Health inequalities over the adult life course: the role of lifestyle choices

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Abstract

The relationship between socioeconomic status and health is dynamic and evolves throughout the adult life course. However, relatively little empirical attention has been directed to the role of health affecting lifestyle choices in explaining these dynamics. Using Norwegian repeated cross-section data from the period 1997–2009, this study explores how the income and education gradients in physical activity, the consumption of fruits and vegetables, cigarette smoking and self-assessed health evolve over the age range 25–79 years. The findings indicate that while the education gradients in physical activity and the consumption of fruits and vegetables remain relatively stable throughout the adult life course, the education gradient in smoking is clearly decreasing in age. Further, with the exception of the income gradient in physical activity among females, the income gradients in lifestyles are generally concave in age and slightly decreasing in older age. However, the role of lifestyles in moderating the relationship between income and self-assessed health appears modest. This result partly reflects that while the income gradients in lifestyles decrease substantially once we control for education, the reverse is not true. Overall, while income and education differences in lifestyles should generally contribute to cumulative advantage effects in health by socioeconomic status over the adult life course, our results provide some evidence of increased health consciousness and associated lifestyle improvements in age among lower socioeconomic status groups. This could potentially contribute to reducing cumulative advantage effects in health by socioeconomic status at older ages.

JEL classification: D12; D91; I12; I14; I18

Keywords: age; inequality; life course; lifestyles; self-assessed health; socioeconomic status

1. Introduction

An increasingly large literature seeks to improve our understanding of why indicators of socioeconomic status and health are so strongly associated. Acknowledging the dynamic nature of health production, this literature has partly focused on how socioeconomic inequalities in health evolve over the adult life course. The current empirical evidence on this important issue is mixed, partly because different indicators of socioeconomic status and health have been investigated (Kim and Durden, 2007). However, two main patterns of results stand out.

In some studies, health differences by socioeconomic status are found to be increasing in age throughout the adult life course (Ross and Wu, 1996; Wilson *et al.*, 2007). These results correspond with the cumulative advantage hypothesis. This hypothesis asserts that throughout the life course, socioeconomic status is closely associated with daily investments in the production of poor and good health. Gradually, these investments result in a relatively more rapid deterioration of health among lower than higher socioeconomic status groups. In contrast, in other studies health differences by socioeconomic status are found to be increasing in age until late midlife (50–60 years of age), after which they level off or begin to decrease (Beckett, 2000; Huijts *et al.*, 2010; van Kippersluis *et al.*, 2010). The results from these studies are then supportive of the cumulative advantage hypothesis until late midlife, but with an age-as-leveler hypothesis thereafter. More particularly, biological factors (arguably somewhat randomly distributed across people of different socioeconomic status) become increasingly important with older age in determining health, thus downplaying the role of socioeconomic status (Herd, 2006). Also other factors may contribute to age-as-leveler effects in health, including sample selection (Kim and Durden, 2007), cohort effects (Lynch, 2003) and labor market characteristics (Case and Deaton, 2005; van Kippersluis *et al.*, 2010). For example, according to the results in Case and Deaton (2005) and van Kippersluis *et* *al.* (2010), the strong correlation that typically exists between income and self-assessed health during late midlife mostly reflects the effect of poor health on premature exit from the labor force. This in turn negatively affects incomes because of the shift from wage earning to a reliance on social security payments.

While the above factors may be important in explaining why income and education differences in health vary over the adult life course, there has been relatively little empirical attention directed to the role of health affecting lifestyle choices. For example, do the education and income gradients in physical activity, dietary behavior and cigarette smoking remain stable over the adult life course? Alternatively, do they increase, become smaller, or fluctuate? Moreover, are such life course patterns similar across different lifestyles and across education and income? If education and income gradients in lifestyles remain stable (or increase) over the adult life course, we would expect the corresponding gradients in health, all other things being equal, to be gradually increasing in age because of the long-term, cumulative nature of health production. On the other hand, people of lower socioeconomic status may grow more health conscious and thus engage in healthier lifestyles when they reach late midlife and possibly find themselves in a relatively poor state of health, and thus realize that good health investments are important for longevity. If so, this could contribute to age-as-leveler effects in health, at least to the extent that such changes at older ages are relatively larger among people in lower than higher socioeconomic status groups.

To address these concerns, this paper examines how education and income gradients in important lifestyle and health indicators evolve over the adult life course (the period between 25 and 79 years of age). For this purpose, we employ repeated cross-section data from the Norwegian Monitor Survey 1997–2009. We measure health by self-assessed health (SAH), while physical activity (PA), the consumption of fruits and vegetables (FV) and not smoking cigarettes (NSMOKE) represent lifestyles. These lifestyle indicators are closely associated with the risk of major health outcomes, including type II diabetes, cardiovascular disease and certain types of cancer (World Health Organization, 2003). We analyze the association between age, income, education, lifestyles and SAH using regression models. Sensitivity of the age-specific income and education gradients are assessed by the stepwise inclusion of additional control variables in our models, including occupational status and a variety of sociodemographic characteristics.

2. Data and variables

The Norwegian Monitor Survey is a nationally representative and repeated cross-section survey of adults aged 15–95 years. The survey has been conducted every second year since 1985. The question on SAH was not part of the survey before 1997, and thus only data from the period 1997–2009 are used. We only include respondents aged 25–79 years as we wish to study individuals who can be expected to having completed most of their education and started earning incomes. The sample included relatively few respondents in the age range 80–95 years. After deleting observations with missing information on any of the relevant variables, our final sample comprises 21,706 individual observations.

In the survey, each individual responds to an extensive list of questions. The questions related to PA, FV, NSMOKE and SAH are based on various types of categorical scales. The respondents are asked to indicate their frequency of intake for nine types of fruits and vegetables on the following scale; 'daily'; '3−5 times per week'; '1−2 times per week'; '2−3 times per month'; 'about once per month'; '3−11 times per year'; 'rarer'; or 'never'. Similarly, physical activity has an eight-point frequency scale ranging from 'never' to 'once or more per day'. The respondents also answered if they smoked cigarettes 'daily', 'sometimes' or 'never' at the time of the survey, while SAH is based on the typical five-point scale ranging from 'very poor' to 'very good' health. To facilitate the comparison of education and income gradients over the adult life course, we have chosen to dichotomize each of these categorical variables. Table 1 provides the descriptions and sample means of these and other relevant variables in this study.

Table 1
Variable descriptions and sample means.

Variable	Description	Mean
PA	Undertake physical activity at least twice per week	0.518
FV	Eat fruits, berries and vegetables at least twice per day	0.485
NSMOKE	Not smoking cigarettes daily	0.702
SAH	Self-assessed health is ‘good’ or ‘very good’	0.689
E_1	Lower secondary education (9 years of education) or less	0.168
E_2	Upper secondary education (12 years of education)	0.359
E_3	Has attended some university or college	0.179
E_4	Has obtained a university or college degree	0.295
I_1	Age-group survey-year specific income quartile 1	0.257
I_2	Age-group survey-year specific income quartile 2	0.252
I_3	Age-group survey-year specific income quartile 3	0.248
I_4	Age-group survey-year specific income quartile 4	0.243
A	Respondent age	47.57
Female	Female	0.536
Children	Any children living in household	0.462
(Living as) married	If married or living as married	0.727
Widowed	Widowed	0.047
Divorced	Divorced	0.096
Single	Single	0.130
Non manual	Nonmanual worker	0.382
Skilled manual	Skilled manual worker	0.173
Unskilled manual	Unskilled manual worker	0.076
On social security	On social security or disability benefit	0.088
Other occupations	Unemployed, student, homemaker, retired, or other	0.281

Notes: Variable means using all 21,706 observations. All variables except age (A) are dummy variables taking a value of one if response to description is yes and zero otherwise.

We categorize education into four groups, ranging from having completed only lower secondary education (9 years of education) or less (E_1), to having obtained a university or college degree (E_4). We divide household income into age-group survey-year specific income quartiles (I_1–I_4), with each age group comprising a five-year interval (e.g., people aged 25–29 years). The original survey question on household income included nine response alternatives, each representing a specific income interval. Before dividing income into age-group survey-year specific quartiles, we (i) set household income to the midpoint value of each income interval, and (ii) adjusted for household size by dividing the resulting income measure by the square root of household size (OECD, 2008).

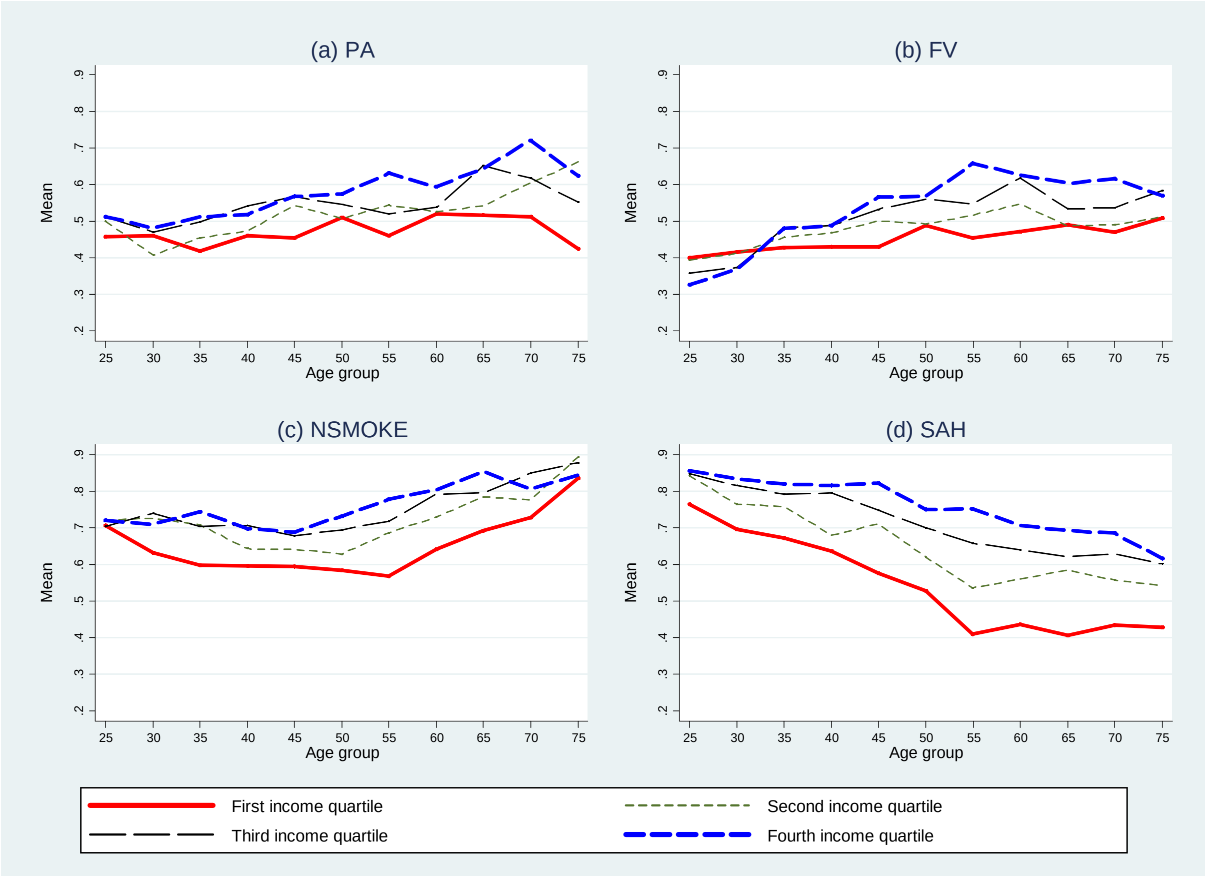

Fig. 1. Mean values for lifestyles and self-assessed health, split by five-year age groups and age-group survey-year specific income quartiles.

Figs. 1 and 2 depict life course variation in lifestyles and SAH by income and education, respectively. These figures essentially illustrate the sample means of PA, FV, NSMOKE and SAH for each income quartile and each education group at each five-year age

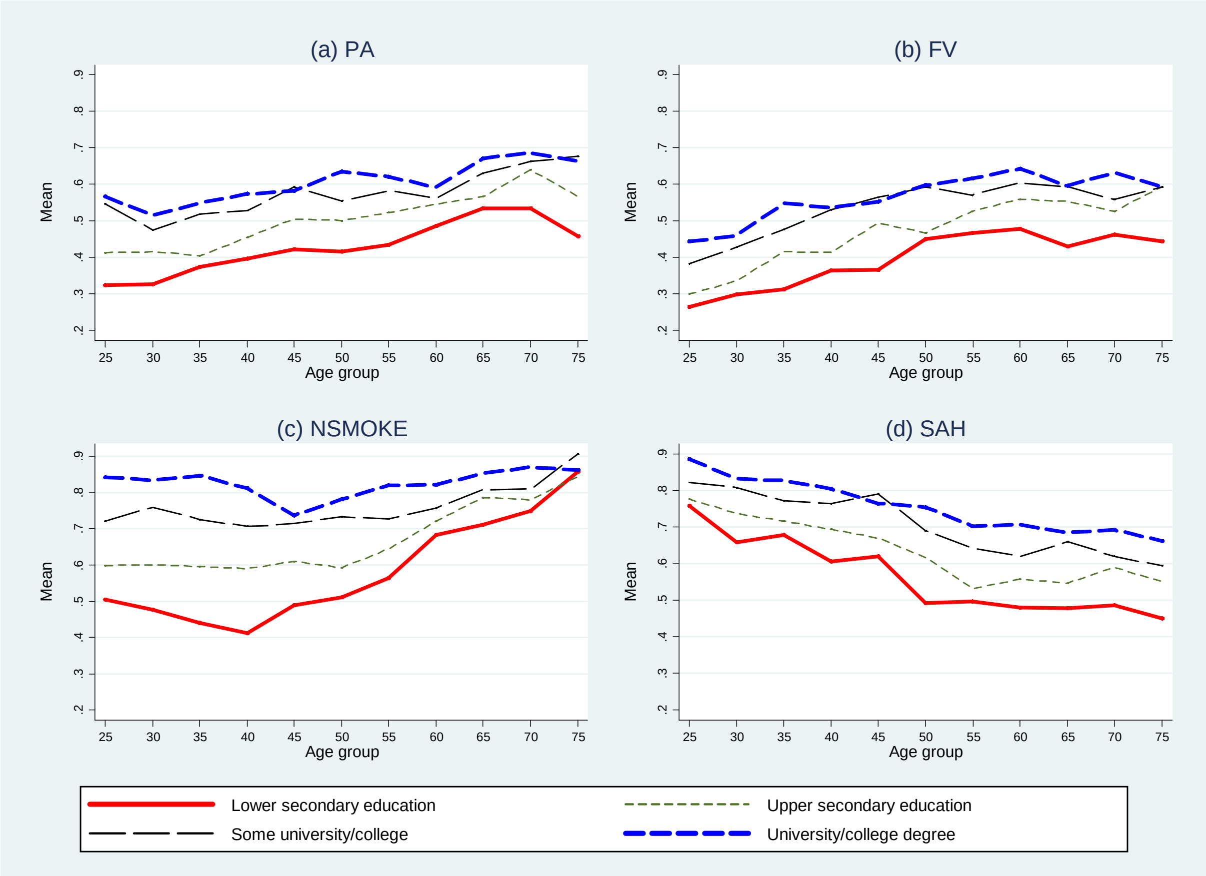

Fig. 2. Mean values for lifestyles and self-assessed health, split by five-year age groups and the four education groups.

interval. As shown, there are generally clear income gradients and particularly clear education gradients in lifestyles and SAH at most stages of the adult life course. The main exceptions are the generally small income gradients in lifestyles at age 25–29 years and the small education and income gradients in NSMOKE at age 75–79 years. Life course variation in the gradients is most evident in the case of income and SAH, with the gradient clearly peaking at age 55–59 years, and in the case of education and NSMOKE, with the gradient clearly declining over the adult life course. However, Figs. 1 and 2 are based on sample means and do not control for confounding factors such as other sociodemographic characteristics and period and cohort effects. We next describe the estimation strategy used to account for these factors.

3. Estimation method

We employ linear probability models (LPM) to predict how the income and education gradients in our three lifestyle variables and SAH evolve over the adult life course. While we obtained very similar results when running logit or probit models as alternatives, LPM coefficients are easier to interpret when using interaction variables (Baum and Ruhm, 2009). For the models focusing on income gradients, our three basic model specifications for lifestyle or health variable *y* for individual *i* are:

$$y_i = \alpha+\beta_1 A_i+\beta_2 A_i^2+\beta_3 I_{2i} +\beta_4 I_{3i} +\beta_5 I_{4i} +\mathbf{X}_i'\boldsymbol{\delta} +\varepsilon_i, \quad (1)$$

$$y_i = \alpha+\beta_1 A_i+\beta_2 A_i^2+\beta_3 I_{2i}+\beta_4 A_i\cdot I_{2i} +\beta_5 I_{3i}+\beta_6 A_i\cdot I_{3i} +\beta_7 I_{4i}+\beta_8 A_i\cdot I_{4i} +\mathbf{X}_i'\boldsymbol{\delta} +\varepsilon_i, \quad (2)$$

$$y_i = \alpha+\beta_1 A_i+\beta_2 A_i^2+\beta_3 I_{2i}+\beta_4 A_i\cdot I_{2i}+\beta_5 A_i^2\cdot I_{2i}+\beta_6 I_{3i}+\beta_7 A_i\cdot I_{3i}+\beta_8 A_i^2\cdot I_{3i}+\beta_9 I_{4i}+\beta_{10} A_i\cdot I_{4i}+\beta_{11} A_i^2\cdot I_{4i}+\mathbf{X}_i'\boldsymbol{\delta} +\varepsilon_i, \quad (3)$$

where A_i is the age of individual *i* centered at age 30, I_2, I_3 and I_4 denote membership of the second, third and fourth income quartiles as defined in Table 1, **X** is a vector of additional control variables, and ε is the stochastic error term. In Model 1 (Eq. 1) the probability of lifestyle or health variable *y* is explained by a second-degree polynomial in age, indicators of income quartiles, and control dummies. Model 2 (Eq. 2) allows for the marginal effects of higher income quartiles to change linearly in age, while Model 3 (Eq. 3) allows for these marginal effects to change nonlinearly in age. Thus, while Model 2 facilitates, for example, the analysis of cumulative advantage effects in *y* by income over the adult life course, Model 3 is more flexible in that it facilitates the analysis of cumulative advantage effects followed by age-as-leveler effects at older ages (Beckett, 2000). Comparable models focusing on the education gradients are identical to Eqs. (1)–(3) with the exception that we replace I_2, I_3 and I_4 with dummy variables representing the three highest-level education groups (E_2, E_3 and E_4) as defined in Table 1.

Sensitivity of the income and education gradients will be assessed by varying what variables are included in vector **X** in Eqs. (1)–(3). We denote these different submodels a, b, c and d. All models control for gender and include dummies for the survey years and the five-year birth cohorts. Models with no additional covariates in vector **X** will be denoted as, for example, Model 3a. In Model 3b, the vector **X** also includes education in the models that focus on income gradients and income in the models that focus on education gradients, and dummies for marital status and having children. Model 3c extends Model 3b by controlling for occupational status, including being on social security or being a nonmanual, skilled manual or unskilled manual worker. Finally, Model 3d extends Model 3b by controlling for PA, FV and NSMOKE, i.e., the three lifestyle variables. Model 3d is estimated only for SAH.

In our models, we treat age, period and cohort effects as fixed effects. The linear dependence between respondent age, birth year and survey year is relieved by allowing for nonlinear effects in age and by using five-year birth cohorts (Sarma *et al.*, 2011). We also tested alternative strategies for estimating age, period and cohort effects, including the random intercept model (O'Brien *et al.*, 2008) and the cross-classified model (Reither *et al.*, 2009). The estimated age effects, which are the focus of this study, are very similar across these alternative model specifications.

We also estimated the models separately by gender. For robustness purposes, we also estimated the models using alternative definitions of age, income and education. In this alternative model specification, we replaced the continuous age variables in Eqs. (1)–(3) with five-year age dummies, and the income and education dummies with the logarithm of income and a continuous education variable. We comment on the results of this alternative model specification and the gender specific models where relevant. Finally, the models were re-estimated using alternative variable definitions for PA, FV and SAH (ordered PA and SAH variables and FV in number of intakes per day). The results (not shown) suggest that the main conclusions of the study are not sensitive to how we define the dependent variables in our models.

4. Results

4.1. Income, lifestyles and SAH over the adult life course

Table 2 presents selected parameter estimates from the linear probability models focusing on income gradients in lifestyles and SAH. Table 3 in the next section provides analogous estimates from the models focusing on education gradients. The column headings indicate the different model specifications discussed earlier. Because of space considerations, the tables only detail the parameters for age and income. Further, the estimated age and income effects in PA and FV were largely unaffected after controlling for occupational status, as will be illustrated graphically below, and so we do not provide the results of Model 3c for either of these lifestyle variables.

After controlling for age, gender, survey years and birth cohorts, we can observe clear overall income gradients in the three lifestyle variables as well as SAH (Model 1a). To the extent that these variables are comparable, we can see that the income gradient is steeper in SAH than in underlying, health affecting lifestyles. For example, on average, people in the fourth income quartile are as much as 22.2 percentage points more likely to report being in good or very good health than those in the first income quartile.

Because of interactions between the age and income variables, the parameters of Models 2a–3d in Table 2 are more difficult to interpret than the parameters of Model 1a. To proceed with our analysis, we will mainly focus on graphically comparing patterns of results for the first and the fourth income quartiles. Before turning to this graphical analysis, we note the following main patterns of results from Table 2; (i) there is generally significant life course variation in the income gradients in lifestyles and SAH; (ii) this life course variation is

Table 2
Linear probability models for the association between age, income, lifestyles and SAH.

Model	(1a)	(2a)	(3a)	(3b)	(1a)	(2a)	(3a)	(3b)	(3c)	(3d)
	Physical activity (PA) models				*Nonsmoking (NSMOKE) models*					
A	0.0354	0.0287	***0.0678***	***0.0758***	0.0201	0.0183	–0.0139	–0.0212	–0.0075	
A^2	–0.0045	–0.0046	**–0.0144**	**–0.0151**	0.0045	0.0047	**0.0118**	**0.0162**	**0.0124**	
I_2	**0.0575**	0.0193	***0.0495***	*0.0378*	**0.0683**	**0.0593**	**0.0543**	0.0250	0.0195	
$A \cdot I_2$		**0.0212**	*–0.0450*	*–0.0452*		0.0051	0.0164	0.0126	–0.0008	
$A^2 \cdot I_2$			**0.0161**	**0.0156**			–0.0028	–0.0017	0.0016	
I_3	**0.0972**	**0.0942**	**0.1142**	**0.0812**	**0.1096**	**0.0973**	**0.0768**	***0.0422***	***0.0335***	
$A \cdot I_3$		0.0018	*–0.0409*	–0.0361		0.0072	***0.0479***	0.0273	0.0082	
$A^2 \cdot I_3$			*0.0103*	0.0086			***–0.0098***	–0.0070	–0.0020	
I_4	**0.1323**	**0.1310**	**0.1602**	**0.1054**	**0.1252**	**0.1579**	**0.1211**	**0.0719**	**0.0592**	
$A \cdot I_4$		0.0010	***–0.0580***	***–0.0568***		***–0.0176***	***0.0516***	0.0224	0.0025	
$A^2 \cdot I_4$			***0.0142***	***0.0143***			**–0.0165**	***–0.0121***	–0.0069	
R^2	0.0290	0.0297	0.0305	0.0409	0.0417	0.0426	0.0434	0.0790	0.0848	
	Fruits and vegetables (FV) models				*Self-assessed health (SAH) models*					
A	**0.1430**	**0.1348**	**0.1034**	**0.0888**	–0.0375	*–0.0472*	***–0.0648***	**–0.0774**	–0.0190	**–0.0838**
A^2	**–0.0221**	**–0.0221**	**–0.0147**	*–0.0096*	–0.0016	–0.0017	0.0019	0.0057	–0.0072	0.0058
I_2	**0.0430**	0.0277	0.0135	–0.0125	**0.1095**	**0.0885**	**0.0898**	**0.0763**	**0.0594**	**0.0709**
$A \cdot I_2$		0.0083	*0.0396*	*0.0395*		0.0114	0.0086	0.0105	*–0.0380*	0.0129
$A^2 \cdot I_2$			–0.0076	–0.0071			0.0007	–0.0001	***0.0112***	–0.0012
I_3	**0.0913**	**0.0572**	*0.0393*	0.0204	**0.1728**	**0.1360**	**0.1303**	**0.1189**	**0.1016**	**0.1074**
$A \cdot I_3$		***0.0184***	***0.0550***	0.0356		**0.0199**	0.0299	0.0225	***–0.0422***	0.0227
$A^2 \cdot I_3$			–0.0088	–0.0060			–0.0023	–0.0021	***0.0123***	–0.0022
I_4	**0.1199**	**0.0797**	***0.0495***	0.0251	**0.2220**	**0.1745**	**0.1459**	**0.1316**	**0.1115**	**0.1152**
$A \cdot I_4$		**0.0216**	**0.0799**	***0.0534***		**0.0255**	**0.0782**	**0.0667**	–0.0033	**0.0690**
$A^2 \cdot I_4$			***–0.0140***	*–0.0101*			***–0.0126***	***–0.0118***	0.0036	***–0.0119***
R^2	0.0836	0.0842	0.0846	0.1017	0.0753	0.0762	0.0767	0.0873	0.1310	0.1065

Notes: All models control for gender, survey years and birth cohorts. Models 3b–3d also control for education, marital status and having children. In addition, Model 3c controls for occupational status, while Model 3d controls for PA, FV and NSMOKE. A denotes age (centered at 30 years of age) and I_2, I_3 and I_4 denote age-group survey-year specific income quartiles 2, 3 and 4, respectively (the reference group is income quartile 1 (I_1)). See Table 1 for further variable definitions. Parameters involving A and A^2 are multiplied by 10 and 10^2, respectively. Parameters in **bold**, ***bold italics*** and *italics* are statistically significant at 99%, 95%, and 90% levels using robust standard errors, respectively. Sample weights are applied. All models are based on 21,706 observations.

usually nonlinear (Model 3a); and (iii) the income gradients are in some cases quite sensitive to the addition of extra control variables to the models (Models 3b–3d).

Based on the results of Model 3a in Table 2, Fig. 3 shows the predicted age trajectories in PA, FV, NSMOKE and SAH for the first and fourth income quartiles, as well as the absolute differences in predicted probabilities between these quartiles. We refer to these differences as the income gradient. These and later predictions are calculated at the mean values of the additional covariates (**X**) that are included in the models.

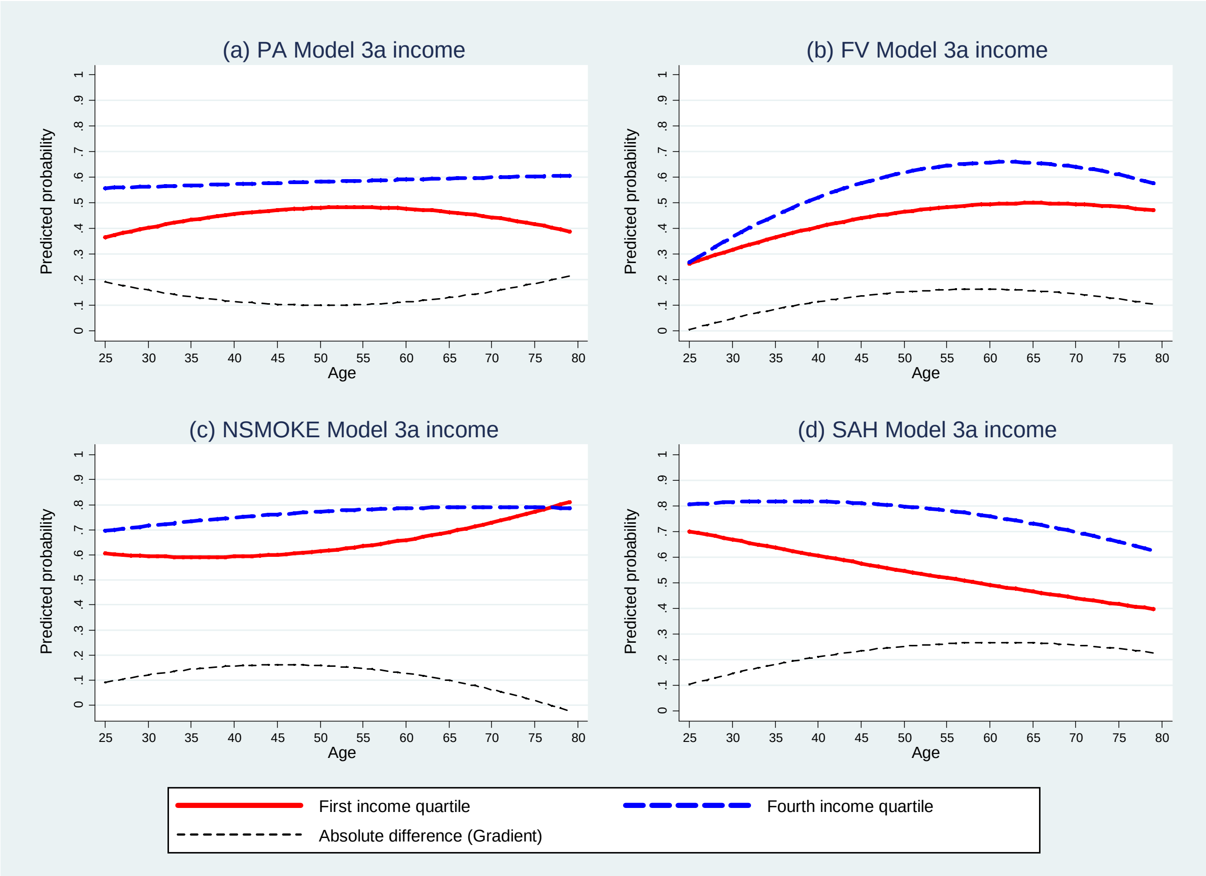

Fig. 3. Predicted age trajectories in lifestyles and self-assessed health for people in the first and fourth income quartiles. Predictions based on the results of Model 3a in Table 2 and calculated at the mean values of the additional covariates that are included in the model.

Fig. 3 shows that there are clear income gradients in the three lifestyle indicators and SAH at most stages of the adult life course. The two notable exceptions are the lack of an income gradient in FV (Fig. 3b) during the first few years of the observed age interval and in NSMOKE (Fig. 3c) during the last few years. The income gradient in SAH (Fig. 3d) is generally stronger than the corresponding gradients in PA, FV and NSMOKE, and reaches a peak at 61 years of age, where only 48.7% of those in the first income quartile are predicted to report being in good or very good health, compared with 75.4% of those in the fourth income quartile. The fact that the income gradient in SAH is particularly strong during late midlife is even clearer in our alternative model specification, where five-year age dummies are interacted with the logarithm of income. Fig. A1 in the Appendix plots the predictions from this alternative model specification.

For the most part, the income gradients in FV, NSMOKE and SAH are qualitatively similar in that they are concave in age. That is, the gradients in these variables are stronger in midlife than during earlier and later stages of the adult life course. As discussed, this life course pattern in SAH of cumulative advantage effects in health by income until late midlife followed by age-as-leveler effects at older ages is evident in several earlier studies (Beckett, 2000; Huijts *et al.*, 2010; van Kippersluis *et al.*, 2010). What we add in this analysis is the potential role of health affecting lifestyles, such as FV and NSMOKE, in partly explaining this finding. If the income gradients in these and other important health affecting lifestyles become smaller as people age, it seems reasonable to assume that this would also hold for the income gradients in SAH and the other health indicators.

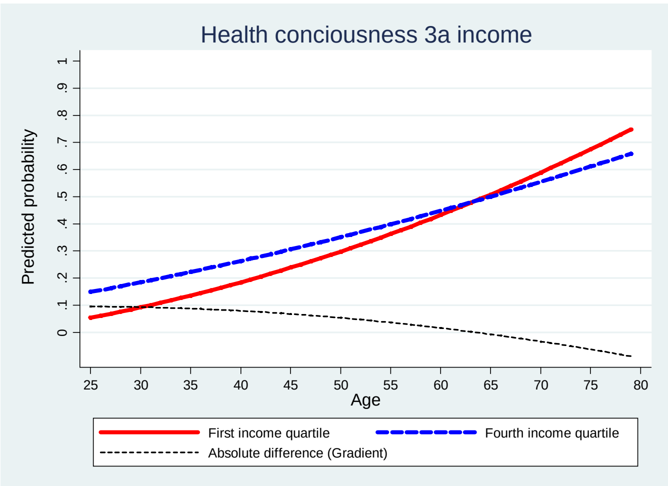

Fig. 4. Predicted age trajectories in subjective health consciousness for people in the first and fourth income quartiles. Predictions based on Model 3a and calculated at the mean values of the additional covariates that are included in the model. The dependent variable is coded one if the respondent ‘totally agrees’ with the statement “I always try to live healthy and keep myself in good physical condition”, and zero if the respondent ‘partly agrees’, ‘partly disagrees’ or ‘totally disagrees’. The underlying linear probability model is based on 21,287 observations, as 419 respondents did not respond to the question on subjective health consciousness.

Reduced income differences in lifestyles at older ages may partly reflect the role of health consciousness. We illustrate this in Fig. 4. We base the plot in this figure on Model 3a, however, the dependent variable now relates to subjective health consciousness. This variable is coded one if the respondent 'totally agrees' with the statement "I always try to live healthy and keep myself in good physical condition" (30.1% of the sample), and zero if the respondent 'partly agrees', 'partly disagrees' or 'totally disagrees' with this same statement. Not surprisingly, people become increasingly health conscious as they age. More interestingly, this process of increased health consciousness in age appears more pronounced for people in the first income quartile than in the fourth income quartile. The predicted association between income and health consciousness actually changes from positive to negative at 64 years of age and remains negative thereafter. Thus, increased health consciousness and associated lifestyle improvements in age among low income people may contribute to age-as-leveler effects in health by income, or at least to slowing down the process of cumulative advantage effects at older ages. However, this conclusion may not hold for several reasons.

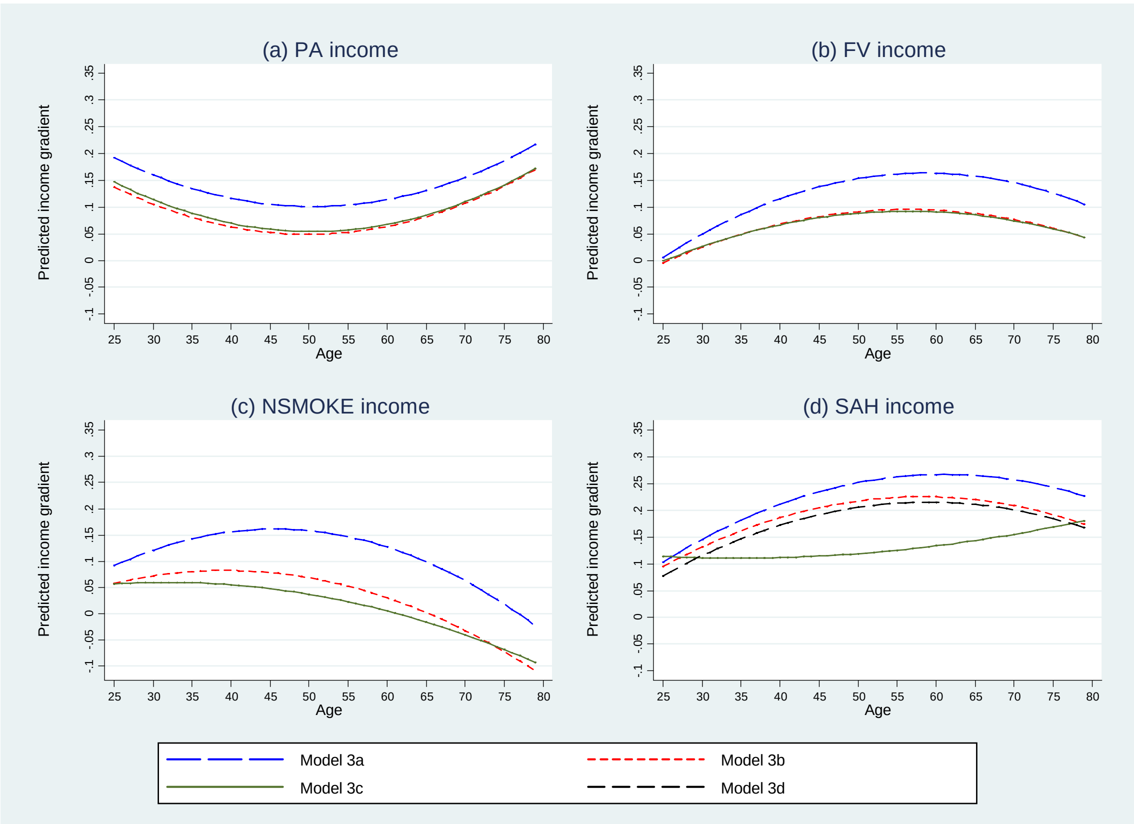

Fig. 5. Predicted age trajectories for the income gradients in lifestyles and self-assessed health resulting from Models 3a–3d in Table 2. Lines indicate absolute differences in predicted probabilities between people in the first and fourth income quartiles when controlling for different sets of variables in the linear probability models. Predictions calculated at the mean values of the additional covariates that are included in the different models.

First, Fig. 5 provides the predicted age trajectories for the income gradients in lifestyles and SAH resulting from Models 3a–3d in Table 2. As shown, the income gradients in the three lifestyle indicators are very sensitive to the choice of control variables. For example, when moving from Model 3a to Model 3b, i.e., when adding control variables for education, marital status and having children, the age-specific income gradients in PA, FV and NSMOKE are on average reduced by 40.4%, 43.0% and 60.7%, respectively. Further analysis suggests that these reductions are mainly attributable to controlling for education.

Second, as shown in Figs. 3a and 5a, the income gradient in PA is generally increasing in age at older ages. This suggests that the pattern of reduced income differences at older ages found for FV and NSMOKE does not hold for all lifestyles. However, when we estimate the PA models separately by gender, we find that the income gradient in PA is decreasing in age among males (Fig. A2a), but increasing in age among females at older ages (Fig. A3a). Thus, at least for males, it seems that also the income gradient in PA is decreasing in age at older ages.

Third, as shown in Fig. 5d, the life course pattern for the income gradient in SAH changes completely once we control for occupational status. In effect, the life course pattern changes from cumulative advantage effects in health by income until late midlife followed by age-as-leveler effects at older ages (Models 3a and 3b), to continuing cumulative advantage effects throughout the adult life course (Model 3c). Additional analysis suggests that this sensitivity of the income gradient in SAH to controlling for occupational status is almost entirely due to the effect of being reliant on social security payments during the last few years before expected retirement. On average, compared with a nonmanual worker, being on social security payments reduces the predicted probability of reporting to being in good or very good health by 39.9 percentage points. As a point of comparison, being an unskilled manual worker reduces the probability of being in good or very good health by only 4.7 percentage points.

For the 8.8% of the total sample that are on social security payments, 53.0% are in the age range 55–66 years (the official retirement age in Norway is 67 years), of which 53.4% belong to the first income quartile. Thus, as in studies from the US (Case and Deaton, 2005) and the Netherlands (van Kippersluis *et al.*, 2010), we find that in Norway, the spike in the income gradient in SAH in late midlife may largely reflect the effect of poor health on premature exit from the labor force. This in turn affects income negatively because of the shift from earning wages to being reliant on social security payments.

Finally, the age-specific income gradient in SAH is reduced by only 6.6% on average when we add our lifestyle indicators as control variables in the SAH model, i.e., when we move from Model 3b to Model 3d in Fig. 5. Because of our use of repeated cross-section data, we are unable to control for the dynamic nature of health production. That said, current lifestyles do not seem very important in moderating the current relationship between income and SAH.

4.2. Education, lifestyles and SAH over the adult life course

Table 3 presents the parameter estimates from the models focusing on education gradients in lifestyles and SAH. These model specifications are the same as in Table 2 except that the income dummies (I_2, I_3 and I_4) are replaced by education dummies (E_2, E_3 and E_4).

The results from Model 1a suggest that there are clear overall education gradients in the three lifestyle variables as well as SAH. Unlike the above findings for income, it is not clear that the education gradient in self-assessed health is steeper than the education gradients in underlying, health affecting lifestyles. In fact, the largest educational differences are found in cigarette smoking. On average, people with a university or college degree are 23.0 percentage points less likely to be daily smokers than those who have completed only lower secondary education or less.

Table 3
Linear probability models for the association between age, education, lifestyles and SAH.

Model	(1a)	(2a)	(3a)	(3b)	(1a)	(2a)	(3a)	(3b)	(3c)	(3d)
	Physical activity (PA) models				*Nonsmoking (NSMOKE) models*					
A	0.0137	0.0026	0.0562	***0.0758***	0.0040	*0.0424*	0.0128	0.0150	0.0256	
A^2	0.0018	0.0022	–0.0076	***–0.0130***	**0.0100**	**0.0092**	***0.0144***	**0.0149**	***0.0115***	
E_2	**0.0576**	0.0206	***0.0646***	0.0518	**0.0577**	**0.1519**	**0.1361**	**0.1339**	**0.1218**	
$A \cdot E_2$		*0.0162*	–0.0390	–0.0312		**–0.0308**	–0.0174	–0.0183	–0.0267	
$A^2 \cdot E_2$			*0.0114*	0.0095			–0.0021	–0.0025	0.0002	
E_3	**0.1308**	**0.1177**	**0.1722**	**0.1467**	**0.1533**	**0.2862**	**0.2551**	**0.2519**	**0.2274**	
$A \cdot E_3$		0.0021	***–0.0759***	***–0.0645***		**–0.0536**	–0.0074	–0.0139	–0.0228	
$A^2 \cdot E_3$			***0.0172***	***0.0147***			–0.0103	–0.0094	–0.0061	
E_4	**0.1581**	**0.1335**	**0.1739**	**0.1379**	**0.2303**	**0.3793**	**0.3515**	**0.3435**	**0.3132**	
$A \cdot E_4$		0.0088	–0.0374	–0.0195		**–0.0671**	–0.0255	–0.0331	–0.0415	
$A^2 \cdot E_4$			0.0091	0.0049			–0.0095	–0.0084	–0.0048	
R^2	0.0326	0.0329	0.0333	0.0402	0.0654	0.0702	0.0705	0.0825	0.0873	
	Fruits and vegetables (FV) models				*Self-assessed health (SAH) models*					
A	**0.1223**	**0.1095**	**0.1259**	**0.1300**	**–0.0759**	**–0.0817**	***–0.0838***	–0.0530	–0.0027	*–0.0633*
A^2	**–0.0161**	**–0.0157**	**–0.0189**	**–0.0189**	***0.0085***	***0.0087***	0.0088	0.0018	–0.0087	0.0019
E_2	**0.0594**	0.0183	0.0381	0.0370	**0.0708**	***0.0535***	*0.0581*	0.0456	0.0426	0.0284
$A \cdot E_2$		***0.0173***	–0.0125	–0.0152		0.0072	–0.0035	–0.0073	–0.0380	–0.0026
$A^2 \cdot E_2$			0.0066	0.0066			0.0027	0.0029	*0.0105*	0.0021
E_3	**0.1282**	**0.1017**	**0.1065**	**0.1062**	**0.1402**	**0.1379**	**0.1228**	**0.0980**	**0.0905**	*0.0606*
$A \cdot E_3$		0.0087	0.0116	–0.0008		–0.0016	0.0305	0.0162	–0.0243	0.0233
$A^2 \cdot E_3$			–0.0016	0.0004			–0.0081	–0.0059	0.0036	–0.0064
E_4	**0.1670**	**0.1370**	**0.1513**	**0.1453**	**0.1885**	**0.1698**	**0.1708**	**0.1306**	**0.1173**	**0.0851**
$A \cdot E_4$		0.0107	–0.0077	–0.0217		0.0085	0.0046	–0.0087	*–0.0519*	–0.0036
$A^2 \cdot E_4$			0.0038	0.0058			0.0011	0.0025	***0.0134***	0.0027
R^2	0.0894	0.0897	0.0899	0.1017	0.0647	0.0648	0.0651	0.0868	0.1310	0.1060

Notes: All models control for gender, survey years and birth cohorts. Models 3b–3d also control for income, marital status and having children. In addition, Model 3c controls for occupational status, while Model 3d controls for PA, FV and NSMOKE. A denotes age (centered at 30 years of age), and E_2, E_3 and E_4 denote education levels at upper secondary education, some university or college and university or college degree, respectively (the reference group is lower secondary education or less (E_1)). See Table 1 for further variable definitions. Parameters involving A and A^2 are multiplied by 10 and 10^2, respectively. Parameters in **bold**, ***bold italics*** and *italics* are statistically significant at the 99%, 95%, and 90% levels using robust standard errors, respectively. Sample weights are applied. All models are based on 21,706 observations.

There is less significant life course variation in the education gradients in lifestyles and SAH than in the corresponding income gradients. The exception is cigarette smoking, where educational differences are clearly decreasing in age (Model 2a). To study further the results in Table 3, we now turn to graphical analysis, similar to the analysis for income. To make the comparison of education and income gradients clearer, we construct Figs. 6–8 for education to be equivalent to Figs. 3–5 for income. Thus, using the results from Model 3a in Table 3, Fig. 6 shows the predicted age trajectories for the probabilities of PA, FV, NSMOKE and SAH for those who have completed lower secondary education or less and for those with a university or college degree, along with the absolute differences in predicted probabilities between these two education groups. We refer to these differences as the education gradient. Fig. 7 depicts the corresponding age trajectories in subjective health consciousness. Finally, Fig. 8 illustrates the predicted education gradients in lifestyles and SAH resulting from Models 3a–3d in Table 3, that is, from models that include different sets of control variables.

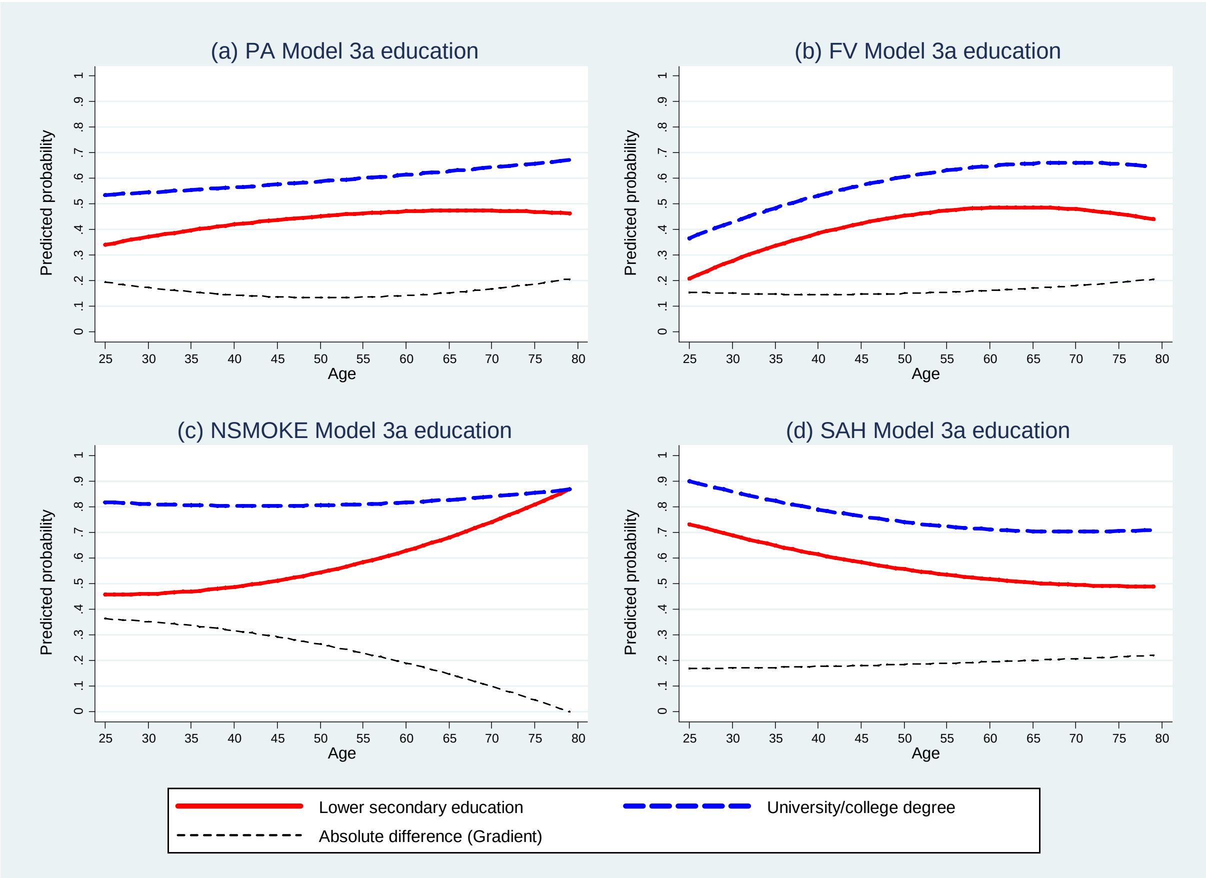

Fig. 6. Predicted age trajectories for lifestyles and self-assessed health for people in the lowest and highest education groups. Predictions based on the results of Model 3a in Table 3 and calculated at the mean values of the additional covariates that are included in the model.

Fig. 6c shows that the education gradient in NSMOKE is very steep at young ages but moves gradually towards zero at older ages. At 25 years of age, those with a university or college degree are 36.2 percentage points less likely than those that have only completed lower secondary education or less to be daily smokers. In contrast, the education gradients in PA and FV remain relatively stable throughout the adult life course. However, when we estimate the FV models separated by gender, we find that the education gradient in FV increases in age among males (Fig. A5b) but decreases in age among females at older ages (Fig. A6b). There are also very large gender differences in the predicted probabilities of eating fruits and vegetables at least two times per day. At all stages of the adult life course, the predicted probability of FV is higher among females that have completed lower secondary education or less (Fig. A6b) than among males with a university or college degree (Fig. A5b). Gender differences in the education gradient are also evident in PA, but here the pattern is opposite to that found in FV. After 55 years of age, the education gradient in PA increases in age among females (Fig. A6a) and decreases slightly in age among males (Fig. A5a).

The education gradient in SAH remains relatively stable throughout the adult life course, although it increases slightly and almost linearly in age, as shown in Fig. 6d. However, as indicated by the results in Table 3, this age variation is not statistically significant. Thus, although there are significant educational differences in SAH at all stages of the adult life course, the evidence on cumulative advantage effects in SAH by education are at most modest.

The life course patterns for the income (Fig. 4) and education (Fig. 7) gradients in subjective health consciousness are very similar, although the reduction of the gradient in age is slightly clearer in education than in income. The education gradient is also somewhat less sensitive to the addition of more control variables to the models (results not shown). These reduced educational differences in subjective health consciousness in age (Fig. 7) are reflected in 'objective' health consciousness in the case of cigarette smoking (Fig. 6c), but not in physical activity (Fig. 6a) and the consumption of fruits and vegetables (Fig. 6b). However, the subjective measures and objective indicators (lifestyles) of health consciousness are generally similar in that they are both positively associated with age.

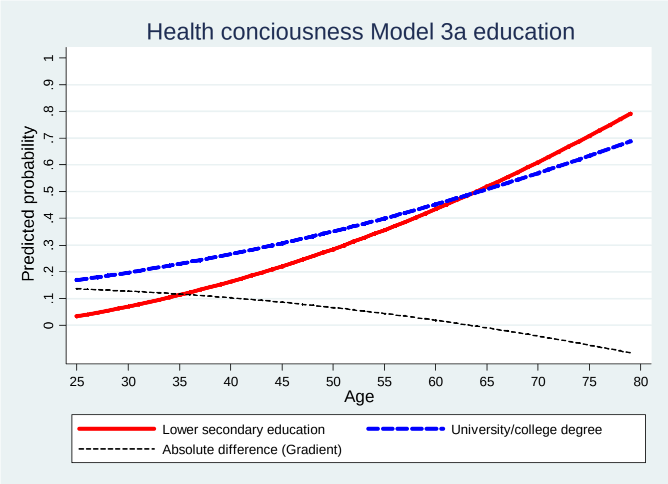

Fig. 7. Predicted age trajectories in subjective health consciousness for people in the lowest and highest education groups. Predictions based on Model 3a and calculated at the mean values of the additional covariates that are included in the model. The dependent variable is coded one if the respondent 'totally agrees' with the statement "I always try to live healthy and keep myself in good physical condition", and zero if the respondent 'partly agrees', 'partly disagrees' or 'totally disagrees'. The underlying linear probability model is based on 21,287 observations, as 419 respondents did not respond to the question on subjective health consciousness.

The education gradients in PA, FV and NSMOKE are more robust than the corresponding income gradients to adding more control variables to the models. We can see this by comparing the gradient lines for Models 3a and 3b in Figs. 5 and 8. When moving from Model 3a to Model 3b, i.e., when adding controls for income, marital status and having children, the age-specific education gradients in PA, FV and NSMOKE are on average reduced by 16.6%, 13.2% and 6.3%, respectively. As discussed, the corresponding income gradients are reduced by 40.4%, 43.0% and 60.7% when adding controls for education, marital status and having children. Thus, the positive correlation that exists between education and income appears to be important in explaining why there are income differences in PA, FV and particularly NSMOKE. Similar to the results for income, the education gradients in PA and FV are largely unaffected by controlling for occupational status, as indicated by the nearly overlapping gradient lines for Models 3b and 3c in Figs. 8a and 8b. The age-specific education gradient in NSMOKE is on average reduced by 11.0% when adding control variables for occupational status (Fig. 8c), and the gradient is more reduced at younger than older ages.

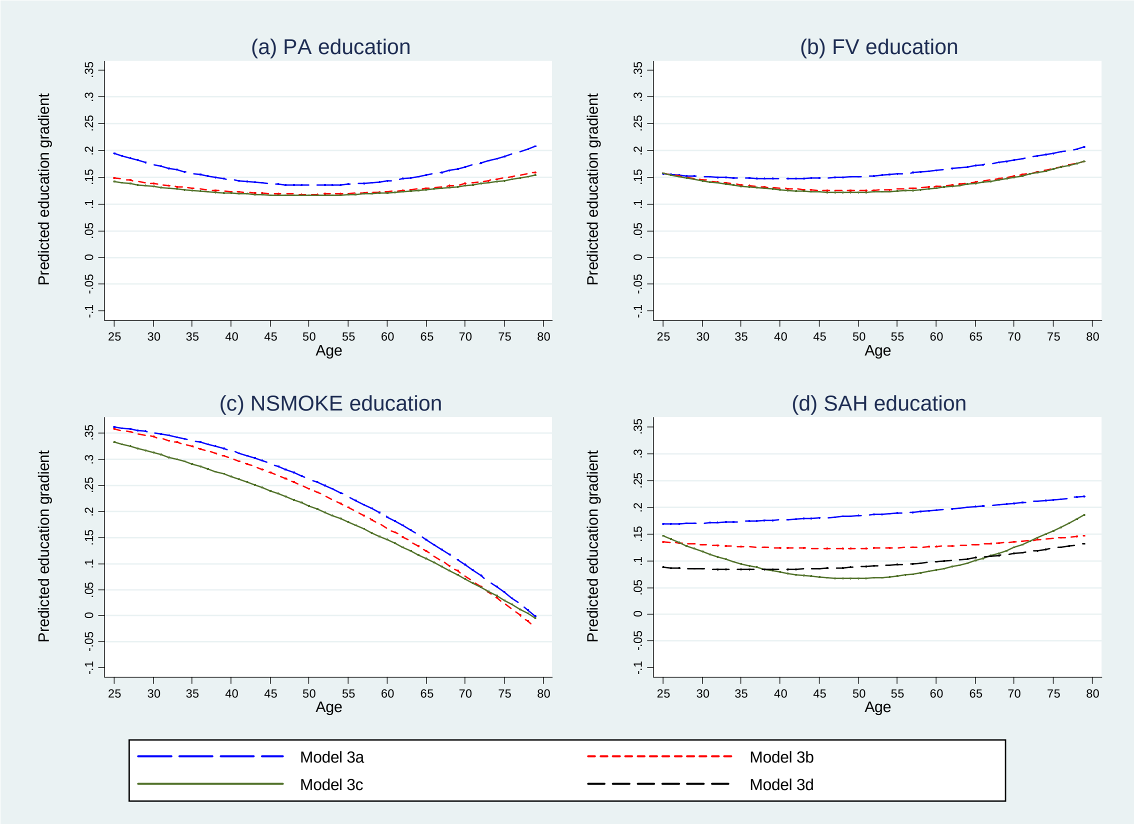

Fig. 8. Predicted age trajectories for the education gradients in lifestyles and self-assessed health resulting from Models 3a–3d in Table 3. Lines indicate the absolute differences in predicted probabilities between people in the lowest and highest education groups when controlling for different sets of variables in the linear probability models. Predictions calculated at the mean values of the additional covariates that are included in the different models.

Averaged over the adult life course, the education gradient in SAH is almost equally reduced when adding controls for occupational status (27.0%) and the lifestyle indicators (27.8%), i.e., when moving from Model 3b to Model 3c and from Model 3b to Model 3d in Fig. 8d, respectively. Thus, lifestyles seem more important in mediating the education–SAH relationship than the income–SAH relationship, as the age-specific income gradient in SAH is reduced by only 6.6% on average when adding lifestyles as control variables.

While controlling for occupational status and lifestyles almost equally affects the education gradient in SAH on average, Fig. 8d illustrates that these two factors differ in terms of their impact at different stages of the adult life course. The education gradient in SAH is moderated by lifestyles at all stages of the adult life course, and interestingly, the reduction in the gradient, i.e., the distance between the gradient lines of Models 3b and 3d in Fig. 8d, is stronger during earlier than later stages of the adult life course. The strong gradual reduction of the education gradient in NSMOKE in age (Fig. 8c) is probably important in explaining this finding. Thus, reduced educational differences in cigarette smoking at older ages could contribute to slowing down cumulative advantage effects in health by education.

Occupational status, on the other hand, is very important in explaining the education gradient in SAH during late midlife and less important during earlier and later stages of the adult life course. As for income and SAH, we find that social security status almost entirely drives this result. For the most part, we can characterize people on social security as being in poor health, in their late midlife, and clustered in the first income quartile and lowest education groups. In the last few years before expected retirement (55–66 years of age), 41.7% of those on social security have only completed lower secondary education or less, compared with 22.4% for those not on social security.

5. Discussion

The relationship between socioeconomic status and health is dynamic and evolves throughout the adult life course. Our analysis explored the role of health affecting lifestyles in explaining these dynamics. We find that in Norway, which is generally considered to be an egalitarian country (OECD, 2011), income and education are generally significantly associated with the probability of being physically active, eating fruits and vegetables and not smoking cigarettes at all stages of the adult life course.

In both low and high socioeconomic status groups, our results generally point toward increased health consciousness and associated lifestyle improvements in age as a mechanism in slowing down the natural deterioration of physical health in age. However, the predicted life course patterns for the education and income gradients in the three lifestyle indicators used in this study are too diverse to firmly conclude that this process of ‘compensating behavior’ at older ages is relatively stronger among lower than higher socioeconomic status groups. Thus, the role of dynamics in the relationship between socioeconomic status and lifestyles in either speeding up or slowing down cumulative advantage effects in health by income and education is not clear. At the same time, the analysis demonstrated that we should not rule out such dynamics as we find that education and income differences in lifestyles do not necessarily remain constant throughout the adult life course.

While the education gradients in physical activity and consumption of fruits and vegetables remain relatively stable throughout the adult life course, the education gradient in cigarette smoking is clearly decreasing in age after being very steep at young ages. This life course pattern in cigarette smoking appears too pronounced to be explained fully by sample selection because of high mortality rates among low-educated smokers or because of cohort effects associated with, for example, the increasing stigmatization of cigarette smokers in recent decades (Bayer, 2008). Thus, while our results generally suggest that lifestyles should contribute to cumulative advantage effects in health by education, the observed life course pattern for smoking could contribute to reducing such cumulative effects at older ages. We find some support for this mechanism in our analysis of self-assessed health.

The different patterns of results across cigarette smoking and the two other lifestyle indicators of this study may to some extent reflect systematic differences in terms of perceived health risks. That is, people with low levels of formal education quit smoking at faster rates as they age because they learn that not doing so can seriously damage their health. While eating fruits and vegetables and being physically active are also clearly associated with good health outcomes (World Health Organization, 2003), this evidence may be less accessible or perceived as less striking than the corresponding evidence on smoking.

With the exception of the income gradient in physical activity among females, the income gradients in lifestyles are generally concave in age and decreasing slightly at older ages. This could contribute to slowing down cumulative advantage effects in health by income at older ages. However, while adding our lifestyle indicators to the regression models reduces the age-specific education gradient in SAH by 27.8% on average, it reduces the corresponding income gradient by only 6.6%. To some extent, this result reflects that while the income gradients in physical activity, consumption of fruits and vegetables and particularly smoking are greatly reduced once we control for the effect of education, the reverse it not true. At least for smoking, this result seems reasonable; that is, there is no strong *a priori* reason to believe that there should be a direct causal effect running from low income to being a cigarette smoker, since the alternative (not smoking cigarettes) is less costly.

The results of this study must be considered in light of its limitations. In particular, our analysis employs repeated cross-section data, and thus we are not able to capture the dynamic nature of health production, nor are we able to capture possible feedbacks between socioeconomic status, occupational status, lifestyles and health. Thus, the results of this study are mainly of a descriptive nature, as the data generally do not allow for causal inference. Some of our key variables may also include measurement error because of incompleteness and the reliance on self-reported data, although for example SAH has been shown to be highly correlated with several objective health measures (Idler and Benyamini, 1997).

Factors such as sample selection (Kim and Durden, 2007), the increasing importance of biological factors relative to socioeconomic status in determining health at older ages (Herd, 2006), cohort effects (Lynch, 2003) and labor market characteristics (van Kippersluis *et al.*, 2010) may be important in explaining life course patterns of cumulative advantage in health by socioeconomic status until late midlife followed by age-as-leveler effects at older ages. However, our results suggest that also dynamics in the relationship between socioeconomic status, health consciousness and associated lifestyle choices may be important. Given the results and limitations of this study, there is a need for more similar research. Studies based on long panel data that track important lifestyle and health indicators as well as socioeconomic status in the same individuals over most stages of the adult life course would be particularly relevant. Studies on other lifestyle indicators, such as alcohol use and the consumption of unhealthy foods, would also be interesting, as would further analyses of the three lifestyle indicators used in this study, but possibly using alternative variable definitions (e.g., physical activity accounting for intensity level). Finally, as our results suggest that education and income differences in subjective health consciousness are gradually decreasing in age, it would be interesting to conduct similar analyses using measures of health consciousness that are more exact.

Although income differences in lifestyles potentially play some role in explaining why there are income differences in health, including how these differences evolve over the adult life course, this seems less clear than in the case of education. Given that the education gradients in physical activity, consumption of fruits and vegetables and cigarette smoking are either stable or declining over the adult life course, policies for improved lifestyle habits should mainly target young people, and particularly young people with low levels of formal education. However, targeting these groups effectively through, for example, pricing and health information policies may be difficult. That said, our results suggest that particularly among low education groups, health consciousness is increasing in age. Thus, health information policies aimed towards making people more health consciousness at earlier stages of the adult life course may be efficient. Such health information could focus on the long-term, cumulative nature of health production and thus the importance of making healthy lifestyle choices also at younger ages.

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APPENDIX

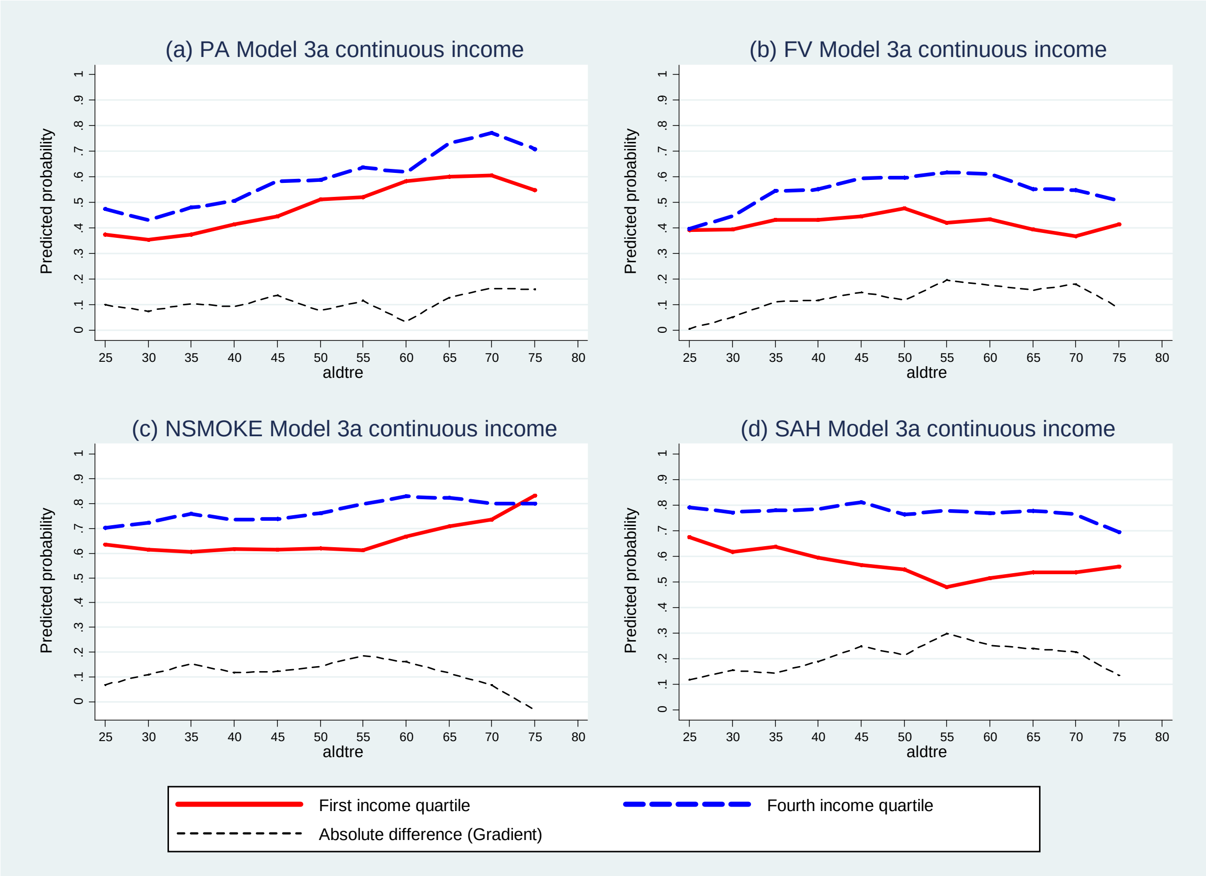

Fig. A1. Predicted age trajectories in lifestyles and self-assessed health for people in the first and fourth income quartiles based on an alternative model specification. The underlying models in this figure include interactions between five-year age dummies and the logarithm of household income. Based on the results of these models, predicted probabilities are calculated and summarized for each income quartile at each five-year age interval. The other covariates in the models are the same as in Model 3a in Table 2. Predictions are calculated at the mean values of the additional covariates.

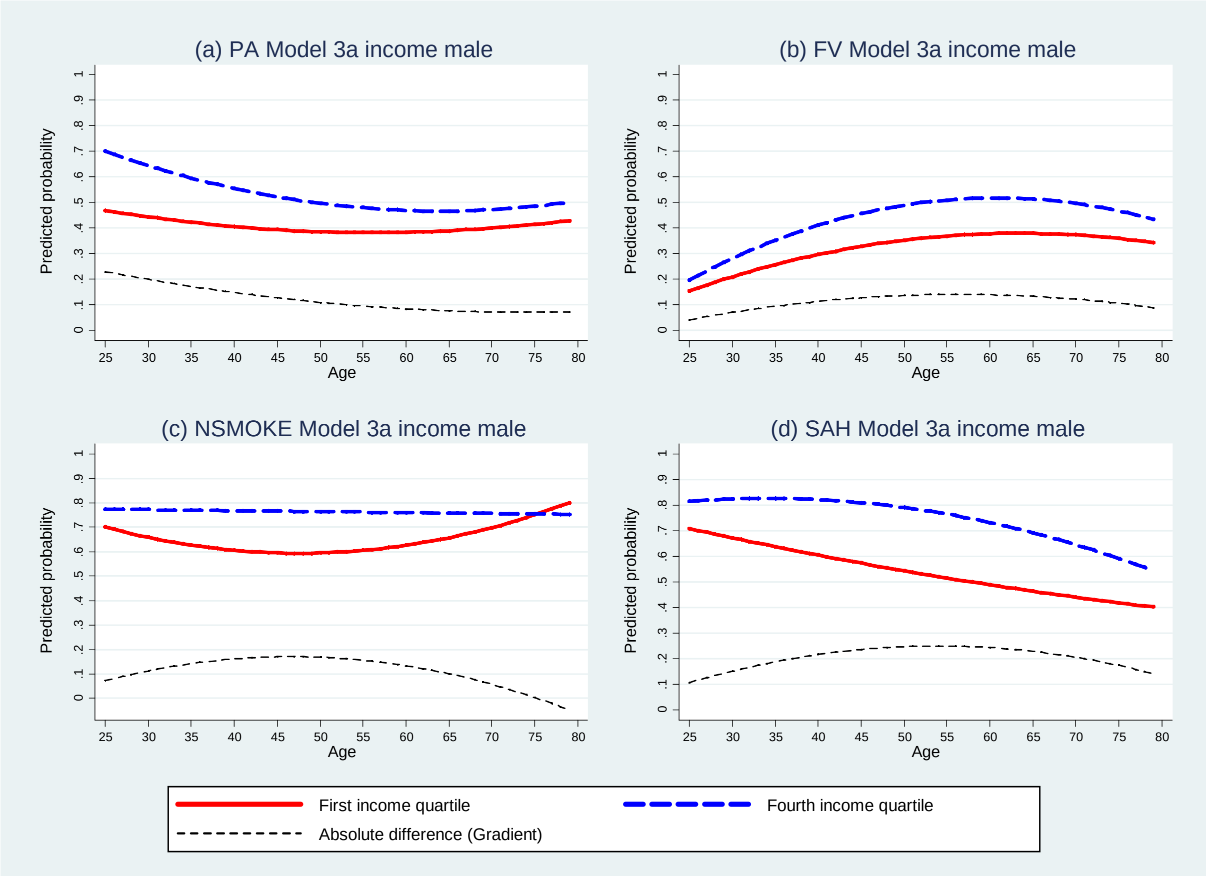

Fig. A2. Predicted age trajectories in lifestyles and self-assessed health for males in the first and fourth income quartiles. Predictions based on Model 3a applied to the male subsample and calculated at the mean values of the additional covariates that are included in the model.

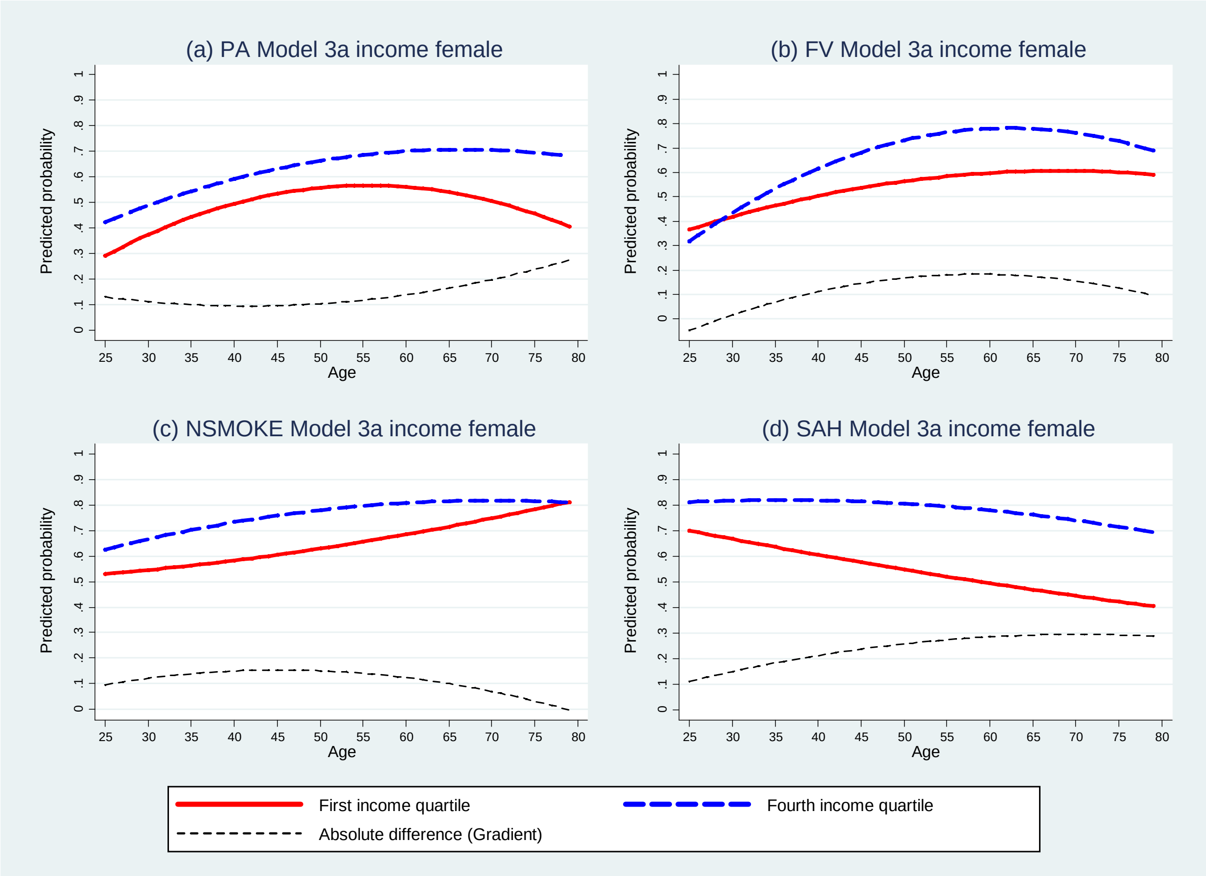

Fig. A3. Predicted age trajectories in lifestyles and self-assessed health for females in the first and fourth income quartiles. Predictions based on Model 3a applied to the female subsample and calculated at the mean values of the additional covariates that are included in the model.

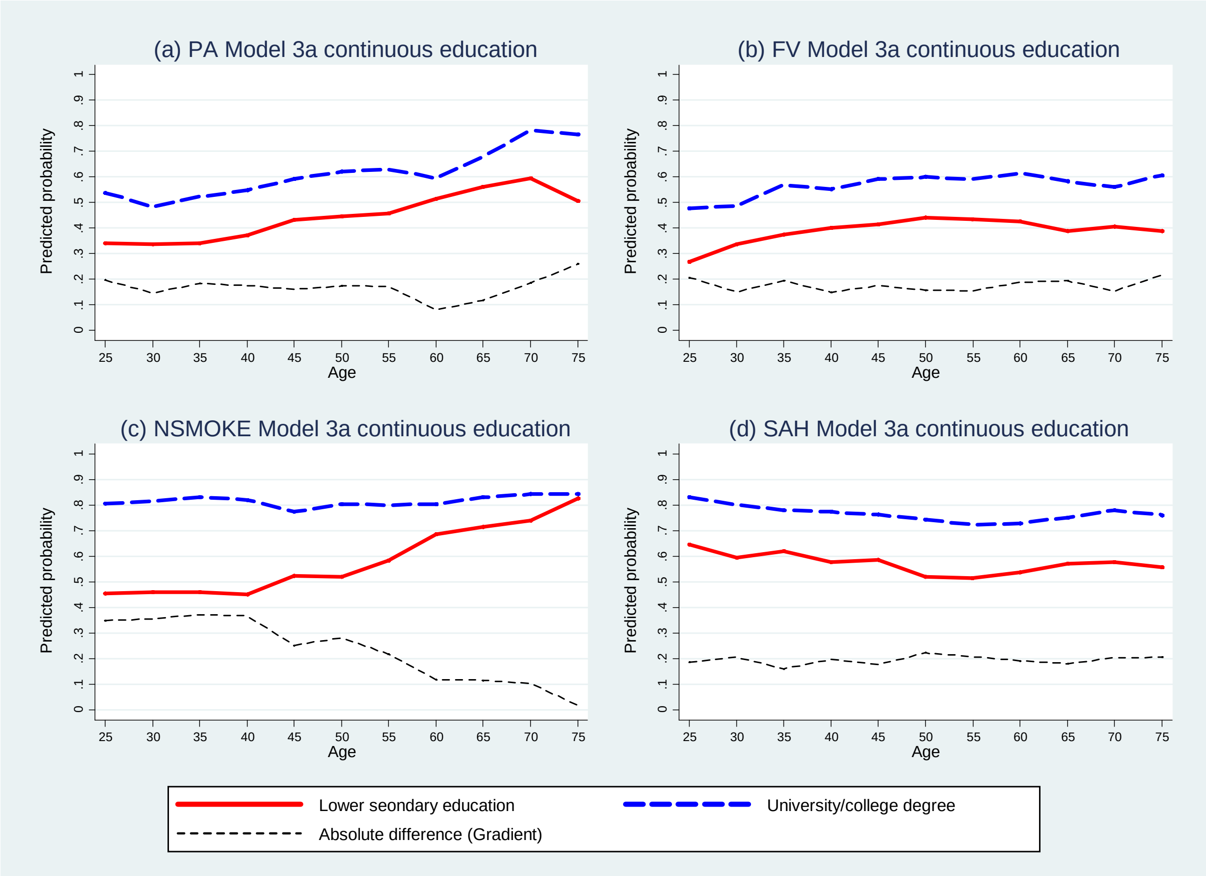

Fig. A4. Predicted age trajectories in lifestyles and self-assessed health for people in the lowest and highest education groups. The underlying models in this figure include interactions between five-year age dummies and a continuous education variable that assumes that $E_1 = 9$ years, $E_2 = 12$ years, $E_3 = 14$ years, and $E_4 = 16$ years of education. Based on the results of these models, predicted probabilities are calculated and summarized for each education group at each five-year age interval. The other covariates in the models are the same as in Model 3a in Table 3. Predictions are calculated at the mean values of the additional covariates.

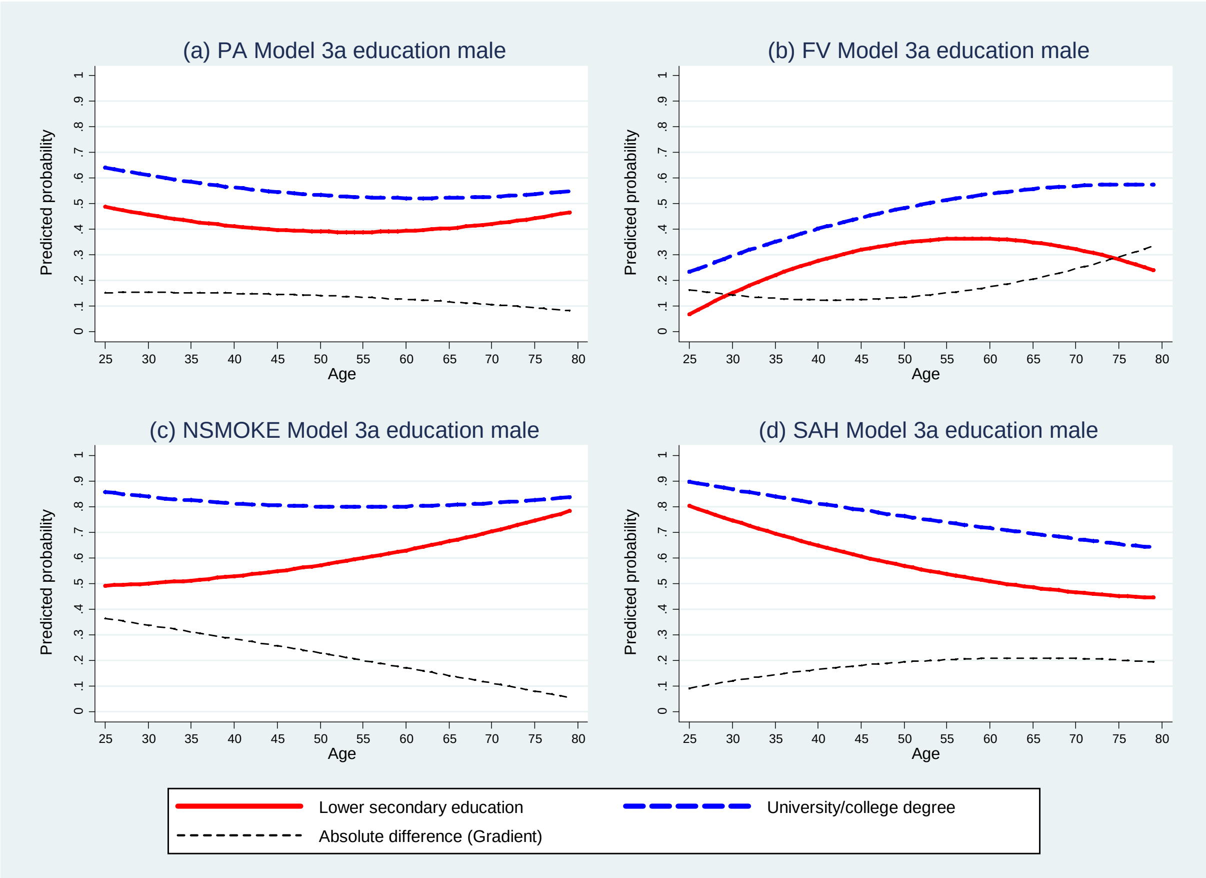

Fig. A5. Predicted age trajectories in lifestyles and self-assessed health for males in the lowest and highest education groups. Predictions based on Model 3a applied to the male subsample and calculated at the mean values of the additional covariates that are included in the model.

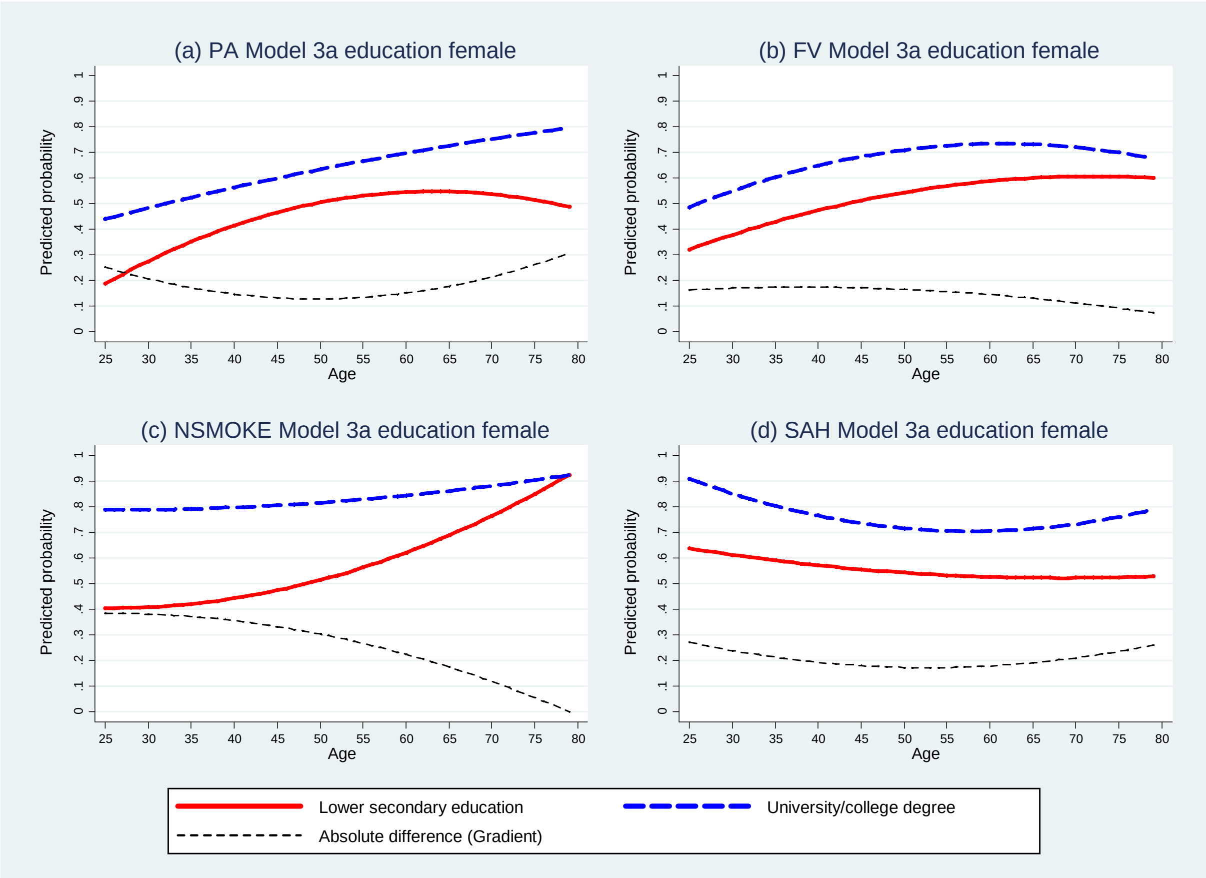

Fig. A6. Predicted age trajectories in lifestyles and self-assessed health for females in the lowest and highest education groups. Predictions based on Model 3a applied to the female subsample and calculated at the mean values of the additional covariates that are included in the model.