Social Science & Medicine 343 (2024) 116581

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

# The influence of parents' and partner's education on own health behaviours

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ARTICLE INFO

Handling Editor: Joanna Coast

*Keywords:*
Health behaviours
Healthy lifestyle index
Spousal education
Parents' education
Norway

ABSTRACT

The link between educational attainment and multiple health behaviours has been explained in various ways. This paper provides new insights into the social patterning in health behaviours by investigating the influence of parents' and partners' educational attainments on a composite indicator that integrates the four commonly studied lifestyle behaviours (smoking, alcohol, physical activity and BMI). Two key outcome indicators of interests were created to reflect both ends of the "healthy – unhealthy spectrum". Data was drawn from The Tromsø Study, conducted in 2015/16 (N = 21,083, aged 40–93 years). We controlled for two indicators of early life human capital and one personality trait variable. Partners' education attainments are relatively more important for avoiding unhealthy behaviour than choosing healthy behaviour; on the contrary, parents' education is more important for healthy behaviour. Heterogeneity by sex and age was also evident. The influences of partner's education on widening the socioeconomic contrasts in health behaviours were much stronger in the younger (40–59 years) age group. In conclusion, our results support the hypothesis that own health behaviour is affected by the educational attainments of our 'nearest and dearest' (i.e. spouse, mother, and father), net of own education. This study facilitates a better understanding of education-health behaviours nexus from a life course perspective and supports the importance of family-based interventions to improve healthy behaviours.

## 1. Introduction

There is overwhelming evidence that various lifestyle factors impact a broad range of chronic conditions (Stanaway et al., 2018), implying that diversities in individuals' health behaviours contribute to explaining variations in health. There is also plenty of evidence for a positive association between individuals' educational attainment and their healthy behaviours; such as more physical activity, more healthy eating, less smoking and less obesity (Huijts et al., 2017; Wong et al., 2014; Øvrum and Rickertsen, 2015).

This link between educational attainment and healthy behaviours is explained in various ways. In the Grossman model [see e.g. (Grossman, 2022; Wagstaff, 1993),], consumers invest in their health stock through healthy behaviour, and education is important by way of increasing health productivity due to being better informed. A related strand of literature focuses on personality traits, such as individuals' time preferences, that affect both educational achievement and healthy behaviour in the *same direction*: myopic individuals have unhealthy behaviour and quit school at an earlier age, while farsighted individuals opt for healthy behaviours and long educations (Golsteyn et al., 2014; Norrgren, 2023). Furthermore, a large body of literature focuses on how health behaviours are influenced by our social environment [see e.g. (Mollborn and Lawrence, 2018)]. Individuals adapt to peer group norms and shared habits within their socioeconomic strata. Thus, higher education provides two separate health effects: it makes an individual better informed to make healthy choices, and it also makes them more likely to socialise with people who have healthy behaviour, e.g. it is not only the information obtained from a university that makes you give up smoking and burgers, but the stigma expressed from your social circle.

Given that the educational gradient in health behaviours would also have occurred in parents, we expect parents' education to affect their offspring's health behaviours. Highly educated parents would have been better informed to create healthy habits in the household, which have lasting effects on their offspring. There is much evidence of intergenerational transmissions of health behaviours, such as diet (Goode et al., 2008), smoking (Melchior et al., 2010), and body mass index (BMI) (Classen, 2010). However, the magnitudes of influence of parents' behaviour on children may vary by gender and type of behaviour

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https://doi.org/10.1016/j.socscimed.2024.116581
Received 18 July 2023; Received in revised form 21 December 2023; Accepted 8 January 2024
Available online 17 January 2024

(Wickrama et al., 1999), as well as the type of family (Kalmijn, 2022). Generally, mothers' educational attainment is more important than fathers' for their offspring's health (Wamani et al., 2004). Literature on the intergenerational promotion of health behaviours tends to suggest that within a family, women are more important than men in gathering and exchanging health information (Oliveira et al., 2017). Mothers also typically spend more time with their children than fathers, although there has been an increasing trend of fathers being more involved with their children in the current generation, particularly in Norway following several extensions of the paternity leave (Craig et al., 2014; Feldman et al., 2022).

Still, the most important 'health influencer' is likely to be one's partner. Spousal concordance in health behaviours is observed for smoking, alcohol consumption, physical activity, BMI and diet (Jackson et al., 2015). A related body of literature considers the influence of a spouse's educational attainment on own health (Brown et al., 2014; Halpern-Manners et al., 2022; Lamu et al., 2023) and health behaviours (Behrman et al., 2015; Falba and Sindelar, 2008; Monden et al., 2003; Sheehan and Iida, 2020). The mechanisms would then either reflect a *direct* effect from the additional health information that one's spouse possesses, or an *indirect* effect via the spouse's more healthy behaviours attributed to higher education. Thus, when studying spousal influence on health behaviours, spousal education may serve as an indicator of a spouse's health behaviour, to which one tends to adapt.

This paper aims to provide new insights into the social patterning in health behaviours by investigating the influence of parents and partners, as measured by their respective educational attainments, i.e. the extent to which individuals' health behaviours are affected by the education levels of their parents and their partner, beyond their own education. If so, the aggregated effects of own -, parents' - and partner's-education levels would amplify the socioeconomic disparities in health behaviour beyond what can be explained by own education alone.

Our paper makes several contributions to the literature. First, while most previous studies on the influence of parents or partners consider one particular health behaviour, e.g., smoking (Takagi et al., 2014), we apply a composite measure that integrates four health behaviours: smoking, drinking, physical activity and BMI. Using the composite outcome also easily allows us to explore the potential difference in the influences of predictors on being healthy versus unhealthy in the same analysis framework.

Second, we consider the educational attainment levels of each of the four relevant agents as key predictors: self; mother; father; and partner, on the probability of living healthy or unhealthy. We show how the education gradient in health behaviour is amplified when accounting for parental influences as measured by parents' educational attainments, and further when including the influence of partner's education. Although previous literature has studied the separate relationships between each or some of the relevant agent's educational levels and health behaviours, using a Shapley value decomposition (Shapley, 1953; Shorrocks, 2013), we can quantify and directly compare the relative contributions of each of the four relevant agent's educational attainment to variation in health behaviour.

Third, we account for potentially important types of confounding, such as personality trait and differences in early life human capital. Fourth, because of assumed sex differences in the degrees to which mother, father and partner may influence one's health behaviour, we conducted analyses separately for men and women. Lastly, because of the wide differences in the distributions of educational attainments across the youngest and the oldest subjects in our data (born between 1925 and 1975), we investigate heterogeneity by age.

## 2. Material and methods

### 2.1. Data

We use data from the latest wave of an ongoing population-based health study in the largest city in Northern Norway; The Tromsø Study, conducted in 2015/16 (N = 21,083, aged 40–93 years) (Hopstock et al., 2022). The study population is considered representative of the Norwegian adult population, however, slightly overrepresented by people with a university degree. The study was approved by the Regional Committee for Medical and Health Research Ethics (ID, 2016/607). All participants gave written informed consent before participation.

### 2.2. Variables

#### 2.2.1. Outcome variable: healthy vs unhealthy behaviours

Health behaviour was measured by the use of a composite indicator that integrates the four lifestyle behaviours that are most often included in a 'healthy lifestyle index': smoking, alcohol, physical activity and BMI (Barbaresko et al., 2018; Chen et al., 2021; Loef and Walach, 2012; Schlesinger et al., 2020). Official public health recommendations commonly concentrate on the same four behaviours (Becker et al., 2004; World Health Organization, 1999).

First, being a *non-smoker* is the least contentious. On *alcohol* consumption, there is less consensus on exactly which maximum weekly intake is considered healthy, and whether the level should be lower for women than men. The Chief Medical Officers' guidelines in the UK recommend not to drink more than 14 units a week, and that this level be the same for men and women (DrinkAware, 2022). As for *physical activity*, the World Health Organization (WHO) guidelines recommend at least 150 min of moderate-intensity physical activity per week (World Health Organisation, 2010). We grouped respondents into three categories: <60 min (physically inactive), 60–150 (moderate physical active), and >150 min (physically active). The *BMI* is included as a fourth indicator, expressed in units of $kg/m^2$, resulting from body mass in kilograms (kg) and height in square meters ($m^2$). Both height and weight were *objectively* measured in our study. A 'normal BMI' ranges between [18.5–25); underweight is defined as less than 18.5; 'overweight' is in the range [25–30); and, 'obese' is 30 $kg/m^2$ and above. The term 'normal BMI' in this context refers to what is a *healthy* BMI range, based on the evidence that, over the life course, a normal BMI leads to the highest life expectancy (Aune et al., 2016).

In the current paper, we categorize individuals who adhere to *all four* public health recommendations as the *super-healthy*, i.e. they do *not* smoke; their weekly alcohol consumption is *not* above 14 units; they are physically active (exercise more than 150 min per week); *and* they fall into the category of a 'normal BMI'.

Given the low proportion of *super-healthy*, we also report the analyses on a wider category of healthy individuals by relaxing the threshold values for either physical activity or BMI in the appendix. The first represents individuals who are only *moderately physically active* (60–150 min per week), but otherwise healthy in that they do not smoke, have low alcohol, and have a normal BMI. Many individuals may well be physically active without perceiving their activities as 'exercising', as conveyed in the two questions on which the variable used is calculated: '*How often do you exercise?*' and '*For how long time do you exercise every time on average?*'. Furthermore, there is a diminishing marginal health effect of increasing levels of physical activity (Moore et al., 2012). The second sub-group of *semi-healthy* represents individuals who are *slightly overweight* with a BMI in the range [25–27.5), but otherwise healthy in that they do not smoke, have low alcohol, and are physically active (>150 min per week). Relaxing the BMI level to 27.5 reflects an apparent controversy in the literature suggesting that slight overweight is not associated with shorter life expectancy (Afzal et al., 2016), particularly so for men (Brønnum-Hansen et al., 2007).

At the other end of the 'healthy – unhealthy spectrum', we categorize two sub-groups as *unhealthy:* i) smokers, and ii) individuals who are obese *and* physically inactive (<60 min per week). While there is a wide consensus that smoking is unhealthy, there is less consensus on exactly how unhealthy inactivity or obesity are. However, there is much

evidence that the *combination* of obese *and* inactive is unhealthy (Moore et al., 2012).

Thus, we identify four levels for the composite measure of (un) healthy behaviours: *super-healthy*, *semi-healthy*, *unhealthy* and a residual reference category that might be labelled *semi-unhealthy*. This residual category includes a wide range of lifestyle combinations, all of which lean towards being relatively unhealthy. It was beyond the scope of the current paper to develop a healthy lifestyle index as measured by the expected life-year losses associated with all the 60 possible lifestyle combinations (i.e. 2 smoking levels * 2 alcohol levels * 3 physical activity levels * 5 BMI levels). Rather, we have considered the two extreme levels as key outcome variables: *super-healthy* and *unhealthy*, where both are binary composite health behaviours. To check the consistency of our results, the supplementary material includes additional analyses of an extended binary outcome – *healthy* – that combines *super-healthy* and *semi-healthy*.

For an overview of the education gradient along different levels of healthy behaviour, and the cut-off points used when categorizing combinations of the four health behaviours into four levels of (un)healthy behaviours, see Table A1 and Table A2 in the supplementary material.

#### 2.2.2. Explanatory variables

The main predictors are the educational attainments of the respondent, parents and partner (or spouse), categorized in line with the International Standard Classification of Education (ISCED). Respondents were asked to report the highest education completed along 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). Due to the relatively low proportions of tertiary education in the parent generation, the two tertiary education levels collapsed for mothers' and fathers' education.

We adjust for variations in individuals' health beliefs (Chew et al., 2002). Individuals' health beliefs reflect their belief in the efficacy of their healthy behaviour for their future health. Within each level of educational attainment, individuals differ by way of their belief that their healthy behaviour improves future health: some believe in faith, others in their own choices. Health belief is defined based on respondents' level of agreement with the statement: 'By living healthy I can prevent severe illnesses', with response options ranging from 1 (strongly disagree) to 7 (strongly agree). To simplify, we dichotomized this variable by classifying those who ticked 6 or 7 as having *strong health beliefs* and the rest as having *weak beliefs*.

We adjust for two indicators of early life circumstances; childhood living standard and height. The adjustment of these two pre-union human capital facilities the control for potential matching selection effect through educational homogamy, i.e. a person with better pre-union human capital has a higher probability of having a spouse with tertiary education (Lamu et al., 2023; Maralani and Portier, 2021).

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 extreme categories (<2% very difficult, and 6%< very good), the four levels were reduced to difficult vs. good. Similar indicators have been used to proxy childhood socioeconomic circumstances in a range of epidemiological studies (Listl et al., 2018; Straughen et al., 2013).

Height is a proxy for birth size (Jelenkovic et al., 2018), and a marker of variation in early nutrition (Perkins et al., 2016). Height is recoded into three levels by five-year age cohorts separately for men and women. 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. Age was also controlled for in all regression analyses.

### 2.3. Statistical analyses

First, we present frequency distributions of each of the four health behaviours across the four levels of respondents' own educational attainment. The appendix includes frequency distributions by sex and education levels for the different levels of the composite health behaviours. To illustrate contrasts in the unhealthy-healthy distributions across education levels, we use figures with traffic lights: red for *unhealthy*, yellow for *semi-unhealthy*, light green for *semi-healthy* and dark green for *super-healthy*.

Alternative binary logistic regression models, reporting average marginal effects (i.e. average predicted probabilities), are estimated separately for men and women. This allows us to better reveal potential gender heterogeneity. In addition to what has been explained in the Introduction about the different maternal versus paternal influences on the intergenerational promotion of health behaviours, we were also interested in exploring whether mothers' education may have a stronger association with daughter's behaviour, and whether fathers' education may have a stronger association with son's behaviour. It is well documented in the economics literature that the returns to investments in daughters and sons differ within the household, in that mothers devote more resources towards their daughters and fathers more towards their sons (D. Thomas, 1994). Gender differences have also been reported in parenting literature that mothers may have had differential expectations and "attributed sons' risky misbehavior predominantly to inborn child characteristics, whereas risky misbehavior by daughters was more often attributed to factors that a parent could expect to influence (page. 117)" (Morrongiello and Hogg, 2004).

Model-1 represents the simple reference case containing own education level only, controlling for respondents' age, height, childhood living standard, and health beliefs. Model-2 further includes parents' education levels. The full Model-3 further includes spouse education by using *no spouse* as the reference category. In order to understand the pure partner's education effect on health behaviour, we re-analaysed Model-3 on only the sub-sample of respondents who have a spouse (Model-3HS). The three model specifications were run separately to explain the variations in the probability of having: i) *super-healthy* behaviour; and ii) *unhealthy* behaviour. In the online supplementary material, we also include a similar set of model specifications for the probability of *healthy* behaviour (=*super-healthy* + *semi-healthy*). Eventually, we apply Shapley value decomposition to quantify the relative contribution of each explanatory variable in the full models. Heterogeneity by two age groups was further investigated for the full model of unhealthy behaviour. Potential multicollinearity was checked for each regression by calculating the variance inflation factor and it was not evident. All models focus on predicted probabilities and we have included the estimated odds ratios for Model-3 in the supplementary material.

We also considered the interaction terms to check if the effects of parent education on health behaviour depend on the level of own or partner's educational attainment in the full model, and found no significant effects (results not reported but available from the corresponding authors). All statistical analyses were conducted using Stata® ver. 19.0 (StataCorp LP, College Station, Texas, USA).

## 3. Results

Table 1 shows sample characteristics. Nearly half of the sample have received tertiary education. Note that parents, particularly mothers, have lower education levels. Table A3 shows much higher education attainments in the younger age groups, reflecting the large increase in years of schooling after the second world war.

Table 2 shows the distributions of the four health behaviours by education. We observe consistent positive gradients between educational attainments and three healthy behaviours: non-smoking, physical activity and normal BMI. On the other hand, similar to previous Norwegian studies, alcohol consumption increases with education attainments, i.e. the higher the education, the higher the proportion of people consuming alcohol (Li et al., 2017; Strand and Steiro, 2003). Admittedly,

**Table 1**
Sample characteristics.

| Variable | Men | | Women | | Total | |
|---|---|---|---|---|---|---|
| | N | Mean/ % | N | Mean/ % | N | Mean/ % |
| **Own education**, n (%) | | | | | | |
| Primary | 2179 | 22.2 | 2617 | 24.1 | 4796 | 23.2 |
| Secondary | 2997 | 30.5 | 2759 | 25.4 | 5756 | 27.8 |
| Tertiary low | 2091 | 21.3 | 1917 | 17.6 | 4008 | 19.4 |
| Tertiary high | 2564 | 26.1 | 3581 | 32.9 | 6145 | 29.7 |
| **Father's education**, n (%) | | | | | | |
| Primary | 5690 | 59.1 | 6350 | 60.0 | 12,040 | 59.5 |
| Secondary | 2400 | 25.0 | 2506 | 23.7 | 4906 | 24.3 |
| Tertiary low | 885 | 9.2 | 982 | 9.3 | 1867 | 9.2 |
| Tertiary high | 653 | 6.8 | 755 | 7.1 | 1408 | 7.0 |
| **Mother's education**, n (%) | | | | | | |
| Primary | 7075 | 73.0 | 7865 | 73.6 | 14,940 | 73.3 |
| Secondary | 1671 | 17.2 | 1729 | 16.2 | 3400 | 16.7 |
| Tertiary low | 659 | 6.8 | 697 | 6.5 | 1356 | 6.6 |
| Tertiary high | 294 | 3.0 | 400 | 3.7 | 694 | 3.4 |
| **Partner's education**, n (%) | | | | | | |
| No partner | 1363 | 14.3 | 2153 | 20.1 | 3516 | 17.3 |
| Primary | 1633 | 17.1 | 1784 | 16.6 | 3417 | 16.8 |
| Secondary | 2481 | 26.0 | 2892 | 26.9 | 5373 | 26.5 |
| Tertiary low | 1689 | 17.7 | 1630 | 15.2 | 3319 | 16.4 |
| Tertiary high | 2386 | 25.0 | 2279 | 21.2 | 4665 | 23.0 |
| **Belief in living healthy**, n (%) | | | | | | |
| Weak | 3187 | 32.9 | 3383 | 31.9 | 6570 | 32.4 |
| Strong | 6489 | 67.1 | 7230 | 68.1 | 13,719 | 67.6 |
| **Height**[a], n (%) | | | | | | |
| Short | 2015 | 20.2 | 2223 | 20.1 | 4238 | 20.2 |
| Medium | 5947 | 59.6 | 6584 | 59.6 | 12,531 | 59.6 |
| Tall | 2021 | 20.2 | 2233 | 20.2 | 4254 | 20.2 |
| **Childhood living standard**, n (%) | | | | | | |
| Good/Very good | 7189 | 73.7 | 8158 | 75.4 | 15,347 | 74.6 |
| Difficult | 2569 | 26.3 | 2667 | 24.6 | 5236 | 25.4 |
| **Age**, mean (SD) | 10,009 | 57.4 (11.4) | 11,074 | 57.2 (11.5) | 21,083 | 57.3 (11.4) |

Tertiary low = less than 4 years university study; Tertiary high = 4 years or more university study.

[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.

**Table 2**
Distribution of health behaviours by own education level.

| | Primary n (%) | Secondary n (%) | Tertiary low n (%) | Tertiary high n (%) | Total n (%) |
|---|---|---|---|---|---|
| **Smoking** | | | | | |
| Non-smoker | 3749 (79.0) | 4726 (82.6) | 3539 (88.8) | 5704 (93.2) | 17,718 (86.1) |
| Current smoker | 995 (21.0) | 997 (17.4) | 446 (11.2) | 417 (6.8) | 2855 (13.9) |
| Total | 4744 (100) | 5723 (100) | 3985 (100) | 6121 (100) | 20,573 (100) |
| **Alcohol** | | | | | |
| Low-alcohol ≤14 units pw | 4605 (98.7) | 5584 (98.1) | 3884 (97.8) | 5920 (97.1) | 19,993 (97.9) |
| High alcohol >14 units pw | 62 (1.3) | 108 (1.9) | 86 (2.2) | 179 (2.9) | 435 (2.1) |
| Total | 4667 (100) | 5692 (100) | 3970 (100) | 6099 (100) | 20,428 (100) |
| **Physical activity** | | | | | |
| Inactive <60 min pw | 2016 (44.4) | 2039 (36.4) | 1206 (30.6) | 1453 (24.0) | 6714 (33.3) |
| Moderate 60–150 min pw | 1120 (24.7) | 1644 (29.3) | 1236 (31.4) | 1896 (31.3) | 5896 (29.3) |
| Active ≥150 min pw | 1402 (30.9) | 1919 (34.3) | 1494 (38.0) | 2716 (44.8) | 7531 (37.4) |
| Total | 4538 (100) | 5602 (100) | 3936 (100) | 6065 (100) | 20,141 (100) |
| **BMI** | | | | | |
| Underweight, <18.5 | 39 (0.8) | 28 (0.5) | 14 (0.4) | 37 (0.6) | 118 (0.6) |
| Normal, 18.5–24.99 | 1290 (27.0) | 1551 (27.0) | 1238 (31.0) | 2530 (41.3) | 6609 (32.0) |
| Overweight I, 25–27.49 | 1118 (23.4) | 1382 (24.1) | 988 (24.7) | 1507 (24.6) | 4995 (24.2) |
| Overweight II, 27.5–29.99 | 1001 (21.0) | 1230 (21.4) | 811 (20.3) | 986 (16.1) | 4028 (19.5) |
| Obese, 30+ | 1325 (27.8) | 1550 (27.0) | 946 (23.7) | 1072 (17.5) | 4893 (23.7) |
| Total | 4773 (100) | 5741 (100) | 3997 (100) | 6132 (100) | 20,643 (100) |

Tertiary low = less than 4 years university study; Tertiary high = 4 years or more university study.

the prevalence of high alcohol consumption (defined as more than 14 units per week) is low, ranging from 1.3% among individuals with the lowest education to 2.9% among those with the highest education.

Fig. 1 shows, by use of traffic light colours, consistent education gradients along different levels of composite health behaviour by sex (see Table A2 for detailed statistics). Fig. 2 depicts distributions of composite health behaviour by spouse education within each level of own education. The general pattern is that individuals without a partner tend to have more unhealthy behaviours, and that individuals who have a partner with tertiary education are the most healthy.

### 3.1. Explaining healthy behaviour

Table 3 reports the probability of being *super-healthy*. The reference Model-1, including own education only, reveals a strong educational gradient in both sexes. When adding parents' educational attainment, Model-2 suggests that women are more influenced by their parents than men, particularly so by their mothers. Compared to those whose mothers had a primary school education, having a mother with tertiary education increased the probability of being super-healthy by 4.2 percent points. In Model-3, the reference case for spouse education is not having a spouse. It appears that the probability of living a super-healthy life is *lower* if the partner has a non-tertiary education. On the other end, if the partner has a high tertiary education, there is a significantly increased probability of living a super-healthy life, particularly so for women: 2.8 percent points higher for men and 4.2 percent points higher for women compared to those having no partner. This health behaviour gradient in spouse education is also depicted in Fig. 2. By considering only the subgroup of respondents who *have spouse*, Model-3HS, the probability of living a super-healthy life is now 5.5 percent points higher for men and 8.5 percent points higher for women, if the partner has high tertiary education compared to the reference case of partner with primary education. Note the stable persistent effects of parents' education even when controlling for spouse education. Furthermore, the health belief variable is robustly significant in all models with the expected sign.

Table A4 reports the probability of being healthy. Here, *healthy* considers wider criteria by including the two subgroups of *semi-healthy* in addition to the *super-healthy*. Generally, the table suggests similar patterns as in the narrow subgroup of *super-healthy* indicating the consistency of our results.

### 3.2. Explaining unhealthy behaviour

Table 4 shows the results for *unhealthy* behaviour, suggesting even stronger gradients along their own education level (Model-1) than in super-healthy (Table 3) and healthy (Table A4). When parents' education is included (Model-2), we note that only mothers' education matters, but primarily so for women. When we further include the partner's education (Model-3), a consistent gradient is revealed for the probability of unhealthy behaviour. In other words, *not* having a partner involves

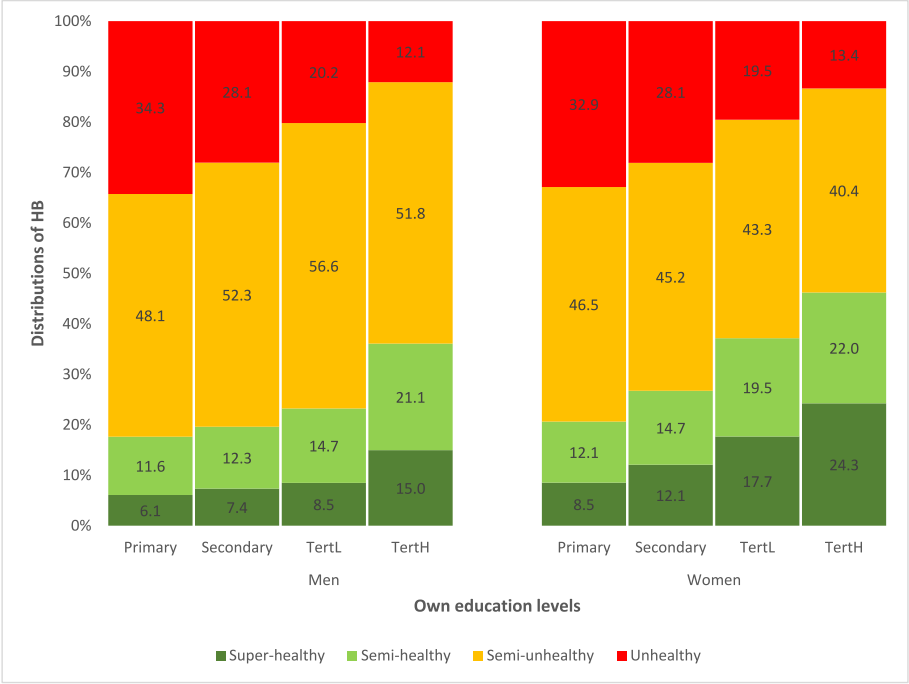


**Fig. 1.** Distribution of composite health behaviours (HB) by own education
*TertL:* Tertiary low (less than 4 years university study); *TetH:* Tertiary high (4 years or more university study).

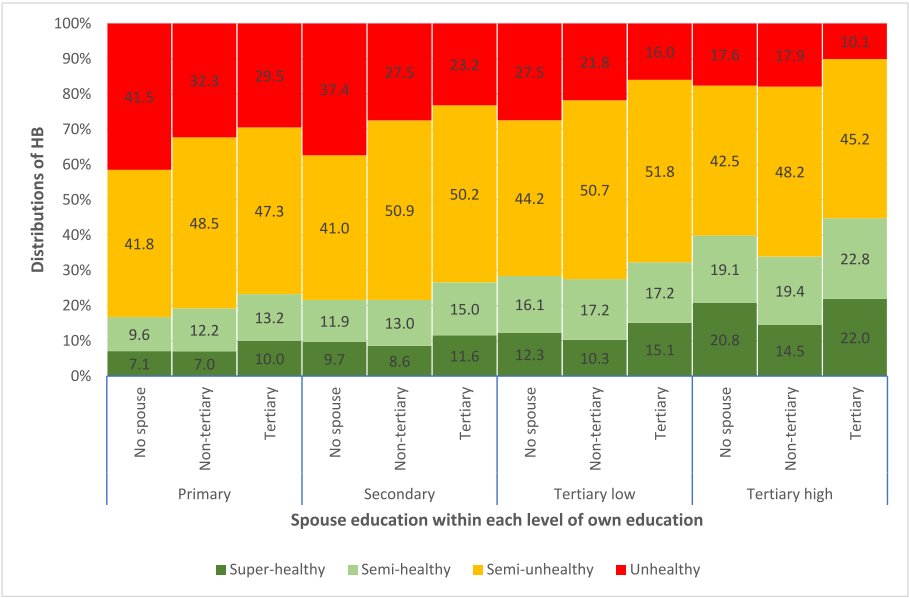


**Fig. 2.** Distribution of composite health behaviours (HB) by spouse education within each level of own education
*TertL:* Tertiary low (less than 4 years university study); *TetH:* Tertiary high (4 years or more university study).

the highest probability of unhealthy behaviour, and for each increased education level of the partner, the probability of unhealthy behaviour is reduced for both sexes. This is also illustrated in Fig. 3. The same pattern is confirmed in Model-3HS when considering only the sub-group of respondents who *have spouse*; as compared to having a spouse with primary education, there is an increasingly lower probability of unhealthy behaviour along with the increased level of spouse education. For both sexes, having a spouse with tertiary high education attainment was associated with around 10 percent points lower probability of being unhealthy as compared to having a spouse with a primary school education.

As a summary, Table A5 presents the Model-3 results for being super-healthy and unhealthy in odds ratios. Table A6 further shows the regression results when we separately look at whether respondents were (1) smoker, or (2) obese and inactive.

### 3.3. *Quantifying the relative contributions of predictors on explaining behaviours*

The Shapley value decomposition results are presented in Table 5. Panel A corresponds to results reported in Model-3 estimates whilst Panel B for Model-3HS estimates. We could see a consistent pattern that

**Table 3**
The probability of ***super-healthy*** behaviour.[a]

| Variables | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Model-1 | Model-2 | Model-3 | Model-3HS | Model-1 | Model-2 | Model-3 | Model-3HS |
| **Own education** | | | | | | | | |
| Secondary | 0.016** (0.007) | 0.014* (0.008) | 0.014* (0.009) | 0.016* (0.009) | 0.035*** (0.009) | 0.034*** (0.010) | 0.026** (0.011) | 0.021* (0.012) |
| Tertiary low | 0.026*** (0.008) | 0.022** (0.009) | 0.016* (0.009) | 0.018* (0.010) | 0.089*** (0.011) | 0.083*** (0.011) | 0.066*** (0.012) | 0.059*** (0.014) |
| Tertiary high | 0.094*** (0.009) | 0.079*** (0.010) | 0.055*** (0.010) | 0.051*** (0.011) | 0.154*** (0.010) | 0.135*** (0.011) | 0.104*** (0.012) | 0.091*** (0.014) |
| **Father's education** | | | | | | | | |
| Secondary | | 0.002 (0.008) | 0.001 (0.008) | 0.0001 (0.008) | | 0.006 (0.009) | 0.000 (0.009) | 0.007 (0.011) |
| Tertiary | | 0.025** (0.011) | 0.023** (0.011) | 0.026** (0.012) | | 0.031** (0.012) | 0.022* (0.012) | 0.029** (0.014) |
| **Mother's education** | | | | | | | | |
| Secondary | | 0.022** (0.009) | 0.022** (0.009) | 0.026** (0.010) | | 0.041*** (0.011) | 0.039*** (0.011) | 0.036*** (0.012) |
| Tertiary | | 0.016 (0.012) | 0.015 (0.012) | 0.013 (0.013) | | 0.042*** (0.014) | 0.039*** (0.014) | 0.039** (0.016) |
| **Partner's education** | | | | | | | | |
| Primary | | | −0.023* (0.012) | – | | | −0.040*** (0.013) | – |
| Secondary | | | −0.025** (0.010) | −0.002 (0.009) | | | −0.024** (0.011) | 0.017 (0.012) |
| Tertiary low | | | 0.00002 (0.011) | 0.024** (0.011) | | | 0.017 (0.013) | 0.058*** (0.014) |
| Tertiary high | | | 0.028** (0.012) | 0.055*** (0.012) | | | 0.042*** (0.012) | 0.085*** (0.014) |
| **Belief in future health** | | | | | | | | |
| Strong belief | 0.021*** (0.006) | 0.020*** (0.006) | 0.022*** (0.006) | 0.024*** (0.007) | 0.037*** (0.008) | 0.037*** (0.008) | 0.037*** (0.008) | 0.033*** (0.009) |
| **Childhood living standard** | | | | | | | | |
| Difficult | 0.009 (0.007) | 0.014* (0.008) | 0.013* (0.008) | 0.009 (0.008) | −0.033*** (0.008) | −0.025*** (0.009) | −0.025*** (0.009) | −0.027*** (0.010) |
| **Height** | | | | | | | | |
| Shortest 20% | −0.021*** (0.008) | −0.020** (0.008) | −0.017** (0.008) | −0.018** (0.009) | −0.020** (0.009) | −0.016* (0.010) | −0.015 (0.010) | −0.021* (0.011) |
| Tallest 20% | −0.001 (0.008) | −0.003 (0.008) | −0.002 (0.008) | −0.004 (0.008) | 0.028*** (0.009) | 0.027*** (0.009) | 0.026*** (0.009) | 0.018* (0.010) |
| Observations | 9292 | 9084 | 8811 | 7651 | 10,173 | 9900 | 9705 | 7874 |
| Pseudo R-squared | 0.027 | 0.030 | 0.037 | 0.039 | 0.044 | 0.049 | 0.051 | 0.052 |

Results are average marginal effects, indicating average predicted probabilities from binary logistic regression.
All models are adjusted for age (in years). Robust standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.
[a] Super-healthy is a binary outcome variable and refers to: Non-smokers; alcohol ≤14 units per week; BMI [18.5–25]; physical activity ≥150 min per week. Tertiary low = less than 4 years university study; Tertiary high = 4 years or more university study.

own education plays a more important roles than other explanatory variables in explaining health behaviours, followed by spouse education. The magnitudes of contributions from the father's and mother's education are similar and the sum of both is still less than the spouse education (with the exception of the super-healthy behaviour among women). In particular, if we consider unhealthy behaviour, the total contribution of parents' education accounts for around one-fifth to two-fifths of spouse education, pending on the sample and outcome of interest.

### 3.4. Heterogeneity

Given the wide age differences in the distributions across educational attainment (Table A3), we examined the heterogeneity among two age cohorts. A closer investigation into the younger age group suggests a stronger education gradient across levels of (un)healthy behaviours (compare Fig. A1 for the younger sub-group with Fig. 1 for the total sample). Fig. A2 shows the distribution of (un)healthy behaviours by spouse education within each own education level for the younger age group only. Generally, the association between spouse education and own health behaviours are even stronger among the younger. A striking contrast emerges across the combinations, *primary education & no spouse*, vs *tertiary high education & spouse with tertiary education*. In the former group, 50.4% have an unhealthy lifestyle, compared to 9.5% in the latter group. Thus, having a partner is associated with less unhealthy behaviour, particularly so for individuals with lower levels of education.

We further performed regression analyses for the full model (Model-3) by two age groups in Table A7 for being unhealthy (which is of particular policy interest to health promotion interventions). As compared to the total sample, variations in the younger age group [40–59 years] were even better explained, with generally higher coefficients. In this younger age group, we consistently observed strong gradients for both own - and spouse educational attainment in both sexes, even after adjusting for age, health beliefs and the two indicators of early life human capital.

## 4. Discussion

Health behaviours are key contributors to the socioeconomic gradient in health, and own educational attainment is the most widely used indicator for socioeconomic position in this literature (Petrovic et al., 2018). In the current paper, we apply a composite outcome measure that includes four health behaviours, to study the extent to which the educational attainments of parents and partners contribute to widening the socioeconomic gradient in health behaviours beyond what is explained by own education alone.

**Table 4**
The probability of ***unhealthy*** behaviour.[a]

| Variables | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Model-1 | Model-2 | Model-3 | Model-3HS | Model-1 | Model-2 | Model-3 | Model-3HS |
| **Own education** | | | | | | | | |
| Secondary | −0.073*** | −0.067*** | −0.049*** | −0.049*** | −0.071*** | −0.067*** | −0.058*** | −0.053*** |
| | (0.014) | (0.014) | (0.014) | (0.015) | (0.014) | (0.014) | (0.014) | (0.015) |
| Tertiary low | −0.145*** | −0.135*** | −0.103*** | −0.101*** | −0.157*** | −0.147*** | −0.125*** | −0.112*** |
| | (0.014) | (0.015) | (0.015) | (0.016) | (0.015) | (0.015) | (0.015) | (0.017) |
| Tertiary high | −0.229*** | −0.213*** | −0.172*** | −0.157*** | −0.217*** | −0.201*** | −0.169*** | −0.153*** |
| | (0.013) | (0.014) | (0.015) | (0.017) | (0.013) | (0.014) | (0.015) | (0.017) |
| **Father's education** | | | | | | | | |
| Secondary | | −0.002 (0.011) | −0.003 (0.012) | 0.001 (0.012) | | −0.002 (0.011) | 0.003 (0.011) | 0.005 (0.012) |
| Tertiary | | −0.026* (0.015) | −0.026 (0.016) | −0.027 (0.017) | | −0.003 (0.015) | 0.006 (0.016) | 0.003 (0.017) |
| **Mother's education** | | | | | | | | |
| Secondary | | −0.009 (0.013) | −0.006 (0.013) | −0.008 (0.014) | | −0.026** | −0.020 (0.013) | −0.010 (0.014) |
| | | | | | | (0.013) | | |
| Tertiary | | −0.030 (0.018) | −0.020 (0.019) | −0.023 (0.020) | | −0.061*** | −0.055*** | −0.050*** |
| | | | | | | (0.016) | (0.017) | (0.019) |
| **Partner's education** | | | | | | | | |
| Primary | | | −0.030* (0.018) | | | | −0.024 (0.015) | |
| Secondary | | | −0.075*** | −0.045*** | | | −0.050*** | −0.028** |
| | | | (0.016) | (0.015) | | | (0.013) | (0.013) |
| Tertiary low | | | −0.123*** | −0.094*** | | | −0.066*** | −0.046*** |
| | | | (0.016) | (0.016) | | | (0.015) | (0.016) |
| Tertiary high | | | −0.127*** | −0.099*** | | | −0.128*** | −0.109*** |
| | | | (0.016) | (0.017) | | | (0.013) | (0.016) |
| **Belief in future health** | | | | | | | | |
| Strong belief | −0.066*** | −0.065*** | −0.060*** | −0.054*** | −0.048*** | −0.049*** | −0.048*** | −0.034*** |
| | (0.009) | (0.009) | (0.010) | (0.010) | (0.009) | (0.009) | (0.009) | (0.010) |
| **Childhood living standard** | | | | | | | | |
| Difficult | 0.011 (0.010) | 0.007 (0.010) | 0.008 (0.010) | 0.008 (0.011) | 0.004 (0.009) | 0.000 (0.010) | −0.001 (0.010) | 0.001 (0.011) |
| **Height** | | | | | | | | |
| Shortest 20% | 0.016 (0.011) | 0.016 (0.011) | 0.010 (0.011) | 0.010 (0.012) | −0.001 (0.011) | 0.001 (0.011) | 0.001 (0.011) | 0.013 (0.012) |
| Tallest 20% | −0.003 (0.011) | −0.002 (0.011) | 0.0002 (0.011) | 0.001 (0.012) | −0.041*** | −0.038*** | −0.037*** | −0.032*** |
| | | | | | (0.010) | (0.010) | (0.010) | (0.011) |
| Observations | 9292 | 9084 | 8811 | 7651 | 10,173 | 9900 | 9705 | 7874 |
| Pseudo R-squared | 0.045 | 0.045 | 0.055 | 0.047 | 0.040 | 0.041 | 0.051 | 0.049 |

Results are average marginal effects, indicating average predicted probabilities from binary logistic regression.
All models are adjusted for age (in years). Robust standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.
[a] Unhealthy is a binary outcome variable and is defined as: BMI >30 & PA < 60 min per week & non-smokers; plus all smokers, no matter their BMI, PA or alcohol intake. Tertiary low = less than 4 years university study; Tertiary high = 4 years or more university study.

In all regression models, we control for differences in early life human capital (height and childhood living standard), and a personality trait (whether believe that healthy behaviour will enhance future health). Interestingly, and importantly, there was no indication of multicollinearity between these three variables, and the four key predictors, i.e. own-, father's -, mother's -, partner's educational attainments. There could be a concern that getting married could influence health beliefs, particularly for males (Markey et al., 2005). However, in our data, we only found weak correlations between marital status and health belief (r = 0.039 for men and r = 0.029 for women) or between partner's education level and health belief (r = 0.057 for men and r = 0.014) for women). We think this potential issue is of less concern for this study.

The simple reference model revealed significant associations between own education and (un)healthy behaviours, and showed consistent patterns in both sexes. When including parents' educational attainments, the associations pointed in the expected direction, i.e. higher parental education attainments are associated with more healthy behaviour. Generally, these associations were stronger in women than in men, and particularly so for mothers' education. When further including the partner's education, a consistent pattern emerged in both sexes: higher partner's education is associated with more healthy behaviour.

The relationship between parents' education and healthy behaviour is well documented, whilst in this study we further found that the influence of parents' education attainment was larger on explaining being healthy than being unhealthy in adults. Healthy behaviour could be shaped since childhood in which parents would act as the primary socialisation agents in children's lives. Parents could have both positive and negative impacts on children's lives. For instance, Fuemmeler et al. (2011) found that parents of moderate-to-vigorous physical activity (MVPA) were significantly associated with increased child MVPA whereas the sedentary activity of parents and children was much weaker. This long-lasting protection effect could be seen from the literature that physically active children are also likely to be physically active during their adulthood (Telama et al., 2005).

Generally, the influences of partners' educational attainment were much stronger than those of parents. As discussed by Liu and Waite (2014), from a life course perspective, a partner's influence could be stronger when getting older given other social relationships (e.g., parents, and friends) are often lost due to death or geographic relocation. The important role of having a partner on their own behaviour could be explained under the marital resource model, where marriage increases access to health-promoting resources (P. A. Thomas et al., 2017), and/or social control model in which spouses monitor and attempt to control each other's health behaviour (Umberson, 1992; Umberson and Thomeer, 2020). Improved educational opportunities for both sexes have led to more educational homogamy (Katrňák and Manea, 2020; Naszodi and Mendonca, 2022), and thereby more social stratifications into subgroups characterized by distinct differences in norms and habits. Behaviour would then not only be influenced by *own* educational attainment, but also that of the partner, thereby reinforcing (un)healthy habits (Christakis and Fowler, 2008; Jackson et al., 2015; Monden et al., 2003).

When comparing results between being (super)-healthy vs. being

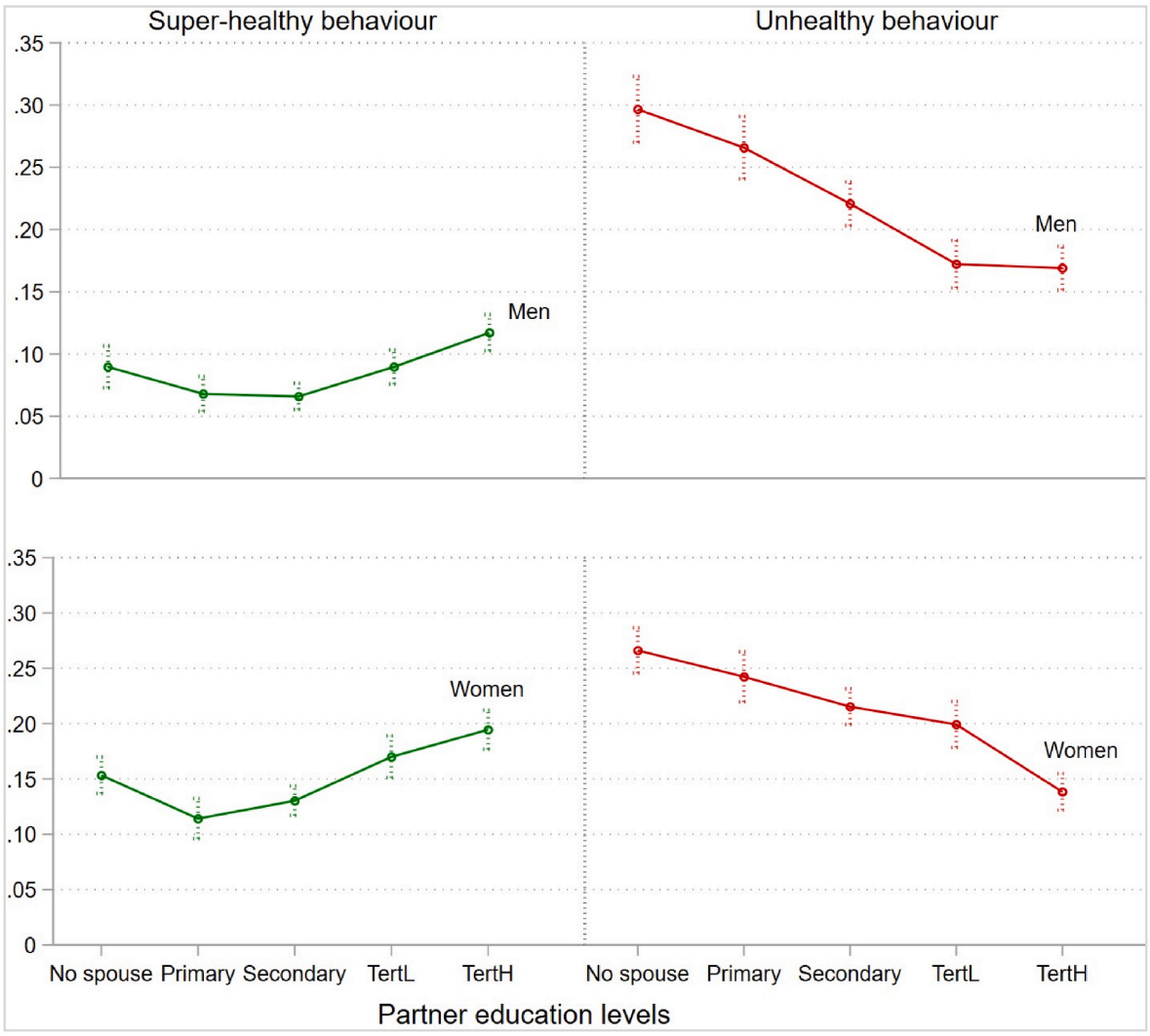


**Fig. 3.** The predicted probabilities of *super-healthy* and *unhealthy* behaviours for each level of partner education, holding other variables at their mean (with 95% CI in dotted lines) The predicted probabilities are based on results reported in Table 3 for *super-healthy* and Table 4 for *unhealthy* behaviours.
*TertL:* Tertiary low (less than 4 years university study); *TetH:* Tertiary high (4 years or more university study).

unhealthy, it appears that more variations are explained in the latter. Furthermore, partners' education levels are relatively more important for avoiding unhealthy behaviour, than it is for choosing healthy behaviours. The comparison could be more easily observed from the predicted probabilities of being *super-healthy* and *unhealthy* in Fig. 3 (plotted based on the regression results from Tables 3 and 4). The steeper red lines for *unhealthy* behaviour as compared to the green lines for *super-healthy* behaviour demonstrated this pattern clearly. This finding implies a stronger externality of interventions to change unhealthy behaviours (such as to aid smoking cessation) of one member of a couple would likely influence the other untargeted member.

We also noted some gender differences in the key findings, albeit the differences were not substantial, which could also be observed from Fig. 3. As mentioned above, partners could exert social control to change others' health behaviour to follow their own behaviour. It typically suggests that within couples, females are more likely to monitor and attempt to influence their partner's health behaviours (Umberson, 1992).

Because of large differences in the distributions of educational attainments across the youngest and the oldest cohorts, we split the sample into two age groups: 40–59 and 60+ years. Interestingly, the contrasts in health behaviours along the education gradient were much stronger in the younger age group, particularly so for non-tertiary education. Furthermore, the influences of partner's education on widening the socioeconomic contrasts in health behaviours were also stronger in the younger (40–59 years) age group, suggesting that the topic of the paper has increasing policy relevance. It is important to note that given a cross-sectional data is used it is difficult to separate age effects from cohort effects. Consequently, the reported differences between the two age groups could also be driven by the cohort effect. Furthermore, the weaker effect found among older adults may reflect a potential mortality selection in our data (Jacobsen et al., 2011).

There are some limitations to this study. First, the main analyses were based on cross-sectional data which prevents us from analysing the dynamic change of health behaviours over time in detail and drawing causal conclusions. For spousal education, we do not know for how long they have been married to their current partner, or whether there were any previous partners (with possibly different education levels). Nor do we know whether respondents' parents were still alive by the time of the survey. Although we have included two early-life human capital indicators and a personality trait, there could be other unobserved personal heterogeneity not been controlled for. However, the key predictors of interest, i.e. educational attainments, were completed many years prior to the observed health behaviours (so the reverse causality is less of a concern).

Second, this study only investigated the educational attainments of

**Table 5**
Relative contribution of major predictors to health behaviours: Decomposition results.

| | Super-healthy | | | | Unhealthy | | | |
|---|---|---|---|---|---|---|---|---|
| | Men | | Women | | Men | | Women | |
| | SV | % R2 | SV | % R2 | SV | % R2 | SV | % R2 |
| ***Panel-A: Full sample*** | | | | | | | | |
| Own education | 0.0124 | 34.0 | 0.0207 | 42.2 | 0.029 | 43.7 | 0.0244 | 48.3 |
| Father's education | 0.0032 | 8.7 | 0.0050 | 10.2 | 0.0020 | 3.6 | 0.0019 | 3.7 |
| Mother's education | 0.0027 | 7.5 | 0.0061 | 12.4 | 0.0014 | 2.6 | 0.0035 | 6.9 |
| Spouse education | 0.0058 | 15.8 | 0.0061 | 12.4 | 0.0158 | 28.8 | 0.0132 | 26.1 |
| Health beliefs | 0.0020 | 5.4 | 0.0023 | 4.6 | 0.0046 | 8.5 | 0.0026 | 5.2 |
| Early life circumstances[a] | 0.0018 | 4.9 | 0.0045 | 9.1 | 0.0008 | 1.4 | 0.0021 | 4.2 |
| Age (in years) | 0.0030 | 8.2 | 0.0009 | 1.8 | 0.0052 | 9.6 | 0.0019 | 3.7 |
| Total | 0.0366 | 100 | 0.0490 | 100 | 0.0547 | 100 | 0.0507 | 100 |
| ***Panel-B: Sub-sample having spouse*** | | | | | | | | |
| Own education | 0.0105 | 27.3 | 0.0165 | 31.9 | 0.0217 | 45.9 | 0.0220 | 45.3 |
| Father's education | 0.0032 | 8.3 | 0.0058 | 11.3 | 0.0021 | 4.4 | 0.0020 | 4.2 |
| Mother's education | 0.0027 | 7.0 | 0.0061 | 11.9 | 0.0016 | 3.4 | 0.0032 | 6.5 |
| Spouse education | 0.0114 | 29.5 | 0.0155 | 30.0 | 0.0118 | 25.1 | 0.0147 | 30.3 |
| Health beliefs | 0.0023 | 5.8 | 0.0018 | 3.5 | 0.0037 | 7.9 | 0.0013 | 2.6 |
| Early life circumstances[a] | 0.0015 | 4.0 | 0.0044 | 8.6 | 0.0006 | 1.3 | 0.0025 | 5.1 |
| Age (in years) | 0.0044 | 11.3 | 0.0009 | 1.8 | 0.0047 | 10.0 | 0.0018 | 3.8 |
| Total | 0.0387 | 100 | 0.0516 | 100 | 0.0472 | 100 | 0.0486 | 100 |

Results are based on the decomposition of the goodness-of-fits (Pseudo $R^2$) for the full models reported in Tables 3 and 4 *SV*: Shapley value.
[a] Early life circumstances include both height and childhood financial situation.

our closest family members, i.e. mother, father and partner, which may omit potential influence from the broader family structure. An interesting Norwegian study with a broad perspective on education and mortality included the educational attainments of not only *own* parents, but parents-in-law, and not only *current* spouse but former spouse (Kravdal, 2008). Additionally, by including the education of the oldest own sibling and the oldest sibling-in-law, as well as the average education in the municipality, Kravdal (2008) found that the strongest external education influence on mortality was that from a partner, former or current.

Third, the composite measure of health behaviour includes BMI, physical activity, smoking and alcohol intake, but not diet. Except for BMI, all other health behaviour variables were self-reported, potentially having response bias (Rosenman et al., 2011). We included BMI as a proxy for diet, which might not be considered a health *behaviour per se*, however, it is included in most healthy lifestyle indexes. Besides, reviews of what is included in healthy lifestyle indexes (Loef and Walach, 2012) also showed diet was less often accounted for. When included, reviews show that diet has been applied in very diverse ways, from the use of a single question on whether the daily fruit intake is above or below a given level (Kvaavik et al., 2010), to a detailed diet-specific scoring instrument (Chen et al., 2021). We, therefore, chose not to consider diet in our composite indicator, thereby making our composite measure more widely replicated in other population surveys. It should be noted that alternative approaches to categorizing respondents by multi-health behaviours also exist, such as using a latent class analysis or a cluster analysis. However, the above data-driven or data-mining approach may have issues with the interpretability of different classes and the findings could be sensitive to the data being analysed. In this study, we opted to define the composite measure of health behaviour according to the globally widely used guidelines such that it is more transparent and other researchers could replicate the analyses.

To summarise, in this paper, we focus on an important set of intermediary variables in the pathway between education and health, namely behaviours that affect health. These modifiable factors are particularly relevant for policy makers when attempting to reduce health inequalities by targeting those with unhealthy behaviour. Different from most studies that have explored the effect of own education on particular lifestyle indicators, our results support the hypothesis that health behaviour is affected by the educational attainments of our 'nearest and dearest', i.e. spouse, mother, and father.

## Funding

This study was part of the *Tracing causes of inequalities in health and wellbeing* project funded by the Research Council of Norway, grant 273812.

## CRediT authorship contribution statement

**Gang Chen:** Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. **Jan Abel Olsen:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing. **Admassu N. Lamu:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – review & editing.

## 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.2024.116581.

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