



Miscellaneous

# Welfare regimes modify the association of disadvantaged adult-life socioeconomic circumstances with self-rated health in old age

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## Abstract

**Background:** Welfare regimes in Europe modify individuals’ socioeconomic trajectories over their life-course, and, ultimately, the link between socioeconomic circumstances (SECs) and health. This paper aimed to assess whether the associations between life-course SECs (early-life, young adult-life, middle-age and old-age) and risk of poor self-rated health (SRH) trajectories in old age are modified by welfare regimes (Scandinavian [SC], Bismarckian [BM], Southern European [SE], Eastern European [EE]).

**Methods:** We used data from the longitudinal SHARE survey. Early-life SECs consisted of four indicators of living conditions at age 10. Young adult-life, middle-age, and old-age SECs indicators were education, main occupation and satisfaction with household income, respectively. The association of life-course SECs with poor SRH trajectories was analysed by confounder-adjusted multilevel logistic regression models stratified by welfare regime. We included 24 011 participants (3626 in SC, 10 256 in BM, 6891 in SE, 3238 in EE) aged 50 to 96 years from 13 European countries.

**Results:** The risk of poor SRH increased gradually with early-life SECs from most advantaged to most disadvantaged. The addition of adult-life SECs differentially attenuated the

association of early-life SECs and SRH at older age across regimes: education attenuated the association only in SC and SE regimes and occupation only in SC and BM regimes; satisfaction with household income attenuated the association across regimes.

**Conclusions:** Early-life SECs have a long-lasting effect on SRH in all welfare regimes. Adult-life SECs attenuated this influence differently across welfare regimes.

**Key words:** Social conditions, Europe, longitudinal studies, multilevel analysis, healthy aging, social welfare

#### Key Messages

- In all four welfare regimes, early-life socioeconomic circumstances are associated with poor self-rated health in old age, with a gradient of improving health from 'most disadvantaged' to 'most advantaged'.
- Early-life socioeconomic circumstances have long-lasting consequences for health in old age, irrespective of welfare regime.
- The association of early-life socioeconomic circumstances with risk of poor self-rated health in old age is attenuated differently by adult-life socioeconomic circumstances (education, occupation, household income) across welfare regimes, which suggests a differential modifying effect across adult life.

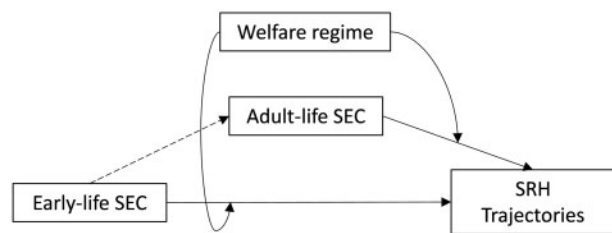
## Introduction

With an ageing European population signalling a demographic transition, research on ageing and the factors influencing how people age is becoming increasingly relevant.<sup>1</sup> The society in which people live and age has a crucial influence on how their health declines in old age.<sup>2,3</sup> In this regard, welfare regimes (WRs) can have a decelerating or accelerating effect on the rate of health decline through differing welfare programmes and measures.<sup>4,5</sup>

Disadvantaged socioeconomic circumstances (SECs) in early and adult life are associated with adverse health outcomes, including poor self-rated health (SRH),<sup>6</sup> chronic disease,<sup>7</sup> lower quality of life,<sup>8,9</sup> lower well-being,<sup>10</sup> greater risk of cardiovascular diseases,<sup>11</sup> physical inactivity,<sup>12</sup> lower muscle strength,<sup>13</sup> higher mortality rates,<sup>14,15</sup> low respiratory function<sup>16</sup> and disability.<sup>17</sup> However, health in old age is not only affected by an individual's SECs over the life-course but also by factors at the societal level such as the welfare state.<sup>4,18,19</sup> Social transfers and welfare services provided by the state are designed to address socioeconomic inequalities that influence health status.<sup>20,21</sup> Research on WRs and health remains particularly important because inequalities in Europe have persisted or even widened despite the expansion of the welfare state.<sup>22–24</sup> Some studies have shown that WRs modify the impact of life-course SECs on health.<sup>4,19,25–27</sup> However, as a major gap in the literature, this modification has not been examined over the whole life-course, from early life to old age.

The modifying effects of WRs are thought to occur because social policies alleviate adversities in an individual's life. More generous welfare regimes, providing higher levels of benefits, reduce social stratification and have a positive effect in situations of need by absorbing the impact of material shortfalls in terms of diet, heating and housing quality.<sup>4,28</sup> Moreover, it has been shown that redistributive policies create a more stable psychosocial environment, even for those not in direct need of benefits.<sup>4</sup> As such, this research indicates that not only adverse socioeconomic circumstances per se but also the anticipation of this adversity can impact health.<sup>4</sup> Social services influence the degree to which people experience insecurity and uncertainty when confronted with adverse circumstances. By extension, the influence of insecurity and uncertainty on SECs and health substantially differs across types of welfare state provision.<sup>4,25,29</sup> Life-course models suggest that these influences of social services impact health trajectories in old age through pathways from early through adult life (Figure 1).<sup>7</sup>

To reflect similarities in terms of the relative roles of the state, family and market in the providing of welfare, countries were grouped in WRs according to Ferrera's typology augmented by the Eastern European WR.<sup>19,30,31</sup> Ferrera's typology focuses on different dimensions of how social benefits are granted and organized and is considered as one of the most accurate typologies.<sup>25</sup> The Scandinavian WR promotes equality of the highest standard unlike other



**Figure 1** Diagram of the performed analyses. The arrows represent associations tested in this study including the direct effect of early-life (model 1) and adult-life (models 2, 3, and 4) socioeconomic circumstances (SEC) on self-rated health (SRH) trajectories as well as the moderating effect of welfare regime on these associations. The dashed arrow represents the direct effect of early-life SECs on adult-life SECs, which was not tested in this study.

WRs where the objective is equality of minimal needs.<sup>32</sup> This WR is characterized by a strong interventionist state that promotes social equality through a comparatively generous redistributive social-security system and universal coverage.<sup>19,30</sup> The Bismarckian WR is characterized by a minimal redistributive impact, with an emphasis on the role of the family. The benefits are often related to earnings and administered by the employer, which distinguishes this WR from others by its ‘status-differentiating’ welfare programmes.<sup>19,30,32</sup> The Southern European WR is characterized by a fragmented system of welfare provision with a strong reliance on the family and charitable sector and only limited and partial healthcare coverage.<sup>19,31</sup> This WR is considered a ‘rudimentary’ type of welfare state that consists of diverse income-maintenance schemes ranging from basic to generous.<sup>32</sup> The Eastern European WR consists of the formerly Communist countries of East Europe that experienced a shift from the universalism of the Communist welfare state to a welfare state characterized by marketization and decentralization.<sup>32</sup> The Eastern European WR is distinguished from others by limited health service provision and poor overall population health.<sup>25</sup>

Recent research on wellbeing suggests that WR explained a higher proportion of between-country differences than any other measure of social protection effort, emphasis or expenditure.<sup>33</sup> In addition, WR has proven to explain between-country variations in quality of work and in the association of work-life balance and health.<sup>34,35</sup> Furthermore, variations in the SRH outcome have been shown across different WRs.<sup>36</sup> These findings confirm the usefulness of the WR typology when trying to explain differences between countries.

In this study, we used a life-course approach to examine, to our knowledge for the first time, whether the association between life-course SECs (early-life, young adult-life, middle-age and old-age) and the risk of poor SRH trajectories in old age are modified by WR.

## Methods

### Study design and participants

This study uses data from SHARE, a cross-national and longitudinal survey that gathered data on health and SECs of more than 120 000 individuals aged 50 years and older in 27 European countries. Between 2004 and 2016, SHARE collected 6 waves of data in intervals of 2 years. Retrospective life-course data including early- and adult-life SECs were collected in wave 3. In our study, we included data for participants between 50 and 96 years old who participated in the third wave (including 13 countries in the analyses) and provided at least one SRH measure over the survey. More details on the study are available in its data-resource profile.<sup>37</sup>

### Welfare regimes

In our study, we used Ferrera’s typology expanded by the Eastern European WR as proposed by Eikemo *et al.*<sup>19,30,31</sup> We classified countries into four WRs: Scandinavian (Denmark, Sweden), Bismarckian (Austria, Belgium, France, Germany, the Netherlands, Switzerland), Southern European (Greece, Italy, Spain), Eastern European (Czech Republic, Poland).<sup>19,31</sup> WRs were investigated at follow-up, as a proxy for an individual’s life-course regime. To avoid misclassification bias because respondents may have changed WRs during follow-up, we compared WRs at baseline and the last follow-up and found no participant who had changed. In addition, we compared the regime participants lived in at follow-up with the regime they lived in at age 10 (early life). Only 3.7% of the participants had a different WR in these two life stages, so changes across regimes were few in the analysed cohorts. Additional models controlling for early-life WR did not change the results (data not shown).

### Measures

#### Outcome: self-reported health

Respondents rated their present general health on a 5-point Likert scale ranging from 1, ‘poor’, to 5, ‘excellent’.<sup>38</sup> We grouped the answer categories ‘poor’ and ‘fair’ to indicate poor SRH as compared with ‘good’, ‘very good’ and ‘excellent’, indicating good SRH.

#### Early-life SECs

Early-life SECs were computed according to Wahrendorf and Blane’s measure of childhood circumstances, combining the following four binary indicators of adverse SECs at age 10 into an index: 1) occupational position of the main breadwinner, 2) number of books in the home, 3) a

measure of overcrowding and 4) quality of the household.<sup>9</sup> This index consisted of a 5-level categorical variable including ‘most disadvantaged’, ‘disadvantaged’, ‘middle’, ‘advantaged’ and ‘most advantaged’. Because of lack of observations in the ‘most advantaged’ category for the Eastern European WR, we merged this category with the ‘advantaged’ category to obtain more consistent results. Consequently, early-life SECs for the Eastern European WR had only four categories ranging from ‘most disadvantaged’ to ‘advantaged’. A sensitivity analysis including the five categories for the Eastern European WR showed similar results. A detailed description of the early-life SECs measure can be found elsewhere.<sup>12,13</sup>

### Prior confounders

Three confounders were included in all models: sex, birth cohort [1919–28/1929–38 (Great Depression)/1939–45 (World War II)/post-1945] and whether participants were living with biological parents at age 10 (both parents/one parent/no parent).

### Mediators

*Adult-life SECs.* Three potential mediators were considered. First, representing young adult-life, we included participants’ highest educational attainment during follow-up by coding tertiary education according to the International Standard Classification of Education as highly educated, with primary and secondary education coded as low level of education. Second, we coded main occupation according to the International Standard Classification of Occupations (ISCO) classification of an individual’s main job over the life-course, which represents middle-age SECs. The ten main occupational groups in ISCO were reclassified according to their skill levels. Skill levels one and two were grouped into ‘low’ and the third and fourth levels grouped into ‘high’ main occupation. Participants who never had paid work were included in the low occupational position. Third, we used satisfaction with current household income based on the question ‘Is the household able to make ends meet?’ as an indicator for old-age SECs. Answers ranged from 1 ‘with great difficulty’ to 4 ‘easily’. We calculated the mode over all waves for each individual to keep as many observations as possible.

### Covariates

*Unhealthy behaviour index.* This index combines four binary indicators of detrimental health behaviours. By taking the mean of 1) physical inactivity, 2) unhealthy eating, 3) smoking and 4) alcohol consumption across waves for each participant, we obtained a continuous variable ranging from 0, none of the 4, to 1, all 4 unhealthy behaviours.<sup>39–41</sup>

*Living without a partner.* Independent of individuals’ marital status, we measured whether the person was living with a partner during follow-up, coded 0, mostly living alone, and 1, mostly living with a partner.<sup>42,43</sup>

### Statistical analysis

Data were analysed by using logistic mixed-effects models with a random intercept for participants. Our models revealed significant interactions between adult-life SECs and WRs, confirming the interest to examine the associations between life-course SECs and SRH separately by WR. Model 1 tested the association between early-life SECs and the odds of poor SRH in older age, adjusting for prior confounders. We centred age at the mid-point of the sample (i.e. 73 years). In addition, to test whether early-life SECs moderated the association of ageing and the odds of poor SRH, an interaction term between early-life SECs and age was included in all models. Adult-life SECs indicators were added sequentially in model 2 (educational attainment), model 3 (main occupation), and model 4 (satisfaction with current household income) for young adult-life, middle age and old age, respectively. When adding the adult-life SECs indicators sequentially, we followed the chronological order of the indicators in the life-course.<sup>13,17,44</sup> The attenuation effects were calculated by comparing the raw estimates of early-life SECs of the models with mediators (models 2 to 4) with model 1 without mediators. This allowed to calculate a percentage of decrease of the effect of early-life SECs on SRH trajectories in old age when including the different mediators. Model 5 included the unhealthy behaviour index and living without a partner covariates. All models were adjusted for participant attrition [no dropout/dropout (participants who did not respond to waves 5 and 6)/death (participants who died during follow-up)]. Finally, we performed sensitivity analyses excluding participants 1) older than 90 years because the descriptive statistics showed that observations above this age were few, 2) who died during the survey, 3) who dropped out and 4) who lived in a different WR in childhood than at follow-up and one that used a 5-level early-SECs variable for the Eastern European WR.

## Results

### Participants

The study sample included 24 011 participants (3626 in Scandinavian, 10 256 in Bismarckian, 6891 in Southern European, 3238 in Eastern European WRs) aged 50 to 96 years and living in 13 European countries (Austria, Belgium, Czech Republic, Denmark, France, Germany,



Greece, Italy, The Netherlands, Poland, Spain, Sweden and Switzerland). Descriptive statistics showed a gradient relation between early-life SECs and the prevalence of poor SRH across WRs (Table 1), with the more advantaged participants showing lower prevalence of poor SRH.

### Effect of early-life SECs on risk of poor self-rated health during ageing (Table 2, model 1)

For all WRs, early-life SECs were associated with risk of poor SRH at age 73 (centered age). A gradient indicated decreasing risk of poor SRH with increasing early-life SECs categories (Figure 2). The interaction of early-life SECs and age had no effects except for the Bismarckian WR. The adverse effect of ageing was higher with middle, advantaged and most advantaged early-life SECs versus the most disadvantaged.

### Effect of adult-life mediators on risk of poor SRH during ageing (Table 2, models 2 to 5)

The associations of the mediators with risk of poor SRH differed across WRs. High educational attainment was associated with reduced risk of poor SRH for all WRs (model 2) and it attenuated the association (compared to model 1) of early-life SECs with risk of poor SRH (model 2) for the Scandinavian (reduced the effect of disadvantaged, middle, advantaged and most advantaged early-life SECs by 12, 15, 18 and 23%, respectively) and Southern European (reduced the effect by 8, 13, 23 and 35%, respectively) WRs. For the Bismarckian WR, the adverse effect of ageing was greater with high versus low educational level (interaction of age with educational level).

Main occupation position was associated with risk of poor SRH in Scandinavian and Bismarckian WRs and, with education, attenuated the association (compared to model 1) of early-life SECs with risk of poor SRH (model 3) for all WRs: Scandinavian (reduced the effect of disadvantaged, middle, advantaged and most advantaged early-life SECs by 10, 22, 25 and 32%, respectively), Bismarckian (reduced the effect by 12, 14, 21 and 25%, respectively), Southern European (reduced the effect by 5, 13, 22 and 34%, respectively) and Eastern European (reduced the effect by 8, 8 and 11% for disadvantaged, middle and advantaged, respectively) (Figure 3). Low main occupation was associated with risk of poor SRH for Scandinavian and Bismarckian WRs, with 74 and 69% greater odds of poor SRH, respectively (model 3). The adverse effect of ageing was lower with low (versus high) main occupation position in Scandinavian and Eastern European WRs (interaction of age with low main occupation position).

Satisfaction with household income was associated with risk of poor SRH for all WRs. The effects for disadvantaged, middle, advantaged and most advantaged early-life SECs were reduced (model 4 compared to model 1) with the addition of household income for the Scandinavian (by 38, 40, 35 and 41%, respectively), Bismarckian (by 37, 34, 39 and 38%, respectively), Southern European (by 18, 26, 37 and 53%, respectively) and Eastern European (by 30, 23 and 23%, for disadvantaged, middle and advantaged, respectively) WRs. For the Bismarckian WR, the adverse effect of ageing was reduced with greater difficulty making ends meet (interaction of age with satisfaction with household income).

The addition of the unhealthy behaviour index and living without a partner (model 5) did not change the association of early-life SECs and risk of poor SRH or any of the other mediators.

### Sensitivity analyses

Overall, sensitivity analyses revealed consistent results with those of the main analyses, with gradually attenuated associations between early-life SECs and risk of poor SRH in old age with the addition of adult-life SECs across WRs. In contrast, the interactions between age and early-life SECs as well as age and adult-life SECs seemed not to be robust in the different analyses. Thus, the associations of early- and adult-life SECs with the evolution of poor SRH with ageing seemed less robust than their associations with level of poor SRH.

### Discussion

One of the main novel results of this cross-national and multi-measurement longitudinal study was the persisting association of early-life SECs with risk of poor SRH in older age across all WRs. This pattern has important implications, suggesting that the welfare context did not differentially modify the association between early-life SECs and SRH at old age. The association showed a social gradient in risk of poor SRH in old age, from the lowest risk for the most advantaged individuals to the highest risk for the most disadvantaged in terms of early-life SECs. These associations remained significant after full adjustment for adult-life mediators.

In contrast to early-life SECs, adult-life SECs were associated differently with risk of poor SRH across WRs and had varying attenuation effects on the relation between early-life SECs and SRH, which agrees with the original analysis before stratification including interaction terms of life-course SECs with WRs. Satisfaction with household income had the most important attenuation effect while also

**Table 1.** Participant characteristics by welfare regimes and early-life socioeconomic circumstances (SECs) at baseline

	Scandinavian (n = 3626)				Bismarckian (n = 10256)				Southern European (n = 6891)				Eastern European (n = 3238)							
	MD	D	M	A	MA	MD	D	M	A	MA	MD	D	M	A	MA	MD	D	M	A	
<b>n</b>	217	545	1397	1081	386	1063	2378	3579	2414	822	2266	2359	1614	556	96	966	761	1119	392	
<b>Outcome</b>																				
<b>Self-rated health</b>																				
<b>Poor</b>	58 (27%)	119 (22%)	202 (14%)	120 (11%)	31 (8%)	395 (37%)	707 (30%)	866 (24%)	493 (20%)	135 (16%)	940 (41%)	803 (34%)	410 (25%)	139 (25%)	16 (17%)	626 (65%)	435 (57%)	444 (40%)	129 (33%)	
<b>Good</b>	159	426	1195	961	355	668	1671	2713	1921	687	1326	1556	1204	417	80	340	326	675	263	
<b>Prior confounders</b>																				
<b>Age, years (SD)</b>	70.3 (8.3)	66 (9.0)	61.8 (8.7)	60.2 (8.5)	60.3 (8.7)	67.0 (9.2)	64.3 (9.1)	61.2 (8.7)	60.7 (8.9)	61.3 (9.4)	66 (9.0)	62 (9.0)	60 (8.8)	60 (8.4)	62 (9.0)	66 (9.4)	63 (9.1)	61 (8.6)	60 (8.1)	
<b>Sex</b>																				
<b>Women</b>	118 (54%)	309 (57%)	764 (55%)	595 (55%)	211 (55%)	599 (56%)	1327 (56%)	2021 (56%)	1311 (54%)	456 (55%)	1246 (55%)	1316 (56%)	935 (58%)	320 (58%)	52 (54%)	527 (55%)	445 (58%)	659 (59%)	229 (58%)	
<b>Men</b>	99	236	633	486	175	464	1051	1558	1103	366	1020	1043	679	236	44	439	316	460	163	
<b>Birth cohort</b>																				
<b>After 1945</b>	20 (9%)	137 (25%)	613 (44%)	566 (52%)	206 (53%)	244 (23%)	789 (33%)	1738 (49%)	1253 (52%)	395 (48%)	600 (27%)	1070 (45%)	907 (56%)	304 (55%)	40 (42%)	358 (37%)	361 (47%)	625 (56%)	242 (62%)	
<b>1939–45</b>	40 (19%)	134 (25%)	374 (27%)	266 (25%)	94 (24%)	217 (20%)	586 (25%)	837 (24%)	539 (22%)	196 (24%)	540 (24%)	539 (23%)	304 (19%)	131 (24%)	23 (24%)	208 (22%)	182 (24%)	248 (22%)	87 (22%)	
<b>1929–38</b>	96 (44%)	173 (32%)	295 (21%)	177 (16%)	54 (14%)	388 (37%)	690 (29%)	729 (20%)	430 (18%)	150 (18%)	791 (35%)	560 (24%)	297 (18%)	91 (16%)	23 (24%)	292 (30%)	152 (20%)	189 (17%)	45 (12%)	
<b>1919–28</b>	61 (28%)	101 (18%)	115 (8%)	72 (7%)	32 (9%)	214 (20%)	313 (13%)	275 (7%)	192 (8%)	81 (10%)	335 (14%)	190 (8%)	106 (7%)	30 (5%)	10 (10%)	108 (11%)	66 (9%)	57 (5%)	18 (4%)	
<b>Living with biological parents</b>																				
<b>Both parents</b>	183 (84%)	465 (85%)	1249 (90%)	972 (90%)	341 (88%)	942 (89%)	2095 (88%)	3215 (90%)	2147 (90%)	756 (92%)	2118 (93%)	2209 (94%)	1532 (95%)	517 (93%)	90 (94%)	854 (88%)	668 (88%)	1013 (91%)	363 (92%)	
<b>One biological parent</b>	22 (10%)	57 (11%)	114 (8%)	80 (7%)	27 (7%)	98 (9%)	229 (10%)	295 (8%)	213 (8%)	54 (7%)	126 (6%)	116 (5%)	59 (4%)	24 (4%)	3 (3%)	104 (11%)	84 (11%)	92 (8%)	26 (7%)	
<b>No biological parent</b>	12 (6%)	23 (4%)	34 (2%)	29 (3%)	18 (5%)	23 (2%)	54 (2%)	69 (2%)	54 (2%)	12 (1%)	22 (1%)	34 (1%)	23 (1%)	15 (3%)	3 (3%)	8 (1%)	9 (1%)	14 (1%)	3 (1%)	
<b>Attrition</b>																				
<b>No drop out</b>	134 (62%)	391 (72%)	1092 (78%)	887 (82%)	308 (80%)	670 (63%)	1605 (67%)	2500 (70%)	1718 (71%)	570 (69%)	1607 (71%)	1726 (73%)	1217 (75%)	421 (75%)	77 (80%)	668 (69%)	501 (66%)	739 (66%)	265 (68%)	
<b>Drop out</b>	28 (13%)	78 (14%)	179 (13%)	134 (12%)	38 (10%)	275 (26%)	601 (25%)	910 (25%)	573 (24%)	195 (24%)	333 (15%)	391 (17%)	271 (17%)	92 (17%)	8 (8%)	118 (12%)	139 (18%)	261 (23%)	92 (24%)	
<b>Deceased</b>	55 (25%)	76 (14%)	126 (9%)	60 (6%)	40 (10%)	118 (11%)	172 (7%)	169 (5%)	123 (5%)	57 (7%)	326 (14%)	242 (10%)	126 (8%)	43 (8%)	11 (12%)	180 (19%)	121 (16%)	119 (11%)	35 (8%)	

(Continued)

Table 1. Continued

	Scandinavian (n = 3626)				Bismarckian (n = 10 256)				Southern European (n = 6891)				Eastern European (n = 3238)							
	MD	D	M	A	MA	MD	D	M	A	MA	MD	D	M	A	MA	MD	D	M	A	
<b>Adult-life SECs</b>																				
<b>Educational attainment</b>																				
High education	16 (7%)	75 (14%)	404 (29%)	474 (44%)	250 (65%)	69 (6%)	254 (11%)	796 (22%)	845 (35%)	454 (55%)	71 (3%)	149 (6%)	265 (16%)	164 (29%)	51 (53%)	35 (4%)	44 (6%)	128 (11%)	78 (20%)	
Low education	201	470	993	607	136	994	2124	2783	1569	368	2195	2210	1349	392	45	931	717	991	314	
<b>Main occupational class</b>																				
High	28 (13%)	90 (17%)	451 (32%)	482 (45%)	249 (65%)	82 (8%)	353 (15%)	884 (25%)	882 (36%)	462 (56%)	104 (5%)	179 (8%)	280 (17%)	169 (30%)	54 (56%)	69 (7%)	121 (16%)	294 (26%)	172 (44%)	
Low	189	455	946	599	137	981	2025	2695	1532	360	2162	2180	1334	387	42	897	640	825	220	
<b>Satisfaction with household income ('make ends meet')</b>																				
Easily	117 (54%)	322 (59%)	967 (69%)	782 (72%)	287 (74%)	378 (36%)	991 (42%)	1770 (49%)	1337 (55%)	510 (62%)	239 (11%)	314 (13%)	328 (20%)	130 (23%)	30 (31%)	68 (7%)	96 (13%)	198 (18%)	68 (17%)	
Fairly easily	70	161	328	218	77	420	890	1209	725	210	559	632	510	214	42	279	243	385	166	
With some difficulty	21	52	77	71	19	188	356	452	262	82	857	849	519	142	21	399	298	414	127	
With great difficulty	9 (10%)	10 (10%)	25 (6%)	10 (7%)	3 (5%)	77 (17%)	141 (15%)	148 (13%)	90 (11%)	20 (10%)	611 (37%)	564 (36%)	257 (32%)	70 (26%)	3 (22%)	220 (41%)	124 (39%)	122 (37%)	31 (32%)	
(4%)	(2%)	(2%)	(2%)	(1%)	(1%)	(7%)	(6%)	(4%)	(4%)	(2%)	(27%)	(24%)	(16%)	(13%)	(3%)	(23%)	(16%)	(11%)	(9%)	
<b>Covariates</b>																				
Living with a partner																				
Without	75 (35%)	159 (29%)	321 (23%)	249 (23%)	83 (22%)	344 (32%)	701 (29%)	887 (25%)	585 (24%)	221 (27%)	493 (22%)	464 (20%)	349 (22%)	110 (20%)	21 (22%)	253 (26%)	220 (29%)	318 (28%)	123 (31%)	
With	142	386	1076	832	303	719	1677	2692	1829	601	1773	1895	1265	446	75	713	541	801	269	
Unhealthy behaviour index <sup>a</sup>	0.25 (0.3)	0.26 (0.3)	0.24 (0.2)	0.23 (0.2)	0.22 (0.2)	0.23 (0.2)	0.24 (0.3)	0.22 (0.2)	0.22 (0.2)	0.22 (0.2)	0.31 (0.3)	0.29 (0.3)	0.31 (0.3)	0.28 (0.3)	0.23 (0.3)	0.43 (0.3)	0.40 (0.3)	0.39 (0.3)	0.38 (0.3)	

MD, most disadvantaged; D, disadvantaged; M, middle; A, advantaged; MA, most advantaged.

<sup>a</sup> Range: 0, none of the four health-detrimental behaviours, to 1, all of the four health-detrimental behaviours.

**Table 2.** Associations between early-life SECs and poor self-rated health (SRH) at older age, by welfare regime

	SC <i>n</i> = 3626 OR (95% CI)		BM <i>n</i> = 10 256 OR (95% CI)		SE <i>n</i> = 6891 OR (95% CI)		EE <i>n</i> = 3238 OR (95% CI)	
		<i>P</i>		<i>P</i>		<i>P</i>		<i>P</i>
<b>Model 1</b>								
Early-life SECs								
Most advantaged	0.17 (0.45–1.11)	<0.001	0.21 (0.15–0.28)	<0.001	0.24 (0.13–0.43)	<0.001	–	–
Advantaged	0.24 (0.15–0.38)	<0.001	0.35 (0.28–0.44)	<0.001	0.40 (0.29–0.53)	<0.001	0.21 (0.15–0.30)	<0.001
Middle	0.41 (0.27–0.63)	<0.001	0.44 (0.35–0.54)	<0.001	0.47 (0.39–0.57)	<0.001	0.34 (0.27–0.44)	<0.001
Disadvantaged	0.70 (0.45–1.11)	0.128	0.72 (0.58–0.90)	0.003	0.78 (0.66–0.91)	0.002	0.63 (0.48–0.81)	<0.001
Most disadvantaged	(ref)		(ref)		(ref)		(ref)	
Age x early-life SECs								
Age x most adv	1.05 (1.00–1.10)	0.063	1.03 (1.00–1.05)	0.020	0.98 (0.94–1.03)	0.457	–	–
Age x adv	1.03 (0.99–1.08)	0.112	1.03 (1.01–1.05)	0.010	1.01 (0.99–1.04)	0.295	1.02 (0.99–1.04)	0.292
Age x middle	1.03 (1.00–1.08)	0.085	1.02 (1.00–1.04)	0.039	1.01 (0.99–1.02)	0.395	1.02 (1.00–1.04)	0.089
Age x disadv	1.01 (0.97–1.05)	0.719	1.01 (0.99–1.03)	0.186	1.00 (0.99–1.01)	0.979	0.99 (0.97–1.01)	0.470
Age x most disadv	(ref)		(ref)		(ref)		(ref)	
<b>Model 2</b>								
Early-life SECs								
Most advantaged	0.25 (0.14–0.44)	<0.001	0.26 (0.19–0.36)	<0.001	0.39 (0.21–0.73)	0.003	–	–
Advantaged	0.31 (0.20–0.49)	<0.001	0.40 (0.32–0.51)	<0.001	0.49 (0.36–0.66)	<0.001	0.23 (0.16–0.33)	<0.001
Middle	0.47 (0.31–0.72)	0.001	0.47 (0.38–0.58)	<0.001	0.52 (0.43–0.63)	<0.001	0.36 (0.28–0.46)	<0.001
Disadvantaged	0.73 (0.47–1.15)	0.175	0.73 (0.59–0.91)	0.005	0.79 (0.67–0.93)	0.004	0.63 (0.49–0.82)	0.001
Most disadvantaged	(ref)		(ref)		(ref)		(ref)	
Educational attainment								
High	0.44 (0.34–0.57)	<0.001	0.61 (0.51–0.73)	<0.001	0.36 (0.26–0.50)	<0.001	0.62 (0.43–0.90)	0.012
Low	(ref)		(ref)		(ref)		(ref)	
Age x early-life SECs								
Age x most adv	1.04 (0.99–1.09)	0.094	1.02 (0.99–1.04)	0.166	0.98 (0.93–1.03)	0.461	–	–
Age x adv	1.03 (0.99–1.08)	0.125	1.02 (1.00–1.04)	0.056	1.01 (0.98–1.03)	0.574	1.01 (0.98–1.04)	0.375
Age x middle	1.04 (1.00–1.08)	0.080	1.02 (1.00–1.03)	0.091	1.00 (0.99–1.02)	0.746	1.02 (1.00–1.04)	0.121
Age x disadv	1.01 (0.97–1.06)	0.568	1.01 (0.99–1.03)	0.176	1.00 (0.99–1.01)	0.930	0.99 (0.97–1.01)	0.427
Age x most disadv	(ref)		(ref)		(ref)		(ref)	
Age x educ attainment								
Age x high	1.01 (0.99–1.03)	0.214	1.02 (1.01–1.04)	0.001	1.01 (0.99–1.04)	0.282	1.02 (0.99–1.05)	0.290
Age x low	(ref)		(ref)		(ref)		(ref)	
<b>Model 3</b>								
Early life SECs								
Most advantaged	0.29 (0.17–0.51)	<0.001	0.31 (0.22–0.42)	<0.001	0.39 (0.21–0.73)	0.003	–	–
Advantaged	0.34 (0.22–0.54)	<0.001	0.44 (0.35–0.55)	<0.001	0.49 (0.36–0.66)	<0.001	0.25 (0.17–0.36)	<0.001
Middle	0.50 (0.33–0.76)	0.001	0.49 (0.40–0.61)	<0.001	0.52 (0.43–0.63)	<0.001	0.37 (0.29–0.48)	<0.001
Disadvantaged	0.73 (0.46–1.14)	0.165	0.75 (0.60–0.93)	0.009	0.79 (0.68–0.93)	0.004	0.65 (0.50–0.84)	0.001
Most disadvantaged	(ref)		(ref)		(ref)		(ref)	
Educational attainment								
High	0.56 (0.42–0.74)	<0.001	0.74 (0.61–0.90)	0.003	0.36 (0.26–0.50)	<0.001	0.72 (0.48–1.08)	0.116
Low	(ref)		(ref)		(ref)		(ref)	
Main occupation								
Low	1.74 (1.33–2.27)	<0.001	1.69 (1.40–2.04)	<0.001	1.01 (0.77–1.31)	0.945	1.31 (0.97–1.76)	0.076
High	(ref)		(ref)		(ref)		(ref)	
Age x early-life SECs								
Age x most adv	1.04 (0.99–1.09)	0.160	1.01 (0.99–1.04)	0.288	0.98 (0.93–1.03)	0.439	–	–
Age x adv	1.03 (0.99–1.07)	0.171	1.02 (1.00–1.04)	0.107	1.01 (0.98–1.03)	0.668	1.01 (0.98–1.04)	0.656
Age x middle	1.03 (0.99–1.07)	0.097	1.01 (0.99–1.03)	0.157	1.00 (0.99–1.02)	0.749	1.01 (0.99–1.03)	0.213
Age x disadv	1.01 (0.97–1.06)	0.521	1.01 (0.99–1.03)	0.219	1.00 (0.99–1.01)	0.983	0.99 (0.97–1.01)	0.322
Age x most disadv	(ref)		(ref)		(ref)		(ref)	

(Continued)



Table 2. Continued

	SC <i>n</i> = 3626		BM <i>n</i> = 10 256		SE <i>n</i> = 6891		EE <i>n</i> = 3238	
	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
Age x educ attainment								
Age x high	1.00 (0.98–1.03)	0.735	1.02 (1.01–1.04)	0.008	1.01 (0.99–1.04)	0.306	1.01 (0.97–1.04)	0.750
Age x low	(ref)		(ref)		(ref)		(ref)	
Age x main occup pos								
Age x low	0.98 (0.96–1.00)	0.039	0.99 (0.97–1.00)	0.148	1.00 (0.98–1.02)	0.927	0.98 (0.95–1.00)	0.046
Age x high	(ref)		(ref)		(ref)		(ref)	
Model 4								
Early-life SECs								
Most advantaged	0.35 (0.20–0.60)	<0.001	0.38 (0.28–0.52)	<0.001	0.51 (0.28–0.94)	0.032	–	–
Advantaged	0.40 (0.25–0.62)	<0.001	0.53 (0.42–0.67)	<0.001	0.56 (0.41–0.75)	<0.001	0.30 (0.21–0.43)	<0.001
Middle	0.59 (0.39–0.89)	0.012	0.58 (0.47–0.71)	<0.001	0.57 (0.47–0.70)	<0.001	0.44 (0.34–0.56)	<0.001
Disadvantaged	0.80 (0.51–1.25)	0.329	0.81 (0.66–1.00)	0.054	0.81 (0.69–0.95)	0.010	0.72 (0.56–0.93)	0.011
Most disadvantaged	(ref)		(ref)		(ref)		(ref)	
Educational attainment								
High	0.61 (0.46–0.81)	0.001	0.86 (0.71–1.04)	0.125	0.42 (0.30–0.59)	<0.001	0.80 (0.53–1.19)	0.269
Low	(ref)		(ref)		(ref)		(ref)	
Main occupation								
Low	1.63 (1.25–2.12)	<0.001	1.48 (1.23–1.78)	<0.001	0.91 (0.70–1.18)	0.457	1.20 (0.90–1.61)	0.210
High	(ref)		(ref)		(ref)		(ref)	
	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
Satisfaction with household income								
Great difficulty	13.34 (5.99–29.71)	<0.001	8.96 (6.39–12.57)	<0.001	3.02 (2.39–3.80)	<0.001	3.82 (2.55–5.74)	<0.001
Some difficulty	3.63 (2.45–5.39)	<0.001	4.21 (3.44–5.16)	<0.001	2.00 (1.62–2.48)	<0.001	1.57 (1.15–2.15)	0.004
Fairly easily	1.91 (1.49–2.45)	<0.001	2.02 (1.75–2.34)	<0.001	1.18 (0.95–1.47)	0.126	1.00 (0.73–1.36)	0.995
Easily	(ref)		(ref)		(ref)		(ref)	
Age x early-life SECs								
Age x most adv	1.03 (0.98–1.08)	0.186	1.01 (0.99–1.04)	0.418	0.98 (0.93–1.03)	0.486	1.01 (0.98–1.03)	0.738
Age x adv	1.02 (0.98–1.07)	0.243	1.01 (0.99–1.03)	0.185	1.00 (0.98–1.03)	0.748	1.01 (0.99–1.03)	0.298
Age x middle	1.03 (0.99–1.07)	0.120	1.01 (0.99–1.03)	0.265	1.00 (0.99–1.02)	0.869	0.99 (0.97–1.01)	0.309
Age x disadv	1.01 (0.97–1.05)	0.713	1.01 (0.99–1.03)	0.302	1.00 (0.99–1.01)	0.887	1.01 (0.98–1.03)	0.738
Age x most disadv	(ref)		(ref)		(ref)		(ref)	
Age x educ attainment								
Age x high	1.01 (0.98–1.03)	0.651	1.02 (1.00–1.03)	0.021	1.02 (0.99–1.04)	0.198	1.00 (0.97–1.04)	0.820
Age x low	(ref)		(ref)		(ref)		(ref)	
Age x main occup pos								
Age x low	0.98 (0.96–1.00)	0.029	0.99 (0.98–1.01)	0.326	1.00 (0.98–1.02)	0.985	0.98 (0.96–1.01)	0.153
Age x high	(ref)		(ref)		(ref)		(ref)	
Age x household income								
Age x great diff	1.01 (0.95–1.08)	0.673	0.95 (0.93–0.98)	<0.001	1.01 (0.99–1.03)	0.534	0.98 (0.95–1.01)	0.158
Age x some diff	1.00 (0.96–1.03)	0.840	1.00 (0.98–1.01)	0.600	1.01 (0.99–1.03)	0.283	0.98 (0.96–1.01)	0.187
Age x fairly easily	1.02 (1.00–1.04)	0.075	1.00 (0.99–1.02)	0.499	1.00 (0.98–1.02)	0.948	0.98 (0.96–1.01)	0.133
Age x easily	(ref)		(ref)		(ref)		(ref)	
Model 5								
Early-life SECs								
Most advantaged	0.34 (0.20–0.58)	<0.001	0.36 (0.27–0.49)	<0.001	0.52 (0.28–0.95)	0.034	–	–
Advantaged	0.39 (0.25–0.60)	<0.001	0.52 (0.41–0.65)	<0.001	0.57 (0.42–0.76)	<0.001	0.30 (0.21–0.44)	<0.001
Middle	0.56 (0.37–0.85)	0.010	0.58 (0.47–0.71)	<0.001	0.58 (0.48–0.70)	<0.001	0.45 (0.35–0.57)	<0.001
Disadvantaged	0.75 (0.49–1.15)	0.190	0.78 (0.64–0.96)	0.020	0.84 (0.72–0.98)	0.019	0.73 (0.57–0.94)	0.016
Most disadvantaged	(ref)		(ref)		(ref)		(ref)	
Educational attainment								
High	0.64 (0.49–0.85)	0.002	0.91 (0.76–1.10)	0.338	0.43 (0.31–0.60)	<0.001	0.85 (0.57–1.27)	0.420
Low	(ref)		(ref)		(ref)		(ref)	

(Continued)

Table 2. Continued

	SC n = 3626		BM n = 10 256		SE n = 6891		EE n = 3238	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Main occupation								
Low	1.52 (1.17–1.96)	0.002	1.40 (1.17–1.68)	<0.001	0.88 (0.68–1.14)	0.343	1.20 (0.90–1.61)	0.207
High	(ref)		(ref)		(ref)		(ref)	
Satisfaction with household income								
Great difficulty	8.36 (3.79–18.42)	<0.001	7.01 (5.02–9.80)	<0.001	2.76 (2.19–3.47)	<0.001	3.53 (2.35–5.31)	<0.001
Some difficulty	2.92 (1.98–4.31)	<0.001	3.57 (2.92–4.37)	<0.001	1.93 (1.56–2.38)	<0.001	1.49 (1.09–2.04)	0.012
Fairly easily	1.78 (1.39–2.28)	<0.001	1.92 (1.66–2.21)	<0.001	1.18 (0.95–1.46)	0.133	0.97 (0.71–1.32)	0.839
Easily	(ref)		(ref)		(ref)		(ref)	
Age x early-life SECs								
Age x most adv	1.03 (0.98–1.08)	0.190	1.01 (0.99–1.04)	0.416	0.98 (0.93–1.03)	0.422	–	–
Age x adv	1.02 (0.98–1.06)	0.260	1.01 (1.00–1.03)	0.139	1.00 (0.98–1.03)	0.770	1.01 (0.98–1.04)	0.686
Age x middle	1.03 (0.99–1.07)	0.130	1.01 (0.99–1.03)	0.196	1.00 (0.99–1.02)	0.653	1.01 (0.99–1.03)	0.228
Age x disadv	1.01 (0.97–1.05)	0.700	1.01 (0.99–1.03)	0.224	1.00 (0.99–1.01)	0.963	0.99 (0.97–1.01)	0.369
Age x most disadv	(ref)		(ref)		(ref)		(ref)	
Age x educ attainment								
Age x high	1.00 (0.98–1.03)	0.761	1.02 (1.00–1.03)	0.030	1.02 (0.99–1.05)	0.125	1.01 (0.97–1.04)	0.663
Age x low	(ref)		(ref)		(ref)		(ref)	
Age x main occup pos								
Age x low	0.98 (0.96–1.00)	0.028	0.99 (0.98–1.01)	0.220	1.00 (0.98–1.02)	0.948	0.99 (0.96–1.01)	0.239
Age x high	(ref)		(ref)		(ref)		(ref)	
Age x household income								
Age x great diff	1.02 (0.96–1.09)	0.530	0.96 (0.93–0.98)	<0.001	1.01 (0.99–1.03)	0.435	0.98 (0.95–1.01)	0.140
Age x some diff	1.00 (0.97–1.04)	0.875	1.00 (0.98–1.01)	0.824	1.01 (0.99–1.03)	0.190	0.98 (0.96–1.01)	0.139
Age x fairly easily	1.02 (1.00–1.04)	0.053	1.00 (0.99–1.01)	0.589	1.00 (0.98–1.02)	0.876	0.98 (0.96–1.01)	0.122
Age x easily	(ref)		(ref)		(ref)		(ref)	

SC, Scandinavian; BM, Bismarkian; SE, Southern European; EE, Eastern European; CI, confidence interval; OR, odds ratio; P, P value.

Model 1: adjusted for prior confounders and attrition.

Model 2: M1 + adjusted for educational attainment.

Model 3: M2 + adjusted for main occupation.

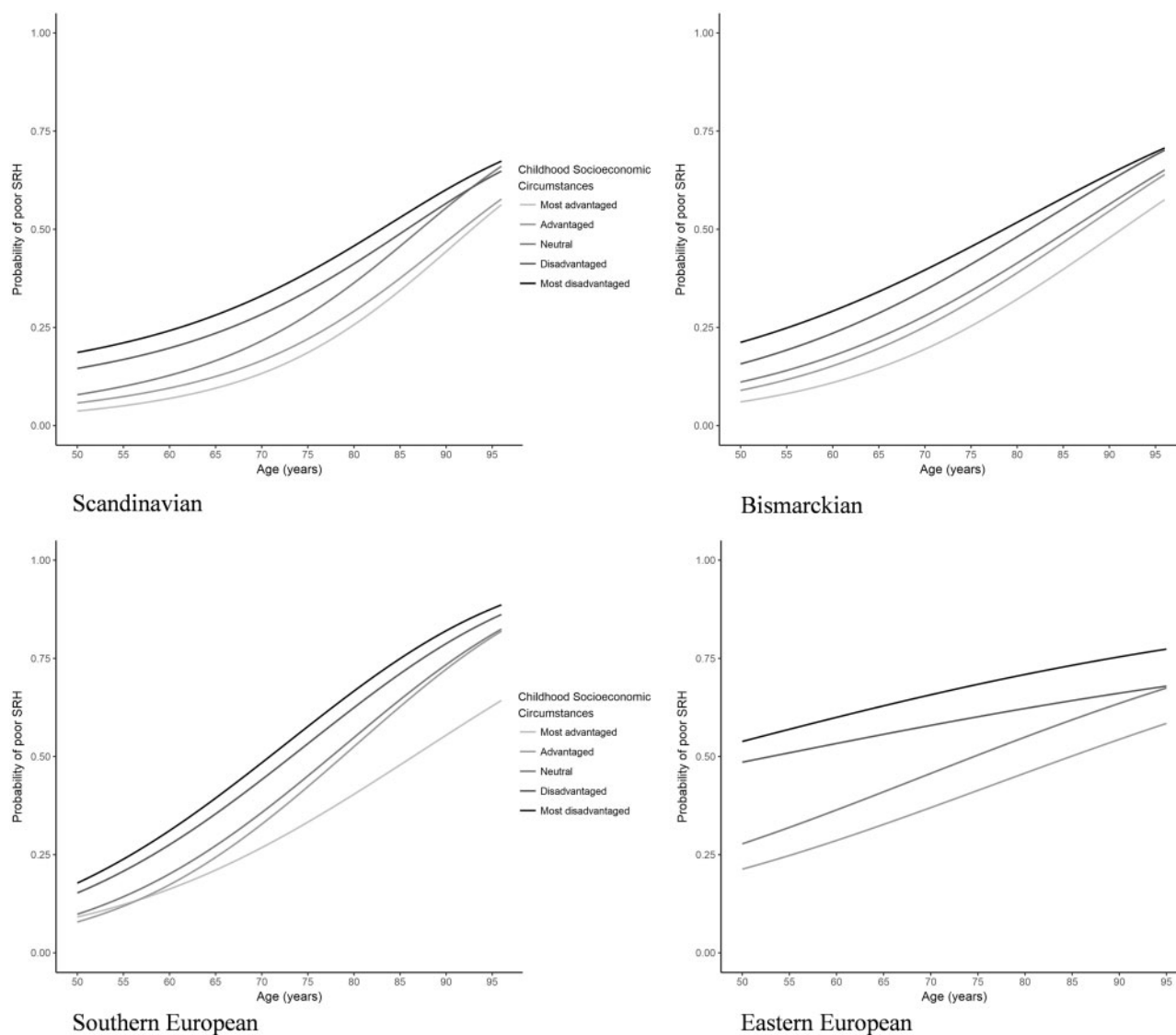
Model 4: M3 + adjusted for satisfaction with household income.

Model 5: M4 + adjusted for living without partner and unhealthy behaviour index.

being associated with risk of poor SRH for all WRs. Main occupation position had an attenuating effect for all WRs except the Southern European and Eastern European WR, and was associated with high risk of poor SRH in only Scandinavian and Bismarckian WRs. Education attenuated the association only in the Scandinavian and Southern European WRs, where it remained associated with low risk of poor SRH after full adjustment. We did not find changing patterns with ageing for early- and adult-life SECs. The few interaction terms that were significant proved not to be robust with further adjustments or in sensitivity analyses.

Previous studies showing that early-life SECs are associated with adulthood SRH were based on cross-sectional data and could therefore not account for SRH trajectories.<sup>10,18,45–47</sup> In addition to supporting previous results,<sup>45–53</sup> our results extend them to the population of old adults and account for SRH trajectories. Our results corroborate findings showing that adult-life SECs mediate the association

between early-life SECs and SRH later in life. In contrast to McKenzie *et al.*,<sup>45</sup> who, in a study of adult SRH, suggested that educational attainment mediated most of the association, we found that satisfaction with household income was the strongest mediator. Studies investigating the mediating role of adult-life SECs on the association of early-life SECs and SRH in old age are few. The existing literature shows that WRs affect the association of life-course SECs and health or life satisfaction differently. In general, socioeconomic inequalities in health exist across all WRs, but they are narrower in Scandinavian and Bismarckian than Southern and Eastern European WRs.<sup>10,18,23,54,55</sup> Furthermore, previous studies found that the financial situation in adult life is a strong predictor of health inequalities in old age, which agrees with our study.<sup>10,18,54</sup> However, previous studies did not use a life-course approach for measuring SECs, which allowed for the analysis of the mediating role of adult-life SECs on the association of early-life SECs and poor SRH trajectories.

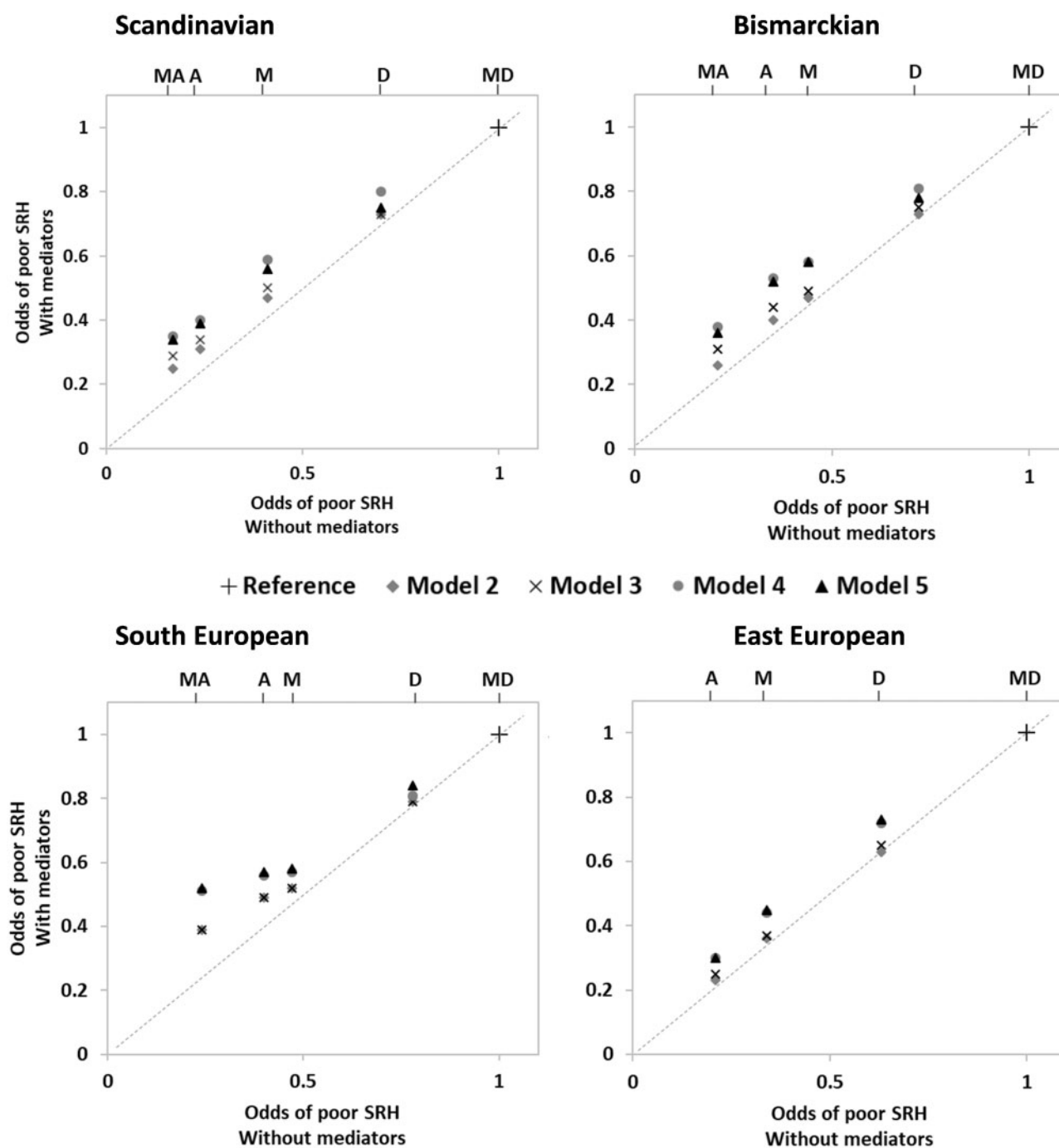


**Figure 2.** Predicted probability of poor SRH across age by early-life SECs and welfare regime.

Rather, they used a measure for life-course SECs that mixed early- and adult-life SECs. Our study allowed for disentangling the effects of these different periods, showing the differential modifying influence of WRs on early- and adult-life SECs.

The strengths of this study include the large sample size, a follow-up of 12 years with repeated measurements every 2 years, and combined and comprehensive early- and adult-life SECs measures that allow for an analysis of varying life-course influences on SRH in old age across different WRs. Furthermore, this study considered a structural determinant of health by including WR rather than focusing only on the role of individual factors such as education, occupation and income. However, one limitation is the self-reported and retrospective data used for early-life SECs and main occupation, which may be

influenced by recall bias or social desirability. However, previous studies have shown adequate validity for recall measures of SECs.<sup>56,57</sup> Also, attrition in this longitudinal study may imply a selection bias in the remaining sample. We accounted for this potential limitation by adjusting our models for attrition and conducting sensitivity analyses excluding participants who died and dropped out during follow-up. Further, we merge respondents in the 'most advantaged' early-life SECs with the previous category 'advantaged' in Eastern WR, because of the lack of observations in the former category that caused inconsistent results due to a strong selection effect. However, because we were interested in the gradient between the lowest and highest early-life SECs as opposed to single categories, this merging did not change how we approached our research questions. Finally, we accounted



**Figure 3** Effect of early-life SECs on poor SRH mediated by adult-life SECs, living without a partner and unhealthy behaviour index. Above the dotted line, the effect of early-life SECs decreases when the indicators are included in the model (i.e. attenuation effect). Below the dotted line, the effect of early-life SECs increases (i.e. suppressive effect). Model 1 tested the association between early-life SECs and risk of poor SRH. Model 2 added education. Model 3 added main occupation. Model 4 added satisfaction with household income. Model 5 added living without partner and unhealthy behaviour index. Here, the adult-life indicators attenuated the association between early-life SECs and risk of poor SRH across welfare regimes. MD, most disadvantaged (reference; black plus sign); D, disadvantaged; M, middle; A, advantaged; MA, most advantaged.

only for the WR in which respondents lived at the time of follow-up and we did not include the country they lived in during early and adult life. However, a sensitivity analysis considering WR at age 10 revealed similar results (not shown).

In conclusion, this study shows long-lasting consequences of early-life SECs for adult health and reveals that socioeconomic policies of emerging WRs in the 20th century have not fully compensated for an unfavourable start in life. The associations between early-life SECs and SRH in

old age remained even after adjusting for adult-life SECs. However, the varying degree by which the different mediators attenuated the associations between early-life SECs and SRH in old age across WRs indicates differing modification effects in adult life. Education (early adult-life) attenuated the association only in the Scandinavian and Southern European WRs, but satisfaction with household income (in old age) seemed to play an important role across all WRs, specifically for the Eastern European WR, where it remained the only significant mediator. The occupational position in middle age seemed to play a role only in Scandinavian and Bismarckian WRs. These findings strengthen previous evidence showing that early life has long-lasting consequences for an individual's health development during the rest of the life course. This finding supports public policy interventions in childhood to promote better health in later life regardless of the different WRs examined. Furthermore, the differing adult-life attenuation of the association between early life and health in old age across WRs underpins the importance of context-specific public policies. As main occupation attenuated the association between early-life SECs and SRH in old age only in Scandinavian and Bismarckian WRs, occupation-related social-insurance schemes and other strategies may be important to overcome the impact of job insecurity and loss on health. Indeed, compared with the Southern and Eastern European WRs, the Scandinavian and Bismarckian WRs have stronger policies linked to decommodification, with the Scandinavian having the strongest.<sup>28</sup> Further research is needed to identify robust policy conclusions from these findings.

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