Long-term association between neighbourhood socioeconomic deprivation in early childhood and perceived stress in early adulthood

a multilevel cohort study

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The long-term association between neighbourhood socioeconomic deprivation in early childhood and perceived stress in early adulthood: a multilevel cohort study

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ABSTRACT

Background: Previous studies have shown that neighbourhood socioeconomic deprivation is related to mental health problems, with chronic stress responses as one possible biopsychological pathway; however, less is known about the possible long-term effects of neighbourhood deprivation throughout the life course. The aim of this study was to examine the association between neighbourhood socioeconomic deprivation in early childhood and perceived stress in early adulthood.

Methods: Data from the Danish National Health Survey 2017, in which Cohen's 10-item Perceived Stress Scale was measured (range 0-40), were used to follow a cohort consisting of all survey respondents aged 20-24 years born between 1992-1996. The respondents were linked to Danish register data, including data on the parent(s) with whom the respondents lived, to measure family-level socioeconomic characteristics, parental mental health problems and neighbourhood socioeconomic deprivation at age 3 for each respondent. Furthermore, the respondents were linked to georeferenced neighbourhoods. Linear mixed models were used to estimate the association between neighbourhood socioeconomic deprivation at age 3 and perceived stress at age 20-24.

Results: A one standard deviation increase in neighbourhood socioeconomic deprivation in early childhood was associated with a 0.59-point increase in perceived stress in early adulthood (95% CI: 0.41 to 0.77). The association was attenuated but remained statistically significant after controlling for individual and family characteristics and neighbourhood socioeconomic deprivation in early adulthood (coef=0.26, 95% CI: 0.06 to 0.46).

Conclusion: The findings suggest that children growing up in more socioeconomically deprived neighbourhoods may be prone to higher levels of perceived stress later in life.

Keywords: Mental health; Life course epidemiology; Social sciences; Cohort studies; Health inequalities

What is already known on this topic

- Previous studies have shown that neighbourhood socioeconomic deprivation is related to mental health problems, but less is known about the possible long-term effects of neighbourhood deprivation throughout the life course.

- A few studies have found evidence of a long-term association between neighbourhood socioeconomic deprivation during early childhood and mental health outcomes later in life.

- No previous study has examined the possible long-term effect of neighbourhood socioeconomic deprivation during early childhood on subsequent perceived stress in early adulthood.

What this study adds

- Neighbourhood socioeconomic deprivation in early childhood was associated with higher levels of perceived stress in early adulthood, even after controlling for individual and family characteristics and neighbourhood socioeconomic deprivation in early adulthood.

How this study might affect research, practice or policy

- This study provides evidence for the importance of the neighbourhood environment in early childhood for stress later in life. Further research is needed to gain a better understanding of the mechanisms that explain this association.

INTRODUCTION

Several studies have linked neighbourhood socioeconomic deprivation (NSD) to mental health problems, even after controlling for individuals' own socioeconomic status, including depression [1,2], internalizing and externalizing problem behaviours and lower well-being [3], and schizophrenia [4]. However, the majority of studies have been conducted using a cross-sectional design, which increases the risk of reverse causation, also known as selection bias in studies investigating neighbourhood effects, when selection into neighbourhoods is influenced by the outcome [5]. Furthermore, living in a socioeconomically deprived neighbourhood may have long-term health effects, which are not captured in cross-sectional studies [6,7].

The life-course perspective on health emphasizes that there can be certain sensitive periods where the effects of exposure can have a larger impact [8]. When focusing on such periods over the life course, the early years of a child's life, understood as the time between birth and age 5, represents a sensitive period for the development of the brain, as the rapid growth of children's brains during this time makes them particularly susceptible to environmental stimuli [9].

In addition to the family and school context, studies have found evidence that neighbourhoods are an important environment for children's development [10], with deprived neighbourhoods associated with children's externalizing problems and poorer well-being [3]. Furthermore, a few studies have investigated the potential long-term effects of NSD during early childhood on mental health outcomes later in life, with NSD linked to psychiatric disorders in adulthood [11], internalizing and externalizing behaviour problems in adolescence [12], and depressive symptoms in both young adulthood to middle age [13].

Even though the complete pathway linking NSD to mental health outcomes is not fully understood, studies have found characteristics, such as perceived neighbourhood disorder [14,15] and low levels of social cohesion and neighbourhood trust [16–18], to be mediating mechanisms. Such characteristics might be perceived as stressors to the residents, thereby linking NSD to increased stress responses, with a recent review study linking NSD to allostatic load, operationalized as a combination of biomarkers including

stress-related hormones and secondary outcomes (subclinical disturbances in markers of cardiovascular, metabolic, and immune functioning) [19].

When focusing on stressors in childhood, a vast amount of literature has focused on the long-term health effects of adverse childhood experiences (ACEs), such as physical neglect, emotional abuse and exposure to violence [20], with studies linking ACEs to later perceived stress in adulthood [21,22]. When comparing the impact of perceived stress with physiological markers of stress, studies have found perceived stress to be a better predictor of outcomes, such as cognitive functioning [23]. Furthermore, measures of perceived stress may be better than cortisol levels in terms of reflecting the emotional states of adolescents [24].

Exposure to stressors in childhood might lead to increased perceived stress in later life through future stress exposures, also known as stress proliferation [25] or through increasing negative responses to subsequent stressors, also known as stress sensitization [22].

As stressors in childhood are related to perceived stress in adulthood, with early childhood as a sensitive period for brain development, and NSD might affect mental health through stress pathways, it is likely that NSD during early childhood can have long-term effects on subsequent perceived stress in early adulthood independent of NSD in early adulthood. However, to my knowledge, no study has yet examined this association.

The aim of this study was therefore to examine the long-term association between NSD during early childhood and perceived stress in early adulthood with survey data linked to Danish register data and georeferenced data using a large Danish national sample to follow a cohort from age 3 to age 20-24. It was hypothesized that respondents growing up in a more socioeconomically deprived neighbourhood in early childhood would report higher levels of perceived stress in early adulthood after adjustments for family- and individual-level characteristics and NSD in early adulthood.

METHODS

Data sources

This cohort study was based on data from the Danish National Health Survey 2017 (DNHS-2017) [26] in which perceived stress was measured. A total of 312,349 individuals were randomly drawn from the adult Danish population (≥16 years) using the Danish Civil Health Registration System and invited by postal or secure electronic mail, with a response rate of 183,372 (58,7%). For a more detailed description of the design and data collection procedure of the survey, see Christensen *et al.* [26]. From the survey, a cohort was constructed consisting of all survey respondents aged 20-24 years born between 1992-1996 (N=9,480).

The respondents were linked to national registers, including data on their legal parents with whom the respondents lived, through Statistics Denmark by using their personal identification number (CPR number). Register data from Statistics Denmark were used to measure family-level socioeconomic characteristics, parental mental health problems and NSD at age 3 of each respondent. Furthermore, the respondents were linked to neighbourhoods at age 3 with the use of georeferenced micro-areas developed by Lund [27]. These areas have been used in previous studies to investigate different neighbourhood characteristics in a Danish context [18,28,29] and have been shown to produce larger between-area variation compared to Danish administrative areas when focusing on mental health outcomes [18,28,29], as well as higher within-group sociodemographic homogeneity [27]. The micro-areas were constructed with an automated redistricting algorithm to form the smallest areas possible that contained at least 100 inhabitants and were separated by large physical barriers, such as large roads. For a more detailed description of the micro-areas, see Lund [27].

Participants in this study included respondents with information on all included survey and register variables. This resulted in a final sample of 7,633 participants nested into 3,692 micro-areas for the analysis. The majority of missing data was due to foreign-born individuals who did not reside in Denmark at the age of 3 (figure 1). Apart from ethnicity, no major differences were observed between the final sample and the study population in key sociodemographic variables (sex, age, income, education, and occupation). The mean number of participants per micro-area was 2.1 with a large

proportion of micro-areas with only one participant. Research shows that when the number of groups are large as was the case in the present analyses, neither fixed nor random components are affected by small group size, even when 90% of areas only have one individual per area and even when aggregated group-level variables are examined [30]

Perceived stress

The outcome variable 'perceived stress' was measured by a Danish version of Cohen's 10-item Perceived Stress Scale (PSS) [31,32]. PSS is a self-report measure of subjective stress with respondents indicating how often they have found their life unpredictable, uncontrollable, and overloaded in the past month. The instrument has demonstrated good validity and reliability in previous studies [33]. All items were scored on a 5-point Likert scale ranging from never to very often. Scores for the four positively stated items (Items 4, 5, 7, 8) are reversed. The sum score ranges from 0–40, with higher scores indicating higher levels of perceived stress (Cronbach's α=0.89). If one item was missing, this item was imputed with the rounded mean of the other 9 items. If more than one item was missing, the PSS sum score was not calculated.

Neighbourhood socioeconomic deprivation

Two composite indices to measure NSD in early childhood and early adulthood was created with the following three indicators based on previous studies [28,34]: the proportion of residents between 30 and 64 years of age who were unemployed for at least half of the year, including recipients of sickness benefits, persons on leave and recipients of cash benefits; the proportion of residents between 30 and 64 years of age with a disposable income in the lowest income quartile; and the proportion of residents between 30 and 64 years of age with basic education [35] as the highest attained educational level. The age group between 30 and 64 years was used to capture individuals of working age, as well as individuals where the majority have completed their education. This ensures a more homogeneous population and comparison of different areas. However, this strategy means that socio-economically deprived areas with a high proportion of young and/or elderly people are potentially overlooked.

All three indicators were standardized to z-scores and used to create two indices with principal component analysis. The final NSD indices was normalized to z-scores with higher scores indicating a higher degree of NSD.

Covariates

To control for possible confounding effects, covariates were included at both the individual and family-level.

Individual-level variables included the respondent's sex and ethnicity dichotomised to Danish or other, with Danish ethnicity measured as persons - regardless of place of birth - who have at least one parent who is both a Danish citizen and born in Denmark. Furthermore, age was included as a fixed effects indicator variable to control for unobservable age and time-period variation.

Family-level variables were measured at age 3 of the respondents, including income, education, unemployment, family type and parental mental health problems that may determine selection into neighbourhoods and furthermore affect the child's mental health. Family income was measured as the median of the total annual parental income in the household. Parental education was measured as the highest level of education attained by any parent residing in the same household as the child using the International Standard Classification of Education (ISCED) [35], categorised into: 'Basic education' (levels 0-2), 'Medium education' (levels 3-5) and 'High education' (levels 6-8). Parental unemployment was measured as unemployment if one or both parents were unemployed for at least half of the year, including recipients of sickness benefits, persons on leave and recipients of cash benefits. Family type was categorised into single- or two-parent households. Parental psychiatric medication purchases were used as a proxy for parental mental health problems. The variable was measured with a register-based indicator categorised as parental mental health problems if one or both parents in the household filled one or more prescriptions for psychiatric medication with the following anatomical therapeutic chemical (ATC) code categories: N05 for antipsychotics, anxiolytics, hypnotics and sedatives and N06A for antidepressants.

Data analysis

The association between NSD in early childhood and perceived stress in early adulthood was analysed using linear mixed models with random intercepts for micro-areas and individuals nested within micro-areas at age 3 to account for the nonindependence of respondents growing up in the same neighbourhood. NSD were measured at level 2 and individual perceived stress and covariates were measured at level 1.

When using multilevel models to analyse potential contextual effects, it is important to distinguish between the general contextual effect (GCE) and specific contextual effects (SCEs) [36]. The GCE expresses how important the specific context is for the outcome, while the SCEs express the effect from specific contextual variables, in this case NSD in early childhood and early adulthood.

The GCE was estimated using the intraclass correlation (ICC) calculated as follows:

$$\text{ICC} = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}$$

where σ_u^2 is the level-2 variance and σ_e^2 is the level-1 variance. The ICC is the percentage of the total variance attributable to the area-level variance [36].

The first model did not include any predictors but only random intercepts for the micro-areas to examine the GCE for perceived stress (Model 0). Next, a separate model was fitted with only NSD as a predictor to determine the crude association between early childhood NSD and early adulthood perceived stress (Model 1). Next, the model was adjusted for the individual-level covariates sex, ethnicity and age (Model 2) and both individual-level and family-level covariates parental income, parental education, family type and parental mental health problems (Model 3), followed by a final model adjusted for both individual-level and family-level covariates and current NSD in early adulthood (Model 4). The inclusion of NSD in early childhood in the final model was to assess the potential association between early childhood NSD and early adulthood perceived stress, over and above NSD in early adulthood as it is possible that NSD in early adulthood may completely mediate the association between NSD in early childhood and early adulthood perceived stress. To account for potential differences in selection probabilities and response rates, calibrated weights constructed by Statistics

Denmark were used for the analyses. All analyses were performed using Stata version 17 [37].

RESULTS

Table 1 Descriptive statistics of study-variables (n=7633 individuals nested into 3,692 neighbourhoods)			
	Category	No. (%) or mean (SD)	Mean perceived stress (SD) ‡
Neighbourhood characteristics			
NSD in early childhood †		0.32 (0.14)	–
	Q1	1908 (25.00)	13.63 (7.49)
	Q2	1908 (25.00)	13.94 (7.62)
	Q3	1908 (25.00)	13.89 (7.43)
	Q4	1909 (25.01)	14.71 (7.99)
NSD in early adulthood ‡		0.29 (0.14)	–
	Q1	1907 (24.98)	13.61 (7.44)
	Q2	1906 (24.97)	13.75 (7.61)
	Q3	1911 (25.04)	14.16 (7.77)
	Q4	1909 (25.01)	14.64 (7.72)
Individual characteristics			
Perceived stress ‡		14.04 (7.64)	–
Age ‡		21.95 (1.41)	–
	20	1581 (20.71)	13.61 (7.62)
	21	1596 (20.91)	14.15 (7.67)
	22	1519 (19.90)	14.36 (7.74)
	23	1478 (19.36)	13.74 (7.46)
	24	1459 (19.11)	14.36 (7.71)
Sex ‡	Male	3239 (42.43)	12.26 (7.22)
	Female	4394 (57.57)	15.35 (7.69)
Ethnicity ‡	Danish	7319 (95.89)	13.94 (7.63)
	Other	314 (4.11)	16.30 (7.53)
Family characteristics			
Parental income - DKK †		233,407.23 (97,436.17)	–
	Q1	1908 (25.00)	14.62 (7.72)
	Q2	1908 (25.00)	14.08 (7.67)
	Q3	1908 (25.00)	13.86 (7.61)
	Q4	1908 (25.00)	13.60 (7.55)
Parental unemployment †	Not unemployed	6509 (85.27)	13.78 (7.55)
	Unemployed	1124 (14.73)	15.55 (8.00)
Parental education †	Low	987 (12.93)	16.02 (8.15)
	Medium	5809 (76.10)	13.80 (7.56)
	High	837 (10.97)	13.34 (7.23)
Family type †	Two-parent household	6873 (90.04)	13.84 (7.57)
	Single-parent household	760 (9.96)	15.88 (8.07)
Parental mental health problem †	No	7063 (92.53)	13.96 (7.62)

| | Yes | 570 (7.47) | 15.09 (7.85) |

SD=standard deviation. Perceived stress = The Perceived Stress Scale (PSS-10). † Age 3. ‡ Age 20-24.

Table 2 Regression coefficients (95% CIs) from linear mixed models of perceived stress in early adulthood (n=7633)

	Model 0	Model 1	Model 2 §	Model 3 §	Model 4 §
Fixed effects					
Neighbourhood characteristics					
NSD in early childhood †		0.59 (0.41 to 0.77)***	0.49 (0.31 to 0.68)***	0.31 (0.11 to 0.50)**	0.26 (0.06 to 0.46)**
NSD in early adulthood†					0.12 (-0.00 to 0.23)
Individual characteristics					
Sex					
Male			Reference	Reference	Reference
Female			3.01 (2.65 to 3.38)***	2.99 (2.63 to 3.35)***	2.98 (2.62 to 3.34)***
Ethnicity					
Danish			Reference	Reference	Reference
Other			1.53 (0.50 to 2.56)**	1.35 (0.30 to 2.40)*	1.31 (0.26 to 2.36)*
Family characteristics					
Parental income‡				0.20 (0.00 to 0.39)*	0.20 (0.01 to 0.40)*
Parental unemployment					
Not unemployed				Reference	Reference
Unemployed				0.62 (0.06 to 1.18)*	0.60 (0.04 to 1.16)*
Parental education					
Low				Reference	Reference
Medium				-1.73 (-2.34 to -1.12)***	-1.70 (-2.31 to -1.09)***
High				-2.25 (-3.05 to -1.44)***	-2.20 (-3.01 to-1.39)***
Family type					
Two-parent household				Reference	Reference
Single-parent household				1.16 (0.49 to 1.83)**	1.17 (0.50 to 1.84)**
Parental mental health problem					
No				Reference	Reference
Yes				0.90 (0.23 to 1.57)**	0.89 (0.22 to 1.56)**
Random effects					
Area level variance σ_u^2	2.82 (1.71 to 4.64)	2.18 (1.18 to 4.05)	2.00 (1.06 to 3.77)	1.91 (0.98 to 3.72)	1.93 (1.00 to 3.72)
ICC %	4.83	3.77	3.60	3.50	3.53
AIC	52674.46	52638.12	52313.9	52220.57	52218.39
BIC	52695.28	52665.88	52383.3	52331.62	52336.38

***p < 0.001, **p < 0.01, *p < 0.05. † Z-score standardized. ‡ Per 100,000 DKK increase.§ With age fixed effects.

Descriptive statistics of the study variables are shown in Table 1.

The results of linear mixed models of perceived stress in early adulthood are shown in Table 2. The ICC for perceived stress in early adulthood was 4.83% in the empty model with no predictors (Model 0). In the crude model (Model 1), NSD during early childhood was significantly associated with higher levels of perceived stress in early adulthood (Coef=0.59; 95% CI=0.41 to 0.77). After NSD in early childhood was added to the model, the area level variance σ_u^2 and ICC were reduced, showing that 22% of the initial area level variance was explained by NSD in early childhood.

When adjusting for individual-level covariates, the association between NSD and perceived stress was attenuated (Coef=0.49; 95% CI=0.31 to 0.68). In the model adjusting for both individual-level and family-level covariates (Model 3), the association between NSD in early childhood and perceived stress in early adulthood was further attenuated (Coef=0.31; 95% CI=0.11 to 0.50), showing that a large part of the crude association between NSD and perceived stress was confounded by family factors. In the final model adjusting for NSD in early adulthood, NSD during early childhood was still significantly associated with higher levels of perceived stress in early adulthood (Coef=0.26 95% CI= 0.06 to 0.46), while the model demonstrated no evidence for an association between early adulthood NSD and early adulthood perceived stress (Coef=0.12 95% CI= -0.00 to 0.23).

DISCUSSION

The main objective of this study was to assess the long-term association between NSD in early childhood and perceived stress in early adulthood. The findings indicate that higher levels of NSD during early childhood are related to higher levels of perceived stress in early adulthood, even after controlling for a wide range of covariates, including family socioeconomic characteristics, parental mental health problems and current NSD in early adulthood. These findings are consistent with other studies linking NSD during early childhood to mental health outcomes later in life [11–13].

There are several possible pathways through which living in a socioeconomically deprived neighbourhood in early childhood can affect later mental health outcomes beyond and above family socioeconomic characteristics. To the best of my knowledge, no previous study has investigated the mediating mechanisms between early childhood NSD and later perceived stress. However, in the study by Wang *et al.,* collective efficacy (neighbourhood social cohesion, trust and informal social control) [38] and family processes (i.e., parenting stress and exposure to ACEs) mediated the relationship between neighbourhood concentrated poverty in early childhood and internalizing and externalizing behavioural problems in adolescence [12]. This finding supports the notion that families living in high poverty neighbourhoods may deal with a variety of stressors while trying to raise their children in a possibly unsafe neighbourhood with few neighbourhood resources, weak social networks, and less social support, independent of the families' own socioeconomic resources. These stressors might raise parental stress levels and impede the healthy development of their children, and children who experience high levels of parental stress, as well as neighbourhood stressors and ACEs, may subsequently exhibit more internalising and externalising problems [12]. These findings suggest a complex multifaceted pathway between growing up in a deprived neighbourhood during childhood and later mental health problems, explained by both neighbourhood, family, and subsequent individual-level social factors.

It is possible that such mechanisms may also explain the link between NSD and subsequent perceived stress found in this study. The possible mechanisms of collective efficacy and family processes can potentially support both stress sensitization [22] and stress proliferation models [25]. It is possible that exposure to stressors, such as ACEs

during early childhood, can increase negative responses to subsequent stressors in early adulthood, as supported by the study of McLaughlin *et al.* [22], and furthermore, children experiencing stressors, such as exposure to ACEs in early childhood, might continue to experience negative life stressors into their adult life, as supported by the study of Scorza *et al.* [21]. Further studies are warranted to test the mechanisms linking early childhood NSD to perceived stress in early adulthood.

Taken together, these results indicate that childhood is a sensitive period for later mental health outcomes, suggesting the need for a life-course approach to the effects of living in a socioeconomically deprived neighbourhood.

One key strength of this study was the use of a longitudinal design with a large population-based cohort sample. This made it possible to investigate possible long-term effects of NSD on later levels of perceived stress from a life-course perspective, which is an important aspect often missing from the field of neighbourhood studies [6]. Another key strength was the use of micro-areas as neighbourhoods, which were designed by an automated redistricting algorithm [27], instead of relying on larger administrative areas as neighbourhood units, as such administrative areas may not accurately capture areas that are likely to reflect the daily experienced neighbourhood of the residents [7]. Especially when analysing neighbourhood effects during childhood, one may argue that smaller areas separated by barriers, such as large roads, may serve as a more accurate measure of children's perception of their neighbourhood compared to larger areas, as children are typically confined to walking arenas and, therefore, are more influenced by the constraints of their immediate physical surroundings compared to adults [39].

Among the weaknesses of this study, the study was an observational study. Despite the use of a longitudinal design and the inclusion of several possible confounding variables to control for selection into neighbourhoods, there is potentially still residual confounding or important unmeasured confounders, which means that the causal inferences based on the associations are limited. Furthermore, this study only focused on two time periods to study the association between NSD in early childhood and perceived stress in early adulthood. However, exposure to NSD may change dynamically throughout the life course and other life periods including late childhood, adolescence

as well as the cumulative exposure to NSD may also be important for later levels of perceived stress.

In conclusion, this study is among the first to examine the long-term association between NSD in early childhood and perceived stress in early adulthood. The findings suggest that children growing up in more deprived neighbourhoods may be more prone to higher levels of perceived stress later in life. Future research should continue to investigate the long-term effects of the neighbourhood environment on mental health outcomes and further investigate the mediating factors explaining such relationships.

Competing interests

None.

Data availability statement

Data were stored and processed in the data secure remote server environment of Statistics Denmark. The data used in the present paper cannot be shared publicly due to legal and ethical restrictions pertaining to Danish register-based data.

Ethics statements

According to Danish Law, approval from ethical committees is not required for questionnaire-based projects and usage of register-based data. The study was approved by Statistics Denmark and The Danish Health Data Authority.

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Figure 1 Flowchart of the study participants

9,480

Not residing in Denmark age 3
(n = 790)

8,690

Missing information on

Perceived stress scale
(n = 526)

Register variables
(n = 61)

Micro-areas age 3
(n = 268)

Micro-areas age 20-24
(n = 202)

7,633 (study sample)