Title:

The long arm of childhood circumstances on health in old age: Evidence from SHARELIFE.

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Abstract

Socioeconomic status (SES) and health during childhood have been consistently observed to be associated with health in old age in many studies. However, the exact mechanisms behind these two associations have not yet been fully understood. The key challenge is to understand how childhood SES and health are associated. Furthermore, data on childhood factors and life course mediators are sometimes unavailable, limiting potential analyses. Using SHARELIFE data (N=17230) we measure childhood SES and health circumstances, and examine their associations with old age health and their possible pathways via education, adult SES, behavioural risks, and labour market deprivation. We employ structural equation modelling to examine the mechanism of the long lasting impact of childhood SES and health on later life health, and how mediators partly contribute to these associations. The results show that childhood SES is substantially associated with old age health, albeit almost fully mediated by education and adult SES. Childhood health and behavioural risks have a strong effect on old age health, but they do not mediate the association between childhood SES and old age health. Childhood health in contrast retains a strong association with old age health after taking adulthood characteristics into account. This paper discusses the notion of the 'long arm of childhood', and concludes that it is a lengthy, mediated, incremental progression rather than a direct effect. Policies should certainly focus on childhood, especially when it comes to addressing childhood health conditions, but our results suggest other important entry points for improving old age health when it comes to socioeconomic determinants.

Keywords: socioeconomic status, childhood, old age health, education, mediators, Europe

1. Introduction

Social scientists and public health researchers who are interested in understanding the determinants of health in later life are now increasingly using life course data and analytical methods to gain a better understanding of how social circumstances and health are associated, from childhood to old age. They may, for example, examine childhood SES to learn more about the fundamental social causes of adult mortality (Hayward & Gorman, 2004), based on

the assumption that health in later life may be a result of complex combinations of circumstances taking place over time (Davey Smith, Ben-Shlomo, & Lynch, 2002).

This research is important because child poverty is on the rise, even in EU countries. For instance, since 2008, child poverty rates in Ireland, Croatia, Latvia, Greece and Iceland have risen by over 50% (Georgi, 2014). In addition, a recent report by UNICEF (2012) states that "… failure to protect children from poverty is one of the costliest mistakes a society can make. The heaviest cost of all is borne by the children themselves. But their nations must also pay a very significant price – in reduced skills and productivity, in lower levels of health and educational achievement, in increased likelihood of unemployment and welfare dependence, in the higher costs of judicial and social protection systems, and in the loss of social cohesion."

There are several scientific questions deriving from this statement: If, during childhood, individuals have already experienced less-fortunate situations (lower levels of either SES or health, or both), will their health in adulthood and old age suffer as well? Are they able to improve their health? Do they have capacity to overcome the disadvantages of low SES or poor health?

These questions incorporate the two general causal directions between SES and health, namely social causation and health selection, which might both contribute to overall health inequalities over the life course (Kröger, Pakpahan, & Hoffmann, 2015; Stavola et al., 2006; Warren, 2009). In addition, an observed association between SES and health might also be the result of common background factors that influence both SES and health over the life course. However, this is beyond the scope of our study (see discussion).

We adopt the life course perspective because it enables us to focus on those critical points or periods (in terms of timing and duration) when both an individual's social circumstances and their health may be actively improving or deteriorating (Graham & Power, 2004). In addition, it represents a solid foundation for understanding the structural determinants of socioeconomic inequalities and their subsequent relationship to health over time (Corna, 2013). For example, men's mortality is associated with their childhood circumstances, including family living arrangements, their mother's work status, whether they grew up in a rural or urban environment, and their parents' nativity (Hayward & Gorman, 2004).

SES is broadly defined as the relative position within a hierarchical social structure, based on wealth, prestige and power (Mueller & Parcel, 1981). We do not use the term 'status' in the sociological meaning of 'prestige' but for all three of the above resources. In this paper, we define SES as access to those resources – chiefly income, occupation and education – which are necessary to achieve and maintain good health (Shavers, 2007). We do not consider SES as separate from social class, social status, and material circumstances (Krieger, Williams, & Moss, 1997), given that these three theoretical aspects are empirically strongly interrelated. Furthermore, given that the significance of different dimensions of SES changes over the life course (Cutler, Lleras-Muney, & Vogl, 2008), we use different indicators for adulthood SES than for childhood SES. We combine income, occupation and wealth as adult SES indicators in order to see how they contribute to the explanation of pathways from childhood to health in later life.

Our question is: By what mechanisms do childhood SES and childhood health affect old age health? The effects of childhood SES in the long run originate in two related mechanisms: economic capital and human capital formation. Economic capital refers to one's material resources, such as income and assets, used to procure further social status, while human capital refers to one's knowledge and skills, also used to gain social status (Lui, Chung, Wallace, & Aneshensel, 2014). Meanwhile, the effects of childhood health are the result of the development of various well-being indicators – be they cognitive, motoric or linguistic – which have a long lasting impact on health trajectories until old age (Haas, 2006). There are a number of ways in which childhood circumstances can have a lasting impact. First, people with material and social disadvantages in childhood may retain their lower SES in early adulthood, which can have a negative influence on old age health status. Second, poorer children perform less well educationally than better-off children, which in turn could place them in a less favourable situation regarding the acquisition of health-related behaviours and knowledge in old age. Third, children who are exposed to various diseases may suffer negative consequences for their physical and cognitive functioning, thus limiting their chances of acquiring an adequate education and good old age health. Fourth, low childhood SES is detrimental to adult health because of the unfavourable unhealthy environmental exposure associated with inadequate SES. Childhood is important because this is when patterns of physical, emotional and cognitive development are established (Berndt & Fors, 2016).

Numerous studies consistently show that disadvantageous social and economic conditions during childhood are associated with poor health in later life, such as cardiovascular disease and mental health (Agahi, Shaw, & Fors, 2014; Bartley, 2004; Fors, Lennartsson, & Lundberg, 2009; Galobardes, Smith, & Lynch, 2006; Herd, 2016; Kalil, Duncan, & Ziol-Guest, 2016; Kelly-Irving et al., 2013; Kendig, Loh, O'Loughlin, Byles, & Nazroo, 2015; Lundberg, 1993; Poulton et al., 2002; Tubeuf, Jusot, & Bricard, 2012). In particular, Galobardes et al. (2006) conclude that individuals with lower SES during both childhood and adulthood were at elevated risk of developing cardiovascular disease. A recent study by Agahi et al. (2014) concludes that childhood SES is associated with the earlier onset and faster progression of functional health problems such as mobility limitations in mid-life and old age. Examining, on the other hand, the link between childhood health and later life, Latham (2015) concludes that individuals who experienced childhood health problems (childhood disability) may have an increased risk of depressive symptoms in later life.

We contribute to the literature investigating the long arm of childhood by using data on SES and health in childhood, adulthood and old age. We use measurement models for childhood SES and health to account for measurement error in these conditions, addressing a potential downward bias in the association between childhood, adulthood and old age indicators. Given that, for older individuals, childhood experiences took place many decades ago, measurement error is of particular importance, as our study uses retrospective data regarding childhood circumstances. In their literature review, Juneau et al. (2015) point out that published estimates of agreement with historical records range from 53,7% to 80%, which is a considerable variation. This means that the loss of accuracy ranges from 20% to 50%, and it is therefore advisable to account for measurement error. In addition, we consider the total effect of both childhood SES and health on old age health – that is, not only their direct effects, but also the ones that pass through various intervening variables.

We use self-rated health in old age as our outcome variable, since it gives a picture of individuals' general health status that goes beyond the simple interpretation of single health conditions (Bowling, 2005). It is a holistic and comprehensive representation of health that captures state of well-being and predicts mortality (Hardy, Acciai, & Reyes, 2014; Idler & Benyamini, 1997). In fact, some studies report that self-rated health retains some predictive power for mortality even after large sets of objective indicators are adjusted for (Jylhä, 2009). However, we are also aware that self-rated health may not perfectly capture objective

differences in health conditions between individuals, since it is subjectively measured. Instead, it could reflect differences in reporting behaviour (Jürges, 2007; Kaplan & Baron-Epel, 2003). Therefore, in appendix D, we use grip strength as an objective health measure in old age. It is both indicative of overall muscle and physical functioning and predicts mortality (Cooper et al., 2011).

We explore and test the associations between childhood circumstances and old age health using a set of childhood SES and health indicators, applying it in multiple European countries. To be more specific, this study tests the hypotheses exploring which pathways of childhood SES and health have a lasting impact on health in old age, and investigates the extent to which these associations can be attributed to differences in education, adult SES (occupation, income and wealth), behavioural risks (smoking and physical activities) and labour market deprivation.

2. Data and method

The data we use is based on SHARELIFE, i.e. the third wave (2008/2009) of the Survey of Health Ageing and Retirement in Europe (SHARE), which is a European household panel survey. SHARE collects micro-data on the health and SES of individuals aged 50 and over across 15 European countries, and captures the mechanisms of economic, health and social factors shaping older people's living conditions (Börsch-Supan et al., 2013). The survey was designed to be comparable across countries and was harmonised with The Health and Retirement Study (HRS) and The English of Longitudinal Study of Aging (ELSA). The SHARELIFE questionnaire covers many important areas of the respondents' life course, ranging from partners and children to housing and work history to detailed questions on health and health care. The countries we examine in this paper are Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, the Czech Republic and Poland (N=8720 males and N=8510 females). The average national response rate is about 60% (ranging from about 40% to 80%) and details of participating countries are provided here http://www.share-project.org/data-access-documentation/sample.html or in Börsch-Supan & Schröder (2011). We supplement the life history data from SHARELIFE with information on behavioural risks collected in SHARE Wave 2, in order to obtain information about smoking and physical activity, assuming that both reflect earlier health behaviour. Our definition of 'old age' in this paper encompasses those individuals aged

between 60 and 90 years old. A brief report of the data set is described in Pakpahan et.al., (2016).

2.1 Measurements

For a graphical representation of our approach, we divide the life course into three schematic periods: *childhood*, *adulthood* and *old age* (Figure 1).

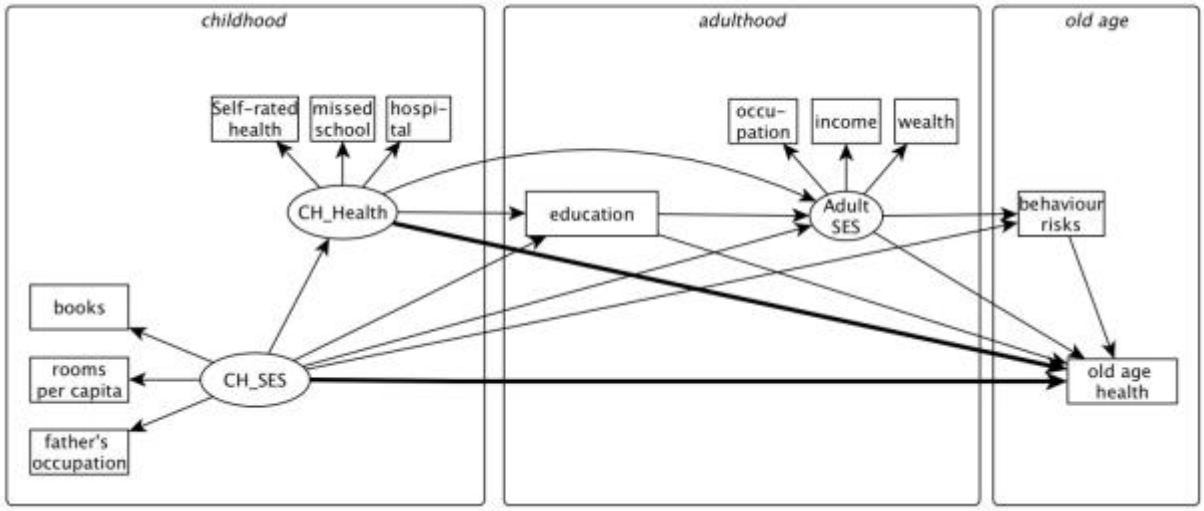

Figure 1: The pathways of the long arm of childhood on old age health. The bold arrows indicate our main pathways of interest.

In the first box we have two latent variables, childhood SES and childhood health. We construct latent variables for childhood SES and health; as the information is retrospective, the responses may suffer recall bias (measurement error). The childhood SES (CH_SES), as one of the key independent variables, has three indicators or observed variables: (a) number of books in the household, which represents the cultural background and parents' education (Martins & Veiga, 2010), (b) rooms per capita, which is a proxy for long-term household wealth (McKenzie, 2005), and (c) father's occupation, which we group into four categories according to ISCO (International Standard Classification of Occupation) skills levels: elementary occupations, skilled (service, shop or market sales worker, skilled agricultural or fishery worker, craft or related trades worker, and plant/machine operator or assembler), associate (technician or associate professional, clerk), and manager (legislator, senior official

or manager, professional). All these SES indicators refer to when the respondents were aged 10. The second latent variable is childhood health (CH_Health), which is constructed using three indicators: (a) childhood self-rated health, a five-point scale of health, from poor to excellent, (b) a binary variable indicating if the individual ever missed school for at least one month because of health, and (c) a binary variable indicating if the individual was ever hospitalised for at least one month. A higher childhood health score represents a more favourable health condition. These health indicators refer to respondents up to the age of 15. We analyse the association between childhood health and childhood SES, assuming that lower SES at age 10 causing lower childhood health at age 15 is more plausible and common than the reverse.

The second box contains covariates in adulthood. First, education that took place in early adulthood as a time-invariant covariate is expressed by years of schooling. Education provides individual knowledge and skills (Mazzonna, 2014; Sirin, 2005), which – among other advantages – allow individuals to gain more access to information and resources to promote health (Adler & Newman, 2002). Education is correlated both with occupation (and other adult SES markers) and health (Kulhánová et al., 2014; Yen, Gregorich, Cohen, & Stewart, 2013). The second covariate is a latent variable, adult SES. We construct it using three indicators: occupation (according to ISCO), household income and household wealth (Mulatu & Schooler, 2002; Warren, 2009). Income and wealth are corrected by purchasing power parities (PPP) relative to German 2006 Euros (Weiss, 2012). We took occupation since it is an important and very widespread measure of socioeconomic status. It has an important influence on health, because exposure to the working environment frequently has direct physical consequences, and this also reflects occupational prestige. Income and wealth reflect the overall level of resources currently earned on a regular basis, but also the resources accumulated over the life course. These resources are necessary to enable a healthy lifestyle and housing, and for access to high quality health care and services. Adulthood indicators refers to aged 30 and 60 years old.

The third box contains the variables in old age, i.e. behavioural risks and old age health. The behavioural risks we take into account have been found to be associated with old age health (Doblhammer, Hoffmann, Muth, Westphal, & Kruse, 2009; Eikemo et al., 2014; Kulik et al., 2013). Specifically, we consider smoking (currently smoking, former smoker, and never having smoked) and physical activities (non-active and active) which require moderate level

of energy such as gardening, cleaning the car, or taking a walk. Old age health is based on the question "Would you say your health now is...", with the possible responses: "poor", "fair", "good", "very good" and "excellent". We also take into account the indicator of labour market deprivation, which is measured by the experience of unemployment, which may be associated with health in later life (not shown in the graph). The old age variables refer to respondents aged 60 and over.

To facilitate our interpretations, all variables are constructed in such a way that the higher the score, the better or more favourable the condition.

2.2 Statistical Analyses

We employ a structural equation model (SEM) approach, which is a combination of measurement models, to construct latent variables and structural models for the relationships between variables. SEM allows us to test direct and mediating (indirect) effects via path analysis, and combine this with measurement models for SES and health to reduce measurement error (Bollen, 1989; Pakpahan, Hoffmann, & Kröger, 2015; Wang & Wang, 2012), which is particularly important when using complex structural equation modelling; otherwise, the direction of the bias due to measurement error is hard to assess (Kröger, Hoffmann, & Pakpahan, 2016). The link between observed variables and latent variable in the measurement model is represented by the factor loadings. The factor loadings show how reliably each observed variable reflects the underlying latent variable. Conventionally, the minimum cut-off point for standardised factor loadings to be considered an acceptable indicator is 0.30, but values above 0.5 are desirable (Wang & Wang, 2012). Estimating direct, indirect and total effects in our model represents the two ways in which childhood exerts its influence (the long arm) on health in old age. By direct effect we mean the extent to which childhood SES and childhood health affect old age health directly – that is, unmediated by any other variables – whereas the total effect is the sum of the direct and the indirect effects (i.e., those mediated by at least one intervening variable). The term 'effect' is used in its technical sense and does not imply causal effect in the sense of the potential outcomes framework (Rubin, 2005).

In this paper we distinguish between 'association' and 'effect' based on the time frame. For all relationships between childhood and later life we use 'association'; from adulthood onwards we use 'effect'.

We begin the analysis with the baseline model (Model 1) which specifies that the latent variable childhood SES determines old age health. Then, in Model 2, we add childhood health and allow for two additional paths: the latent variable childhood SES affecting childhood health and childhood health affecting old age health. From here onwards we subsequently add the mediators in a stepwise procedure, allowing us to see the extent to which the associations between childhood circumstances and old age health change once we condition on specific intervening (mediator) variables.

We report fully standardised coefficients. They can be interpreted as one standard deviation change in the predictor being associated with one standard deviation change in self-rated health, where the five-point scale represents the latent construct of old age health (Breen, Holm, & Karlson, 2014).

In all our analyses we control for differences among countries by introducing dummy variables for each country. Data preparation is performed using Stata 14.1, including the newspell package (Kröger, 2015). All analyses are carried out in Mplus 7.4 (L. K. Muthén & Muthén, 2015). Given that the outcome variable is an ordinal variable, to estimate the parameters in the model we use Weighted Least Square with robust standard error (WLSMV), which is based on probit regression (B. Muthén, du Toit, & Spisic, 1997). In addition, it allows us to include all individuals who have missing values on one or several observed indicators (but not missing on all variables) in the analyses. This reduces potential bias in the estimates due to missing values that are systematically related to the level of variables used in our analysis (Asparouhov & Muthén, 2010). All analyses were adjusted for sex and age (cohort).

3. Results

The characteristics of the sample are reported in Table 1.

Table 1. Descriptive statistics of the data set. Percentages are shown for categorical variables; actual numbers of cases are provided in parentheses. Means, standard deviation and ranges are shown for continuous variables.

Variables	Category	Male (N=8720)	Female (N=8510)	All (N = 17230)
Age	Mean	70.56	70.38	70.47
	Std. Deviation	7.54	7.72	7.62
Number of books	Up to 10 books (=1)	48.55 (4193)	43.62 (3673)	46.12 (7866)
	11-25 books	22.07 (1906)	22.25 (1874)	22.16 (3780)
	26-100 books	18.50 (1598)	21.10 (1777)	19.79 (3375)
	101-200 books	5.44 (470)	6.69 (563)	6.06 (1033)
	>200 books (=5)	5.43 (469)	6.34 (534)	5.88 (1003)
	Missing	*84*	*89*	*173*
Rooms per capita	Mean	0.71	0.71	0.71
	Std. Deviation	0.43	0.41	0.42
	Range	0 : 7	0 : 8.75	0 : 8.75
	Missing	*114*	*99*	*213*
Father's occupation	Elementary (=1)	18.18 (1497)	18.00 (1444)	18.09 (2941)
	Skilled	69.73 (5742)	69.11 (5545)	69.42 (11287)
	Associate	4.06 (334)	4.39 (352)	4.22 (686)
	Manager (=4)	8.04 (662)	8.51 (683)	8.27 (1345)
	Missing	*485*	*486*	*971*
Childhood SRH	Excellent (=5)	37.43 (3247)	30.58 (2589)	34.05 (5836)
	Very good	33.66 (2920)	33.72 (2855)	33.69 (5775)
	Good	21.78 (1889)	26.11 (2211)	23.92 (4100)
	Fair	5.37 (466)	6.96 (589)	6.15 (1055)
	Poor (=1)	1.75 (152)	2.63 (223)	2.19 (375)
	Missing	*46*	*43*	*89*
Ever missed school	No (=1)	89.83 (7803)	87.82 (7447)	88.84 (15250)
	Yes (=0)	10.17 (883)	12.18 (1033)	11.16 (1916)
	Missing	*34*	*30*	*64*
Ever in hospital	No (=0)	94.33 (8207)	93.75 (7965)	94.05 (16172)
	Yes (=1)	5.67 (493)	6.25 (531)	5.95 (1024)
	Missing	*20*	*14*	*34*
Education	Mean	10.63	10.05	10.34
(years of schooling)	Std. Deviation	4.56	4.03	4.31
	Range	0 : 25	0 : 25	0 : 25
	Missing	*1148*	*967*	*2115*
Occupation	Elementary (=1)	15.40 (1306)	23.42 (1974)	19.40 (3280)
	Skilled	54.54 (4626)	59.65 (5028)	57.09 (9654)
	Associate	11.92 (1011)	5.61 (473)	8.78 (1484)
	Manager (=4)	18.14 (1539)	11.32 (954)	14.74 (2493)
	Missing	*238*	*81*	*319*
Income (2006 PPP Euros)	Mean	16861.84	16697.77	16779.89
	Std. Deviation	17733.20	17708.84	17720.65
	Range	0 : 360685.6	0 : 586047.1	0 : 586047.1
	Missing	*1055*	*861*	*1916*
Wealth (2006 PPP Euros)	Mean	145060.90	137423.40	141249.20
	Std. Deviation	229605.30	224462.50	227077.80
	Range	-341522.3 : 6932346	-3041502 : 5046995	-341522.3 : 6932346
	Missing	*1138*	*956*	*2094*
Smoking	Current (=1)	19.90 (1641)	13.02 (1074)	16.46 (2715)
	Former	43.13 (3557)	20.01 (1650)	31.57 (5207)
	Never (=3)	36.98 (3050)	66.97 (5523)	51.97 (8573)
	Missing	*472*	*263*	*735*
Physical activity	Non-active (=1)	9.17 (760)	12.93 (1068)	11.05 (1828)
	Active (=2)	90.82 (7524)	87.07 (7192)	88.95 (14716)
	Missing	*436*	*250*	*686*
Old age health	Poor (=1)	13.47 (1174)	14.90 (1267)	14.18 (2441)
	Fair	27.92 (2433)	30.69 (2609)	29.29 (5042)
	Good	36.72 (3200)	35.94 (3056)	36.34 (6256)
	Very good	15.03 (1310)	12.84 (1092)	13.95 (2402)
	Excellent (=5)	6.85 (597)	5.62 (478)	6.24 (1075)
	Missing	*6*	*8*	*14*

In general, both male and female respondents share the same characteristics in their childhood, and from early adulthood onwards minor differences appear, in particular in adult SES and behavioural risks. Regarding the occupation of male respondents, approximately 30% are in associate positions or higher, and 70% work at an elementary or skilled level; for females, around 83% are at the skilled or lower level, and only 17% are in associate positions or higher. As for behavioural risks, about 40% of male respondents are former smokers, twice the number of female former smokers. Only 6% more males than females report being current smokers, but there are 30% more females than males who report never having smoked. In terms of health in old age, we found that the proportions for both male and female do not differ greatly, i.e. most respondents report having good health condition.

Table 2. Parameter estimates (standardised) for Model 1 to Model 6 which show the stepwise inclusion of mediators. "Old age health ON CH_SES" means the old age self-rated health is regressed 'on' the childhood SES, etc. For "smoke", the reference is current smoker and for "physical activity" is non-active; and for "ever unemployed" is never. ***: $p<0.01$, **: $p<0.05$, *: $p<0.1$.

		Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Old age health ON	CH_SES	0.156***	0.151***	0.102***	0.026*	0.025*	0.026*
	CH_Health		0.234***	0.235***	0.229***	0.229***	0.229***
	Education			0.106***	0.074***	0.061***	0.061***
	Adult SES				0.183***	0.183***	0.181***
	Former smoker					-0.001	-0.001
	Never smoker					0.042***	0.042***
	Physical activity: Always					0.182***	0.182***
	Ever unemployed						-0.109***
	Gender (Male)	0.057***	0.041***	0.030***	0.007	0.009	0.010
Education ON	CH_SES			0.459***	0.462***	0.465***	0.465***
	CH_Health			-0.002	-0.002	-0.004	-0.005
ASES ON	Education				0.170***	0.170***	0.171***
	CH_SES				0.426***	0.425***	0.423***
	CH_Health				0.031**	0.031**	0.035**
Total Effect	Old age health ON CH_SES		0.156***	0.156***	0.157***	0.157***	0.157***
	Old age health ON CH_Health			0.234***	0.234***	0.234***	0.234***
	Old age health ON Education				0.105***	0.107***	0.107***
RMSEA		0.055	0.049	0.049	0.057	0.053	0.052
CI 90%		0.053 - 0.057	0.048 - 0.051	0.047 - 0.050	0.056 - 0.058	0.052 - 0.054	0.051 - 0.053

Table 2 presents the estimated parameters of the six specified models. In the lower part we report the goodness of fit for RMSEA (Root Mean Square Error of Approximation), which, when the value is closer to or below 0.050 and the upper limit of its 90% of confidence interval is less than 0.080, indicates that the proposed model fits the data well (Wang & Wang, 2012).

In Model 1, the estimated parameter takes the expected direction and is statistically significant: that is, controlling for sex and age, a one standard deviation (SD) increase in childhood SES produces, on average, a 0.156 SD increase in old age health. The goodness of fit in Model 1 indicates fair fit (0.055, and the upper limit of 90% confidence interval is less than 0.080). The factor loadings of each latent variable are presented in Appendix A. For example, all factor loadings for the latent variable childhood SES are considered acceptable indicators (the coefficients are 0.769, 0.400, and 0.627). In order to have a clearer picture of life course characteristics between male and female respondents, in Appendix B and C we present the parameter estimations and measurement models (the factor loadings) based on gender. The fact that the results are so close between men and women that it was possible to collapse the analyses is in itself an interesting finding, showing that for our specific research question, gender-specific life and career trajectories are of little relevance.

In Model 2 we have two coefficients, namely the association of childhood SES with old age health (controlling for sex, age, and childhood health), and the association of childhood health with old age health (controlling for sex and age). In this model, the childhood SES coefficient remains statistically significant, i.e. the coefficient is 0.151. As also expected, the association of childhood health with old age health is positive, i.e. a one standard deviation increase in childhood health produces (on average) a 0.234 SD increase in old age health. The total effect of childhood SES on old age health (the sum of the direct and indirect effects, where the direct effect is childhood SES → old age health, and the indirect effects is the product of two effects: childhood SES → childhood health, and childhood health → old age health) is 0.156 and statistically significant.

Adding education in Model 3, both childhood SES and health parameters remain statistically significant, i.e. controlling for sex, age, childhood health and education, the association of childhood SES with old age health is 0.102, while the association of childhood health with old age health after controlling for sex, age and education is 0.235. Furthermore, the effect of

education on old age health is statistically significant as well (0.106, which means that the longer an individual's the education, the better their health condition in old age). Summing up all effects (the direct effect of childhood SES on old age health, and the sum of three indirect ones: 1. childhood SES → education → old age health, 2. childhood SES → childhood health → old age health, and 3. childhood SES → childhood health → education → old age health), we obtain the total effect of childhood SES on old age health is 0.156. We see also that childhood SES has a statistically significant association with education (0.459), but this is not the case for childhood health; the association is small and not significant. As in the previous model, we see the goodness of fit shows improvements.

In Model 4, by adding adult SES, the association of childhood SES with old age health is reduced drastically both in size and statistical significance – the coefficient is 0.026. In contrast, the coefficient for childhood health remain relatively stable in size and is still statistically significant (0.229). The effect of adult SES on old age health itself is statistically significant (0.183). This shows that, in our sample, those adults who have higher SES – in terms of occupation, income and wealth – are healthier in later life. As with Model 3, the effect of education on old age health remains statistically significant (0.074). For sensitivity analysis, in Appendix D we present the parameter estimations using grip strength as the health outcome in old age. It shows that childhood SES is not associated with grip strength, but childhood health is. Furthermore, in Appendix E we present the parameter estimations using all three adult SES indicators without a measurement model. The direct association between childhood SES and old age health in this analysis is 0.073, which is substantially larger than the estimate we get using a latent variable approach (vs. 0.026 in Model 4, Table 1). This indicates that the part of the total association between childhood SES and old age health that is mediated is larger when using a latent variable approach than when using each SES indicators individually. We cannot distinguish whether this reflects only the effect of measurement error or whether a latent variable approach is substantively superior for our research question.

In Model 5, in which we include behavioural risks, the coefficient of childhood SES is about the same as in previous models and is statistically significant. The coefficient of childhood health remains statistically significant. For smoking, health in old age for 'never-smokers' is 0.042 SD higher compared to current smokers. For those who actively engage in physical activity, health in old age is 0.182 SD higher compared to non-active individuals. The effect

of adult SES on old age health does not change in this model, suggesting that the social gradient in old age health by adult SES does not change when taking our measures of behavioural risks into account.

In the last model, Model 6, where we include the event of unemployment, almost all parameters remain similar to Model 5, not only in terms of size but also in the level of statistical significance. The additional parameter, event of unemployment, is statistically significant, -0.109. In this last model, the goodness of fit consistently show improvement, i.e. the RMSEA is 0.052 and its upper limit of 90% confidence of interval is less than 0.080.

When comparing models 2 to 6, the direct effect of childhood SES is reduced in several stages, but the association of childhood health remains remarkably constant after introducing additional adulthood characteristics. This points to a substantive difference in the way childhood SES and childhood health are linked to old age health.

4. Discussion and conclusion

We analyse the long lasting impact of childhood SES and health on old age health, and we take into account how the associations change once we consider various mediators. Furthermore, the application of latent variables allows us to reduce the impact of measurement error, in particular related to the retrospective questions that address events that took place decades ago. We consider not only the direct effect, but also the total effect, in order to give a complete picture of the mechanisms of how the long arm of childhood influences health in old age.

Neglecting mediators, both childhood SES and health are strongly associated with old age health, and adding childhood health does not change the coefficients for childhood SES. Once we include all mediators, the effect of childhood SES remains positive, but is reduced drastically, and becomes less significant in the association with health in old age, while the coefficients for childhood health hardly change. These results suggest, firstly, that childhood health is neither a strong mediator nor a strong confounder of the life-spanning association between childhood SES and health in old age. Secondly, the mediating effect of education and adult SES is in the same substantial order of magnitude, while health behaviour (as measured in our study) or being unemployed do not affect our underlying association. We assert that our model can explain the common finding that childhood SES is associated with old age

health because it includes all relevant mediators. Our comparison of the effect on old age health across mediators shows, firstly, that the coefficient for childhood health does not change across models, which indicates that it has a 'direct effect' in the sense that it is not mediated by any of our life course variables. The question as to whether the effect of childhood health really is direct in the sense that there is a critical period in childhood where an individual's health is significant for the rest of their life, or whether it is just mediated by other variables, is beyond the scope of this study. Secondly, education has a partly direct, partly indirect effect through adult SES and, thirdly, health behaviours do not seem to mediate much of the analysed associations. While SES does indeed correlate with health behaviour (results not shown) three possible explanations might be responsible for the latter finding: a) because behaviour is measured a long time after the childhood, b) because behaviour risks were measured shortly before old age self-rated health, meaning it did not have time to affect old age health, or c) the set of variables that we could use to measure health behaviour is too limited.

In line with our findings, Berndt & Fors (2016) – who looked at various old age health indicators (musculoskeletal disorders, cardiovascular disease, self-rated health and impaired mobility) – found that the associations between childhood conditions and health among old people in Sweden is mediated by education. On the other hand, Tampubolon (2015) used an extensive set of control variables (such as adult health, social support and social connection) and found that a disadvantaged childhood is still associated with old age health, i.e. slower gait speed, poorer memory and greater risk of depression.

Our results suggest that, even though we can detect the presence of the long arm of childhood SES on health in old age, we believe that this is only a mediated (and not a direct) effect because we were able to 'explain it away' as the result of a set of mediators.

Considering the magnitude of the total effects of both childhood SES and health on old age health, it appears that experiences in childhood do substantially regulate health in later life, because they are the beginning of probable pathways that lead to good or bad health. These pathways are mediated; alongside adult SES – however, it is education that shapes the association between early years and later life, because it not only contributes to the association between childhood and old age health, but also affects old age through adult SES and behavioural risks. We interpret this mediation and conclude that childhood is an important period for effective intervention because it is the start of many different pathways,

but also that childhood is not the only period for successful intervention, because in principle a disadvantaged childhood could be offset by a good education and subsequent good occupational status and material wealth. We refer to the insightful discussion of early-life circumstances in a life course context by Dannefer et al. (2016: 97) who subdivide existing theoretical frameworks into two groups: (1) latency frameworks that claim a causal link of an early life exposure and an adult outcome, even if this link mediated, and (2) path dependency frameworks that assume risk pathways, accumulative processes and "a relatively fixed opportunity structure". Dannefer et al. (2016: 100) also comment on existing research, stating that "social structure is both assumed to be rigid and determinative of individual life chances, yet kept invisible, keeping social structure in a conceptual 'black box'". We would claim that our differentiation of separate social structural variables has the potential to open this black box and to examine how rigid the social structure is, which could be pursued by further research in order to reveal more detailed pathways and related intervention points.

We acknowledge the on-going discussion about when it is best to intervene; for instance, Heckman (2011) suggests that childhood is the best period to invest. Specifically, he explains that the highest rate of return in early childhood development comes from investing as early as possible, from birth to age five. On the other hand, any investment in childhood needs to be followed up later in order to produce the desired effects (Heckman, 2013). Based on our model, favourable adulthood conditions can compensate negative childhood socioeconomic conditions to a large extent, if not completely. This contradicts to some previous evidence showing that upward mobility does not compensate for inadequate childhood conditions (Poulton et al., 2002). Our findings support the compensatory effect of upward mobility and other favourable adulthood conditions as have other studies (Luo & Waite, 2005; Turrell et al., 2002). In contrast, our results show that, using this framework, we would not expect to find a compensatory effect of adulthood characteristics for childhood health conditions, as childhood health remains strongly related to old age health in our full model, taking all mediators into account. It is therefore important that the discussion of the potential for compensation of early childhood conditions should clearly distinguish between compensating for the different early life health and early life socioeconomic adversities that children face.

We cannot offer a detailed analysis comparing the rate of return of investments in different life stages, and this would substantially depend on the outcome measure. Nevertheless, our results suggest that policies that improve childhood circumstances are important, because this

is where an incremental pathway to old age health begins, although we would add that there are alternative intervention points later in life (education and adult SES) that would also efficiently improve old age health.

Our analysis is not without limitations, and there is potential for further research. Given the limited sample size for each country, we were unable to perform an analysis on the national level, or to compare countries. Due to the limited availability of the mediator factors, we cannot address some factors that may also explain old age health, such as objective health measurements (e.g. gait speed, biomarkers, more detail in behaviour risks, such as amount of alcohol consumed, number of cigarette smoked, etc.). If available, it would also be interesting to use alternative measures of childhood and later life health and to include common background factors that can explain some of the association between childhood SES and health (such as IQ, cognitive traits or parental background). We acknowledge the possibility that the association between childhood and old age may be driven by these factors. However, we cannot explicitly take them into account in our model since these indicators are not available in SHARE. IQ and non-cognitive traits have been extensively studied by Heckman and his colleagues (Conti & Heckman, 2010; Conti, Heckman, & Urzua, 2010; Elango, García, Heckman, & Hojman, 2015; Heckman, 2013). However, the measurement of common background factors for SES and health contains sizeable limitation, and we would assert that any existing variable that has been used in other studies (IQ, non-cognitive traits, school performance, birth weight, height etc.) is accompanied by a number of problems and questions, so no easy solution is available – primarily because they might still be influenced by their own SES or that of the parents.

Another limitation which is common in retrospective data is the problem of recall bias. Respondents may systematically misremember their childhood situation in light of their old age health conditions. In order to limit this problem, we use a measurement model that can partly correct the bias by adding more reliable indicators (proxy) for specific factors. We refrained from adding more mediators because we had already found the most important factors, which is shown by the fact that we 'controlled away' the association between childhood and old age health that we started with.

To conclude, our contribution is to have explained the association between childhood SES and old age health for a given set of indicators for a given population. Our interpretation is to recognise the importance of childhood as the start of a mediated, incremental process during

the life course, but not to over-interpret the notion of the long arm of childhood as having a direct, deterministic effect on old age.

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