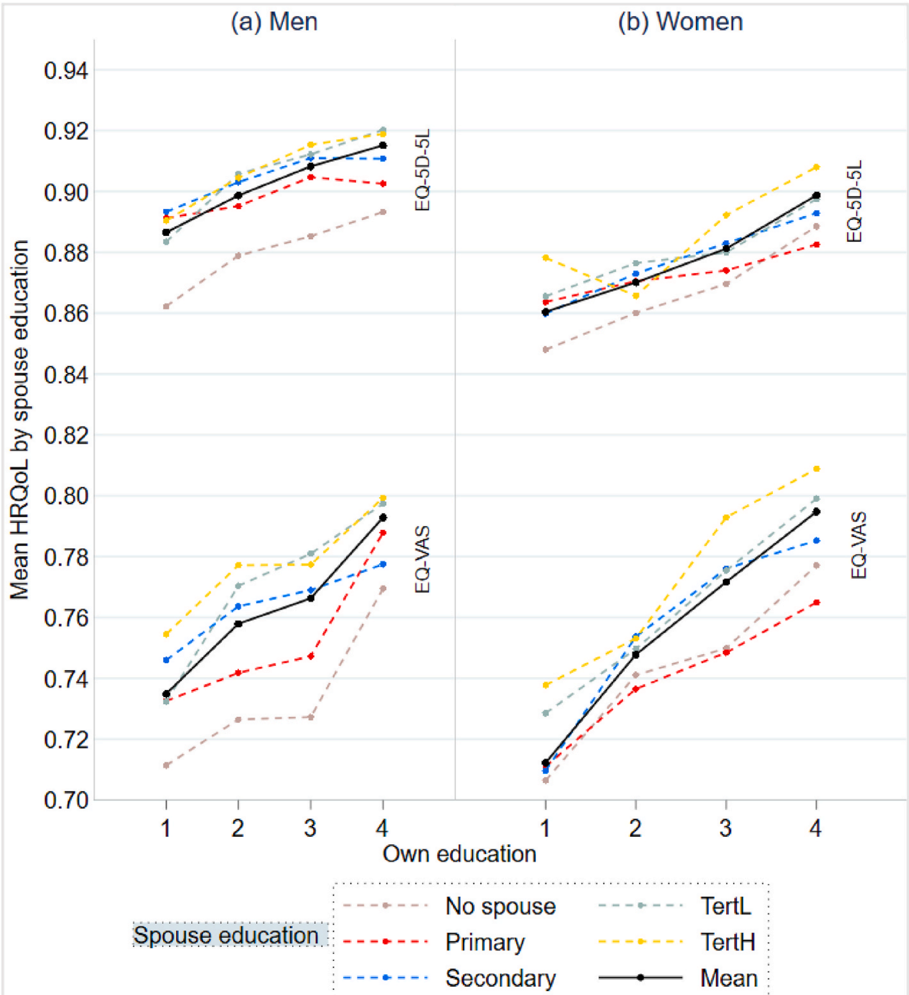

Fig. 2. The education gradient in health for each level of spouse education. *HRQoL*: health-related quality of life measured by EQ-5D-5L index and EQ-VAS score converted to [0–1] scale; *TertL*: Tertiary low (<4 years university study); *TertH*: Tertiary high (4 years and more university study). Own education on the horizontal axis is categorized along four levels: 1 (Primary and lower secondary); 2 (Secondary or vocational); 3 (Tertiary low, <4 years university study); 4 (Tertiary high, 4 years and more university study).

models exploring the probability of having a spouse with tertiary education (both low and high tertiary). The results suggested that higher pre-union human capital was more likely to match spouses with higher education. As expected, own educational gradients in having spouses with tertiary education were evident for both men and women, and quite similar in magnitude. For example, compared to own primary education, high tertiary education increased the probability of having a spouse with tertiary education by 57 percentage points. Furthermore, both variables of pre-union human capital (height and childhood living standard) were significantly associated with the likelihood of having a spouse with tertiary education. However, there were some notable sex differences: for men, height was more important (8.1 percentage points difference between being tall *vs* short), while for women, the childhood living standard was more important (8.2 percentage points difference between very good *vs* difficult childhood living standard). Thus, some of the spouse effects observed in Tables 2–4 may attribute to this selection effect.

4. Discussion

Educational attainment is a widely used socioeconomic indicator in the literature on the social gradient in health, showing that the higher your education, the better your health. When seeking to explain the mechanism that may contribute to persisting – and even *amplifying* – health inequalities, this paper investigates the association between a *spouse's* educational attainment and own health, based on a sample of 21,083 Norwegian adults. Norway is characterized by equal opportunities for publicly financed healthcare and tertiary education. The country has a policy of free education for all with generous study loans. Norway has also a long-standing commitment to gender equality in several areas including education. Hence, Norway offers a useful 'best-case' benchmark against which other countries can be compared. We showed that spousal education net of own education contributed to amplified health disparities, and this finding holds when taking into account the potential confounding effect of pre-union human capital.

This paper provides new evidence on the association between a spouse's education and own health by the use of three different health measures. In the generic multidimensional EQ-5D-5L instrument, respondents described their current health state, which was then assigned a corresponding index value based on preference-based population norms. To our knowledge, this is the first study on the association between spousal education and health to apply a multidimensional generic preference-based measure of HRQoL. In addition, respondents directly evaluate their health state on two global ratings (the EQ-VAS and self-rated health).

The first model with own education only, showed a clear gradient along the four levels of own educational attainment and health, in both sexes and for all three health measures used (Tables 2–4). The mean difference in the EQ-5D-5L index between the highest and lowest education level was 0.030 for men, and 0.038 for women. The corresponding mean differences in EQ-VAS were 0.056 and 0.079. Interestingly, a most recent study from Sweden (Teni et al., 2022) showed similar findings when measured by EQ-VAS; 0.068 in men and 0.085 in women. When measured by the EQ-5D-5L index, the gaps in

Table 2
Associations between own- and spousal educations and the *EQ-5D-5L* index.

	Men				Women			
	Model-1	Model-2	Model-3	Model-3HS	Model-1	Model-2	Model-3	Model-3HS
Own education (ref. primary)								
Secondary	0.013***	0.011***	0.010***	0.009***	0.010***	0.008**	0.007*	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Tertiary low	0.023***	0.020***	0.018***	0.018***	0.021***	0.018***	0.015***	0.011**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Tertiary high	0.030***	0.025***	0.022***	0.022***	0.038***	0.034***	0.030***	0.025***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)
Spouse education (ref. no spouse[a])								
Primary		0.020***	0.018***	–		0.009**	0.010**	–
		(0.005)	(0.004)			(0.004)	(0.004)	
Secondary		0.025***	0.023***	0.004		0.010***	0.009***	−0.0002
		(0.004)	(0.004)	(0.004)		(0.004)	(0.003)	(0.004)
Tertiary low		0.027***	0.025***	0.006		0.013***	0.010***	0.001
		(0.004)	(0.004)	(0.004)		(0.004)	(0.004)	(0.004)
Tertiary high		0.028***	0.026***	0.007*		0.021***	0.019***	0.010**
		(0.004)	(0.004)	(0.004)		(0.004)	(0.004)	(0.004)
Height[b]								
Short			−0.005*	−0.004			−0.004	−0.006*
			(0.003)	(0.003)			(0.003)	(0.003)
Tall			−0.001	−0.002			0.001	0.004
			(0.003)	(0.003)			(0.003)	(0.003)
Childhood living standard (ref. good)								
Difficult			−0.020***	−0.018***			−0.029***	−0.027***
			(0.003)	(0.003)			(0.003)	(0.003)
Very good			0.007	0.002			0.010**	0.013***
			(0.005)	(0.005)			(0.005)	(0.005)
Constant	0.875***	0.859***	0.860***	0.886***	0.860***	0.855***	0.861***	0.885***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
Observations	9473	9137	9022	7789	10,467	10,213	10,086	8136
R-squared	0.011	0.018	0.027	0.017	0.018	0.021	0.035	0.035

EQ-5D-5L: Five-level EQ-5D, based on the WePP value set (Western Preference Pattern, hybrid of four Western countries' value sets).
All models adjusted for age (in years).
Robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.
[a] Reference: primary education in Model-3HS, which includes only respondents who ***have*** *spouse.*
[b] Short refers to the shortest 20%, and Tall, the tallest 20%, within each subgroup split by sex*5-years age cohort, with the remaining 60% as the reference group.

Sweden were larger than in our study; 0.047 in men and 0.057 in women. However, note that the education-health disparities were consistently larger among women than among men in both countries. A study based on the US population also demonstrated that education has a significantly larger effect on women's health than on men's (Ross et al., 2012).

One possible explanation for the persistence of substantial socioeconomic inequalities in health in generous welfare states, such as Norway is the Nordic paradox (Mackenbach, 2012). Despite a low level of income inequalities, the Nordic countries have larger socioeconomic inequalities in health. For instance, a previous study found that relative inequalities in both morbidity and mortality were larger than average in Sweden and Norway (Mackenbach et al., 1997), a paradox that is mainly linked to the expansion of education. Such education expansion could foster intergenerational mobility and hence, a stronger social selection that may partly contribute to persistence – or even widening – health inequalities (Mackenbach, 2012). Generally, the highly educated benefit more from the recent advancement in health prevention and treatment interventions, mainly due to easier access and higher utilization of care, and better treatment adherence (Mackenbach, 2017). Furthermore, the highly educated are in a better position to avoid unhealthy behaviour (Eikemo et al., 2014; European Observatory on Health et al., 2014).

Most previous studies on the association between spousal education level and own health have focused on married couples only (e.g. Egeland et al. (2002), Jaffe et al. (2006), Brown et al. (2014), Halpern-Manners et al. (2022), except for Kilpi et al. (2018) who considered no partner as well. In our full sample, the variable used for spousal education captures both the spousal education effect, and the effect of having a spouse which in itself is health-enhancing (Goldman et al., 1995). Thus, the further levels on this variable indicate the additional advantage of *increments* in spousal education level. Note the differences between sexes: For men, the *effect of having a partner* as well as spouse education *level* effect are generally larger than for women.

Previous studies on sex differences suggest they may reflect differences in the educational attainment levels between men and women as well as institutional contexts. Based on US data, where women had lower education levels than men, Halpern-Manners et al. (2022) found spousal education had a stronger effect on women than men. In our study, women were generally more highly educated than men, particularly in the younger cohorts. Furthermore, in Norway women tend to be financially independent, and less reliant on their partner's resources. This may partially explain the differences in our findings.

It can be argued that having a highly educated spouse might signal *initially* better health prior to marriage, commonly referred to as a *selection effect* (Guner et al., 2018). We have found suggestive evidence of this effect, in that after adjusting for own education, both height (a proxy for birth size) and childhood living standard (a proxy for the *financial circumstances in early life*) influence the probability of having a tertiary-educated spouse (Table 6). We note an interesting contrast between the sexes in what tertiary-educated people look for in a prospective partner: For a man to attract a woman with tertiary education, he should to be taller than his peers. For a woman to attract a man with tertiary education, it is beneficial to come from a wealthy family background (dowry is apparently still in the mind of Norwegian men with a university degree).

The inclusion of the two variables that may contribute to explaining variations in health *prior* to the choice of partner slightly attenuated the spousal education effects, but was still significantly associated with own health. Thus, it appears that the dominant part of the associations between spousal education and own health reflects what is commonly

Table 3
Associations between own- and spousal educations and the *EQ-VAS* score.

	Men				Women			
	Model-1	Model-2	Model-3	Model-3HS	Model-1	Model-2	Model-3	Model-3HS
Own education (ref. primary)								
Secondary	0.022***	0.017***	0.016***	0.017***	0.033***	0.029***	0.027***	0.024***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Tertiary low	0.030***	0.023***	0.022***	0.023***	0.057***	0.049***	0.046***	0.045***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
Tertiary high	0.056***	0.045***	0.042***	0.040***	0.079***	0.068***	0.063***	0.060***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
Spouse education (ref. no spouse[a])								
Primary		0.018***	0.017***	–		0.002	0.002	–
		(0.007)	(0.007)			(0.006)	(0.006)	
Secondary		0.033***	0.032***	0.015***		0.012**	0.011**	0.009
		(0.006)	(0.006)	(0.005)		(0.005)	(0.005)	(0.006)
Tertiary low		0.040***	0.039***	0.022***		0.019***	0.017***	0.015**
		(0.006)	(0.006)	(0.006)		(0.006)	(0.006)	(0.006)
Tertiary high		0.043***	0.041***	0.025***		0.031***	0.029***	0.026***
		(0.006)	(0.006)	(0.006)		(0.005)	(0.005)	(0.006)
Height[b]								
Short			-0.013***	-0.012**			-0.003	-0.003
			(0.004)	(0.005)			(0.004)	(0.005)
Tall			-0.006	-0.005			0.005	0.008*
			(0.004)	(0.004)			(0.004)	(0.005)
Childhood living standard (ref. good)								
Difficult			-0.028***	-0.025***			-0.038***	-0.035***
			(0.004)	(0.004)			(0.004)	(0.004)
Very good			0.014**	0.010			0.018**	0.024***
			(0.007)	(0.008)			(0.007)	(0.008)
Constant	0.752***	0.720***	0.724***	0.743***	0.730***	0.725***	0.735***	0.749***
	(0.010)	(0.011)	(0.011)	(0.012)	(0.011)	(0.012)	(0.012)	(0.013)
Observations	9,659	9,314	9,193	7,939	10,661	10,410	10,283	8,287
R-squared	0.018	0.026	0.035	0.028	0.035	0.039	0.049	0.053

EQ-VAS: EuroQol Visual Analogue Scale, converted to [0–1] scale.
Robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.
[a] Reference: primary education in Model-3HS which includes only respondents who ***have*** *spouse*.
[b] Short refers to the shortest 20%, and Tall the tallest 20%, within each subgroup split by sex*5-years age cohort, with the remaining 60% as the reference group. All models adjusted for age (in years).

referred to as *protection effects*.

Early life *circumstances* lie outside of individuals' own control, representing *inequalities in opportunities* that cause unfair health inequalities. Previous work has considered education either as a circumstance (Davillas and Jones, 2020) or as an effort (Rosa Dias, 2009). Given the intergenerational transmission of education and social norms, own educational attainment is arguably *partly* outside of one's control, and therefore difficult to locate on the circumstances-efforts continuum. However, we are inclined to place spousal education more towards efforts, despite it being affected by childhood circumstances (Table 6). Still, we take no position as to whether the disparities in health associated with variations in spousal educational attainment should be considered fair or not.

Educational status inconsistency would be another source of social disparities in health; i.e.; status discrepancies between spouses that are inconsistent with broader social norms initiate role conflict and stress, leading to poor health (Hornung and McCullough, 1981; Pearlin, 1975). However, in the present study, there is no significant interaction between own- and spousal education, which suggests a trivial effect of status inconsistency on health in Norway.

A closer look at heterogeneity across age groups showed lower associations between spousal education and own health in older age (see Tables A4-A6). This finding is consistent with previous literature (Brown et al., 2014). However, rather than interpreting this finding as an indicator of merely diminishing effect of spousal education on own health as people get older, this can also be explained by cohort differences across the four educational levels. Interestingly, with increased education levels, we observe increased educational homogamy (Table A1) and stronger associations between spousal education and own health; i.e., the *education gap* is even stronger in the younger age groups. Such cohort differences in educational levels would likely influence the educational differences in health behaviour, particularly in smoking, and hence health. For instance, an age-period-cohort study of education, gender and smoking in Norway showed that the differences in daily smoking between tertiary and non-tertiary education groups decreased with age in both sexes (Vedøy, 2014). Still, more research using panel data is needed on the extent to which these associations would diminish or increase as people get older.

Furthermore, differential mortality between education groups among older people may explain the variation related to heterogeneity across age cohorts. Although both men and women benefited from declining mortality in recent years, relative educational inequalities in mortality periodically increased in both genders in Norway (Moe et al., 2012). The same study also showed that the trends in relative inequalities in mortality were smaller in older compared with younger age groups.

Although our analyses appear robust, some limitations of the study need to be acknowledged. First, we acknowledge the setback related to the use of cross-sectional data, which generally makes causal inferences problematic. However, the variables used follow a distinct timeline (Fig. 1) with *current* health as the outcome. For most respondents, their educational attainment was completed in their twenties, or before. We have no reason to question the accuracy of their reporting, nor their reporting of spousal education. Respondents' height was objectively measured as part of the health examination. As for childhood living standards, we acknowledge that this variable might be affected by a recall bias. However, it is interesting to observe that the distributions of respondents on the three levels were remarkably similar across age cohorts, whose *absolute* standard of living during childhood increased tremendously over time (approximately 3% p. a. GDP/capita growth

Table 4
Associations between own- and spousal educations and self-rated health.

Variables	Men				Women			
	Model-1	Model-2	Model-3	Model-3HS	Model-1	Model-2	Model-3	Model-3HS
Own education (ref. Primary)								
Secondary	0.094***	0.072***	0.067***	0.078***	0.097***	0.081***	0.072***	0.069***
	(0.014)	(0.014)	(0.014)	(0.016)	(0.014)	(0.014)	(0.014)	(0.016)
Tertiary low	0.159***	0.124***	0.117***	0.128***	0.168***	0.143***	0.132***	0.130***
	(0.015)	(0.016)	(0.016)	(0.017)	(0.015)	(0.016)	(0.016)	(0.018)
Tertiary high	0.224***	0.176***	0.165***	0.167***	0.246***	0.208***	0.193***	0.180***
	(0.014)	(0.016)	(0.016)	(0.018)	(0.013)	(0.015)	(0.015)	(0.017)
Spouse's education (ref. No spouse[a])								
Primary		0.020	0.009			0.021	0.012	
		(0.019)	(0.019)			(0.016)	(0.016)	
Secondary		0.096***	0.084***	0.071***		0.051***	0.042***	0.028*
		(0.016)	(0.016)	(0.016)		(0.013)	(0.014)	(0.014)
Tertiary low		0.127***	0.114***	0.100***		0.071***	0.057***	0.043***
		(0.017)	(0.017)	(0.018)		(0.015)	(0.015)	(0.017)
Tertiary high		0.133***	0.122***	0.109***		0.112***	0.099***	0.087***
		(0.017)	(0.017)	(0.018)		(0.015)	(0.015)	(0.017)
Height[b]								
Short			−0.027**	−0.023*			−0.016	−0.018
			(0.012)	(0.013)			(0.012)	(0.013)
Tall			−0.011	−0.005			0.009	0.010
			(0.012)	(0.013)			(0.011)	(0.013)
Childhood living standard (ref. good)								
Difficult			−0.080***	−0.069***			−0.099***	−0.090***
			(0.011)	(0.012)			(0.011)	(0.012)
Very good			0.020	0.004			0.037**	0.048**
			(0.021)	(0.023)			(0.018)	(0.020)
Observations	9782	9348	9190	7933	10,783	10,463	10,273	8273
Pseudo R^2	0.031	0.039	0.043	0.041	0.040	0.045	0.052	0.056

Self-rated health was converted to a binary variable (1 = Good, Excellent and 0 = Very bad, Bad, Neither good nor bad). A binary logit model was used, and the average marginal effects are reported.
Robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.
[a] Reference: primary education in Model-3HS which includes only respondents who *have spouse*.
[b] Short refers to the shortest 20%, and Tall, the tallest 20%, within each subgroup split by sex*5-years age cohort, with the remaining 60% as the reference group. All models adjusted for age (in years).

Table 5
Relative contribution of major predictors to health-related quality of life and self-rated health: Decomposition results.

	Full sample				Sample of those having spouse			
	Men		Women		Men		Women	
	SV	% R^2	SV	% R^2	SV	% R^2	SV	% R^2
EQ-5D-5L								
Own education	0.0066	24.6	0.0123	34.8	0.0072	41.4	0.0112	32.1
Spouse education	0.0078	29.0	0.0052	14.7	0.0023	13.0	0.0049	14.1
Height	0.0006	2.1	0.0008	2.2	0.0002	0.9	0.0015	4.4
Childhood living standard	0.0082	30.4	0.0142	40.4	0.0061	34.8	0.0137	39.4
Age (in years)	0.0007	2.6	0.0008	2.4	0.0002	1.1	0.0019	5.4
Total	0.0269	100.0	0.0353	100.0	0.0174	100.0	0.0349	100.0
EQ-VAS								
Own education	0.0113	32.5	0.0241	48.8	0.0109	39.4	0.0237	44.5
Spouse education	0.0116	33.5	0.0074	15.0	0.0070	25.1	0.0105	19.7
Height	0.0007	2.0	0.0009	1.9	0.0005	1.9	0.0012	2.2
Childhood living standard	0.0081	23.4	0.0124	25.0	0.0065	23.4	0.0121	22.8
Age (in years)	0.0006	1.7	0.0037	7.4	0.0011	3.9	0.0053	10.0
Total	0.0347	100.0	0.0494	100.0	0.0278	100.0	0.0531	100.0
Self-rated health								
Own education	0.0190	44.1	0.0269	51.6	0.0188	45.3	0.0255	45.8
Spouse education	0.0134	31.2	0.0083	15.9	0.0122	29.6	0.0115	20.6
Height	0.0006	1.3	0.0010	1.9	0.0006	1.4	0.0010	1.8
Childhood living standard	0.0059	13.7	0.0093	17.8	0.0044	10.6	0.0086	15.3
Age (in years)	0.0025	5.8	0.0061	11.8	0.0034	8.3	0.0089	15.9
Total	0.0430	100.0	0.0521	100.0	0.0414	100.0	0.0558	100.0

Note: Results are based on the decomposition of the goodness-of-fits (R^2/Pseudo R^2) reported in Tables 2–4 Self-rated health was converted to a binary variable (from its original five levels: 0 = , Very bad, Bad, Neither good nor bad vs 1 = Good, Excellent).
SV: Shapley value; *%R^2*: the percentage share of predictors in the total explained variance; *EQ-5D-5L:* Five-level EQ-5D, based on the WePP value set (Western Preference Pattern, hybrid based on four Western countries' value sets); *VAS*: Visual Analogue Scale, converted to [0–1] scale.

Table 6
Logistic regression results on the probability of having a spouse with tertiary education.

Variables	Men	Women
Own education (ref. Primary)		
Secondary	0.123***	0.149***
	(0.015)	(0.014)
Tertiary low	0.316***	0.356***
	(0.016)	(0.016)
Tertiary high	0.575***	0.565***
	(0.014)	(0.013)
Height[a] (ref. Short)		
Medium	0.047***	0.035***
	(0.013)	(0.013)
Tall	0.081***	0.050***
	(0.015)	(0.016)
Childhood living standard (ref. Difficult)		
Good	−0.012	0.039***
	(0.011)	(0.012)
Very Good	0.004	0.082***
	(0.023)	(0.022))
Observations	7970	8338
Pseudo R^2	0.234	0.165

Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
[a] Short refers to the shortest 20% (reference category), and Tall, the tallest 20%, within each subgroup split by sex*5-years age cohort, with the remaining 60% as medium height. All regression results are average marginal effects and adjusted for age (in years).

between 1950 and 1990). This suggests that our measure of childhood living standard represents a good proxy for *relative* deprivation. In general, we acknowledge that the problems of omitted variables and unobserved individual heterogeneity as challenges in cross-sectional studies, and may bias our findings. Second, self-selection bias might have occurred, as respondents volunteered to participate in the Tromsø study.

Lastly, we only know the respondents' *current* civil status and their eventual *current* spouse's educational attainment. This means that the category 'not having a spouse' includes all respondents who for whatever reason do not currently have a partner, i.e., they are single, widowed, separated, or divorced. Some might therefore have been exposed to spousal externalities for a long past period of their lives. For the spousal education categories, we do not know for how long they have had their current partner, or any previous partners with possibly different education levels. While we ideally should have had data on respondents' complete 'civil status history', in order to measure for how long they have been 'under the influence' of one or more partners, it would in practice be very hard to obtain.

More research is needed on the various channels through which spousal education influences own health. One such channel is healthcare utilization, such as encouraging the partner to have regular visits to the GPs and follow medication compliance. Another channel is represented by health-related behaviour, by encouraging physical activity, a healthy diet and avoiding substance misuse. We would welcome more studies on these topics.

To conclude, even in an egalitarian country like Norway, characterized by generous social insurance schemes, publicly funded healthcare and equal opportunities for higher education, health inequalities persist, and may even get wider. We have provided empirical evidence that spousal education may contribute to explaining the amplified social gradient in health.

Credit author statement

Admassu N. Lamu: Methodology, Software, Validation, Writing, Visualization, **Gang Chen:** Conceptualization, Methodology, Validation, Writing, **Jan Abel Olsen:** Conceptualization, Methodology, Resources, Writing, Project administration, Funding acquisition.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.115832.

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