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Article

Social class and infirmity. The role of social class over the life-course

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ABSTRACT

In an aging society, it is important to promote the compression of poor health. To do so, we need to know more about how life-course trajectories influence late-life health and health inequalities. In this study, we used a life-course perspective to examine how health and health inequalities in late-midlife and in late-life are influenced by socioeconomic position at different stages of the life course. We used a representative sample of the Swedish population born between 1925 and 1934 derived from the Swedish Level of Living Survey (LNU) and the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD) to investigate the impact of socioeconomic position during childhood (social class of origin) and of socioeconomic position in young adulthood (social class of entry) and late-midlife (social class of destination) on infirmity in late-midlife (age 60) and late-life (age 80). The results of structural equation modelling showed that poor social class of origin had no direct effect on late-midlife and late-life infirmity, but the overall indirect effect through chains of risks was significant. Thus, late-midlife and late-life health inequalities are the result of complex pathways through different social and material conditions that are unevenly distributed over the life course. Our findings suggest that policies that break the chain of disadvantage may help reduce health inequalities in late-midlife and in late-life.

Introduction

Health inequalities are a major challenge for many societies, and reducing them is a major goal of health and social policies at the national and European levels. Although most health problems and the vast majority of deaths occur late in life, our understanding of the life-course determinants of inequalities in old-age health and the impact of social policies on these determinants remains poor (Kuh, Cooper, Hardy, Richards, & Ben-Shlomo, 2014). Understanding the pathways to late-life health outcomes is important to promoting the compression of poor health in an aging society.

In Sweden, as elsewhere, people of different socioeconomic positions have fundamentally different access to resources and opportunities over the life-course. According to the theory of fundamental causes – these social conditions are through multiple pathways important for later life health (Phelan, Link, & Tehranifar, 2010). It is relatively well known that socioeconomic inequalities in health prevail into late-life. However, only a few studies have had the possibility to study the relationship between socioeconomic position and health over the whole life-course. Moreover, little is known on the influence of childhood condition on late-life health. By using a life-course perspective and national representative longitudinal data over 80 years period with rich information about socioeconomic position and health collected both repeatedly and retrospectively, we examine how socioeconomic position and health in late-life are associated over the life-course. The objective is to understand differences in infirmity in late-midlife and late-life by social class using three different life-course models: accumulation of exposures, chain-of-risk, and sensitive periods. We use structural equation modelling to estimate the relative contribution of socioeconomic position in childhood, young adulthood and late-midlife to health in late-midlife (age ~60) and late-life (age ~80).

This study contributes to the field of life-course research by decomposing the effects of social class at different life stages with best available methods to disentangle their direct and indirect effects on infirmity in late-midlife and in late-life.

Despite substantial increases in life-expectancy in most countries, the likelihood of reaching old age remains unevenly distributed. Socioeconomic position has a strong influence on health and risk of premature death in all countries in which it has been investigated (Fritzell, 2014; Mackenbach *et al.* 2008). In Sweden, as elsewhere, both women and men in socioeconomically disadvantaged groups have shorter life expectancies and higher rates of health problems and disability (Erikson & Torssander, 2008; Fritzell, Lennartsson, & Lundberg, 2007). Current research suggests that not only do health inequalities persist, but also that they have increased in many countries (Mackenbach, 2012; Mackenbach et al., 2015). Research also reveals

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the persistence of socioeconomic inequalities in the oldest old, and shows higher morbidity, lower functioning and mortality rates in people of lower socioeconomic position (Fors & Thorslund, 2015; Kröger, Fritzell & Hoffmann 2016).

In epidemiological life course research, a theoretical distinction is made between sensitive periods, accumulation of risk, and chains of risk (Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003). Sensitive period models stress certain windows of time, typically childhood, which may have a profound impact on subsequent health. Thus, childhood disadvantage may directly affect later-life health. A combination of material deprivation, poor nutrition, and/or infectious diseases in utero, during infancy, and in childhood may negatively affect growth, increasing the subsequent risk for morbidity, functional limitation, and mortality. The notion of early life as a sensitive period has become central to life-course epidemiology (Kuh et al., 2014), and today a great deal of empirical evidence shows that adverse socioeconomic conditions in early life increase the risk of poor health and mortality in adulthood (i.e. Galobardes, Smith, & Lynch, 2006; Campbell et al. 2014; Schafer & Ferraro, 2013).

The research on the relative importance of the direct effect of childhood socioeconomic position on health in *old age* is still somewhat inconclusive. For instance, Tampubolon (2015) found that, after controlling for extensive set of control variables, childhood socioeconomic position is independently associated with various health outcomes in old age. On the other hand, Berndt and Fors (2016) found that the association between childhood conditions and various health indicators in old people in Sweden was mediated by education. Pakpahan, Hoffmann, and Kröger (2017) found further support for the hypothesis that the effects of childhood conditions are mediated by education and socioeconomic conditions in adulthood.

Exposure to disadvantages at a specific time period can also have non-direct lifelong effects. In other words, risks to which people are exposed to in specific periods of life can accumulate (Kuh *et al.* 2003). The accumulation model states that life-course exposures accumulate throughout life and may cause health problems later in life. The exposures are either uncorrelated or correlated. Uncorrelated adverse exposures independently damage a person's health, one after the other. There would therefore not be one specific sensitive period in life (Ben-Shlomo, & Kuh, 2002). However, risk factors may also be correlated. In this scenario, exposure to certain disadvantages increases the risk of exposure to additional risk factors either at the same time (risk clustering) or in the future (chain-of-risks), reinforcing socioeconomic disadvantage (von Hippel & Lynch, 2014). Socioeconomically disadvantaged people are exposed to risks related to their work, living and housing conditions, stress, and health behaviors, both in terms of intensity and/or frequency of the risk factors. These conditions increase the risk of adverse health and disability outcomes, and people who are exposed to them are more likely to stay in disadvantaged conditions. Thus, adverse exposure earlier in life might only have a modest direct effect on later life health, but its overall effect via indirect pathways, chains of risks, may be much larger (Kuh et al., 2003). Possible indirect mechanisms through which childhood disadvantages affect later health include lower education or occupational attainment, factors well known to be associated with poor health and disability.

There are several ways of measuring socioeconomic position such as those based on occupation, education, income, status, and wealth. These indicators of socioeconomic position may have different meanings during different life stages. From a theoretical perspective, socioeconomic position at younger ages is linked to resources distributed at the macro-level of society, primarily via the parents. In the literature there is empirical evidence showing that lack of a variety of resources during childhood is associated with educational and occupational attainment and health and wellbeing later in life (e.g. Breen & Jonsson, 2005; Ferraro, Schafer, & Wilkinson, 2016; Otero-Rodríguez *et al.* 2011). To capture these varieties of resources in childhood a latent variable was used to measure socioeconomic position in childhood consisting of information about parent's educational level, social class, and financial resources.

Although the education system in Sweden has facilitate the possibilities to intergenerational social mobility, the opportunities for upward mobility, especially for the children born between 1925 and 1934, were relatively low. Among these cohorts relatively few children from working class families attained higher education (Erikson & Jonsson, 1996). To capture the meaning of socioeconomic position in young adulthood for later life conditions, including health, we therefore use social class based on the first occupation lasting at least six month. The first occupation were for some also the last one, but for some it was a point of departure of an occupational career path often regardless of educational attainment. We also use social class to capture a person's position in the social structure in late-midlife and in late-life. The choice of the socioeconomic indicator used builds on the idea that for these cohorts occupational social class position comprehensively capture the circumstances important for later life opportunities. Furthermore, occupational based social class later in life capture both the results of lifelong working conditions but also composed resources and attained status.

To capture infirmity in late-midlife and in late-life we use indicators covering different dimensions of health (such as musculoskeletal pain, fatigue and shortness of breath). These indicators are not fatal, they do not require specific diagnoses but cover both physical and mental aspects of health. Infirmity is a problem per se but it might also cause suffering, a low quality of life and dependency at an individual level.

Aims

The overall aim is to understand differences in infirmity in late-midlife and late-life by social class using three different life-course models: accumulation of exposures, chain-of-risk, and sensitive periods. We will build on the results of previous research and investigate the impact of socioeconomic position during childhood (social class of origin), social class in young adulthood (social class of entry) and late-midlife (social class of destination) on infirmity in late-midlife (age 60) and late-life (age 80). Fig. 1 illustrates our approach.

We here present our aims in accordance to life-course theories illustrated in Fig. 1.

Our first aim was to test the model of sensitive period. We explore if there are direct effects from class of origin on infirmity in late-midlife and late-life. We hypothesize that having parents with a low educational level, belonging to the working class, and experiencing financial hardship has modest but direct effects on health in old age.

Our second aim was to explore the direct effect of class of origin, class of entry and class of destination on infirmity at two points in time: late-midlife and late-life, testing the accumulation model. We hypothesized that social class at all three time-points in life would have a modest direct effect on infirmity in both late-midlife and late-life.

Our third aim, testing the chain-of-risk model, was to explore the indirect pathways between life-course socioeconomic position and health in late-midlife and late-life. We hypothesized that: 3.a) A lower class position in the social hierarchy in one period would increase the risk of lower social class position in the following period. 3.b) A chain effect would be established whereby only social class position in the latest period would directly affect infirmity in late-midlife and in late-life. 3.c) The effect of previous exposures would be indirect and their overall effect would be larger than any direct effect. Thus, we expected social class of origin to increase the likelihood of entering subsequent chains of risks that are detrimental to health and thus we did not expect social class of origin to have an independent direct effect on late-midlife and late-life infirmity.

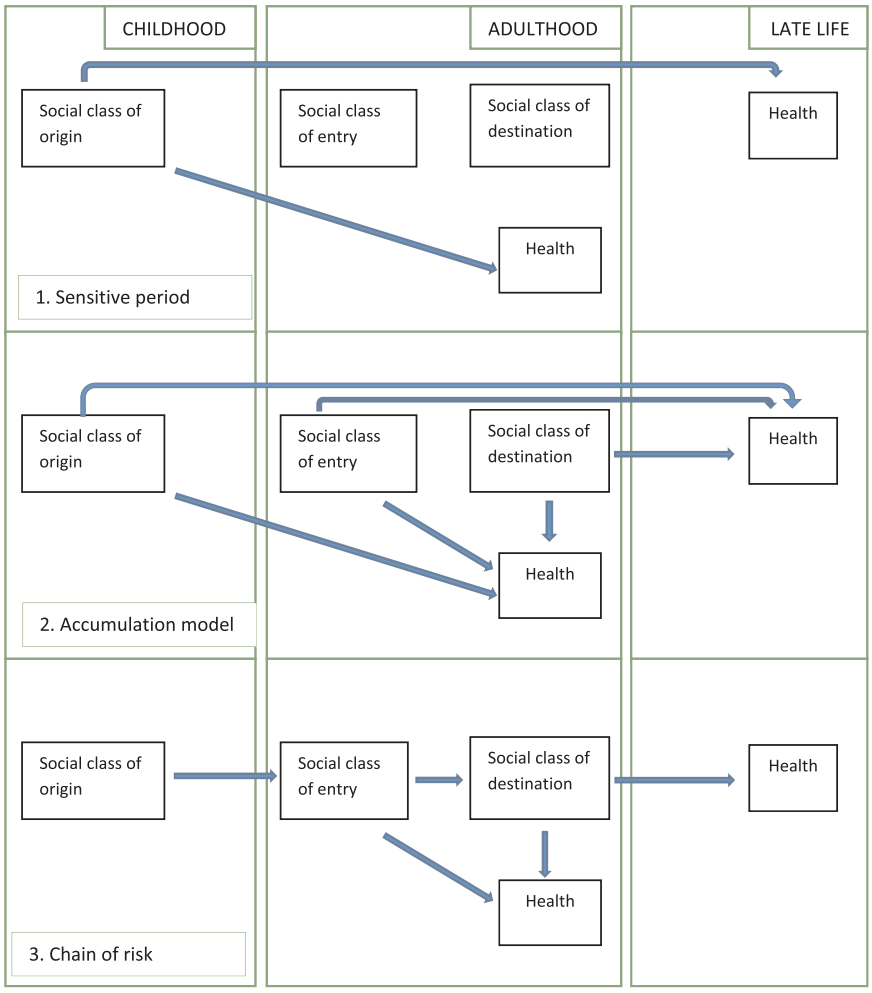

Fig. 1. Theoretical model of the hypothesized pathways between social class at different points during the life-course and infirmity in late-midlife and in late-life. The figure does not display any covariates.

Material and methods

Material

The study uses data from two panel studies that are linked at the individual level: The Level of Living Survey (LNU) and the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD). The sample is obtained using the identification numbers issued to all Swedish residents by the state. LNU started in 1968 and has since been repeated in 1974, 1981, 1991, 2000, and 2010. It is based on face-to-face interviews with a representative sample of the Swedish population 15 to 75 years of age. Each consecutive wave adds a new random sample of young people and new immigrants to the original sample, thus ensuring that each wave remains representative of the total adult population at the time (Fritzell & Lundberg, 2007).

The SWEOLD study was started in 1992 and repeated in 2002, 2004, 2011, and 2014. Its purpose was to follow-up the LNU sample who had reached LNU's upper age-limit of 75 years. The SWEOLD sample is thus also nationally representative and comprises both people living in the community and people living in institutions. Indirect or so called proxy interviews were carried out if the participant was not able to answer questions by themselves. The most common reason for an indirect interview was dementia or frailty. Indirect interviews were mostly conducted with a close relative (Lennartsson et al., 2014). Together, LNU and SWEOLD provide longitudinal information on individuals over a 46-years period.

We limited our study sample to women and men sampled in LNU and born between 1925 and 1934 (n = 1129). After excluding an over-selected group of immigrants (2.8%) and people that never participated in any wave of LNU (5.2%), our sample consisted of 1039 people. Available data from all survey years are included in the model. Thus, complete data for the whole follow-up period are not required for inclusion. Thus, even if a respondent do not participate in all interview waves, or if they die during the follow-up, they contribute with data when information is available.

Measures

Outcome

Infirmity is captured with a set of indicators that include musculoskeletal pain, general fatigue, and shortness of breath. Both musculoskeletal pain and fatigue are common in old age, and these health conditions are also highly correlated (Jakobsson, 2006). Pain is associated with impaired muscle strength and physical performance (Onder et al., 2006), and people with pain develop the functional limitations typically associated with aging at younger ages than those without pain (Covinsky, Lindquist, Dunlop, and Yelin (2009). Breathlessness is negatively associated with well-being and positively associated with greater health service use, higher risk for worsened function, and higher risk for death (Smith *et al.* (2016). We modelled infirmity as latent variables at two points in time: 1991 (age 57 through 66) and 2011 (age 77 through 86). The latent infirmity variable consisted of five variables in 1991 but six in 2011, as one of the variables from 1991 was split into two in 2011. Participants were asked if, during the past 12 months, they had pain in the chest; pain in shoulders; pain in the hands, elbows, legs, or knees (1991 only); pain in the hands or elbows (2011 only); pain in

Table 1
Distribution of the study population.

		Percent	*Number*		
Sex	Men	49.7	516		
	Women	50.3	523		
Father's social class	Low	63.3	639		
	High	36.7	365		
Mother's education	Compulsory	89.2	921		
	Vocational training	3.7	38		
	Extended compulsory	4.7	49		
	High school	2.2	23		
	University	0.0	1		
Father's education	Compulsory	82.6	849		
	Vocational training	6.1	63		
	Extended compulsory	6.0	62		
	High school	5.0	51		
	University	0.3	3		
Financial hardship in childhood	Yes	26.9	278		
	No	73.1	756		
Education	Mean years of education	8.6			
Social class of entry	Unskilled manual workers	62.5	524		
	Skilled manual workers	26.8	225		
	Lower non-manuals	1.3	11		
	Higher non-manuals	9.2	78		
Social class of destination	Unskilled manual workers	34.2	302		
	Skilled manual workers	28.6	252		
	Lower non-manuals	12.6	111		
	Higher non-manuals	24.6	217		
Year		*1991*		*2011*	
		%	*n*	*%*	*n*
Pain in chest	No	84.2	577	77.8	360
	Yes, slight	11.1	76	18.4	85
	Yes, severe	4.7	32	3.9	18
Pain in shoulders	No	58.5	401	56.2	258
	Yes, slight	23.9	165	29.0	113
	Yes, severe	17.5	120	14.8	68
Pain in hands, elbows, legs and knees	No	61.5	421		
	Yes, slight	22.5	154		
	Yes, severe	16.1	110		
Pain in hands or elbows	No			65.1	299
	Yes, slight			24.2	11
	Yes, severe			10.7	49
Pain in legs or knees	No			45.5	210
	Yes, slight			33.3	154
	Yes, severe			21.2	98
General fatigue	No	73.3	502	50.5	233
	Yes, slight	20.7	142	37.5	173
	Yes, severe	6.0	41	11.9	55
Shortness of breath	No	89.5	613	67.0	309
	Yes, slight	6.3	43	24.7	114
	Yes, severe	4.2	29	8.2	38

the legs or knees (2011 only); general fatigue; and shortness of breath (no = 0; yes, slight = 1; yes, severe = 2).

Main exposures

In this study the measurement of socioeconomic position was collected at three time points over the life course, childhood, young adulthood and late-midlife. A latent variable was used to measure socioeconomic position in childhood, and social class based on occupation was used to measure socioeconomic position in young adulthood and in late-midlife.

Social class of origin (childhood) is a latent variable measured by father's social class through the respondent's sixteenth year (manual = 0; non-manual class = 1). Father's social class, father's highest level of education and mother's highest level of education (five categories ranging from compulsory education to university education), and financial hardship in childhood (yes = 0; no = 1). Hence, social class of origin reflects childhood socioeconomic position over a 16-years period. Information on class of origin was collected from LNU 1968.

Table 2
Confirmatory factor analysis for grouping variables related to class of origin and to infirmity in late-midlife and late-life (N = 1037 for social class of origin; N = 685 for infirmity in late-midlife (1991); N = 465 for infirmity in late-life (2011)).

	Total Score Factor-1		*Total Score Factor-2*		*Total Score Factor-3*	
	Class of origin		*Infirmity 1991*		*Infirmity 2011*	
Variable	λ	δ	λ	δ	λ	δ
Father's social class (i1)	0.69	0.47				
Father's education (i2)	0.96	0.92				
Mother's education (i3)	0.71	0.51				
Financial hardship in childhood (i4)	0.32	0.10				
Pain in chest (i5)			0.73	0.53	0.53	0.28
Pain in shoulders (i6)			0.54	0.29	0.65	0.41
Pain in legs or knees (i8)			0.58	0.34	0.48	0.23
General fatigue (i9)			0.75	0.56	0.77	0.59
Shortness of breath (i10)			0.73	0.53	0.46	0.21
Residual correlation						
i8 WITH i6			0.33			
i9 WITH i6					-0.58	
Fit Indices						
χ^2 (p-value)	7.29 (0.03)		11.60 (0.02)		7.81 (0.10)	
RMSEA	0.05		0.05		0.04	
WRMR	0.56		0.58		0.52	
CFI	0.99		0.99		0.98	
TLI	0.98		0.97		0.96	

λ - factor loading, δ - communality.

Social class of entry was measured as the respondent's first occupation that lasted more than 6 months. Hence, social class of entry might reflect a very short or long period of time, since it could cover a person's whole working life or only their entry into a career path. Information about first occupation (social class of entry) was collected retrospectively in LNU 1991 when the respondents were 57 to 66 years old. In general the same questions are included in each wave of the Level of Living Survey. If information about class of entry was missing in LNU 1981 we collected information from LNU 1991, if information about class of entry was still missing we used LNU 2000 to add information about class of entry.

Social class of destination was collected as close to age 60 as possible; that is, the 1991 wave of LNU. Social class of destination operates from the end of the career path into retirement and covers at least 20 years in our study example. If information was missing in particular wave, information on main occupation was gathered from the wave next-closest to the year the respondent was 60 (LNU 1981 and LNU 2000).

The measure of social class of entry and social class destination follow the official Swedish socioeconomic (SEI) classification (Andersson, Erikson, & Wärneryd, 1981), which in many ways corresponds to the internationally well-known Erikson-Goldthorpe (EGP) social class scheme (Erikson & Goldthorpe, 1992). The occupation of the individual is the base for the SEI - classification and is divided into four groups: 0 = unskilled manual workers; 1 = skilled manual workers, lower non-manual workers I, small farmers and self-employed people without employees; 2 = lower non-manual workers II, farmers with extensive land and/or employees, and self-employed people with 1–19 employees; and 3 = higher non-manual workers, academic professionals, and self-employed people with at least 20 employees. For all social class variables, the higher the score, the higher the social

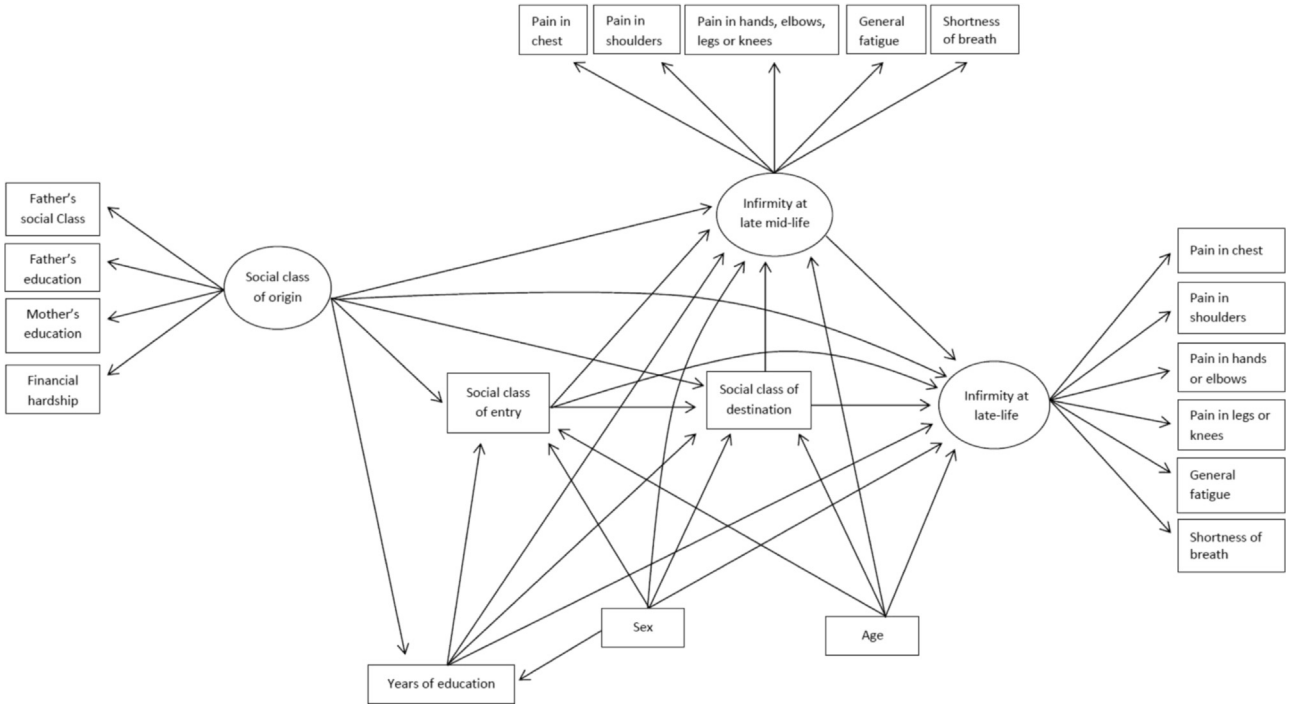

Fig. 2. Initial structural model.

position. Father's social class was measured in the same way but dichotomised (1 and 2 = 1 and 3 and 4 = 2).

Covariates

Sex (male = 0, female = 1), year of birth, and respondent's years of education were also included as continuous variables in the analysis.

Statistical analysis

All analysis was performed using Mplus software version 7.11 (Muthén & Muthén). Structural Equation Modelling (SEM) was used to analyse the data. SEM consists of two sub-models. The first is the measurement model, which establishes how the latent constructs are measured. The second is the structural model, which analyses the structural relationships between variables. The Weighted Least Squares (WLSMV) estimation method (Acock, 2013) was used in all models, given that it does not assume normality and is asymptotically equivalent to maximum likelihood in studies with large samples. WLSMV uses pairwise deletion as default and does not impute values thereby we assume missing at random. Using the WLSMV is appropriate when categorical variables are included in the model, which is the case of the present study. SEM was used to estimate the magnitude and direction of paths between the variables. We estimated standardized direct, indirect, and total effects on the health outcomes and between the health outcomes. The standardized coefficients (SCs) were interpreted in accordance with Kline (1994), where an SC of about 0.10 indicates a small effect, an SC of about 0.30 indicates a medium effect, and an SC of greater than 0.50 indicates a strong effect.

The goodness-of-fit of the model to the data was evaluated using the ordinary comparative parameters provided by the Mplus software. An overall conclusion about the fit of each model can be obtained by considering the following indices simultaneously (Schermelleh-Engel & Moosbrugger, 2003). Values under 0.05 for Root Mean Square Error of Approximation (RMSEA) suggest close approximate (adequate) fit, whereas values above 0.10 indicate poor fit. The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) represent incremental fit, and values greater than 0.95 are indicative of adequate fit. The Weighted Root Mean Square Residual (WRMR) is a measure of the fit of models with categorical observed variables, and a value less than 1.0 indicates good fit. Modification indices were estimated to examine alternative paths that may be relevant to the model fit. Whenever better-fitting models supported by theory and previous empirical findings were observed, these were implemented. Non-significant paths were removed if $p > 0.30$ as a parsimony rule, as such paths do not contribute to the model. Finally, a test provided by Mplus, called difftest, was used to test if the final model statistically differed from the initial model.

Results

Our sample consisted of 50.3 percent women. Respondents had an average of 8.5 years of education. Sixty-two percent started their working career as unskilled manual workers, and 32 percent worked as unskilled manual workers at age 60, indicating substantial upward mobility during working life. In 1991, 10 to 40 percent of respondents reported slight or severe problems with the variables that indicated infirmity. As expected, at around age 80, a higher percentage of respondents (13 to 55 percent) reported problems with infirmity. The most prevalent complaints were pain in the legs or knees and general fatigue (Table 1).

We estimated polychoric correlation coefficients of all pairwise combinations of the indicators (see Supplementary Table 1). The initial measurement model, which included the three latent constructs shown in Table 2, fit the data well: The first latent construct represents social class of origin: (CFI = 0.99, TLI = 0.98, and RMSEA = 0.05, $X^2 = 7.29$ (0.03)). The second represents infirmity at age 60: (CFI = 0.99, TLI = 0.97, and RMSEA = 0.05, $X^2 = 11.60$ (0.02)), and the third, infirmity at age 80: (CFI = 0.98, TLI = 0.96, and RMSEA = 0.04, $X^2 = 7.81$ (0.10)). Social class of origin was not significantly correlated with infirmity late-midlife and late-life (age 60 and age 80]. However as expected, infirmity at age 60 was correlated with infirmity at age 80. An analysis of the structural relationships between the variables and constructs in Fig. 2 (initial model) and Table 3 resulted in a model with a good fit of final model: CFI = 0.978; TLI = 0.972; WRMR = 0.934; and RMSEA = 0.022 (90% CI = 0.016, 0.028).

All estimated effects and model fits from both initial model and the final model are shown in Table 3. Our initial model was compared against

Table 3
Standardized estimated effects of indicators in initial and final structural models.

Pathway from:	*Std coefficient: initial model*	*Std coefficient: final model*
Social class of origin,	0.23 (p < 0.01)	0.22 (p < 0.01)
Years of education,	0.52 (p < 0.01)	0.52 (p < 0.01)
Sex, and	0.02 (p = 0.85)	
Age	-0.10 (p = 0.01)	-0.06 (p = 0.12)
… to social class of entry		
Social class of origin,	0.10 (p = 0.03)	0.10 (p = 0.05)
Social class of entry,	0.28 (p < 0.01)	0.28 (p < 0.01)
Years of education,	0.37 (p < 0.01)	0.37 (p < 0.01)
Age, and	-0.05 (p = 0.18)	
Sex	-0.56 (p < 0.01)	-0.57 (p < 0.01)
… to social class of destination		
Social class of origin,	0.51 (p < 0.01)	0.51 (p < 0.01)
Age, and		-0.09 (p < 0.01)
Sex	-0.87 (p < 0.01)	-0.88 (p < 0.01)
… to years of education		
Social class of origin,	0.07 (p = 0.37)	
Social class of entry,	-0.11 (p = 0.25)	-0.10 (p = 0.22)
Social class of destination,	-0.17 (p = 0.06)	-0.15 (p = 0.06)
Years of education,	-0.15 (p = 0.08)	-0.10 (p = 0.23)
Age, and	-0.06 (p = 0.19)	-0.07 (p = 0.13)
Sex	0.15 (p = 0.15)	0.20 (p = 0.04)
… to infirmity at late-midlife		
Social class of origin,	-0.06 (p = 0.53)	
Social class of entry,	-0.06 (p = 0.61)	
Social class of destination,	-0.06 (p = 0.52)	-0.11 (p = 0.14)
Years of education,	0.08 (p = 0.44)	
Age,	0.14 (p = 0.03)	0.14 (p = 0.03)
Sex, and	0.12 (p = 0.34)	
Infirmity at late-midlife	0.61 (p < 0.01)	0.60 (p < 0.01)
… to infirmity at late-life		
Fit Indices		
RMSEA	0.026	0.022
CFI	0.970	0.978
TLI	0.962	0.972
WRMR	0.969	0.934

Std, standardized; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; WRMR, Weighted Root Mean Square Residual.

observed data and showed a good model fit. Pathways that were not significant were removed one by one, starting from the highest p-value until all associations had a p-value 0.30 or lower. A statistical test provided by Mplus, called difftest, showed that the initial model and the final model were not statistically different from each other (p = 0.76), after removing paths with p > 0.30. In the final model a path was added between age and years of education, this is theoretically supported as younger birth cohorts have more years of education than older birth cohorts (Parker & Agahi, 2013). This extra path improved the model significantly (p < 0.01). All results are presented as standardized coefficients.

The results show that social class of origin had direct effect on both social class of entry (SC = 0.22, p < 0.01) and social class of destination (SC = 0.10, p = 0.04), but no direct effects on infirmity in late midlife or in late-life. The results show that social class of entry directly affected infirmity in late-midlife (SC = 0.10, p = 0.22). Furthermore, social class of destination—the class position closest in time to the outcomes—is the only social class position that directly affected both infirmity at late-midlife and at late-life. Those with a lower social class position at late-midlife had a higher probability of health problems at late-midlife and at late-life. The results also show a strong association between infirmity at late-midlife and at late-life (Fig. 3).

Direct, indirect and total effects are shown in Table 4. Class of origin had no direct effect on infirmity in late-midlife and in late-life. The total effect of social class of origin on infirmity was -0.16 at late-midlife and -0.14 at late-life; pathways between social class of origin and infirmity ran through education, social class of entry and social class of destination. Social class of entry directly affected infirmity at late-midlife but not at late-life; instead, ran through social class of destination and infirmity in late midlife.

Years of education directly but weakly affected infirmity in late-midlife (-0.10, p = 0.06). Education did not directly affect infirmity in late-life. Years of education also had a strong direct effect on social class of entry and destination, thereby contributed to the total effect of social class of origin on infirmity in late-midlife and in late-life.

Finally, we performed sensitivity analysis by gender. The results showed no variation in the pathways between social class of origin and education, and between education and social class of entry for men and women. However, for infirmity in late-midlife years of education was stronger for men (-0.33, p = 0.02) than for women (0.07, p = 0.48), and class of destination was stronger for woman (-0.23, p = 0.02) than for men (-0.01, p = 0.92). Thus, although some variation between women and men were found, the overall results supporting the chain-of-risk hypothesis sustained.

Discussion

This study, which adopted a life-course perspective and used nationally representative data that covered a period of more than 80 years (both retrospectively from 1968 and longitudinally onwards), contributes to our understanding of health inequalities in old age. Life-course studies are theoretically challenging, and the choice of analytical methods must take the complexity of the theory and the data into account. There are still only a few studies about the relative importance of the direct effect of childhood socioeconomic position on health and health inequalities in old age, and their findings are mixed. The overall aim was to understand differences in infirmity in late-midlife and late-life by social class using three different life-course models: sensitive periods, accumulation of exposures, and chain-of-risk. Our study contributes to this field by taking not only childhood socioeconomic position but also socioeconomic position in young adulthood (social class of entry) into account. Thus, we investigated the impact of socioeconomic conditions over the life-course, from childhood to late-midlife (social class of destination), on infirmity in late-midlife and late-life, separating indirect and direct effects across the life course.

Using structural equation modelling to decompose effects, we found that social class of destination affected infirmity in late-midlife. The effect of class of destination on changes in infirmity from late-midlife to late-life was weak and not significant. However, as expected, infirmity in late-midlife had a strong effect on infirmity in late-life. A lower social class in late-midlife was associated with a higher probability of infirmity in late-midlife, which in turn increased the probability of infirmity in late-life.

Our first aim was to test the model of sensitive period. We explored if there were direct effects from class of origin on infirmity in late-midlife and late-life. We hypothesized that class of origin has modest but direct effects on health in old age. Social class origin did not directly affect infirmity in late-midlife or late-life. Thus, we found no support for our first hypothesis.

Our second aim was to explore the direct effect of class of origin, class of entry and class of destination on infirmity in late-midlife and at late-life, testing the accumulation model. We hypothesized that social class at all three time-points in life would have a modest direct effect on infirmity in both late-midlife and late-life. We partly reject his hypothesis in the light of our findings that social class of origin had no direct effect on infirmity at late-midlife and late-life. However, social class of entry showed direct effect on midlife infirmity and social class of destination showed both direct effect on infirmity in late midlife and in late-life.

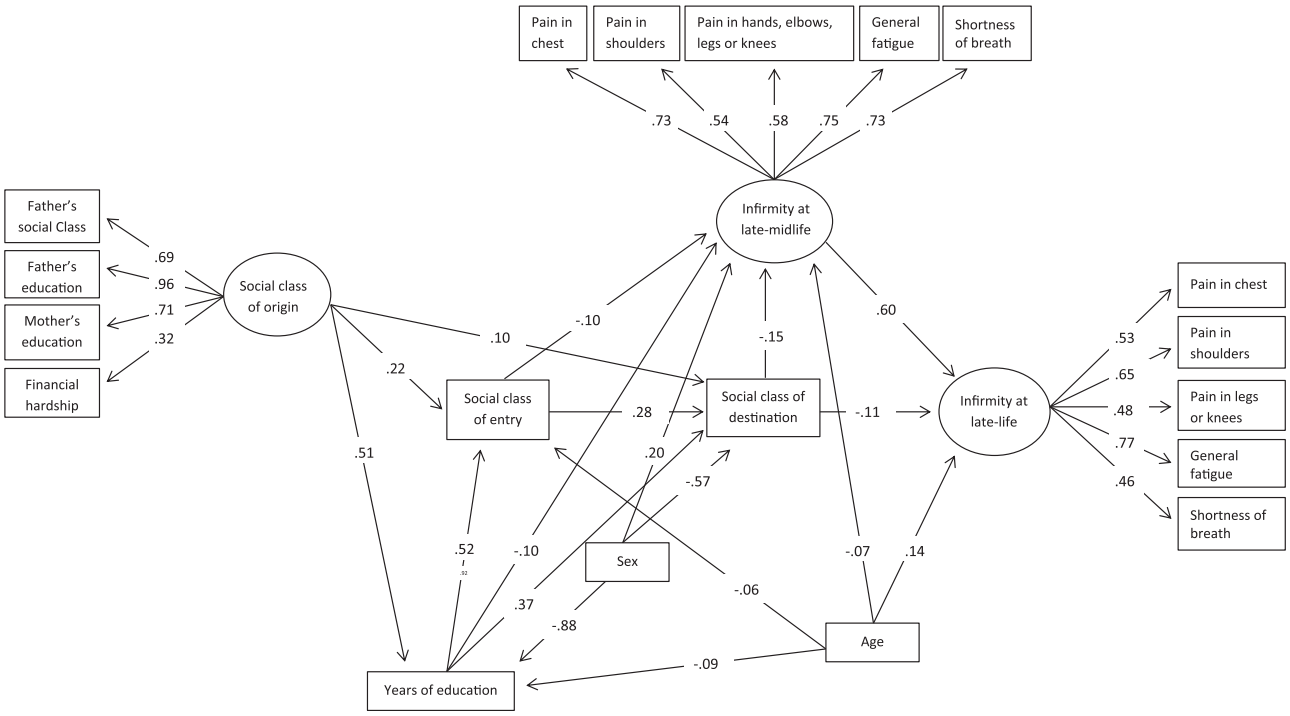

Fig. 3. Final structural model.

Table 4
Standardized coefficients for direct and indirect effects of social class of origin, social class of entry, and social class of destination on infirmity in late-midlife (1991) and late-life (2011).

	Direct effects	*Indirect effects*	*Total effects*
Infirmity in late-midlife			
Social class of origin	–	-0.16	-0.16
Social class of entry	-0.10	-0.04	-0.14
Social class of destination	-0.15	–	-0.15
Infirmity in late-life			
Class of origin	–	-0.14	-0.14
Class of entry	–	-0.12	-0.12
Class of destination	-0.11	-0.09	-0.20

In addition, social class of origin and social class of entry had significant indirect effects on later infirmity via social class of destination (supporting hypothesis 3.a of the chain-of-risk model). Our hypotheses 3.b can be rejected as we found not only social class of destination having direct effect on infirmity, but also social class of entry had a direct effect on infirmity in late-midlife. The effect size of the indirect effects from social class of origin and of entry are about the same as the direct effects of social class of destination. Thus, we find that previous exposures are indirect and the overall effects are larger than the direct effect, supporting hypothesis 3.c. The results, thereby, partly support the chain-of-risk hypotheses.

Years of education significantly contributed to the indirect effect of social class on infirmity in late-midlife and in late-life. For more than half of our study sample, education was a childhood event that took place between the ages of seven and fourteen. Thus, our results are in line with earlier findings that childhood socioeconomic position is associated with old age health, although the association is partly mediated by years of education and socioeconomic conditions in adulthood (Pakpahan et al., 2017; Berndt & Fors, 2016).

These findings highlight the importance of equal opportunities for education. Fewer years of education can lead to less healthy working conditions and reduce health literacy, which in turn is directly associated with poor health in middle age. Research comparing developed countries has shown that the association between education and health has strengthened over the years (Mackenbach, 2012), which means educational attainment plays an increasingly import role in health. Our conclusions are in agreement with those discussed by Berndt & Fors (2016), who suggest that public policies that encourage equal access to education and allocate resources in a way that helps less privileged children achieve a higher level of education may be a significant way to break unhealthy pathways.

Because of cumulative exposures, the great amount of time people spend in the labor force plays an important role in health during working years and after retirement (Niedhammer, Chastang, David, & Kelleher, 2008). Two of the social class measures used in this study (social class of entry and social class of destination) are directly associated with health through working environment and working conditions. Poor, stressful and/or hazardous working conditions increase the risk for both short- and long-term health problems (i.e. Andel et al., 2015; Kivimäki et al. 2012; Nilsen et al., 2014; Wahrendorf et al., 2012). Our findings reveal that health inequalities in old age are the result of social and material conditions unevenly distributed over the life course. Pathways characterized by greater deprivation (measured by social class) increase infirmity at late-midlife, which in turn had a great impact on infirmity in late-life.

Furthermore, policy interventions that improve people's working environment and reduce work stress will not only improve people's health during their working years, but also after retirement and at late life. Such policies may help us combat late-life health inequalities.

Strengths and limitations

One strength of the current study was that few people in our longitudinal dataset were lost to follow-up between the interview waves because of non-response. In addition, proxy interviews were used when needed, which increased the response rate of older people. Earlier findings based on the same data show that the selective mortality that occurs in longitudinal samples might be compounded by selective non-participation among the most disadvantaged groups (Kelfve, 2017). Thus, over the life course, the higher mortality rates in people in lower socioeconomic groups result in selective mortality, which in turn is

associated with the magnitude of the health inequalities in the surviving older population. This might have implications for our results and the conclusions we draw from this study. Specifically, we might have underestimated the indirect and direct effect of social class at different points in life due to selective mortality.

Another strength of our analyses was the use of information from four points in the life course: childhood, young adulthood, late-midlife and late-life. Social class was measured at three points in time and infirmity at two points in time. Information about current infirmity was gathered via interview in 1991 (late midlife) and 2011 (old age), minimizing recall bias about this variable.

Although we prospectively followed people from midlife to old age, we used retrospective data to address childhood and young adulthood circumstances. The retrospective nature of the data on father's social class, parents' education, and financial hardship, could be affected by recall bias. Information on socioeconomic position in childhood was collected retrospectively at time of the first interview, which means that for the great majority of the people in the sample, this information was obtained when the respondents were 34 to 43 years old. In addition, any possible random error was minimized by the fact that our measurement was compounded by four indicators of social class.

Another potential reservation relates to the idea that health in childhood has implication for later socioeconomic position and health. Unfortunately we do not have access to relevant data on childhood health and therefore we cannot rule out that some parts of our results are overestimated.

Conclusions

Longitudinal data with rich information about socioeconomic circumstances and health collected both repeatedly and retrospectively and an advanced statistical approach were vital to obtaining the empirical results. The effect of the accumulation of exposures, chains of risk, and sensitive periods over the life course on later life infirmity was tested with structural equation modelling. The results of these analyses, which used data from a representative sample of the Swedish population, partly support the chain-of-risk approach. Our results showed that poor conditions in childhood had no direct effect on late-midlife and late-life infirmity. Instead our results show that late-midlife and late-life health inequalities are the result of complex pathways through different social and material conditions that are unevenly distributed over the life course. We recommend policies targeting exposures in childhood and young adulthood to break chains of disadvantage and reduce health inequalities in late-midlife and late-life.

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Ethics approval

Ethical approval for this study was provided by the Regional Ethical Review Board in Stockholm, Sweden (reg. no. 2014/1003-31/5; 2015/1070-31/5).

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ssmph.2017.12.001.

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