Recall error and recall bias in life course epidemiology

Tampubolon, Gindo

Institute for Social Change, University of Manchester

12 July 2010

Recall error and recall bias in life course epidemiology

Gindo Tampubolon[a,*]

[a] *Institute for Social Change*
University of Manchester

Abstract

Objectives I propose a distinction between recall error and recall bias and examine the the effect of childhood financial hardship on adult health, subject to such recall problems. Studying the effect of childhood hardship on adult health is a prototypical investigation in life course studies where both non-clinical factors and long-duration processes are at play in determining health outcome. These factors and processes are often elicited retrospectively. Unfortunately, retrospective information on childhood hardship is often subject to recall error and recall bias. There is surprisingly little methodological work on how to purge their effects in retrospective life course studies. **Methods** I recast a variant of generalised latent variable models as covariate error measurement model to purge recall error in life course study. Additionally, I recast the endogeneous treatment model as a solution to the problem of recall bias. I apply both models to examine the effect of childhood financial hardship on adult health status of more than 359,000 European respondents from 23 countries. In addition, I validate the solutions using the National Child Development Study cohort where both prospective and restrospective information are available. **Results** Childhood financial

*I thank James Nazroo and Andrew Pickles for helpful discussions. All remaining errors are my own.

Email address: `tampubolon@manchester.ac.uk` (Gindo Tampubolon)

hardship has a strong effect on adult health status. Once recall error is accounted for in a generalised latent variable model, the effect reduced by an order of magnitude though remain statistically significant. Applying the endogeneous treatment model of recall bias suggests that childhood hardship is systematically misreported by respondents. Once this bias is purged, the effect of childhood deprivation on adult health increased markedly. Such an increase is consistent with multiple direct and indirect pathways linking childhood hardship and adult health. **Conclusion** Problems of recall error and recall bias are common in life course retrospective studies. Applied to data from 23 European countries, the proposed solutions recover the effect of childhood hardship on adult health outcome.

Keywords: recall bias, generalised latent variable model, life course epidemiology, childhood hardship, European Survey of Income and Living Conditions, EUSILC, NCDS

---

1. Introduction

The arms of childhood conditions are very long indeed. The influential collection on life course epidemiology (Kuh and Ben-Shlomo, 2004) conveys very strongly that childhood circumstances are associated with health outcomes long into adult life. Kuh et al. (2004, :376-377) summarise the extant studies by saying "there is evidence from a growing number of studies that the childhood socioeconomic environment has long-term influences on various adult health outcomes." I am not aware of any studies that could rewrite this summary as yet.

There are at least three ways how childhood conditions can have such a lasting influence. Case et al. (2005) demonstrate two of them. The pathway models as they label them posit that socioeconomic status during childhood leads to lower initial socioeconomic position in early adulthood. In turn, this lower position leads to lower adult health status. Essentially because socioeconomic position in early adulthood (including education and occupation) summarises a range of conditions, no remaining direct association between childhood socioeconomic position and adult health status is found. In this context, the study by Holland et al. (2000) shows that socioeconomic disadvantage during childhood leads to subsequent working conditions that expose people to cumulative environmental hazards.

Additionally, they label the life course models those models that posit both direct and indirect effect of childhood condition on adult health. Disadvantaged socioeconomic conditions during childhood may be contemporaneously harmful to health, and this health disadvantage may persist. Thus childhood conditions lead to both restricted life chances (lower socioeconomic status) as well as poorer health later in adulthood. The links in these path models and life course models have been found not only in developed countries but also in developing countries (Glewwe et al., 2001) using both prospective and retrospective study design (Case et al., 2005; Holland et al., 2000).

Inspired by these long-lasting influences, life course studies have amply shown the lasting effects of childhood conditions on various individual outcomes. Two tenets lie at the heart of life course epidemiology: multiple factors affecting health outcomes necessitating cross-disciplinary study, and long duration of health processes often requiring extended prospective or retrospective study. While prospective studies following cohorts of individuals over extended period of time have been around, e.g. the British Cohort Study 1970 and the National Child Development Study 1958, these have not exhausted all the possible relationships between determinants of health over the life course. As Berney and Blane (1997, p. 1525) note "the investigation of accumulated lifecourse influences on social variations in health ... will in consequence involve retrospective data." These authors, taking retrospective study as a necessary resource for awhile yet, assess the accuracy of recall after a lapse of half a century. They conclude that for some purposes, usable information can be recalled.

That said, it remains true that recall problems in retrospective life course epidemiology study needs to be recognised. And on this, surprisingly little methodological work has been done (Andrew Pickles, personal communication, 01 April 2010). The number of studies specifically accounting for recall bias is still few; e.g. Rabe-Hesketh et al. (2001) deal specifically with 'telescoping' bias of age-of-onset. Given the recognition that retrospective life course studies are needed and that more than anthropometric or clinical measures (so, to include social and economic measures) are going to be used, accessible models to deal with recall problems are needed.

2. The long arm of childhood conditions

The link between childhood hardship and adult health is part of a series of complicated, direct and indirect, pathways. The literature has not settled on a consensus though some common sub-paths or links are repeatedly discerned. Notably the literature reports studies from both developed and developing countries (Glewwe et al., 2001; Szanton et al., 2010; Schoon, 2006; Ryff et al., 2001; Conger et al., 1997; Davey Smith and Lynch, 2004; Kuh et al., 2004; Case et al., 2005). Almost all these studies cannot dismiss the notion that the effects of childhood conditions reached long into adulthood.

Case et al. (2005) studied the British cohort born in 1958 (the National Childhood Development Study) up to the age of 42. They conclude with two major themes. Both life-course model and pathways model that link childhood hardship and adult health can be used to understand such long range links. They write [:387]

> Consistent with *life-course models* of health, childhood health conditions have a lasting impact on health and socioeconomic status in middle adulthood. . . . and support for *pathways models*, in that ... childhood factors affect initial adult social position, which in turn affects health in middle age."

The authors examine childhood socio-economic status with measures beyond financial resources or income. The measures also include mother's age at leaving school and father's age at leaving school.

Such long term effect of childhood condition has not been as instensely examined in the developing world but a study by Glewwe et al. (2001) on Filipino children find a sub-path in the long-range links. Using educational achievement production function, these authors show that nutrition deprivation during childhood has a negative impact on educational achievement of the child. Using instrumental variable estimation to establish the causal link between nutrition and achievement, the authors demonstrate that nutritional deprivation has deleterious effect. Although, in this particular study, the link examined end at educational attainment, plenty of studies of subsequent link have shown that education matters for health (Feinstein et al., 2006).

Holland et al. (2000) examine laborate the link by bringing in the role of exposure to health-damaging environment. A more elaborate pathways linking childhood hardship and adult health can be discerned by looking at the adult working environments of people grew up in hardship during childhood. The authors found that not only that these group of people find themselves lower in the occupational strata, this also exposes them to less favourable working environments. Thus the effect observed on adult health operates through the accumulation of environmental hazards during the life course.

The potential deleterious effect of childhood hardship, even during childhood itself, has also been examined. Conger et al. (1997) train the light on parental skills effect of financial hardship in the household. They write [:300ff],

> income loss or continuing financial strains are painful for parents and lead to negative emotions that range from depressed mood to feelings of anger and hostility . . . this in turn, influences interactions with children, leading to an increased risk for expressions of hostility, reductions in warmth and support, and impairments in skillful child rearing.

It must be emphasised here that the space allocated to these negative links beween childhood hardship and adult health does not amount to a law of nature. Social scientists have also demonstrated that some children, even after exposure to hardship and deprivation, can thrive. Schoon (2006, :6) explicate this by using the increasingly influential notion of resilience, "a dynamic process whereby individuals show adaptive functioning in the face of significant adversity."

Nevertheless, the predominant theme is of harmful effect of childhood hardship on edualt health. The most recent study is reported by Szanton et al. (2010) based on a sample of nearly 700 African-American twins. Using twin studies, individual fixed effects or genetic predispositions are controlled for much more satisfactorily than using a sample from the general population. They put childhood and adulthood financial hardships within the cumulative advantage theory. Childhood and adulthood financial hardship are most harmful to adult health than either experience (this is after controlling for a range of confounders). This strong harmful joint effect, they find, is consistent with both psychosocial and neo-materialist explanations that are often advanced in social epidemiology literature. In the former, joint hardships stand as chronic stressors in the allostatic load framework that affect physiological functionings as measured in cortisol level, blood pressure or free fatty acid level (Ryff et al., 2001; Ryff and Singer, 2001). In neo-materialist explanation, lack of income to access material resources prevents adequate access to foods, medical resources or safe environments which contemporaneously or ultimately increase risks to health.

Two cautions with retrospective studies. Not all of the studies on childhood hardship and adult health use measures that are contemporaneous with the stages of the life course. Some cohort studies do provide contemporaneous data e.g. (Case et al., 2005) while others have to rely on retrospective measures e.g. (Szanton et al., 2010). Report of childhood financial deprivation is likely to be measured with error because respondents' childhood were sometimes a couple of decades in the past. Memory about childhood financial hardship maybe unreliable or noisy especially with typical survey question of rating such condition on a limited scale (say one to five). Such report may be subject to random recall error.

On the other hand, report on childhood financial hardship can be unreliable due to bias that is related to current health status. For instance, healthy adults who are also likely to be socioeconomically advantaged (Marmot and Wilkinson, 2006), may suppress their childhood deprivation memory (Kuh et al., 2004). Somehow it may not be congruent with their current health and socioeconomic status. The converse may also present. Adults may attribute their current health status to conditions in the past. In short, such retrospective report may be result in recall bias in unknown direction.

3. Methods

I propose recasting the increasingly popular generalised latent variable models (Skrondal and Rabe-hesketh, 2004, Chapter 14), as a covariate measurement models to deal with recall error. Childhood financial hardship may not be accurately recalled yet point to the true latent hardship. If repeated or multiple indicators are also collected (as is often the case in surveys using lifegrid technique), all these recalled information can be constructed as part of a covariate measurement model. Such measurement model recovers the true childhood hardship which can then be simultaneously related to adult health outcomes in the so called disease model or structural model of health inequality.

On the other hand, the recall problem can be different from 'hardship' measured with error. It could be that report of childhood hardship is coloured by current position or health status. A suppression of unpleasant childhood hardship may be present; conversely, an attribution to unpleasant childhood hardship may be operating. There is therefore a latent factor that systematically affects both report of childhood hardship (in a childhood hardship equation) and affects health (in a disease or health equation).

The covariate measurement model as solution to recall error problem has two parts: measurement model (equation 1) and disease model (equation 2) (Skrondal and Rabe-hesketh, 2004, :418).

$$
\begin{aligned}
y_{ij} &= \eta_j + \epsilon_{ij}, \qquad \epsilon_{ij} \sim N(0, \theta) && (1) \\
\text{logit}[\Pr(H_j = 1|\eta_j)] &= X_j'\beta + \gamma\zeta_j && (2)
\end{aligned}
$$

where η is true childhood hardship and γ is its effect on health H, the i indexed measures or indicators of childhood circumstances i.e. report of childhood financial hardship, growing up in non-intact family and head of household did not finish primary school, X include age, gender and household size. As is standard in factor analytic models (of which covariate measurement model is one), identification is secured by setting one of the loadings or one of the variances in the measurement model to one. In this instance, the former is chosen.

The endogeneous treatment model as solution to recall bias also has two parts: disease or health model (equation 3) and childhood hardship (equation 4) (Skrondal and Rabe-hesketh, 2004, :434).

$$
\begin{aligned}
\text{logit}[\Pr(H_j = 1|\zeta_j)] &= X_j'\beta + C\alpha + 1\zeta_j && (3) \\
\text{logit}[\Pr(C_j = 1|\zeta_j)] &= Z_j'\gamma + \lambda\zeta_j && (4)
\end{aligned}
$$

Both are generalised linear models, and in this instance they are logistic models. Both has an additional covariate that is the latent bias. Comparable to covariate measurement error above, for identification, one of the coefficient is set to one. In this instance, this setting is chosen for the disease or health equation. The other covariates for the main or health equation is the same as for the covariate measurement solution. The other covariates for the childhood hardship equation are report of childhood financial hardship, growing up in non-intact family and head of household did not finish primary school. This set of covariates conforms to the measurement model indicators above.

Below I apply the solutions to the European Community Statistics on Income and Living Condition (EUSILC). I shall also present a validation exercise using the National Child Development Study (NCDS 1958) cohort study where a comparison between prospective (at age 11) and retrospective (at age 50) information is possible.

4. Data for main application: EUSILC 2005

The European Survey of Income and Living Conditions (EUSILC), provided by the Eurostat, is a survey on living conditions in 23 European countries and thus has a broader focus beyond income. Such focus is occasionally even broadened to include other aspect such that in 2005 childhood financial hardship becomes part of the survey. Respondents were asked in their national languages about their childhood condition: "When you were a young teenager, how often did the household you were living in have financial problems at that time. Was it? Never:1 ... most of the time:5." In some countries the direction is reversed. For instance, in Finland the respondents were asked: "When you think about the times when you were young, did your family have difficulties in making ends meet? Always or almost always:1 ... no difficulties at all:5."

The dependent variable is general (self-rated) health with 5 original categories which are then grouped into good/excellent health versus worse.

These two categories are commonly used especially, as in this case, there are slight difference in categories across the 23 countries ('good health' is the constant category; better categories or worse categories sometime differ). The covariates included are only gender, age, and household size. This small set is chosen in order to focus on the methodological issues of recall problems rather than on the epidemiology of general health. These limited covariates are ensure to minimize the effect of other non-comparable covariates such use housing tenure across the European countries.

For measurement model and for childhood hardship bias equation in endogeneous treatment model, I use two other indicators or covariates, respectively. They are whether the respondent grew up in foster family or non-intact family (following McLanahan (1997)) and whether the head of the household when growing up did not finish primary school. Both are associated with childhood financial hardship.

4.1. Validation data: NCDS waves 2 and 8

The National Child Development Study 1958 is a cohort study of all children (nearly 17,5000) born in the United Kingdom in one week in March 1958. In addition to their mothers' information when pregnant with these cohort (the perinatal mortality survey), the cohort members were followed at ages 7, 11, 16, 18, 23, 33, 42, 46 and 50. At age 11 two pieces of information about number of rooms in their accomodation and number of people in their household were collected. Nearly forty years later, nearly 3000 random sample of the original cohort were asked questions about these pieces of information. I shall use these pairs of information (prospective and retrospective) to provide evidence on the plausibility of these two solutions to recall error and recall bias. The dependent variable for the analysis is health

(5 categories from poor to excellent); the covariates are gender, household size, marital status. The two pieces of information above are used in the measurement part and the bias equation after they are log-transformed to reduce the obvious skewness.

5. Result on the main application: EUSILC 2005

A direct model relating childhood financial hardship and general health while controlling for gender, age and household size gives a significant negative effect of childhood financial hardship (coefficients -0.2651, all coefficients are significant at $p < 0.0001$). Men, compared to women, report to be in better health (coefficient 0.112); household size has a negative association with reported health (coefficient -0.0615).

Report of childhood financial deprivation is likely to be measured with error because their childhood were, in cases, a couple of decades in the past. A solution to this is to employ a covariate measurement error to find a latent or true measure of childhood financial hardship. This is presented in Model 2 (second block of table 1). To get a latent measure of childhood financial hardship two other indicators are used: whether the respondent grew up apart from both biological parents e.g. in foster homes or in single parent household and whether the head of the household when growing up did not finish primary school. These covariates have been found to have a lasting effect on life chances and health in later life (McLanahan, 1997, :47). Loadings of both covariates are found to be significantly related to latent childhood hardship; the loadings are also in the expected direction.

When latent childhood hardship is estimated together with health status in a covariate measurement error, two things are apparent. The effects of all other observed covariates (gender, age and household size) do not visibly change (i.e. only the fourth digits onwards). In contrast, the effect of latent childhood hardship reduced to about 3% of the original magnitude.

As alluded to above, report on childhood financial hardship can be biased and such bias may be related to current health status. Healthy adults (often, socioeconomically advantaged as well), may suppress their childhood hardship memory since it may seem incongruent with their current status. Conversely, adults may attribute their current health status to conditions in the past. Suppression or attribution are empirically possible. Model 3 (block 3 in table 1) presents estimates based on an endogeneous treatment solution. It is assumed that a latent bias factor colours their recall of the childhood hardship and is related also to current health status. There are therefore two equations: childhood hardship equation and health equation. In both, the bias factor is a covariate. For identification, the effect is set to one in one of these two equations (here it is set to one in the health equation). Such setting for identification is comparable to the setting in factor analytic methods generally (covariate measurement error above is an example; one loading is set to one). In practice, there is no reason to limit the bias equation to retrospective information only. Were there retrospective information that correlate with childhood hardship, these can be used to improve the estimate.

When observed childhood hardship is deemed to be biased and a solution based on endogeneous treatment model is applied, two things are apparent. Remarkably, like the covariate measurement error above, the effects of all other observed covariates (gender, age and household size) do not visibly change (i.e. only the fourth digits onwards). In contrast to both the simple model and the covariate measurement model, the effect of childhood

Table 1: Simple effects (M1), recall error (M2), and recall bias (M3) models of childhood financial hardship on good/excellent self-rated health, N=359,013

	M1: Simple		M2: Recall error sol		M3: Recall bias sol	
Covariate	coef	s.e.	coef	s.e.	coef	s.e.
Constant	2.4046	0.0321	2.3589	0.0324	2.4369	0.0327
Male	0.1120	0.0077	0.1121	0.0077	0.1124	0.0077
Age	-0.0166	0.0013	-0.0159	0.0013	-0.0154	0.0013
Hhold. size	-0.0615	0.0030	-0.0617	0.0030	-0.0618	0.0030
Child. hardship	-0.2651	0.0109	-0.0087	0.0014	-0.5170	0.0315
			Measurement eq.			
Indicator			loading	constant		
Child. hardship			1	-17.0910		
Foster family			0.0470	-2.6832		
Unfinished primary			0.0652	-3.0242		
					Child. hardship eq.	
Constant					-4.4147	0.4229
Foster family					3.0692	0.2879
Unfinished primary					3.9463	0.3611
λ					18.2500	3.2581
σ^2_ζ					0.1706	0.0199

All coefficients, loadings and variance are significant, $p < 0.0001$
Country dummies are included

hardship doubled from -0.2651 to -0.5170. Other notable points are the significance of the variance of bias (last line) and the comparable relative sizes of both indicators or auxilary covariates. Bearing in mind that the scale of measurement equation in Model 2 is not the same as the scale of the childhood hardship equation in Model 3, the relative sizes of the coefficients of foster family and primary education are comparable: $0.72 = \frac{0.047}{0.0652}$ versus $0.78 = \frac{3.0692}{3.9463}$.

6. Validation with NCDS 1958

How plausible are the results from these solutions? For validations we ought to have pairs of prospective and retrospective measures that are relevant for the substantive question at hand. In this case, the question is about health and its link with childhood financial hardship. The NCDS did ask the mother about financial hardship prospectively; however, the same question was never asked to the cohort members either prospectively or retrospectively. Instead the information that can be paired (prospective-retrospective) are number of rooms and number of persons in the household. This situation is problematic since substantively, there is no strong consensus on the link between number of room during childhood and health status during adulthood. Of course, there is plausible negative link between the ratio of number of people and room during childhood (as a measure of crowding) and health status during adulthood.[1] However, if we use this ratio, as a proxy for crowding, then we cannot investigate either recall error or recall bias since we are left with effectively one childhood measure that is error-prone or bias-induced. Thus I build a model of adult health including one childhood condition measure that is prospective or contemporaneous i.e. number of rooms in the house (other covariates above are included). Next I examine the extent of the recall problems when retrospective information is used. I then apply both solutions. The result is given in table 2 with four models: true model, model with recall problems, recall error solution and recall bias solution.

The true model, that is, one that uses prospective measure of number

[1]Even here, this ratio cannot be straightforwardly interpreted as crowding which is a social notion rather than simply density which is an aritmetic notion.

Table 2: Model validation of health, NCDS 1958, true model, recall problem, recall error solution, and recall bias solution, N=2894

	True model		Recall problem		Error sol		Bias sol	
Covariate	coef	p val.	coef	p val.	coef	p val.	coef	p val.
Female	-0.0170	0.63	0.0011	0.97	0.0020	0.95	0.0044	0.91
Separated	-0.1781	$< .001$	-0.1632	$< .001$	-0.1632	$< .001$	-0.1821	$< .001$
Single	-0.2495	$< .001$	-0.2381	$< .001$	-0.2338	$< .001$	-0.2573	$< .001$
Hhold size	0.0405	0.012	0.0360	0.015	0.0359	0.015	0.0404	0.021
Child. nroom	0.1950	0.0023	0.2630	$< .001$	0.2679	$< .001$	-0.6315	0.12
					Measurement eq.			
Indicator					loading	constant		
Child. nroom					1	1.5184		
Child. nperson					0.2639	1.4463		
							Child. nroom eq.	
Constant							1.3867	$< .001$
Child. nperson							0.0955	$< .001$
λ							0.4742	0.2500
σ^2_ζ							0.1787	0.4000

of rooms is given in the first block. The problematic model, that is, one that uses retrospective measure is given in the second block. The covariate measurement solution is given in the third block. Consistent with the results on EUSILC above, coefficients of observed covariates are comparable across the covariate measurement solution and the true model. This consistency strengthens the plausibility of the solutions. The erroneous effect of number of rooms during childhood appears in the form of strengthening its effect, from 0.195 to 0.263. The solution of covariate measurement error makes the situation slightly worse at the third decimal digit (0.268).

It is however notable from the bias and its variance (last column block) that there is no suggestion of those who are healthier systematically tend to report growing up in larger houses. Moreover the effect of number of rooms is not significantly different from zero. The focus should be on measurement error.

7. Discussion and conclusion

The problems of recall error and recall bias are present in retrospective life course studies. To an extent, discussions with subject matter specialists may be helpful in distinguishing which of the two problems (error or bias) is the most acute in each application. The effects of such recall problems can be decisive. If one believes that recall error primarily drives the result, then the effect of childhood hardship is negligible in this application (odds ratio $= \exp(0.0087) = 1.0$). If one believes that systematic bias may be present, then the effect of childhood hardship is marked and long lasting.

It is remarkable in this case that the effects of observable covariates in the main equation is the same across the three specifications. We can thus focus on the effect of childhood hardship to gauge the plausibility of recall error or recall bias. On this, the substantive literature of social epidemiology or medical sociology discussed above is helpful. Given that childhood circumstances, broadly construed to include among others financial hardship, parents' occupational status, parents' parenting skills, are consequential for adult health both directly and indirectly, I am inclined to conclude that recall bias is present. The evidence presented here points to the suppression of childhood hardship condition such that the simple (problematic) coefficient is only half of the true coefficient. The immediate question of why should the true or unbiased effect is doubled is illuminated using the literature above. We see above the repeated demonstrations that childhood hardship has contemporaneous, direct and indirect effect in life course model or pathway model (to use the phrases of Case et al. (2005)). In this specific instance, the doubling of the coefficient may simply capture the total of these various pathways. Moreover, the substantive model presented here with only age, gender, and household size is too parsimonious bordering on the simplistic. No doubt the childhood hardship effect also captures other factors that commonly included in models of self-rated health such as education or health behaviours. Nevertheless, undiluted, this model serves the message that recall problems is real and recall problems are not entirely solved by recourse to statistical solutions.

NCDS results or validation discussion. The endogeneous treatment solution performs reasonably well since this shows that there is no systematic bias. Plausibly, there is no reason to expect that those who are healthier are systematically more prone to inflate the size of the houses they grew up in. The positive effect may capture the possibility that house size is a proxy for wealth. On the association between childhood wealth or childhood economic status more broadly and adult health, the literature on health inequality tend to find a positive association. The covariate measurement error solution performs with face validity but there is clearly a need for more indicators (not just two) to get a better grip of the true childhood measure. The cure is not visibly worse than the disease.

Lastly, based on the experience of applying these models to the data, one must always be aware that the covariate measurement model and endogeneous treatment model as solutions to recall error and recall problem are not a panacea. These modelling solutions do not constitute a substitute for prospective study. Applications of these models can break down when there are too much noise in the data, for instance because of the long lapsed duration or because of the coarse categories used. Combined with small sample size, such situation cannot guarantee the success of modelling solution. This serves only to emphasise the importance of both good prospective design and principled application of models. It is in this spirit that these models as solutions to recall error and recall bias are offered.

Reference

Berney, L. R., Blane, D. B., 1997. Collecting retrospective data: Accuracy of recall after 50 years judged against historical records. Social Science & Medicine 45 (10), 1519–1525.

Case, A., Fertig, A., Paxson, C., 2005. The lasting impact of childhood health and circumstance. Journal of Health Economics 24 (2), 365–389.

Conger, R. D., Conger, K. J., Elder, Jr., G. H., 1997. Family economic hardship and adolescent adjustment: Mediating and moderating processes. In: Duncan and Brooks-Gunn (1997), pp. 288–310.

Davey Smith, G., Lynch, J., 2004. Life course approaches to socioeconomic differentials in health. In: Kuh and Ben-Shlomo (2004), pp. 77–115.

Duncan, G. J., Brooks-Gunn, J. (Eds.), 1997. Consequences of Growing Up Poor. Russell Sage Foundation, New York.

Feinstein, L., Sabates, R., Anderson, T. M., Sorhaindo, A., Hammond, C., 2006. What are the effects of education on health? In: Measuring the Effects of Education on Health and Civic Engagement. OECD, Paris, pp. 171–354.

Glewwe, P., Jacoby, H. G., King, E. M., 2001. Early childhood nutrition and academic achievement: a longitudinal analysis. Journal of Public economics 81 (3), 345–368.

Holland, P., Berney, L., Blane, D., Davey Smith, G., Gunnell, D. J., Montgomery, S. M., 2000. Life course accumulation of disadvantage: childhood health and hazard exposure during adulthood. Social Science & Medicine 50 (9), 1285–1295.

Kuh, D., Ben-Shlomo, Y. (Eds.), 2004. A Life Course Approach to Chronic Disease Epidemiology, 2nd Edition. Life Course Approach to Adult Health. Oxford University Press, Oxford.

Kuh, D., Power, C., Blane, D., Bartley, M., 2004. Socioeconomic pathways between childhood and adult health. In: Kuh and Ben-Shlomo (2004), pp. 371–395.

Marmot, M., Wilkinson, R. G. (Eds.), 2006. Social Determinants of Health, 2nd Edition. Oxford University Press, Oxford.

McLanahan, S. S., 1997. Parent absence or poverty: Which matters more? In: Duncan and Brooks-Gunn (1997), pp. 35–48.

Rabe-Hesketh, S., Yang, S., Pickles, A., 2001. Multilevel models for censored and latent responses. Statistical Methods in Medical Research 10 (6), 409–427.

Ryff, C. D., Singer, B. H. (Eds.), 2001. Emotion, Social Relationshps, and Health. Oxford University Press, Oxford.

Ryff, C. D., Singer, B. H., Wing, E., Love, G. D., 2001. Elective affinities and uninvited agonies: Mapping emotion with significant others onto health. In: Ryff and Singer (2001), pp. 133–175.

Schoon, I., 2006. Risk and Resilience: Adaptations in Changing Times. Cambridge University Press, Cambridge.

Skrondal, A., Rabe-hesketh, S., 2004. Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models. Chapman & hall/CRC, London.

Szanton, S. L., Thorpe, R. J., Whitfield, K., 2010. Life-course financial strain and health in african-americans. Social Science & Medicine 71 (2), 259–265.