Exposure to Neighborhood Income Inequality in Childhood and Later-Life Mortality, Sweden 1939-2015

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Abstract

The degree of inequality in a society may be harmful to individual health, regardless of where someone is located in the income ladder. An underlying assumption in the literature is that there is an instant link between income inequality and individual health and most studies consider a contemporary correlation, assessing inequality and health just about the same point in time. Moreover, research is limited regarding the long-term consequences of exposure to income inequality and inequality is often measured at coarse geographical levels, although potential mechanisms mediate a relationship may be very local. We use geocoded longitudinal microdata for the city of Landskrona, 1947-1967, linked to Swedish national registers, 1968-2015, to analyze how exposure to economic inequality in childhood neighborhoods influence mortality in adulthood. For the period 1947-1967, the whole population of Landskrona is geocoded at the address-level, and we observe their full residential histories within the city. Here, we measure continuous individual neighborhood conditions, using on the k-nearest neighbors approach, for the children (ages 1-17) in the town. We focus on the Gini-index, and average income in the childhood neighborhood. We follow up exposed children nationwide at age 40 (1968-2015) and use Cox proportional hazards models to analyze the effect of neighborhood income and Gini-index on adult mortality from age 40 to 69. We control for childhood family income, socio-spatial neighborhood characteristics, and social class in adulthood.

The preliminary results indicate that economic inequalities within the childhood neighborhoods were important for adult mortality of men, but not for women. Men who grew up in neighborhoods with low inequality experienced a relatively lower mortality risk in adulthood compared to men growing up in high inequality neighborhoods, even when adjusting for both childhood family income, neighborhood income, and adult class. The main contribution of this study is the analysis of exposure to neighborhood inequality in childhood, at the micro-level, and the implications over the life-course.

Introduction

A large multidisciplinary strand of research examines the relationship between contextual income differences and various health outcomes, addressing the question whether we fall sick of inequality (Gerdtham & Johannesson 2004; Jen et al. 2009; Karlsson et al 2010; Grönqvist et al 2012; Zagoriski et al 2014; Du et al 2019). The income inequality hypothesis states that the degree of inequality in a society is harmful to everyone's health, regardless of where someone is located in the income ladder. Bergh et al. (2016) present an extensive summary of the literature using individual level data to test the inequality hypothesis and conclude that the evidence is mixed, with some considerable variation across studies, further supported by recent meta-analyses focusing on specific health conditions (Ngamaba et al 2018; Silva Ribeiro 2018).1

An underlying assumption in the literature is that there is an instant link between income inequality and individual health. There is limited work on income inequality and the life course, and a clear majority of studies consider a contemporary correlation, assessing inequality and individual health just about the same point in time. A few studies explore lagged effects of income inequality, suggesting that the association up to 15 years earlier is stronger than the relationship between contemporary inequality and individual health (Blakely et al. 2000; Kondo et al. 2012; Zheng 2012; Bergh et al 2016). If the health consequences of income inequality do not manifest until after a certain amount of time, or if the long-term effects of income inequality on individual health are stronger if exposure takes place in some periods or life stages that are more sensitive than others, a potential explanation to the mixed evidence in the literature could be that inequality is not measured at a stage when it really matters. While there is no clear-cut theoretical prediction to when in life (at what age) exposure to inequality would matter the most to long-term health, there are arguments to why inequality during childhood could be of relevance. First, the early years of life are critical for human development, health, and mortality in adulthood. This is an important period for infants but also for children, and there is extensive empirical evidence confirming the importance of life conditions in childhood (see e.g., Bhalotra et al 2022; Lundborg et al 2020; Almond and Currie 2019). Second, the health impact of exposure to inequality may take time to develop. If this is the case, studies examining inequality and health at the same time will underestimate the long-term association.

A second pattern in the literature is that most studies use measures on income inequality that are aggregated at coarse geographical levels, such as at the country, state, or regional level. Some studies highlight the role of the geographical level (and what level of aggregation regarding inequality is relevant when we want to evaluate health effects), looking into the relationship between inequality and health in US metropolitan areas and counties, respectively. For example, Blakely et al. (2002) find a null relationship between income inequality across metropolitan areas and self-assessed health, whereas Chen and Crawford (2012), focusing on state and county inequality and various self-reported health measures (including insurance status, influenza vaccination and self-assessed health), find some evidence in line with the income inequality hypothesis. Rostila et al (2012) examining the role of inequality to self-reported health in the urban capital area of Stockholm is one of few studies focusing on the role of very local, or micro-level, inequality to individual health and longevity. The inequality-health nexus suggests several potential mechanisms which may mediate a relationship also when examining exposure at the very local level, including stressful effects following social comparisons, the role of trust and fear and stress related to crime.

[1] There is strong evidence in support of the income inequality hypothesis in studies using focusing on population health, i.e., aggregate data. As discussed by e.g., Gravelle (1998) and Bergh et al. (2016) this type of studies are all at risk of ecological fallacy. A negative relationship between income inequality and longevity at the population level may simply follow from that the relationship between income and health at the individual level is positive but nonlinear (concave). As discussed by Wagstaff and van Doorslaer (2004), the noted aggregate relationship between inequality and population health de facto align with several hypotheses, including a positive non-linear relationship between absolute income and individual health (the absolute income hypothesis), a negative relationship between average contextual incomes and individual health, conditional on controlling for individual incomes (the relative income hypothesis) and a negative relationship between income inequality and individual health (the income inequality hypothesis).

Neglection of the role of on the one hand income disparities in early years to later life health outcomes and the role of local inequality to such relationship on the other, is largely driven by the scarcity of appropriate data. To investigate such effects, we need to know the age (and duration) of individuals' exposure to income inequality together with later life information on health or mortality, which requires detailed individual residential histories. It also requires geocoded information and income from historical times.

The aim of this paper is to examine the relationship between on the one hand family income, neighborhood average income, and neighborhood inequality, and individual health on the other to test the hypothesis that inequalities during childhood predicts later-life mortality. For these purposes we use individual level longitudinal data from 1947-1967 geocoded at the address level for individuals residing in the city of Landskrona, situated in the very south of Sweden.

The rich individual-level longitudinal information on income and demographic outcomes, including death, geocoded at the address level (see Hedefalk and Dribe, 2020), gives a unique opportunity to examine the relationship between childhood local inequality and later-life mortality. The setting is also an interesting case as it allows us to study the relationship during a period when overall inequality changes much (the Gini coefficient first decreased from 0.48 to 0.32, and the increased to 0.38 between 1935 to 1965: (Debiasi et al., 2021)). So, although Sweden is a relatively egalitarian country, we expect the variation in average income and inequality, respectively, across local neighborhoods to be sufficient. Moreover, the setting is interesting as our study covers the period when the income gradient in mortality in Sweden seem to have first emerged (Bengtsson and Dribe 2011; Debiasi et al 2021).

Data and sample

Our study area is Landskrona, a typical middle-sized town in the west-coast of southern Sweden. During the study period (1947-1967), the town relied much on shipbuilding, but also on industries related to textiles and manufacturing. The population grew rapidly during the study period, from approximately 20 000 in 1940 to 30 000 in 1970.

We use two types of data sources for our empirical analyses. First, we measure continuous neighborhood conditions at the address-level for those that were children (ages 1-17) in Landskrona from 1947 to 1967. We derive childhood variables using the Scanian Economic-Demographic Database (SEDD), which contains rich individual-level longitudinal data on income, occupation, family conditions, migration, birth, and marriages for the population in Landskrona during the period (Bengtsson et al. 2021). For the same period, the entire population of the town has been geocoded at the address level (Hedefalk and Dribe 2020). In this geocoding, we follow every residential move within the city. Therefore, we have both detailed and continuous information of everyone's place of residence. In addition, we have geographical information on buildings, streets, schools, and industries for the study period.

Second, we follow up these children nationwide at age 40 for the period 1968-2015. Here, the population in SEDD are linked to Swedish national administrative register data. For this study, we use individual data on occupation, marriage, and cause-specific mortality from Statistics Sweden (SCB) and the National Board of Health and Welfare.

Our total sample consists of 8618 men (deaths = 1058) and 8218 women (deaths = 685), born between 1930 and 1966. When selecting the sample, those that were children (aged 1-17) in

Landskrona had to have their residential location geocoded and observed on at least one time on May 31 or November 30, or both, between 1947 and 1967 (about 96%). In addition, all individuals who died or migrated from Sweden before 1968 or at age 40, or who were not possible to link to the register data for other reasons, were excluded from the sample. The total sample consists of about 82% of all individuals that were children in Landskrona from 1947 to 1967.

Methods

Our overall approach is to focus on two childhood neighborhood variables: the nearest neighbors' average income and the corresponding Gini-index. We use Cox proportional hazards models, which accounts for any right censoring, to analyze the effect of these neighborhood variables on adult mortality from age 40 to 69. We control for family income in childhood and other childhood conditions, some of the socio-spatial properties of the childhood neighborhoods (building density, population density, school districts, and type of building), and adult occupation and marital status.

To compute the neighborhood variables, we use the total annual family income, derived as the equivalized family income (OECD 2011). We estimate individual neighborhoods, in which each individual at the address-level is the center of their own neighborhood, surrounded by their k-nearest neighbors. For all neighborhood variables, we construct matrices two times per year (May 31 and November 30), from 1947 to 1967, that contain the Euclidean distances between each child and all other individuals in the town.

For the neighborhood income, we measure the average family income of the nearest 25 children of the same (±1 year) age. We do this selection following a previous study suggesting that the SES of nearby peers rather than adult neighbors in childhood affected adult mortality (Hedefalk et al. 2022). When computing the neighborhood Gini-index, we instead measure the family income of the nearest neighbors aged 20-64, using a range of k varying from 50 (50) to 1000 (i.e., we create neighborhoods at every 50 nearest neighbors until k = 1000). Here, we consider the inequality in the neighborhood to operate on a larger and more contextual scale. For both the neighborhood income and neighborhood Gini-index, we normalize the measure for each time point to account for changing income and inequality during the observation period. Thereafter we take the average value for each individual throughout the period and classify them into quartiles. For example, a neighborhood Gini-index variable in the lowest quartile at k = 250 means that an individual on average have had a low inequality among his/her 250 nearest neighbors in childhood.

In addition to neighborhood income and Gini-index, we control for the following variables.

- Family income (1939-1967): highest observed income in childhood and classified into quartiles (for the specific year).
- Childhood controls (1939-1967)
    - Place of birth: binary variable indicating whether the child was born in Landskrona.
    - Household size: average household size in childhood.
    - Birth year.
- Childhood socio-spatial neighborhood controls (1939-1967)
    - Building density: The average percentage of built area, throughout childhood, within a radius of 100 meter from the individual (proxy for built environment / green areas).

  - Geometric neighborhood size (log): The average radius, throughout childhood, from the individual to the k-nearest neighbor residing farthest away (proxy for population density).
  - Building type: The building an individual resided most of his/her time in. Apartment or single house/town house.
  - Elementary school district: Five schools provided elementary education in Landskrona from 1939 to 1967 (see Figure 1). We assume that children went to the nearest school. We create school districts that cover their nearest geocoded address points and assign each individual to the school district they resided most of their time within.
  - Average age of the k-nearest neighbors. This variable may affect the income and inequality within the neighborhood.
- Adult controls (time-varying, 1968-2015)
  - Social class by own occupation (quinquennial information 1970-1990; annual information 2001-2015)
  - Marital status (annual information, 1968-2015).

We use Cox proportional hazards model to estimate seven models for adult mortality, and run independent models by sex. The models are as follows:

- Model 1a: Family income + childhood controls
- Model 1b: Neighborhood income (k = 25, same-aged neighbors) + childhood controls
- Model 1c: Neighborhood Gini-index (k = 250, adult neighbors) + childhood controls
- Model 2: Models 1a + 1b + 1c
- Model 3: Model 2 + Childhood socio-spatial neighborhood controls
- Model 4a: Model 3 + Adult controls

To better identify at what neighborhood scale any effects of the neighborhood Gini-index may operate on, we also estimate separate models by every 50 k of the nearest adult neighbors, ranging from 50 to 1000 (using the model 4a setting). As a sensitivity test, we measure the neighborhood income variable using the same range of nearest 50 (50) 1000 adult neighbors as for the neighborhood Gini-index (model 4b). For example, a model that includes the neighborhood Gini-index at k = 400 also includes the neighborhood income at k = 400 (both using adult as neighbors).

Preliminary results

Figure 1 displays the variables childhood neighborhood income and Gini index for all children aged 1-17 that resided in Landskrona on 1950-05-31 or 1965-05-31. Both the variables are computed using the income of each child’s 250 nearest adult neighbors, aged 20-64 (the average neighborhood radius for all children at k = 250 is 127 m). Each point in the maps shows the child’s address location, and the color scale is classified by quartiles. When multiple children reside at the same address point, the average neighborhood income or Gini index is shown.

Landskrona’s spatial segregation in terms of average income levels changed and partly increased during the study period. In 1950, many of the relatively wealthy neighborhoods were concentrated within the city center (Figure 1C). As they were mixed with relatively poor neighborhoods, it resulted in areas of high Gini-index close to the city center (Figure 1A). In 1965, many of the wealthy families seem to have moved out from the city center to the newly built areas in the outskirts of the city (Figure 1D). Some lower income families also moved to newly built apartment complexes in the middle-north end of the city. These moves resulted in a higher inequality within the city center, especially around to cultural center near Landskrona's only secondary school (Figure 1B). In contrast, as the population in the newly built areas was relatively economically homogenous, we observe low values of Gini-index in these areas. Overall, the maps illustrate rapid urban growth resulting in higher clustering of both income and inequality.

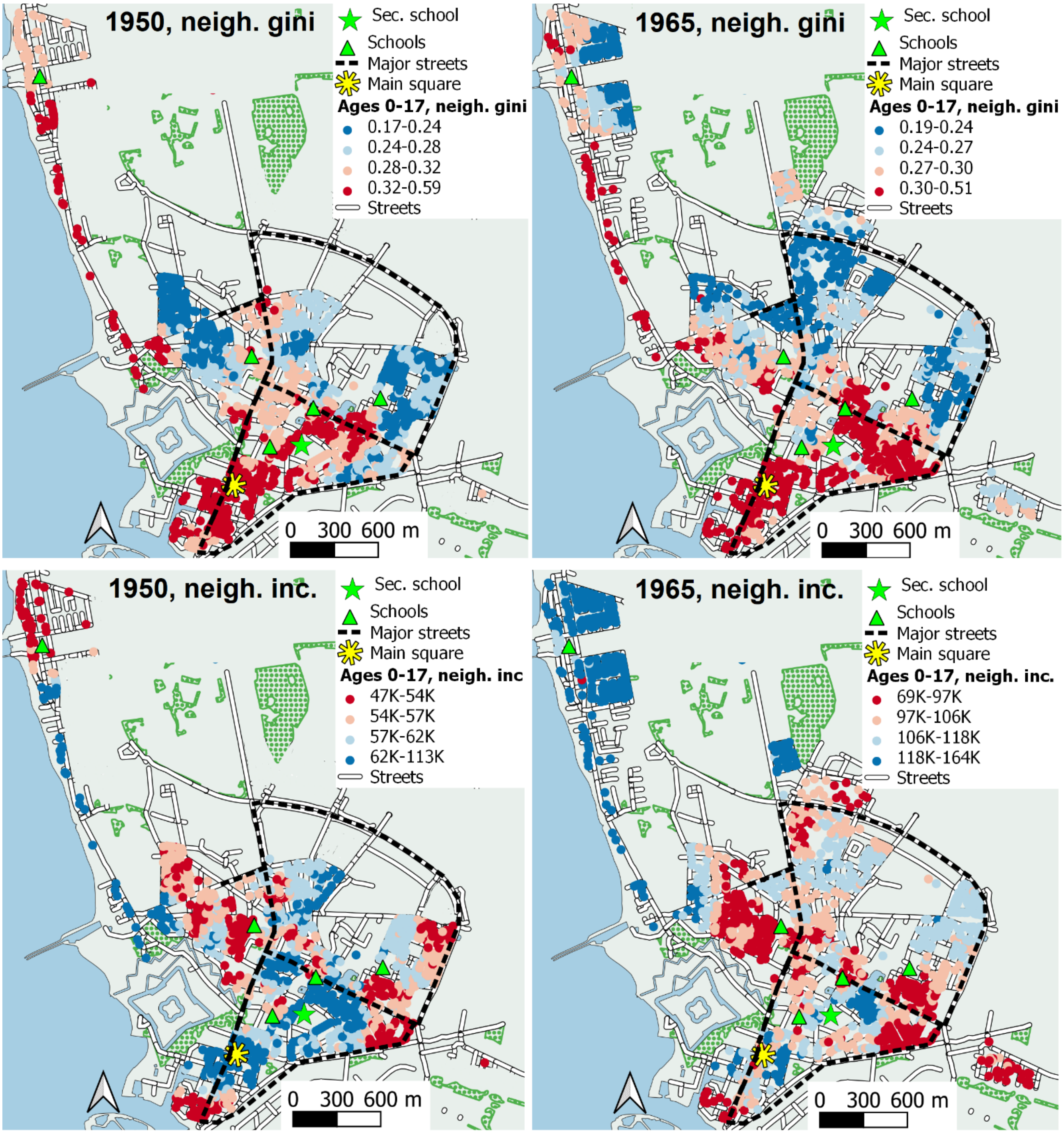

Figure 1: Maps showing quartiles of the variables neighborhood Gini index and neighborhood income in Landskrona, both at k = 250 and using adults aged 20-64 as neighbors. Each point represents the address location of at least one child aged 0-17 in 1950 or 1965 (on May 31). When more than one child resided at the same address point, the average neighborhood income or average Gini index is shown. (A) neighborhood Gini index, 1950-05-31; (B)

neighborhood Gini index, 1965-05-31; (C) yearly average neighborhood income in thousand, 1950-05-31; (D) yearly average neighborhood income in thousand, 1965-05-31.

Figure 2 shows the effect of childhood family income (2 A and B), childhood neighborhood income (2 C and D), and childhood neighborhood Gini-index (2 E and F) on adult mortality. Remember that the neighborhood income is based on the family income of the 25 nearest same-age neighbors (average radius: 155 m), whereas the Gini-index is based on the family income of the 250 nearest adult neighbors in ages 20-64 (average radius: 127 m).

The figures reveal that in these three basic models, family income, neighborhood income and neighborhood Gini-index were all important for men's mortality. Overall, men who grew up in families and neighborhoods with higher income, and in neighborhoods with lower inequality, experienced a relatively lower mortality in adulthood. For women, however, only family income seems to have affected their mortality in adulthood. For both sexes, no clear mortality gradient is observed for the quartiles of the three variables.

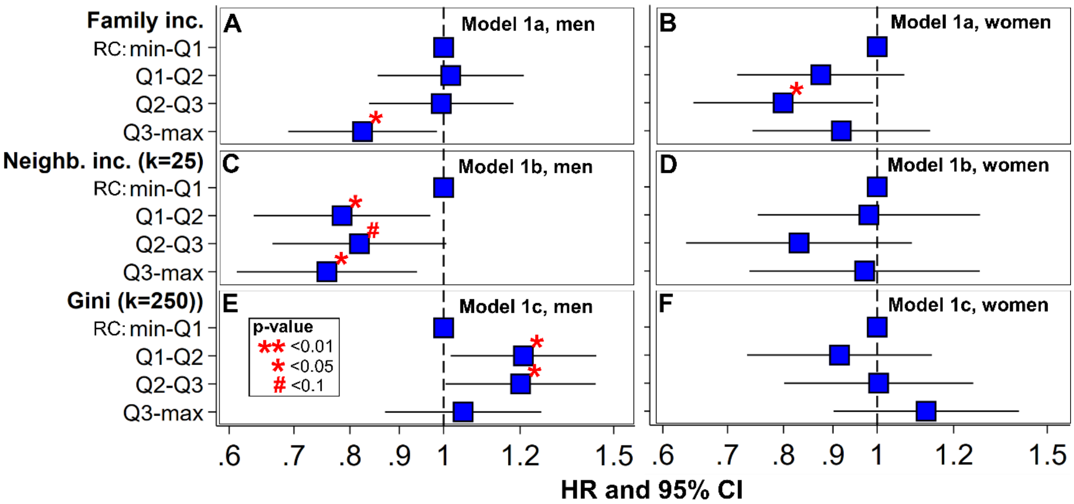

Figure 2. Impact of childhood context on all-cause mortality, ages 40-69, 1947 to 2015, basic models. Only the main variable of interest; i.e., family income, neighborhood income, or neighborhood Gini index, is shown for each model. (A) Model 1a (basic model, family income), men (B) Model 1a (basic model, family income), women; (C) Model 1b (basic model, neigh. income), men (D) Model 1a (basic model, neigh. income), women; (E) Model 1c (basic model, neigh. Gini), men (F) Model 1c (basic model, neigh. Gini), women. Men: N = 8618, deaths = 1058; women: N = 8218, deaths = 685.

Figures 3-4 show the results from the extended models (models 2 – 4a). For men, the effect of family income disappears, and the effect of neighborhood income remains but decrease, with the inclusion of more controls (3 A and B). In contrast, the effect of neighborhood Gini-index is robust across the models and increases even slightly in the final model which controls for adult social class (3 C). For women, we observe no effects from family income, neighborhood income or neighborhood Gini-index on adult mortality in the final models (4 A-C).

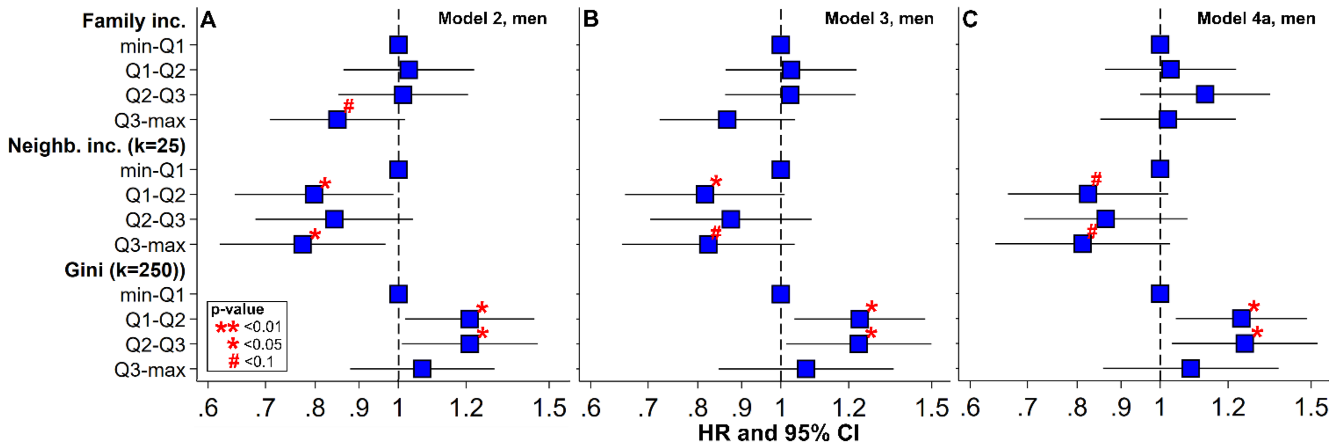

Figure 3. Impact of childhood context and control variables on all-cause mortality, ages 40-69, 1947 to 2015, models 2-4a, men. Only the variables childhood family income, neighborhood income, and neighborhood Gini index are shown. (A) Model 2; (B) Model 3 (model 2 + socio-spatial neighborhood controls); (C) Model 4a (model 3 + adult controls). N = 8618, deaths = 1058.

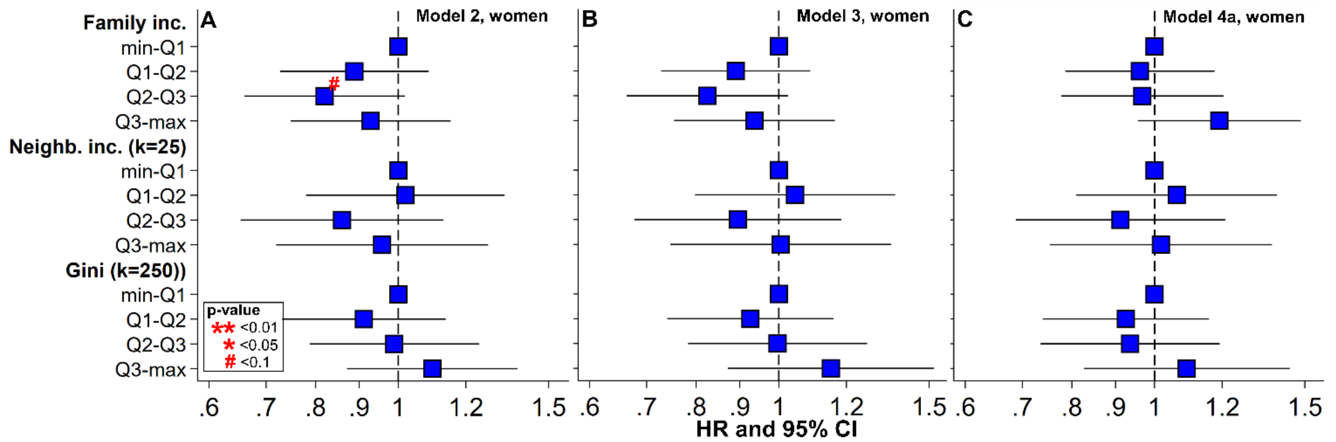

Figure 4. Impact of childhood context and control variables on all-cause mortality, ages 40-69, 1947 to 2015, models 2-4a, women. Only the variables childhood family income, neighborhood income, and neighborhood Gini index are shown. (A) Model 2; (B) Model 3 (model 2 + socio-spatial neighborhood controls); (C) Model 4a (model 3 + adult controls). N = 8218, deaths = 685.

Figures 5-6 show the results for all-cause adult mortality, for men (Figure 5) and women (Figure 6), using model 4a and 4b. The figures show only the variable neighborhood Gini-index (classified by quartiles). Separate models are estimated for each size of the neighborhood, ranging from k = 50 to k = 1000 (one model at every 50 k). Model 4a uses a static k for the control variable neighborhood income (25 nearest children of same age), whereas model 4b uses a dynamic k of adult neighbors (aged 20-64), in which the same k (50 (50) 1000) as the neighborhood Gini-index is used.

Overall, inequality in childhood neighborhoods had lasting effects on men's mortality in adulthood, in which a high inequality increases the adult mortality risk (Figure 5 A and B). For both models, we observe the strongest effects between 150 and 600 k (average neighborhood radius from 94 m to 229 m). However, growing up in the highest quartiles of neighborhood Gini-index does not significantly increase the mortality risk in adulthood.

Hence, the effect of the neighborhood Gini-index does not seem to be linear. For women, in contrast, the effect of the neighborhood Gini-index on adult mortality is less clear, although growing up in neighborhoods with the highest Gini-index seem to increase the adult mortality at the highest levels of k (Figure 6 A and B).

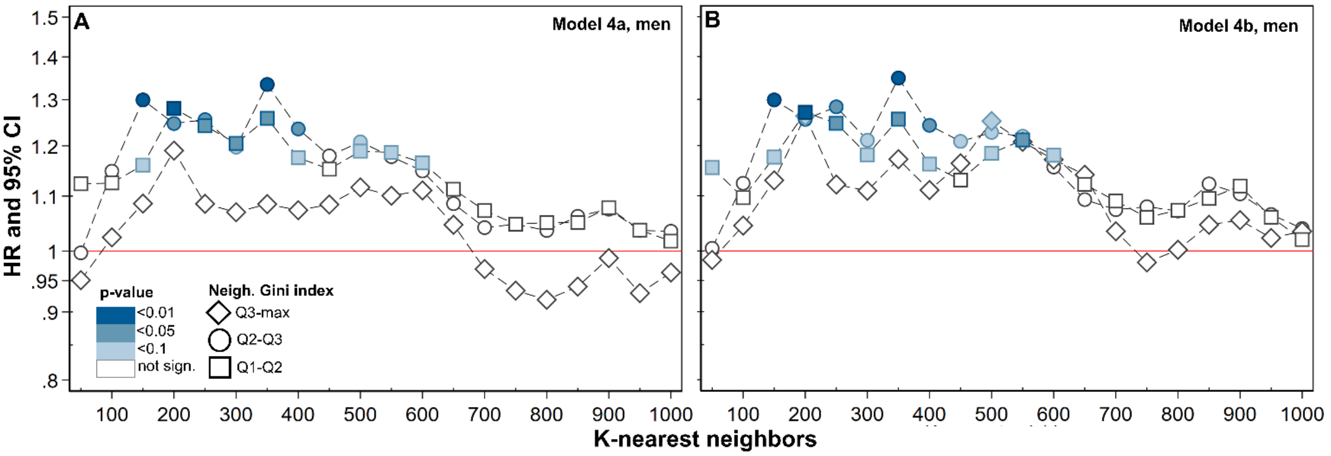

Figure 5. Impact of childhood context and control variables on all-cause mortality, ages 40-69, 1947 to 2015, models 4a and b, men. Only the variable neighborhood Gini index is shown. (A) Model 4a (controlling for static neighborhood income variable based on same-aged children at k = 25); A) Model 4b (controlling for a dynamic neighborhood income based on adult neighbors using same k as the neigh. Gini index). N = 8618, deaths = 1058.

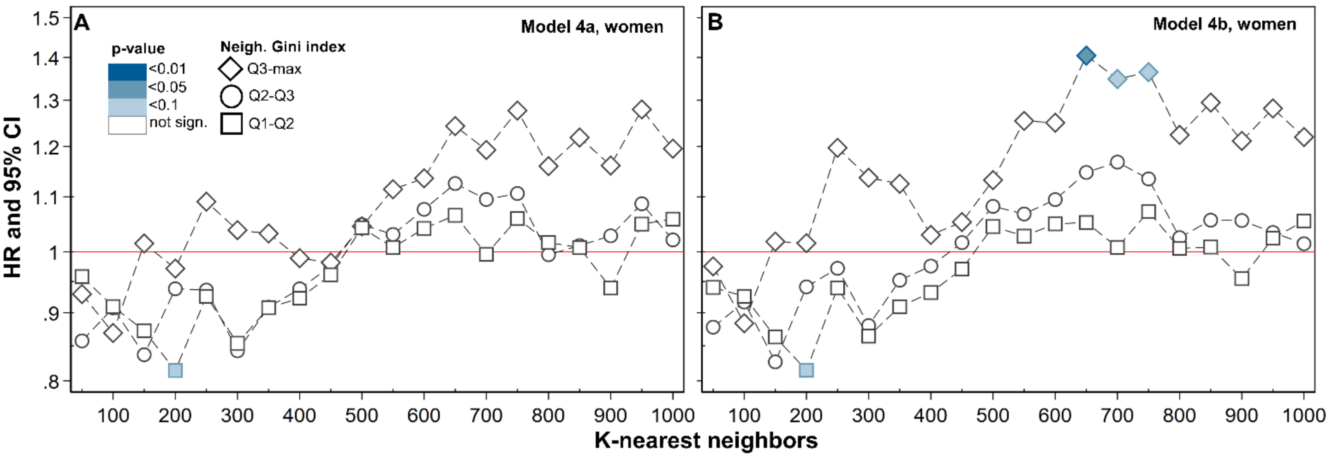

Figure 6. Impact of childhood context and control variables on all-cause mortality, ages 40-69, 1947 to 2015, models 4a and b, women. Only the variable neighborhood Gini index is shown. (A) Model 4a (controlling for static neighborhood income variable based on same-aged children at k = 25); A) Model 4b (controlling for a dynamic neighborhood income based on adult neighbors using same k as the neigh. Gini index). N = 8218, deaths = 685.

Concluding remarks (preliminary)

We use longitudinal geocoded microdata for a Swedish town (1939-1967), linked to Swedish national administrative registers, 1968-2015, to study the impact of average income and inequality in childhood neighborhoods on adult mortality, net of childhood family income and own class in adulthood. We do this to test the hypothesis that inequalities during childhood predicts later-life mortality. The preliminary results indicate that economic inequalities within the childhood neighborhoods were important for the adult mortality of men but not for women. Men who grew up in neighborhoods with low inequality experienced a relatively lower mortality risk in adulthood compared to men growing up in more unequal neighborhoods, even when adjusting for both the childhood family and neighborhood income, and adult class.

We cannot test possible mechanisms in this preliminary study, but a positive relationship between income inequality and mortality may be mediated by, for example, trust and social cohesion, or crime and violence, or both. The preliminary results are consistent with the inequality hypothesis, and research showing that disadvantaged outcomes are more common in contexts with greater income differences between rich and poor (Picket and Wilkinson, 2015).

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