The Contribution of Childhood Adversity to the Socioeconomic Gradient in Mortality in a Swedish Birth Cohort

Josephine Jackisch
Centre for Health Equity Studies, Stockholm University/ Karolinska Institute, Sweden, josephine.jackisch@su.se

Alyson van Raalte
Max Planck Institute for Demographic Research, Rostock, Germany, vanraalte@demogr.mpg.de

Abstract (211 words)

Background
“Child maltreatment is a leading cause of health inequality“ according to the WHO. This statement is often assumed, yet, the size of the contribution of childhood adversity to the socioeconomic gradient in mortality remains unknown. Inequalities in mortality have mostly been investigated by taking adult conditions as a starting point. The objective of this study is to quantify how much of the socioeconomic gradient in adult life expectancy is associated with childhood adversity.

Methods
Using the 1953 Stockholm Birth Cohort (n=14,210), we compared inequalities in adult mortality within the full cohort to a counterfactual scenario where individuals with a history of childhood adversity (child welfare involvement) experienced the mortality rates of those achieving the same adult socioeconomic position, but with no history of childhood adversity. The socioeconomic gradient is measured by the slope index of inequality of temporary life expectancy (ages 30-68) across income quintiles and education groups.

Results
The counterfactual scenario attenuated the income gradient by 48 percent for men and 44 percent for women. Similarly, inequalities by attained education were reduced in the counterfactual scenario by 40 percent for men and 54 percent for women.

Conclusion
These results contribute to our understanding of the extent to which childhood adversity plays a role in the etiology of social inequalities in mortality.
Introduction

Life expectancy is shortest in the lowest socioeconomic group and with each step up the social ladder some life expectancy is gained. This socioeconomic gradient constitutes a major health inequality (1). Such inequalities persist over time and across countries, in spite of a surge in health inequality research and political momentum to address health inequalities (2). New entry points for policy are needed if countries are to reduce inequalities in mortality.

To date, most studies have taken adult socioeconomic conditions as a starting point and compared individual behaviors and contextual factors to explain mortality gradients (3,4). Life course researchers have been critical of this approach. Childhood circumstances set people up on socioeconomic and health trajectories (5–7).

Among childhood circumstances, the experience of adversity is thought to be a particularly important determinant of inequality (8). The WHO Regional Office for Europe even advanced that “child maltreatment is a leading cause of health inequality” (9). Experiences of adversity in childhood are socially patterned with individuals growing up in socioeconomically disadvantaged families at greater risks of experiencing childhood adversities (10). Research has also documented negative effects of adverse social experiences on physiological markers (11,12) affecting health (13) and mortality (14) in human observational studies, and also in experimental studies of other mammals (15). The biological response might differ by socioeconomic position (16) and occur as a direct effect of adversity or indirectly, e.g. via health behaviors and socioeconomic factors in adulthood (17).

Yet to date no study has directly estimated the contribution of experiences of childhood adversity to inequality in mortality, despite the compelling evidence that is an important determinant. This is likely due to a shortage of prospective data on childhood adversity and key methodological limitations in retrospective studies (e.g. recall bias) (18,19). Instead, attempts to integrate childhood factors into studies of mortality gradients have been mostly limited to investigating childhood socioeconomic circumstances (20–22).

In the absence of representative prospectively measured data on experiences of childhood adversities with a long enough follow up, administrative child welfare registrations can be leveraged as a proxy (23). Child welfare agencies investigate reports of suspected neglect or harm to a child and in some cases, place children in out-of-home care either in institutions or foster families. Those children have consistently been shown to achieve lower socioeconomic status (24), and experience increased morbidity (25) and premature mortality (26,27).

Based on the population of people born in 1953 and living at the age of 10 in the greater Stockholm municipal area, this study aims to estimate the contribution of childhood adversity to the educational and income gradients in survival between the ages of 30 and 68.
Methods

Study population

We used individual level data from the Stockholm Birth Cohort Multigenerational Study (SBC Multigen). The SBC Multigen was created in 2018/2019 through a probability matching between two anonymous data sources: a 1953 birth cohort of the Stockholm Metropolitan Study, and a compilation of linked national registers (RELINK53). The former is defined as all individuals who were born in 1953 and living in the Stockholm area (city core and periurban peripheries) in 1963 (n=15,117). A total of 14,608 individuals could be positively matched between RELINK53 and the original Stockholm Metropolitan cohort (28).

Individuals were followed from birth until emigration, death or the end of their 67th year of age. We excluded those who died before the start of follow-up in 1983 (age 30), resulting in an analytical sample of 14,210 in the main analysis.

Measurements

Childhood adversity was proxied by administrative data about involvement with child welfare services as registered in childhood in local social registers in larger Stockholm area municipalities.

Socioeconomic status was measured by education and income attained by age 30. We grouped individuals into income quintiles, based on the maximum yearly individual income received in any of the five years between 1978-1982 (ages 25-29). Maximum yearly income for the years 1978-1982 was based on the assessed income by the Swedish National Tax Board (in thousands of SEK). Educational attainment was measured through triangulating information from the different School boards and mark registers and the highest attained educational level registered up to 1983 with Statistics Sweden. We distinguish (1) Basic education for those without a recorded upper secondary degree, (2) Upper-secondary education for those who have completed secondary education and or a basic degree from a programme shorter than 3-years, and finally (3) University education for those who completed a degree of at least 3-years of studies.

Statistical analysis

We calculated Kaplan-Meier survival curves for each sex and income quintile or education group based on observed deaths and censored observations from 1983 to the end of 2020. These curves were estimated for the entire population as well as for the restricted population who had never experienced childhood adversity within each education and income grouping. We show plots for the gap between highest and lowest income and education group.

Cohort temporary life expectancy (hereafter TLE) was calculated for each subgroup as the integral of the survival curve between starting age 30 to the end of age 67. Thus, the maximum TLE would be 38 years, if everyone from the cohort survived to their 68th birthday. TLE is also called partial
life expectancy and restricted mean survival time in epidemiological circles (Royston & Parmar, 2013).

Mortality inequality was operationalized as the absolute income gap in cohort TLE between ages 30 and 68. Specifically we calculated the slope index of inequality in TLE by fitting a linear model to the TLE gradient. When groups are lined up in a bar plot from the lowest to highest income quintiles/education groups, with the width of the bar representing the subgroup proportion of the cohort at age 30, the slope of the regression line fit through the middle point of each bar is the slope index of inequality (SII), this accounts for differences in distributions across socioeconomic strata (29).

We measured the contribution of childhood adversity to the income gradient in TLE by the percentage of attenuation in the SII in the absence of childhood adversity. This was estimated by recalculating the SII under a counterfactual scenario where individuals who experienced childhood adversity were assigned the same survival as the rest of the cohort within the same sex-income-grouping. All analyses are stratified by sex (men, women) referring to the biological sex assigned at birth.

Robustness checks

In order to estimate potential bias introduced through conditioning on survival until age 30, a sensitivity analysis was conducted extending the follow-up period to mortality between age 19-67. Income indicators for those who died were imputed proportional to the distribution of income quintiles in the corresponding child welfare group.

Results

Descriptive statistics of the Stockholm 1953 cohort are given in Table 1. The 14,210 individuals of our sample contributed 5,137,723 person-years at risk and consisted of 7261 men, and 6949 women. A substantial 20.7 % of the cohort experienced contact with child welfare services at some point during their childhood (26.7 % of men and 14.6 % of women). Substantiated child welfare contact, resulting in out-of-home care placements, was experienced by 9.6 % of men and 8.5 % of women of the cohort.

Overall men have higher individual income than women and are more highly concentrated in the upper quintiles compared to women. Individuals who experienced contact with child welfare services or out-of-home care could be found in all income quintiles but were also more highly concentrated in the lower quintiles compared to the general population.
Table 1. Sample description

<table>
<thead>
<tr>
<th>Men</th>
<th>No child welfare</th>
<th>Child welfare contact without out-of-home care</th>
<th>Out-of-home care</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (Person years)</td>
<td>n (Person years)</td>
<td>n (Person years)</td>
<td>n (Person years)</td>
</tr>
<tr>
<td>Total</td>
<td>5 326 (193 259)</td>
<td>1 236 (43 606)</td>
<td>699 (23 575)</td>
<td>7 261 (260 441)</td>
</tr>
<tr>
<td>by income quintile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 low</td>
<td>494 (17 137)</td>
<td>137 (4 454)</td>
<td>161 (4 881)</td>
<td>792 (26 472)</td>
</tr>
<tr>
<td>2</td>
<td>661 (23 749)</td>
<td>246 (8 384)</td>
<td>140 (4 576)</td>
<td>1 047 (36 708)</td>
</tr>
<tr>
<td>3</td>
<td>1 077 (39 238)</td>
<td>299 (10 745)</td>
<td>155 (5 477)</td>
<td>1 531 (55 460)</td>
</tr>
<tr>
<td>4</td>
<td>1 242 (45 359)</td>
<td>323 (11 627)</td>
<td>127 (4 516)</td>
<td>1 692 (61 503)</td>
</tr>
<tr>
<td>5 high</td>
<td>1 852 (67 776)</td>
<td>231 (8 396)</td>
<td>116 (4 125)</td>
<td>2 199 (80 297)</td>
</tr>
</tbody>
</table>

By education

<table>
<thead>
<tr>
<th>Women</th>
<th>n (Person years)</th>
<th>n (Person years)</th>
<th>n (Person years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (Person years)</td>
<td>n (Person years)</td>
<td>n (Person years)</td>
</tr>
<tr>
<td>Total</td>
<td>5 936 (217 188)</td>
<td>425 (15 238)</td>
<td>588 (20 855)</td>
</tr>
<tr>
<td>by income quintile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 low</td>
<td>1 495 (53 497)</td>
<td>148 (5 126)</td>
<td>215 (7 359)</td>
</tr>
<tr>
<td>2</td>
<td>1 558 (57 708)</td>
<td>97 (3 528)</td>
<td>180 (6 516)</td>
</tr>
<tr>
<td>3</td>
<td>1 351 (49 596)</td>
<td>95 (3 446)</td>
<td>120 (4 370)</td>
</tr>
<tr>
<td>4</td>
<td>929 (34 344)</td>
<td>60 (2 219)</td>
<td>45 (1 569)</td>
</tr>
<tr>
<td>5 high</td>
<td>603 (22 043)</td>
<td>25 (9 19)</td>
<td>28 (1 042)</td>
</tr>
<tr>
<td>by education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 basic</td>
<td>1 949 (71 469)</td>
<td>270 (9 677)</td>
<td>384 (13 502)</td>
</tr>
<tr>
<td>2</td>
<td>3 325 (121 473)</td>
<td>139 (4 999)</td>
<td>184 (6 630)</td>
</tr>
<tr>
<td>3 univ.</td>
<td>662 (24 246)</td>
<td>16 (5 63)</td>
<td>20 (7 24)</td>
</tr>
</tbody>
</table>
Of the full sample 1,657 people died before reaching age 68. In Figure 1, we compared the Kaplan-Meier survival curves of the highest and lowest income quintiles. Among the full sample (left column), there were strong differences between the two groups, particularly among men: More than 90 percent of men from the highest income quintile survived from age 30 to age 68, compared to around 75 percent of the lowest income. When the sample was reduced to those individuals who did not experience any form of child welfare contact (right column), the confidence intervals of the survival curves of the highest and lowest income quintiles were overlapping for women, and differences between income groups were highly attenuated among men compared to the full sample. This was driven by increased survival among the lower income group in the sample with no child welfare contact compared to their survival within the full sample.

Figure 1. Description of the mortality gap between lowest and highest income quintile: comparing the full population and the reduced sample of only those who have not been involved with child welfare services by sex.

In Figure 2, we replicate this analysis for educational groups. In the university educated group over 93 percent of both men and women survived between ages 30 and 68, in contrast to only 75 percent of men and 88 percent of women in the lowest educational group (left column). Excluding
individuals who have been in contact with child welfare services (right column), the two curves were overlapping in women and survival increased among the low educated men.

Figure 2. Description of the mortality gap between basic education (lowest) and university education (highest): comparing the full population and the reduced sample of only those who have not been involved with child welfare services by sex.

Figure 3 shows the gradient in TLE between ages 30 and 68 by income quintile. Among men the SII in TLE was 3.3 years among the actual population and 1.7 years assuming the counterfactual scenario where those with child welfare exposure were given the mortality rates of those with no child welfare exposure matched by sex and income quintile. This amounted to a 48% reduction in the TLE gap. Among women, the SII in TLE was 0.7 years for the actual population and 0.4 years in the counterfactual scenario, which resulted in a similar reduction in the TLE gap in relative terms (43%).
Figure 3: The step-function of increasing cohort TLE by income quintile. In yellow are the estimates for the full population, and in red the estimates of the counterfactual where those with contact to child welfare were given the same age-specific survival chances as those of the same sex and income quintile.

Figure 4 shows the gradient in cohort temporary life expectancy between ages 30 and 68 by education group. In the full sample the SII in TLE was 2.9 for men and 0.7 years for women among the actual population and 1.7 (men) and 0.4 years (women) when those with child welfare exposure were given the survival risks of those with no child welfare exposure within the same sex and education strata. Assuming the counterfactual scenario amounted to a decrease of 41% of the SII for men and a decrease of 50% of educational inequality in mortality for women.
Figure 4: The step-function of increasing cohort TLE by education group from basic, upper-secondary to tertiary education (steps from left to right) weighted by proportion of the population in this group. In yellow is the TLE gradient for the full population, and in red the estimates of the counterfactual scenario where those with contact to child welfare were given the same age-specific survival chances as those of the same sex and income quintile.

Discussion

Roughly half of the socioeconomic gradient in TLE could be attributed to the excess mortality associated with childhood adversity, in this population-based cohort of over 14,000 individuals with 48 years of follow-up. Individuals with child welfare involvement are more concentrated in the lower SES groups. They also have substantially higher mortality rates throughout adulthood. Thus, a small share of the population (here 20%) contributes 41-50% of the socioeconomic inequalities in adult mortality. This is important as it shows that the generative process leading to socioeconomic gradient in premature mortality starts long before socioeconomic positions (SEP) are attained and might point to preventable factors. These findings illustrate that inequalities in mortality can be predicted with data routinely collected in childhood.
To our knowledge, this is the first study to directly estimate the contribution of childhood adversity to socioeconomic inequalities in mortality in a prospective cohort. However, these findings represent one cohort in one specific setting and it is unclear how generalisable these findings are. It will take decades before comparable data are available from other long-running cohorts, population registers or panel surveys.

Yet, there are reasons to believe that childhood adversity contributes substantially to the socioeconomic gradient in mortality in other contexts. In the most comparable study to date, childhood adversity mediates 41-46% of the excess mortality experienced over ages 16 to 38 by those in households with lower parental education in Denmark (30). Despite a different operationalisation of childhood adversity, using parental rather than own SEP, and a much shorter follow-up period, they find remarkably similar estimates to our own. Turning from mortality to other health outcomes, in the UK, up to 64% of social inequalities in adolescent mental health were mediated through early childhood factors (31,32).

Although childhood adversity has not been studied as a contributing factor to inequalities in adult mortality, the evidence of childhood SEP found father’s occupational status to contribute to socioeconomic gradients in health but to be less important than other behavioural risk factors (21). The reduction in inequalities in mortality in this study seems large compared to other behavioral risk factors contributing to inequalities. Most adult behavioral factors, like unhealthy diet, alcohol and smoking, have a 29-36% median contribution to inequalities in mortality in Nordic countries (33).

Our results were mainly driven by the lowest SEP group. It has long been known that disadvantaged SEP groups experience far more heterogeneous ages at death compared to advantaged groups, in addition to their shorter life expectancy (34), and that this within-group heterogeneity is growing over time due to persistently high premature adult mortality (35–37). Our results contribute to this finding, by showing that much of the heterogeneity has its roots in troubled childhoods. Among women, TLE was higher and the inequalities were smaller than in men. Nevertheless, the relative reductions in the gradient were similar to those in men.

Our study has a number of strengths. Our data source is unique in the sense that it provides administrative child welfare data from local social records before these have been centrally registered in the national registers. This allows for longer follow-up than other register-based studies. We also minimize survivorship bias and overcome recall bias by using administrative child welfare records as a prospective data source for childhood adversity. Administrative data provides population-based estimates, which are minimally affected by sampling and selection bias and attrition during follow-up. We also measured the exposure, mediator, and outcome events with respect to temporal order. Studying the contribution to education and income gradients separately allow us to reflect on education and income as separate dimensions of socioeconomic gradients, but our findings are remarkably consistent across these measures.
We studied the potential contribution of survivorship bias (sample selection through selective mortality) in a robustness check extending the observation window to TLE between 20-68. Results showed a larger reduction of the gradient in TLE when including these younger deaths, indicating that our findings are conservative. Survivorship bias may lead us to underestimate the contribution of childhood adversity to income inequalities in particular.

We consider a number of limitations. Despite the advantages of using child welfare registers, some measurement error might come from missing cases of childhood adversity that were sent outside the Stockholm region. Moreover, childhood adversity is a broader concept than our operationalization as registrations with child welfare services. We use this term, as we believe that child welfare contact can be used as a marker of adverse childhood experiences, such as parental mental illness, alcohol and substance abuse and potentially violence. Child welfare records are not exhaustive and likely miss certain less visible types of childhood adversity (38). The fact that children and families got reported to services, however, might be indicative of either a combination of a number of factors or a particularly toxic environment - e.g. family domestic violence or neglect. Previous studies have shown that adding additional indicators of childhood adversity – beyond child welfare registrations – does not add explanatory power (39,40).

An additional concern is that reporting to child welfare services might be selective on childhood SEP and other demographic factors in the family. Our analysis here is of rather descriptive nature and did not lend itself to further adjustments to potential confounding factors. We do not suggest that eliminating childhood adversity would cause the socioeconomic gradient in mortality to decline to the levels we found. While this data material is unique in the possibility of prospective follow-up of mortality until age 68, we can only calculate partial life expectancies and cannot extrapolate on inequalities in old age.

Implications for policy, public health and research

The lack of progress in reducing health inequalities in high income countries has led some to argue that new approaches or narratives are needed to better understand and advocate for addressing health inequalities (41,42). Tackling childhood adversity is one such approach. The experience of childhood adversity impacts physiology and child development with potential life-long consequences for social and health trajectories. Our findings lend credence to the claim that the generative process leading to socioeconomic gradients in mortality starts long before socioeconomic positions (SEP) are attained.

Those with child welfare experiences were overrepresented in lower SEP in this study. This is in line with previous research that consistently shows that children involved with the care system more frequently struggle across different areas of life including housing, education, employment, wages, substance abuse and criminality (Gypen et al., 2017). However, this study cannot
distinguish why those with troubled childhoods end up in lower SEP. Individuals who experienced contact with child welfare might be sorted into low SEP because of: (a) underlying experience of adversity - i.e. the cause of the contact from the child welfare contact itself, (b) the trauma of child welfare experience, and (c) selection mechanisms on other family and individual characteristics which make these individuals more likely to have experienced both child welfare contact and attain low levels of SEP. Other mechanisms that remain to be explored are health, social integration, and behavioural factors.

The findings do not negate that attaining social capital is not an important, potentially causal, mechanism to reduce mortality risk. With this same cohort, Almquist et al. showed that individuals who experienced out-of-home care and performed above-average in high school did not differ in their risk of premature mortality to the population that did not experience out-of-home care (43). However, this study helps to shed light on childhood adversity as a policy entry point for reductions of inequalities in life expectancy.

Acknowledgements

We thank the International Max Planck Research School for Population, Health and Data Science for supporting this collaborative research. We are grateful to participants of the PHDS Annual Academy and the PHDS workshop on the Life Course for their constructive feedback. We would also like to thank Anders for help with preparing the Swedish data, and Ylva, Viviane, Lauren, and Angelo for their helpful suggestions. AvR acknowledges funding from the European Research Council, Grant # 716323. The Stockholm Birth Cohort Multigenerational Study (SBCMultigen) was supported by the Swedish Research Council for Health, Working Life and Welfare (Forte), (grant 2016–07148).

References


Appendix figures

Cohort longevity by income quintile
Stockholm cohort of 1953

Cohort longevity by education
Stockholm cohort of 1953
Figure A1 and A2: The same plot as figure 2 and 3, but additionally showing the SII among only those in the population with no child welfare exposure (blue line). The difference between the blue and red lines is the reweighting of the income quintile group sizes after removing individuals with child welfare exposure from the population. Since those with child welfare exposure are concentrated among the lower quintiles, this has the effect of making the first two quintiles proportionally smaller, and the wealthiest two quintiles larger. However the overall impact on the SII is small.