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Understanding and mitigating associations between childhood neighborhood deprivation and adolescent mental health in two UK birth cohorts

Rachel M. Latham[1,2], Louise Arseneault[1,2], George B. Ploubidis[2,3], Jayati Das-Munshi[2,4,5], Darío Moreno-Agostino[2,3], Ioannis Bakolis[6,7], Flora Blangis[1] and Helen L. Fisher[1,2]

[1]King's College London, Social, Genetic & Developmental Psychiatry Centre, Institute of Psychiatry, Psychology & Neuroscience, London, UK, [2]ESRC Centre for Society and Mental Health, King's College London, London, UK, [3]Centre for Longitudinal Studies, UCL Social Research Institute, University College London, UK, [4]King's College London, Department of Psychological Medicine, Institute of Psychiatry, Psychology & Neuroscience, London, UK, [5]Population Health Improvement UK (PHI-UK), UK, [6]King's College London, Department of Biostatistics and Health Informatics, Institute of Psychiatry, Psychology & Neuroscience, London, UK and [7]King's College London, Centre for Implementation Science, Health Services and Population Research Department, Institute of Psychiatry, Psychology & Neuroscience, London, UK

Abstract

This study investigated associations between childhood neighborhood deprivation and adolescent mental health difficulties, and potential protective factors. Data were utilized from the Millennium Cohort Study (MCS) (born in 2000–2002; $N = 5{,}422$; 52% female) and the Environmental Risk (E-Risk) Longitudinal Twin Study (born in 1994–1995; $N = 1{,}920$; 53% female). Childhood neighborhood deprivation was measured using the Index of Multiple Deprivation between age 9 months and 14 years (MCS) and at age 12 (E-Risk). Adolescent mental health was assessed using the Strengths and Difficulties Questionnaire at age 17 (MCS) and the Diagnostic Interview Schedule conducted at age 18 with symptoms loading onto general psychopathology, internalizing and externalizing factors (E-Risk). Cross-classified models showed high levels of neighborhood deprivation in childhood were associated with more total problems (estimate = 0.46, 95% *CI* = 0.04–0.88) and internalizing difficulties (estimate = 0.32, 95% *CI* = 0.06–0.59) in adolescence within MCS. Being male, having higher self-esteem, greater social support, and a more positive parent-child relationship were associated with fewer total problems (estimates = −0.09–−1.87) and internalizing difficulties (estimates = −0.03–−1.88) at age 17 in the full sample regardless of neighborhood deprivation exposure. However, interactions revealed that higher self-esteem was especially beneficial for children exposed to high neighborhood deprivation (estimate = −0.35, 95% *CI* = −0.43–−0.27). No significant associations between childhood neighborhood deprivation and adolescent mental health symptoms were found in E-Risk. Interventions focused on improving self-esteem, social support, and parenting may help promote better adolescent mental health in the general population. Those living in the most deprived areas may benefit most from increased self-esteem.

Keywords: adolescence; poverty; protective factors; self-esteem; social support

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An estimated 970 million people – or 1 in every 8 – around the world live with a mental health disorder (World Health Organization, 2022). Poor mental health can have negative and long-lasting consequences for the individual as well as significant costs for society in terms of health services and economic losses. The need to reduce the prevalence of mental health problems is a public health priority and research to better understand risk and protective factors plays a vital role in this by informing prevention strategies. In addition to well-established risk factors such as genetics (Burmeister et al., 2008), trauma (Danese & Baldwin, 2017), and poor physical health (Daré et al., 2019; Doherty & Gaughran, 2014), there has been growing interest in how the neighborhood environment matters for people's mental health.

Neighborhood deprivation refers to a lack of access to opportunities and resources among residents including material/physical (e.g., food, accommodation, clothing) and social (e.g., crime, education, community services) aspects (Office for National Statistics, 2013), though studies vary in how they operationalize this. Limited education and employment opportunities and limited access to sufficient food, medical services and other collective resources are theorized to leave individuals prone to poor health while poor living conditions can also contribute to stress that undermines mental health (Kröger et al., 2015; Stafford & Marmot, 2003).

Indeed, meta-analyses of longitudinal studies of adults have shown that living in more deprived neighborhoods (defined using

Corresponding author: Helen L. Fisher; Email: helen.2.fisher@kcl.ac.uk

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composite measures) is associated with higher levels of mental disorders including depression (Sui et al., 2022). Moreover, there is evidence of long-term effects of childhood exposure to neighborhood deprivation on mental health problems such as depression and anxiety in adulthood (Elovainio et al., 2020; Pearce et al., 2018) suggesting that childhood and adolescence may be an important period for exposure. Indeed, growing up in a deprived neighborhood has also been linked with a greater risk of internalizing and externalizing problems in childhood and adolescence (Flouri et al., 2020; Leventhal & Brooks-Gunn, 2000; Visser et al., 2021) with socio-economic aspects of neighborhood deprivation potentially driving this association (Flouri et al., 2020). Findings suggest that the effect of neighborhood deprivation is typically modest in size, explaining 5%–10% of the variation in child and adolescent outcomes and is robust to adjustment for family-level disadvantage (Leventhal & Brooks-Gunn, 2000). The latter is important as families are not randomly selected into neighborhoods, rather individuals with similar characteristics often come to live in similar areas. Therefore, ensuring that associations between neighborhood deprivation and poor mental health are robust to factors that influence both is critical to limit reverse causation in observational studies.

There remain important gaps in our knowledge. First, most studies of neighborhood deprivation measure exposure only once – rather than repeated measures over time – which may over- or under-estimate the effect of neighborhood deprivation on mental health (Helbich, 2018; Sui et al., 2022). Second, a review of studies published since 2009 that examined the effects of neighborhood deprivation on young people's mental health showed that the majority had been conducted in the USA, with few examining the UK context (Visser et al., 2021). Although both are western, educated, industrialized, rich and democratic countries, they have differing social, demographic, and political contexts that may impact neighborhood deprivation and its effects on mental health. Third, UK studies using large, representative samples have typically focused on children (Flouri et al., 2010, 2013) with less attention to adolescent mental health. Adolescence and the transition to adulthood is commonly the period in which a variety of mental health problems have their onset (Solmi et al., 2021) and for many this will signal the start of recurrent mental illness (Caspi et al., 2020). Furthermore, neighborhood deprivation may be particularly salient for adolescent mental health as the strength of the effects may accumulate with sustained exposure since childhood. A better understanding of the relationship between neighborhood deprivation during childhood and mental health problems in adolescence in a contemporary UK population sample is therefore needed. Finally, studies of neighborhood deprivation have typically assessed child and adolescent mental health outcomes using parent-reported problem behaviors (e.g. Flouri et al., 2020) such as the Strengths and Difficulties Questionnaire (Goodman, 1997) and the Child Behaviour Checklist (Achenbach, 1991). It remains unclear whether similar associations are found for mental health problems based on adolescents' own reports.

Despite evidence that neighborhood deprivation increases the risk of mental health difficulties, outcomes do vary among those exposed to socio-economic disadvantage (Bakolis et al., 2023; Kim-Cohen et al., 2004) with some individuals having better than expected outcomes. These people are sometimes referred to as showing "resilience" (Luthar et al., 2000; Masten et al., 1990). Resilience is not a personal trait (though it may be facilitated by personal qualities such as self-esteem) but a dynamic process encompassing positive adaptation in the presence of significant adversity (Luthar et al., 2000). Thus, by definition, resilience requires there to have been exposure to some form of adversity and factors that mitigate this risk resulting in adaptive outcomes – so called "protective factors" – can come from personal qualities or may be external to the individual such as from family, friends, and their environment/community (Rutter, 1985). Analyses of children in the UK Millennium Cohort Study (MCS) have highlighted factors such as self-regulation (Flouri et al., 2014a), cognitive ability (Flouri et al., 2014a), green space (Flouri et al., 2014b), and early aspirations (Flouri et al., 2016) as buffering some negative effects of family-level poverty. However, relatively few studies of neighborhood-level deprivation have investigated factors that are protective for mental health. A study of Welsh adults found high levels of social cohesion attenuated the association between neighborhood deprivation and poorer mental health (Fone et al., 2014). Additionally, studies of UK children have shown verbal and non-verbal cognitive ability to moderate the association between neighborhood deprivation and pre-schoolers' peer problems (Flouri et al., 2012); and general intelligence to moderate the effect of neighborhood poverty on behavioral and emotional problems at some, but not all, ages examined during childhood (Flouri et al., 2015). No studies, to our knowledge, have focused on adolescents. However, an understanding of potential protective factors is central to improving knowledge of resilience during adolescence and may inform targets for interventions to better support young people who grow up in deprived neighborhoods and prevent them from developing mental health difficulties as they transition to adulthood.

The current study addresses the identified knowledge gaps by extending existing analyses of the MCS to answer the following research questions: (i) is high neighborhood deprivation in childhood associated with age-17 mental health problems and (ii) which factors protect against age-17 mental health problems for children exposed to high neighborhood deprivation? Drawing on the aforementioned factors that have been found to be protective of mental health in young children from deprived neighborhoods (Flouri et al., 2012, 2015) and among children or adolescents exposed to other forms of adversity (Crush et al., 2018a; Crush et al., 2018b; Flouri et al., 2014b; Masten et al., 1990; Meng et al., 2018; Sharma et al., 2019), we examine the potential protective role of biological sex, infant temperament, cognitive skills, self-esteem, family income, parent-child relationship, parenting behavior, access to green space, and social support. We test the robustness and generalisability of our findings using the Environmental Risk (E-Risk) Longitudinal Twin Study, an independent UK sample born in a similar time period, by investigating: (iii) are the associations between high neighborhood deprivation and mental health problems found in MCS comparable in E-Risk, and do they extend to clinically relevant psychiatric diagnoses at age 18? And (iv) are the putative protective factors found in MCS comparable in E-Risk?

Methods

Samples

MCS is a longitudinal survey of UK children that draws its sample from all live births between 1 September 2000 and 31 August 2001 (in England and Wales) and between 24 November 2000 and 11 January 2002 (in Scotland & Northern Ireland). Detailed information about the cohort is available at https://cls.ucl.ac.uk/cls-studies/millennium-cohort-study/ and in Supplementary Material. Briefly, eligible children were identified using government child

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benefit records. The sample was constructed to be representative of the total UK population and was disproportionately stratified to oversample certain subgroups, namely families living in areas of high child poverty, children of ethnic minority backgrounds, and living in the smaller nations of the UK (Plewis, 2007). At baseline, 18,552 families (18,827 children; 51% male) were included and an additional 692 eligible families were included at sweep 2 (total cohort = 19,244 families). Currently, there are seven sweeps of data, the first took place when children were around 9 months of age, and then they were followed up at ages 3, 5, 7, 11, 14 and 17 years. For comparability with the E-Risk cohort, we selected only MCS families who lived in England or Wales at baseline ($N = 15,170$) and for families with two children participating ($N = 194$; this includes twin and non-twin siblings[1]), one child was randomly selected to prevent family-level clustering. Furthermore, we analyzed cases with complete data for neighborhood deprivation, self-reported adolescent mental health, ethnicity, and family income (N = 5,422).

Ethical approval for MCS was obtained from the National Health Service Multi-Centre Ethics Committee up to age 14 years and the National Research Ethics Service at age 17 years. Study parents (and children after age 11 years) gave informed consent before data collection took place.

E-Risk tracks the development of a nationally representative birth cohort of 2,232 British children. The sample was drawn from a larger birth register of twins born in England and Wales in 1994–1995 (Trouton et al., 2002). Full details about the sample are reported elsewhere (Moffitt & E-Risk Study Team, 2002) and in Supplementary Material. Briefly, the E-Risk sample was constructed in 1999-2000 when 1,116 families (93% of those eligible) with same-sex 5-year-old twins participated in home-visit assessments. Sex was evenly distributed within zygosity (49% male). Follow-up home-visits were conducted when the children were aged 7, 10, 12 and 18 years (participation rates were 98%, 96%, 96%, and 93%, respectively). There were 2,066 E-Risk participants (47% male) assessed at age 18, who represent the full socioeconomic distribution of the UK population (Supplementary Figure S1). We analyzed participants with complete data for neighborhood deprivation, self-reported adolescent mental health, ethnicity, and family income (N = 1,920).

Each phase of the E-Risk Study was approved by the Joint South London and Maudsley and the Institute of Psychiatry Research Ethics Committee. Study parents gave informed consent and children gave assent between 5–12 years and then informed consent at age 18.

Measures

Neighborhood deprivation was assessed in MCS at sweeps 1–6 (ages 9 months – 14 years) with the UK Government's 2004 Index of Multiple Deprivation (IMD). IMD measures the relative levels of deprivation in small geographical areas using a weighted aggregation of several specific dimensions of deprivation. In England, the dimensions are income deprivation, employment deprivation, health deprivation and disability, education, skills and training deprivation, barriers to housing and services, living environment deprivation, and crime (Noble et al., 2006). The IMD ranks every small area in England (so-called Lower-Layer Super Output Areas, LSOAs, containing approximately 650 households or 1,500 individuals) from 1 (most deprived area) to 32,844 (least deprived area). Participants' IMD rank could change between study sweeps only if they moved to a different LSOA. There is no unified measure of IMD across the different UK countries, therefore, for our analyses using MCS we standardized IMD rank within country at each study sweep and then averaged these to create an overall childhood IMD rank for each participant (Supplementary Table S1 shows how many participants' IMD changed quartile during childhood). Because we investigated potential protective factors following exposure to high levels of neighborhood deprivation we defined "high" neighborhood deprivation as an average childhood IMD rank below the 25th centile[2].

In E-Risk, neighborhood deprivation was assessed using the UK Government's 2015 IMD based on participants' address at age 12. Scottish ($N = 6$) and Welsh ($N = 39$) addresses were converted to English IMD equivalents using a published conversion (Abel et al., 2016; Payne & Abel, 2012). For our analyses using E-Risk data we utilized IMD decile (rather than rank) due to IMD rank being uniquely identifying given the twin status of participants. We defined "high neighborhood deprivation" as the two most deprived (i.e. lowest) IMD deciles. This cut-point identified 24% of the E-Risk analysis sample as being exposed to high neighborhood deprivation and is thus comparable to the 25th centile cut used in MCS.

Adolescent mental health was reported separately by participants and parents in MCS at sweep 7 (age 17) using the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997), a 25-item questionnaire with item responses indicated on a three-point scale (ranging from 0 = not true to 2 = certainly true). For self- and parent-reports respectively, a total difficulties score was calculated by summing all items (self-report $\alpha = 0.75$; parent-report $\alpha = 0.63$); items measuring emotional symptoms and peer problems were summed to create a subscale of internalizing problems (self-report $\alpha = 0.88$; parent-report $\alpha = 0.96$); and items measuring conduct problems and hyperactivity/inattention were summed to capture externalizing problems (self-report $\alpha = 0.86$; parent-report $\alpha = 0.95$). Self- and parent-reported adolescent mental health problems were moderately correlated (total problems: $r = 0.46$; internalizing problems: $r = 0.47$; externalizing problems: $r = 0.44$. All $p's < .001$).

In E-Risk, participants were interviewed at age 18 about past-year symptoms of mental disorders. These methods have been previously described (Schaefer et al., 2018) and are detailed in Supplementary Material. Briefly, symptoms of five externalizing-spectrum disorders (alcohol, cannabis and tobacco dependence, conduct disorder, attention-deficit/hyperactivity disorder (ADHD)), four internalizing-spectrum disorders (depression, generalized anxiety disorder, posttraumatic stress disorder, eating disorder), and thought disorder (delusions, hallucinations, unusual thoughts and feelings) were assessed. Using confirmatory factor analysis, we estimated a bifactor model specifying a general psychopathology factor and three factors (representing internalizing, externalizing, and thought disorder symptoms; Supplementary Figure S2). Factor loadings and model fit are provided in Schaefer et al. (2018) and summarized in Supplementary Material. Here we utilize the general psychopathology, internalizing and externalizing factors as

[1]Families with triplets were not included in our analyses as we did not have access to their data due to the identifiable nature of this given the very small number of families (N = 11 in the whole MCS sample).

[2]Weighted centiles were calculated using the MCS weight 'FOVWT2' to account for attrition/non-response.

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outcomes to align with the total problems, internalizing and externalizing problems measured in MCS.

To extend our analyses to clinically relevant psychiatric diagnoses, E-Risk participants were additionally classified using Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994, 2013) criteria as having any internalizing, externalizing or thought disorder based on their symptom reports and an overall outcome of "any psychiatric disorder" based on these three domain specific classifications (see Supplementary Material). For consistency with our main analyses we utilize any psychiatric disorder, any internalizing disorder, and any externalizing disorder as outcomes.

Putative protective factors assessed in MCS are detailed in Table 1. Comparable constructs identified in E-Risk are detailed in Supplementary Material.

Confounders Informed by literature and using a directed acyclic graph (see Supplementary Figure S3) we accounted for the potential confounding effect of family income (Peverill et al., 2021; Townsend, 1987) and ethnicity (Zuccotti, 2019).

Family income was assessed in MCS at sweep 1. Respondents selected the category that captured their total annual family take-home income from all sources after tax and other deductions: "£0 to <£3,100" (coded 1), "£3,100 to <£10,400" (2), "£10,400 to <£20,800" (3), "£20,800 to <£31,200" (4), "£31,200 to <£52,000" (5), or "£52,000 and above" (6).

Family income was assessed in E-Risk at age 5 by asking how much total income the household received from all sources before tax in the previous 12 months. Respondents selected from 15 categories ranging from "<£3,999" (coded 0) to ">£41,000 or more" (15). These categories were re-coded as follows to correspond to the MCS income categories as closely as possible: "<£3,999" (coded 1), "£4,000-£9,999" (2), "£10,000-£19,999" (3), "£20,000-£31,999" (4), "£32,000-£40,999" (5), "£41,000 or more" (6).

Ethnicity of the MCS cohort members was reported at sweep 1 according to one of six census classes: White, Mixed, Indian, Pakistani and Bangladeshi, Black or Black British, or Other ethnic group.

The ethnicity of E-Risk participants was recorded at study baseline according to one of five categories: White, Asian, Black, Mixed race, or Other ethnic group.

Maternal psychological distress was included as an additional confounder in a planned MCS sensitivity test. It was assessed at sweep 2 using the 6-item Kessler (K6) Scale (Kessler et al., 2002). Items ask how often in the last 30 days the mothers felt depressed, hopeless, restless, worthless, nervous, or that everything was an effort. Responses were given on a 5-point scale from "all the time" (coded 1) to "none of the time" (5). Scores were reverse coded and rescaled from 0 to 4, then summed so that a higher total score reflected higher levels of psychological distress ($\alpha = 0.98$).

Statistical analyses

Analyses were conducted using Stata 15 and proceeded in the following steps:

Step 1: Is high neighborhood deprivation in childhood associated with age-17 mental health problems in MCS?

We examined associations between high neighborhood deprivation in childhood and (i) total SDQ problems, (ii) internalizing problems, and (iii) externalizing problems self-reported at age 17. Because IMD is measured at LSOA level, MCS participants who live within the same LSOA may be more similar to one another than those who live in different LSOAs therefore this clustering must be taken into account. Traditional multilevel models are not appropriate as data are non-hierarchical (Figure 1) – that is, children do not necessarily belong to one and only one LSOA, rather this can change over time such that they are nested within a cross classification of up to six LSOAs (one at each study sweep). We accounted for this non-hierarchical data structure using cross-classified models. These were fitted using Markov Chain Monte Carlo (MCMC) estimation using the "runmlwin" command (Leckie & Charlton, 2013); a simulation-based method involving multiple iterations (see Supplementary Material for further details). Parameter estimates were computed at each iteration from which means, standard deviations and credible intervals were calculated. We adjusted models for the potentially confounding effects of family income[3] and ethnicity, and accounted for MCS sample stratification by including dummy variables representing the nine strata of MCS[4].

Step 2: Which factors protect against age-17 mental health problems for children exposed to high neighborhood deprivation in MCS?

Focusing on the outcome(s) that were found to be significantly associated (at $p < .05$) with high neighborhood deprivation in Step 1, we tested each putative protective factor. Consistent with the concept of resilience (Luthar et al., 2000; Rutter, 1985), for something to be protective, there must first have been exposure to a risk – here, high neighborhood deprivation. Therefore, we identified MCS participants who were exposed to high neighborhood deprivation and used cross-classified models to examine whether the following factors were associated with fewer mental health problems at age 17 in these participants: biological sex, infant temperament, cognitive skills, self-esteem, family income, parent-child relationship, parental knowledge of child's whereabouts, green space, and social support. These models were adjusted for family income, ethnicity and MCS sample stratification. When higher family income was examined as a predictor of fewer adolescent mental health problems we adjusted for ethnicity and MCS sample stratification.

For each factor found to be significantly associated (at $p < .05$) with fewer mental health problems among those exposed to high neighborhood deprivation, we then tested the statistical interaction with high neighborhood deprivation in the full MCS analysis sample. This tests whether they are associated with fewer mental health problems *only* in the context of exposure to high neighborhood deprivation in childhood (significant interaction) and thus have a protective effect or whether they are generally promotive for everyone regardless of deprivation exposure (no interaction and evidence of a main association). In other words, they exert a promotive effect in the whole sample. These models were adjusted for family income, ethnicity and MCS sample stratification.

Step 3: sensitivity analyses

To test the robustness of our findings we conducted sensitivity analyses (i) repeating Step 1 additionally controlling for potential confounding by maternal psychological distress (see Supplementary Material for detail); (ii) repeating Step 1 using only MCS participants who did not move residence between ages 14–17 (i.e. after the last IMD assessment); (iii) repeating Step 1 using alternative cut-points to

[3]High neighborhood deprivation and family income were only moderately correlated ($r = -0.42$, $p < .001$) suggesting that multicollinearity was not high.

[4]The use of weights is not supported by MCMC estimation using the 'runmlwin' command so we could only account for the study's sampling stratification.

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Table 1. Description of putative protective factors in the Millennium Cohort Study

Measure	Respondent	Description of measure	Assessment study sweep (age)
Family income	Parent	Respondents selected the category that captured their total annual family take-home income from all sources after tax and other deductions: "£0 to <£3,100" (coded 1), "£3,100 to < £10,400" (2), "£10,400 to <£20,800" (3), "£20,800 to <£31,200" (4), "£31,200 to <£52,000" (5), or "£52,000 and above" (6). To investigate higher income as a protective factor we recoded this variable to "£0 to <£31,200" (coded 0) versus "£31,200 to £52,000 and above" (1) to identify those with household incomes above the UK median at the time of reporting (median=£26,613 in the year 2001/2002; Office for National Statistics, 2023).	Sweep 1 (9 months)
Biological sex	Parent	Coded 1 = male; 2 = female	Sweep 1 (9 months)
Infant temperament	Parent	Assessed using 14 items from the Carey Infant Temperament Scale (Carey & McDevitt, 1977). These items tap into four areas: regularity (4 items), approach-withdrawal (3 items), adaptability (2 items), mood (5 items). Responses were given on a 5-point scale ranging from "Almost never" (coded 1) to "Almost always" (5). Items assessing approach-withdrawal and adaptability were reverse coded, then summed to create an overall total score in which higher scores indicated an easier infant temperament.	Sweep 1 (9 months)
Self-esteem	Child	Assessed using a shortened and adapted version of Rosenberg's Self-Esteem Scale (Rosenberg, 1965) comprising five items that reflect a positive view of self. Item responses were given on a four-point scale ranging from 'Strongly agree' (coded 1) to 'Strongly disagree' (4). Responses were reverse coded and then summed to provide a score ranging from 5 to 20, with higher scores indicating more positive self-esteem. Scores from sweep 5 and sweep 6 were then averaged together.	Sweeps 5 & 6 (11 & 14 years)
Cognitive skills	Child	Assessed using measures from the British Ability Scales, 2nd Edition (BAS II; Elliott, 1996). The BAS Naming Vocabulary scale was administered to measure children's expressive language skills, vocabulary knowledge of nouns, ability to attach verbal labels to pictures, general knowledge, retrieval of names from long-term memory and language stimulation. The BAS Picture Similarity assessed children's problem-solving ability, and the BAS Pattern Construction assessed spatial awareness, dexterity and coordination as well as traits such as perseverance and determination. For all three BAS batteries, scores were converted to standardized T-scores by reference to age-specific population norms.	Sweep 3 (5 years)
Parent-child relationship	Mother	Assessed using the 15-item Child-Parent Relationship Scale short form (Pianta, 1995). Example items include 'It is easy to be in tune with my child's feelings' and 'My child will seek comfort from me'. Item responses were given on a five-point scale, ranging from 'definitely does not apply' (scored 1) to 'definitely applies' (5), and were summed to create a total score such that a higher score reflects a more positive relationship.	Sweep 2 (3 years)
Parental knowledge of child's whereabouts	Parent	Three items measured how often parents know where their child is, who they are with and what they are doing when they go out. Responses were given on a 4-point Likert scale from "always" (coded 1) to "never" (4). Items were reverse scored and summed to create a total score such that higher scores reflect higher levels of parental knowledge.	Sweep 6 (14 years)
Green space		Estimated by combining land use data from the 2001 Generalised Land Use Database (GLUD: Office of the Deputy Prime Minister, 2001) and the Coordination of Information on the Environment (CORINE; European Environment Agency, 2000). GLUD offers an indicator of the percentage of green space per ward in England, covering both public and private green spaces larger than 5 m^2 in an area (excluding domestic gardens). CORINE is a land cover dataset from 2000 covering the whole of the UK derived from remotely sensed satellite imagery. It does not capture smaller green spaces (the smallest area mapped in the UK was roughly 1 hectare) and therefore is only sensitive to larger green spaces like parks. To create the ward-level indicator for all UK wards, a regression model was developed that predicted the GLUD percentage of green space for each English ward by a combination of its CORINE composition (percentage green space, percentage urban fabric, percentage blue space) and population density. As this model predicted the English GLUD ward-level values well, UK-wide ward-level green space data were estimated by applying the same model. These values were grouped into deciles such that the lowest decile corresponds to areas with 0-10% green space per ward and the top decile refers to areas with 90-100% green space per ward. For our analysis, we calculated the average decile across sweeps 1 to 7.	Sweeps 1 – 6 (9 months – 14 years)
Social support	Child	Assessed using three items from the Social Provisions Scale (Cutrona & Russell, 1987). The cohort member was asked to think about their current relationships with friends, family members, and community members and indicate whether each statement was 'very true' (coded 1), 'partly true' (2), or 'not at all true' (3). Example items include 'There is someone I trust whom I would turn to for advice if I were having problems'. Positively worded items were reverse scored, and then all items summed to create a total score such that higher scores represented a higher provision of social support.	Sweep 7 (17 years)

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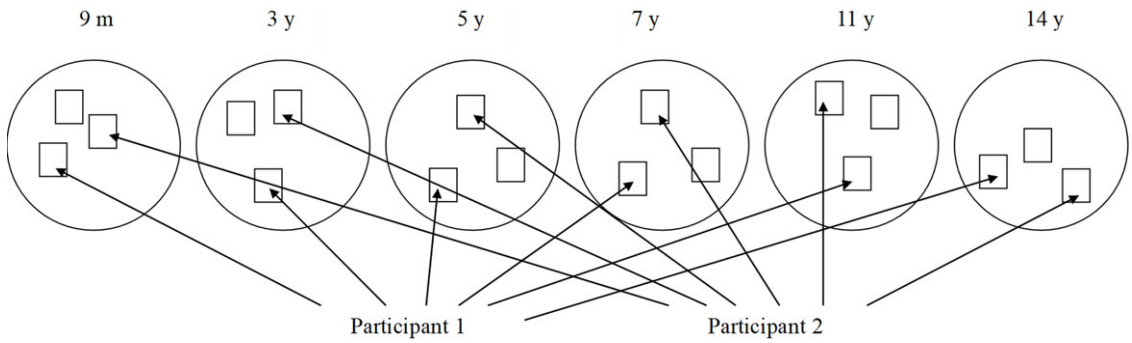

Figure 1. Millennium Cohort Study (MCS) data are not "purely" nested (i.e., children do not necessarily belong to one and only one LSOA), instead participants are nested within a cross-classification of up to six LSOAs (one at each study sweep). *Note*. Circles represent MCS study sweeps in which address data was collected (age 9 months, 3 years, 5 years, 7 years, 11 years, and 14 years); squares represent lower-layer super output areas (LSOAs); participants 1 and 2 shown for illustrative purposes. (Figure adapted from Bakolis et al., 2023).

define "high" neighborhood deprivation (i.e., below the median and using the full continuous scale); (iv) repeating Step 1 stratifying analyses by biological sex; and (v) repeating Steps 1 and 2 using age-17 parent-reported SDQ.

Step 4: Are the associations between high neighborhood deprivation and mental health problems found in MCS comparable in E-Risk, and do they extend to clinically relevant psychiatric diagnoses at age 18?

Using the E-Risk sample, we first used linear regression models to examine associations between high neighborhood deprivation at age 12 and (i) general psychopathology, (ii) internalizing symptoms, and (iii) externalizing symptoms factor scores at age 18. Next, we ran sensitivity analyses using logistic regression extending to (iv) any psychiatric disorder, (v) any internalizing disorder, and (vi) any externalizing disorder at age 18. There is no clustering of E-Risk participants at neighborhood level therefore we did not use cross-classified models. However, E-Risk twins are clustered within families, so we accounted for this using the Huber-White variance estimator (Rogers, 1994). Models were adjusted for the potential confounders of family income[5] and ethnicity.

Step 5: Are the putative protective factors found in MCS comparable in E-Risk?

For any significant associations (at $p < .05$) between neighborhood deprivation and mental health outcomes we then investigated whether the protective factors found in our MCS analyses were also associated with fewer mental health problems in E-Risk participants using linear regression models (logistic regression for categorical outcomes) and conceptually comparable variables.

Analytic samples

We analyzed complete cases (MCS: $N = 5,422$ and E-Risk: $N = 1,920$) because appropriately implementing multiple imputation in cross-classified data is extremely challenging (and understudied) due to the complex dependency between observations that is not captured by hierarchical models (Grund et al., 2023) (see Supplementary Table S2 for details of missingness).

[5]Household income and high neighborhood deprivation correlated $r = -0.39$, $p < .001$ suggesting multicollinearity was not high.

Results

Is high neighborhood *deprivation in childhood associated with age-17 mental health problems in MCS?*

A total of 1,498 MCS participants were exposed to high neighborhood deprivation during childhood (see Table 2 for descriptive statistics for all MCS study variables).

Exposure to high neighborhood deprivation was significantly associated with higher total problems and more internalizing problems (Table 3). No association was found for externalizing problems (Table 3).

Sensitivity analyses (i) additionally controlling for maternal psychological distress and (ii) using only MCS participants who did not move residence during adolescence replicated the above findings (Supplementary Tables S3 & S4).

Sensitivity analyses using average childhood IMD as a continuous scale (Supplementary Table S5) and using the median to define exposure to high deprivation (Supplementary Table S6) showed significant associations with all three mental health outcomes. Consistent with our findings above, the largest effects were found for total problems and internalizing problems.

Stratifying analyses by biological sex (Supplementary Table S7) showed that for males the largest effects were for total problems and internalizing problems, and there was no association with externalizing problems. For females, effect sizes were largest for total problems and were comparable for internalizing and externalizing problems (albeit statistically non-significant).

Sensitivity analyses using parent-reported adolescent mental health problems indicated significant associations between high neighborhood deprivation and more internalizing, externalizing, and total problems (Supplementary Table S8).

Which factors protect against age-17 total problems and internalizing *problems for children exposed to high* neighborhood *deprivation in MCS?*

Within MCS participants exposed to high neighborhood deprivation during childhood ($N = 1,498$), male sex, easier infant temperament, higher self-esteem, a more positive parent-child relationship, greater parental knowledge about their child's whereabouts, and more social support were each associated with fewer total problems self-reported at age 17 (Table 4). None of the interactions with high neighborhood deprivation were found to be significant and all were robustly associated with fewer total problems in the full sample, with male sex showing the largest effects (Supplementary Table S9).

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Table 2. Descriptive statistics of study variables in the whole Millennium Cohort Study (MCS) analysis sample and the subsample exposed to high levels of neighborhood deprivation in childhood

	Whole MCS analysis sample ($N = 5,422$)		High neighborhood deprivation ($N = 1,498$)	
	Categorical variables			
	N	%	*N*	%
Neighborhood deprivation				
High (<25th centile)	1,498	27.6	1,498	100.0
Not high (≥25th centile)	3,924	72.4	0	0.0
Biological sex:				
Male	2,596	47.9	700	46.7
Female	2,826	52.1	798	53.3
Ethnicity:				
White	4,504	83.1	950	63.4
Mixed	170	3.1	66	4.4
Indian	160	3.0	65	4.3
Pakastani & Bangladeshi	362	6.7	298	19.9
Black or Black British	143	2.6	86	5.7
Other	83	4.5	33	2.2
Family income:				
£0 to <£3,100	72	1.3	41	2.7
£3,100 to <£10,400	897	16.5	564	37.7
£10,400 to < £20,800	1,707	31.5	605	40.4
£20,800 to <£31,200	1,277	23.6	193	12.9
£31,200 to <£52,000	1,038	19.1	75	5.0
£52,000+	431	8.0	20	1.3
High family income:				
£0 to <£31,200	3,953	72.9	1403	93.7
£31,200 and above	1,469	27.1	95	6.3
	Continuous variables			
	N	Mean (SE)	*N*	Mean (SE)
Self-reported total problems	5,422	11.32 (0.08)	1,498	11.81 (0.15)
Self-reported internalizing problems	5,422	5.74 (0.05)	1,498	6.04 (0.09)
Self-reported externalizing problems	5,422	5.58 (0.04)	1,498	5.77 (0.09)
Parent-reported total problems	5,011	7.21 (0.08)	1,338	8.84 (0.17)
Parent-reported internalizing problems	5,017	3.75 (0.05)	1,342	4.54 (0.10)
Parent-reported externalizing problems	5,018	3.47 (0.05)	4.30	4.30 (0.10)
Infant temperament	5,304	56.56 (0.09)	1,409	54.88 (0.19)
Self-esteem	5,271	16.86 (0.03)	1,440	16.92 (0.06)
Cognitive skills:				
Picture similarity score	5,410	56.06 (0.14)	1,495	54.01 (0.28)
Pattern construction score	5,412	51.42 (0.13)	1,495	48.68 (0.28)
Vocabulary score	5,422	54.84 (0.15)	1,498	48.93 (0.31)
Parental knowledge	5,318	10.38 (0.02)	1,460	10.33 (0.05)
Parent-child relationship	4,873	64.45 (0.10)	1,164	63.36 (0.22)
Green space	5,422	4.37 (0.03)	1,498	3.13 (0.05)
Social support	3,800	8.28 (0.02)	931	8.15 (0.04)
Maternal psychological distress	4,864	3.08 (0.05)	1,186	3.82 (0.12)

Note. SE = standard error. Tests for statistically significant differences between the whole MCS analysis sample and those exposed to high neighborhood deprivation could not be conducted as these groups are not independent of one another.

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Table 3. Association of high neighborhood deprivation in childhood with self-reported mental health problems at age 17 years in the Millennium Cohort Study (MCS)

Mental health problems	Estimate (SD)	*p*	95% CI
Total problems	**0.46** (0.21)	.015	0.04 – 0.88
Internalizing problems	**0.32** (0.14)	.008	0.06 – 0.59
Externalizing problems	0.14 (0.13)	.142	−0.11 – 0.39

Note. $N = 5{,}422$. CI = credible intervals; SD = standard deviation. Models were adjusted simultaneously for MCS sample stratification, family income and ethnicity. *p* is a Bayesian 1-sided p-value. Statistically significant estimates ($p<0.05$) are highlighted in bold.

Male sex, easier infant temperament, higher self-esteem, a more positive parent-child relationship, and more social support were also associated with fewer age-17 internalizing problems for those exposed to high neighborhood deprivation during childhood (Table 5). Conversely, more green space in their local area was associated with more adolescent internalizing problems for those exposed to high deprivation (Table 5).

The interaction between higher self-esteem and high neighborhood deprivation was significant in the full sample (Supplementary Table S10), with the association with fewer age-17 internalizing problems being slightly stronger for those who were exposed to high neighborhood deprivation (estimate = −0.35, $SD = 0.04$, $p < .001$, 95% $CI = -0.43$– −0.27) compared to those who were not (estimate = −0.29, $SD = 0.03$, $p < .001$, 95% $CI = -0.34$– −0.24). The interaction between green space and high neighborhood deprivation was also significant in the full sample (Supplementary Table S10) such that having more green space in the local area was associated with more internalizing problems for those exposed to high neighborhood deprivation (estimate = 0.12, $SD = 0.06$, $p = .035$, 95% $CI = -0.01$–0.24) but not for those who were unexposed (estimate = −0.21, $SD = 0.03$, $p = .207$, 95% $CI = -0.07$–0.03). No other interactions were found to be significant but male sex, a more positive parent-child relationship, and greater social support were all robustly associated with fewer internalizing problems in the full sample (Supplementary Table S10), with the largest effects found for male sex and social support.

Supplementary analyses using parent-reported age-17 mental health problems showed a consistent pattern across the three outcomes (Supplementary Table S11). An easier infant temperament, higher self-esteem, higher cognitive skills, greater parental knowledge of their child's whereabouts, a more positive parent-child relationship, higher social support, and higher family income were associated with fewer internalizing, externalizing and total problems among those exposed to high neighborhood deprivation in childhood. Additionally, male sex was associated with fewer parent-reported internalizing problems whereas female sex was associated with fewer parent-reported externalizing problems. However, in the full sample, only easier infant temperament, greater parental knowledge, and higher social support were found to be more strongly associated with fewer parent-reported total and externalizing problems among those exposed to high neighborhood deprivation compared to those who were not (Supplementary Tables S12 and S13, respectively). Greater parental knowledge was found to be associated with fewer parent-reported internalizing problems in the high neighborhood deprivation group but not in the unexposed group (Supplementary Tables S14 and S15).

Table 4. Associations between putative protective factors and age-17 total problems among Millennium Cohort Study (MCS) participants exposed to high levels of neighborhood deprivation during childhood

Putative protective factor	*N*	Estimate (SD)	*p*	95% CI
Male sex	1,498	**−1.62** (0.29)	.001	−2.21 – −1.04
Temperament	1,409	**−0.06** (0.02)	.003	−0.11 – −0.02
Self-esteem	1,440	**−0.51** (0.07)	< .001	−0.64 – −0.38
Cognitive skills:				
Picture similarity	1,495	0.01 (0.01)	.312	−0.02 – 0.03
Pattern construction	1,495	−0.02 (0.01)	.140	−0.04 – 0.01
Vocabulary	1,498	−0.01 (0.01)	.226	−0.04 – 0.02
Parental knowledge	1,460	**−0.40** (0.08)	< .001	−0.55 – −0.24
Parent-child relationship	1,164	**−0.11** (0.02)	< .001	−0.15 – −0.06
Green space	1,498	0.08 (0.10)	.216	−0.13 – 0.28
Social support	931	**−1.80** (0.14)	< .001	−2.07 – −1.52
High family income	1,498	−0.83 (0.61)	.087	−2.01 – 0.35

Note. Putative protective factors were tested individually, one at a time. CI = credible intervals; SD = standard deviation. Models were adjusted simultaneously for MCS sample stratification, family income and ethnicity. The model testing high family income as a protective factor was only adjusted for MCS sample stratification and ethnicity. *p* is a Bayesian 1-sided p-value. Statistically significant estimates ($p<0.05$) are highlighted in bold.

Are the associations between high neighborhood *deprivation and mental health problems found in MCS comparable in E-Risk and do they extend to clinically relevant psychiatric diagnoses at age 18?*

A total of 463 (24.1%) E-Risk participants were exposed to high neighborhood deprivation at age 12 (see Table 6 for descriptive statistics of all E-Risk study variables).

There were no significant associations between high neighborhood deprivation in childhood and age-18 general psychopathology (estimate = −0.32, $SE = 1.04$, $p = .758$, 95% $CI = -2.35$–1.72), internalizing symptoms (estimate = −0.29, $SE = 1.03$, $p = .779$, 95% $CI = -2.32$–1.74) or externalizing symptoms (estimate = −0.61, $SE = 1.02$, $p = .549$, 95% $CI = -2.61$–1.39) in E-Risk. Similarly, for clinically relevant psychiatric diagnoses, there were no significant associations between age-12 high neighborhood deprivation and any psychiatric disorder (OR = 0.89, $SE = 0.12$, $p = .372$, 95% $CI = 0.68$–1.15), any internalizing disorder (OR = 0.98, $SE = 0.14$, $p = .857$, 95% $CI = 0.74$–1.28) or any externalizing disorder (OR = 0.82, $SE = 0.12$, $p = .173$, 95% $CI = 0.62$–1.09) at age 18.

Given the absence of a robust association between high neighborhood deprivation and mental health problems in E-Risk participants, we did not proceed to investigate putative protective factors as originally planned in this sample.

Discussion

Main findings

In MCS, exposure to high neighborhood deprivation in childhood was associated with more total mental health problems and internalizing (but not externalizing) difficulties in adolescence. Being male, having an easier infant temperament, higher self-esteem, more social support, a more positive parent-child

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Table 5. Associations between putative protective factors and age-17 internalizing problems among Millennium Cohort Study (MCS) participants exposed to high levels of neighborhood deprivation during childhood

Putative protective factor	*N*	Estimate (SD)	*p*	95% CI
Male sex	1,498	**−1.88** (0.18)	< .001	−2.23 – −1.53
Temperament	1,409	**−0.03** (0.01)	.011	−0.06 – −0.01
Self-esteem	1,440	**−0.35** (0.04)	< .001	−0.43 – −0.27
Cognitive skills:				
Picture similarity	1,495	0.00 (0.01)	.319	−0.02 – 0.01
Pattern construction	1,495	−0.01 (0.01)	.144	−0.03 – 0.01
Vocabulary	1,498	−0.00 (0.01)	.357	−0.02 – 0.01
Parental knowledge	1,460	−0.08 (0.05)	.051	−0.17 – 0.02
Parent-child relationship	1,164	**−0.05** (0.01)	< .001	−0.08 – −0.02
Green space	1,498	**0.12** (0.06)	.035	−0.01 – 0.24
Social support	931	**−1.05** (0.09)	< .001	−1.22 – −0.88
High family income	1,498	−0.61 (0.37)	.050	−1.34 – 0.11

Note. Putative protective factors were tested individually, one at a time. CI = credible intervals; SD = standard deviation. Models were adjusted simultaneously for MCS sample stratification, family income and ethnicity. The model testing high family income as a protective factor was only adjusted for MCS sample stratification and ethnicity. *p* is a Bayesian 1-sided p-value. Statistically significant estimates ($p<0.05$) are highlighted in bold.

relationship, and parents with more knowledge of their child's whereabouts were associated with fewer total problems in individuals exposed to high neighborhood deprivation in childhood and those who were not. Similarly, being male, having higher self-esteem, a more positive parent-child relationship and more social support were also associated with fewer adolescent internalizing problems. These were promotive for all regardless of the level of neighborhood deprivation experienced, however higher self-esteem was linked more strongly with fewer internalizing problems for those exposed to high neighborhood deprivation. Statistically significant associations between neighborhood deprivation and poorer adolescent mental health were not found among E-Risk participants.

Importantly, the relationships between childhood neighborhood deprivation and adolescent internalizing and total problems in MCS were independent of family income. Since income likely influences where someone can live, accounting for this is crucial to demonstrate a true effect of the neighborhood environment over and above family-level disadvantage. The associations were also robust to several sensitivity checks including using the continuous measure of IMD and the median split.

Our finding that MCS participants who lived in relatively highly deprived neighborhoods during childhood reported more internalizing problems at age 17 is consistent with several studies and meta-analyses showing an association between deprived neighborhoods and depression and anxiety in children (Bakolis et al., 2023) and in adults (Elovainio et al., 2020; Pearce et al., 2018; Sui et al., 2022). One possibility is that neighborhood deprivation exposes individuals to more stress alongside less resource to counteract it. Individuals' feelings of safety may also be lower in more deprived areas (Mouratidis, 2020; Polling et al., 2014) which has been linked with young people's emotional but not conduct disorders (Meltzer et al., 2007) mirroring our finding of an association with internalizing but not externalizing problems.

Cross-cohort comparisons

The links between childhood neighborhood deprivation and poorer adolescent mental health demonstrated in MCS were not found in our second cohort, the E-Risk study. This could reflect generational social change such that neighborhood deprivation has become more important for mental health in recent years. Alternatively, it could reflect methodological differences between the cohorts. E-Risk used only a single assessment of IMD at age 12 compared to MCS's multiple measures across childhood with the latter capturing more information about deprivation exposure.

The mental health measures also differ between the cohorts with MCS using a population mental health metric compared to the more clinical interview measure used in E-Risk. Furthermore, there are important differences in the "internalizing" and "externalizing" problems and "total problems" and "general psychopathology" constructs derived from these measures between the two cohorts. Specifically, MCS uses observed scores on the SDQ, the subscales of which can be correlated, whereas E-Risk uses bifactor modeling to obtain independent (uncorrelated) factors from which factor scores are analyzed. Thus, there will be positive intercorrelations between the "total problems," "internalizing" and "externalizing" problems scores in MCS whereas the internalizing and externalizing factor scores in E-Risk represent the constructs of externalizing and internalizing symptoms over and above the latent "general psychopathology" factor and are specified to be uncorrelated with each other (see Schaefer et al., 2018). These differences in the measurement of mental health may also contribute to the different findings we report across the MCS and E-Risk cohorts.

Parent- versus self-reported mental health

Finally, we revealed a different pattern of associations for self- versus parent-reported adolescent mental health problems in MCS with an association between high levels of neighborhood deprivation and externalizing problems evident only when parent-report was utilized. Discrepancies between adolescent and parent reports of mental health are well-documented (Booth et al., 2023; De Los Reyes et al., 2015). Whilst adolescents are assumed to have better insight into their own internalizing problems because feelings and emotions may be unseen by parents (Sourander et al., 1999), parent-report may be more suitable for identifying externalizing problems, particularly oppositional behaviors and those related to conduct disorder and ADHD (Aebi et al., 2017). There were also some differences in the pattern of associations found with the putative protective factors and their interactions with neighborhood deprivation. Most notably, higher cognitive skills were associated with fewer parent-reported mental health problems across all three outcomes for those exposed to high neighborhood deprivation and those who were not. However, despite some differences, social support and self-esteem continued to yield the largest effect sizes of the modifiable factors (alongside higher family income), consistent with our findings using self-report.

Implications

Our study adds to an emerging literature suggesting that tackling the root causes of inequality to prevent neighborhood deprivation may help prevent some mental health issues (Elovainio et al., 2020; Leventhal & Brooks-Gunn, 2000; Pearce et al., 2018; Visser et al., 2021). Structural-level interventions to improve equity in this way have the potential benefit of impacting many people at the same time with cascading effects over the life course. However, our

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Table 6. Descriptive statistics of study variables in the whole E-Risk study analysis sample and the subsample exposed to high levels of neighborhood deprivation in childhood

	Whole E-Risk analysis sample (N = 1,920)		High neighborhood deprivation (N = 463)	
	Categorical variables			
	N	%	N	%
Neighborhood deprivation				
High (≤2nd decile)	463	24.1	463	100.0
Not high (>2nd decile)	1,457	75.9	0	0.0
Biological sex				
Male	913	47.6	232	50.1
Female	1,007	52.5	231	49.9
Ethnicity				
White	1,754	91.4	409	88.3
Asian	56	2.9	20	4.3
Black	40	2.1	20	4.3
Mixed	8	0.4	2	0.4
Other	62	3.2	12	2.6
Family income				
<£3,999	34	1.8	21	4.5
£4,000 - £9,999	319	16.6	160	34.6
£10,000 - £19,999	579	30.2	186	40.2
£20,000 - £31,999	489	25.5	80	17.3
£32,000 - £40,999	223	11.6	14	3.0
£41,000+	276	14.4	2	0.4
High family income				
<£3,999 – £31,999	1,421	74.0	447	96.5
£32,000+	499	26.0	16	3.5
Maternal warmth				
Low warmth	506	28.3	151	37.1
High warmth	1,281	71.7	256	62.9
Any psychiatric disorder				
Yes	904	47.4	233	50.7
No	1,002	52.6	227	49.4
Any internalizing disorder				
Yes	541	28.4	144	31.3
No	1,364	71.6	316	68.7
Any externalizing disorder				
Yes	612	32.0	155	33.6
No	1,299	68.0	306	66.4
	Continuous variables			
	N	Mean (SD)	N	Mean (SD)
General psychopathology factor score	1,920	99.90 (14.95)	463	101.24 (15.69)
Internalizing symptoms factor score	1,920	99.92 (15.02)	463	101.03 (15.63)
Externalizing symptoms factor score	1,920	99.90 (14.97)	463	101.14 (14.83)
Approach temperament	1,915	9.41 (2.97)	461	9.04 (3.09)

(*Continued*)

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Table 6. (*Continued*)

	Continuous variables			
	N	Mean (SD)	N	Mean (SD)
Cognitive skills				
IQ	1,907	95.91 (14.54)	461	90.87 (13.86)
Block design	1,909	9.72 (2.84)	462	8.98 (2.83)
Vocabulary	1,914	8.90 (3.07)	462	7.96 (2.91)
Parental knowledge	1,868	10.96 (1.54)	447	10.85 (1.63)
Parental control	1,867	7.20 (1.20)	446	6.93 (1.46)
Green space	1,900	0.56 (0.09)	461	0.52 (0.09)
Social support				
Family support	1,917	6.99 (1.79)	461	7.04 (1.78)
Friend support	1,917	6.71 (1.99)	461	6.54 (2.12)
Significant others	1,917	7.02 (1.79)	461	7.01 (1.89)
Total	1,917	20.72 (4.31)	461	20.59 (4.55)

Note. E-Risk = Environmental Risk Longitudinal Twin Study; IQ = intelligence quotient; SD = standard deviation. Tests for statistically significant differences between the whole E-Risk analysis sample and those exposed to high neighborhood deprivation could not be conducted as these groups are not independent of one another.

findings also identify several individual-level modifiable factors that could be the focus of interventions to reduce adolescent mental health problems among those exposed to neighborhood deprivation as well as those who are not.

For example, we found a role for parenting (positive parent-child relationship and greater knowledge of child's whereabouts) in promoting better adolescent mental health. This was the case for individuals exposed to high levels of childhood neighborhood deprivation and those who were not and is consistent with research showing the wider benefits of secure attachment (Brumariu, & Kerns, 2010) and parental monitoring (Cadman et al., 2022) for adolescent mental health. Parents who are more involved and knowledgeable about their offspring's whereabouts may be better able to support and help them. Greater knowledge and a more positive parent-child relationship may also reflect open communication allowing the child/adolescent to disclose any difficulties and seek help thus potentially reducing the likelihood of mental health problems.

Additionally, consistent with a wealth of evidence highlighting the benefits of social support (Gariepy et al., 2016; Latham et al., 2022; Wang et al., 2018) and self-esteem (Orth & Robins, 2022) for mental health, we also found evidence that these helped reduce the level of total problems and internalizing problems reported at age 17. These effects were the largest (aside from biological sex) and thus may be viable targets for interventions to increase young people's self-esteem and the social support they have available to them to help prevent mental health difficulties. For example, cognitive behavior therapy and competitive memory training targeting self-esteem have been shown to be effective (Kolubinski et al., 2018; Korrelboom et al., 2022) with beneficial effects on depression and anxiety also reported (Korrelboom et al., 2022; Staring et al., 2016). Whilst our findings suggest that this would be beneficial for everyone, regardless of exposure to neighborhood deprivation, they also indicate that improvements to self-esteem may be especially beneficial for those in deprived neighborhoods. When resources are limited, targeting those in more deprived areas first or with greater intensity (Marmot, 2010) is recommended given their higher risk for developing mental health problems.

Our study also adds to literature highlighting the need to better understand the societal conditions that drive gender inequalities in adolescent mental health problems (Campbell et al., 2021; McElroy et al., 2023). Whilst biological sex at birth is not in itself a modifiable target for intervention, identifying what underlies the benefits of being male for having fewer total problems and internalizing difficulties may help inform interventions to promote adolescent mental health.

Strengths and limitations

To our knowledge, this is the first UK study to examine the association between childhood neighborhood deprivation and adolescent internalizing and externalizing problems, plus investigate factors that are protective of mental health in this risky context. Strengths include the use of two large nationally representative samples, cross-classified models to appropriately model complex data structures, repeated measures of neighborhood deprivation, longitudinal prospective measures of mental health and key confounding variables, and sensitivity analyses to test the robustness of findings.

We also acknowledge limitations. By averaging the repeated measures of neighborhood deprivation in MCS we did not model whether changes reflected improvements or worsening of deprivation exposure over childhood, and it is possible that mental health outcomes may differ accordingly. Averaging the measures also meant that we were blind to any cumulative or sensitive period effects. Furthermore, in MCS changes in IMD during childhood only capture changes resulting from participants moving neighborhoods, changes in the relative deprivation of neighborhoods themselves could not be captured as only the 2004 IMD has been applied to participants' addresses. However, whilst some change in the relative rank of neighborhoods is expected over

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time, evidence suggests that among the most and least deprived areas there is considerable continuity (Office for National Statistics, 2011, 2015).

Although we use IMD to measure neighborhood deprivation in both MCS and E-Risk, the samples consist of different individuals who may be disadvantaged in different ways. This within-group variation is not captured by our study as we investigated group-level differences rather than individual-level prediction. Consistent with the majority of research in this field, we utilized the overall IMD rank and therefore did not separately examine the different domains of neighborhood deprivation. These domains may be differentially associated with mental health problems (Flouri et al., 2020) and they may have different protective factors.

The E-Risk study applied a bifactor model to its measurement of adolescent mental health symptoms which is a popular approach to capture common and unique elements of psychopathology (e.g., Caspi et al., 2014; Laceulle et al., 2015; Sharp et al., 2015). However, concerns have recently been raised about this approach including how bifactor models are evaluated – e.g., that the model has a tendency to overfit such that global fit statistics favor the model even when it is a poor description of the data – and questions about how the "general psychopathology" (or "p factor") and "internalizing and "externalizing" factors are interpreted (Bornovalova et al., 2020; Watts et al., 2024). For example, to what extent internalizing and externalizing factors can be interpreted as traits that are independent of the p factor, and exactly what the causal mechanisms involved in the p factor are (Bonifay et al., 2017; Watts et al., 2024).

Our analyses controlled for family income measured at study baseline. Repeated measures of family income were available in MCS such that an alternative strategy would have been to calculate an average family income variable. However, because family income was only measured at study baseline in E-Risk, we opted to maximize comparability between the studies.

We examined a large number of associations and although the significance level at 5% is purely nominal and the likelihood of type I error is inflated, the majority of our findings in MCS were consistent in terms of the direction and size of the association. In addition, we analyzed complete cases which may have introduced some bias into our MCS results where missing data was higher. As in any observational study, unmeasured confounding is a source of potential bias.

Finally, the E-Risk sample was comprised of twins and the extent to which findings can be generalized to non-twin samples is sometimes questioned. However, the prevalence of mental health problems has been shown to be comparable between twins and non-twins (Kendler et al., 1995), and the E-Risk families closely match the deciles of the UK government IMD (Supplementary Figure S1) suggesting neighborhood deprivation was also comparable.

Conclusion

Children who grow up in more deprived UK neighborhoods may be at risk of developing more mental health problems, including more internalizing problems, in adolescence. Tackling the root causes of inequality may help improve mental health whilst interventions that focus on improving self-esteem and the availability of social support may also be effective in promoting better adolescent mental health in the whole population.

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References

Abel, G., Payne, R., & Barclay, M. (2016). UK deprivation indices. Retrieved from https://data.bris.ac.uk/data/dataset/1ef3q32gybk001v77c1ifmty7x

Achenbach, T. M. (1991). *Manual for the child behavior checklist/4-18 and 1991 Profile*. University of Vermont Department of Psychiatry.

Aebi, M., Kuhn, C., Banaschewski, T., Grimmer, Y., Poustka, L., Steinhausen, H. C., & Goodman, R. (2017). The contribution of parent and youth information to identify mental health disorders or problems in adolescents. *Child and Adolescent Mental Health*, *11*(1), 1–12. https://doi.org/10.1186/s13034-017-0160-9

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders (4th edition)*. American Psychiatric Association.

American Psychiatric Association. (**2013**). *Diagnostic and Statistical Manual of Mental Disorders (5th edition)*. American Psychiatric Association.

Bakolis, I., Murray, E. T., Hardy, R., Hatch, S. L., & Richards, M. (2023). Area disadvantage and mental health over the life course: A 69-year prospective birth cohort study. *Social Psychiatry and Psychiatric Epidemiology*, *58*(5), 735–744. https://doi.org/10.1007/s00127-023-02427-x

Bonifay, W., Lane, S. P., & Reise, S. P. (2017). Three concerns with applying a bifactor model as a structure of psychopathology. *Clinical Psychological Science*, *5*(1), 184–186. https://doi.org/10.1177/2167702616657069

Booth, C., Moreno-Agostino, D., & Fitzsimons, E. (2023). Parent-adolescent informant discrepancy on the strengths and difficulties questionnaire in the

UK millennium cohort study. *Child and Adolescent Psychiatry and Mental Health*, *17*(1), 57. https://doi.org/10.1186/s13034-023-00605-y

Bornovalova, M. A., Choate, A. M., Fatimah, H., Petersen, K. J., & Wiernik, B. M. (2020). Appropriate use of bifactor analysis in psychopathology research: Appreciating benefits and limitations. *Biological Psychiatry*, *88*(1), 18–27. https://doi.org/10.1016/j.biopsych.2020.01.013

Brumariu, L. E., Kerns, K., & **A** (2010). Parent-child attachment and internalizing symptoms in childhood and adolescence: A review of empirical findings and future directions. *Development and Psychopathology*, *22*(1), 177–203. https://doi.org/10.1017/S0954579409990344

Burmeister, M., McInnis, M., & Zöllner, S. (2008). Psychiatric genetics: Progress amid controversy. *Nature Reviews Genetics*, *9*(7), 527–540. https://doi.org/10.1038/nrg2381

Cadman, T., Paul, E., Culpin, I., Sallis, H., Bould, H., & Pearson, R. (2022). Parental monitoring longitudinally associates with reduced risk of adolescent mental health problems. *Journal of Affective Disorder*, *10*, 100420. https://doi.org/10.1016/j.jadr.2022.100420

Campbell, O. L., Bann, D., & Patalay, P. (2021). The gender gap in adolescent mental health: A cross-national investigation of 566,829 adolescents across 73 countries. *SSM-Population Health*, *13*, 100742. https://doi.org/10.1016/j.ssmph.2021.100742

Carey, W. B., & McDevitt, S. C. (1977). *Infant temperament questionnaire*. Department of Educational Psychology, Temple University.

Caspi, A., Houts, R. M., Ambler, A., Danese, A., Elliott, M. L., Hariri, A., Harrington, H. L., Hogan, S., Poulton, R., Ramrakha, S., Rasmussen, L. J. H., Reuben, A., Richmond-Rakerd, L., Sugden, K., Wertz, J., Williams, B. S., & Moffitt, T. E. (2020). Longitudinal assessment of mental health disorders and comorbidities across 4 decades among participants in the Dunedin birth cohort study. *JAMA Network Open*, *3*(4), e203221–e203221. https://doi.org/10.1001/jamanetworkopen.2020.3221

Caspi, A., Houts, R. M., Belsky, D. W., Goldman-Mellor, S. J., Harrington, H., Israel, S., Meier, M. H., Ramrakha, S., Shalev, I., Poulton, R., & Moffitt, T. E. (2014). The p factor: One general psychopathology factor in the structure of psychiatric disorders? *Clinical Psychological Science*, *2*(2), 119–137. https://doi.org/10.1177/2167702613497473

Crush, E., Arseneault, L., Jaffee, S. R., Danese, A., & Fisher, H. L. (2018a). Protective factors for psychotic symptoms among poly-victimized children. *Schizophrenia Bulletin*, *44*(3), 691–700. https://doi.org/10.1093/schbul/sbx111

Crush, E., Arseneault, L., Moffitt, T. E., Danese, A., Caspi, A., Jaffee, S. R., Matthews, T., & Fisher, H. L. (2018b). Protective factors for psychotic experiences amongst adolescents exposed to multiple forms of victimization. *Journal of Psychiatric Research*, *104*, 32–38. https://doi.org/10.1016/j.jpsychires.2018.06.011

Cutrona, C. E., & Russell, D. (1987). The provisions of social relationships and adaption to stress. In W. H. Jones, & D. Pearlman (Eds.), *Advances in personal relationships (Vol 1* (pp. 37–67). Jai Press Inc.

Danese, A., & Baldwin, J. R. (2017). Hidden wounds? Inflammatory links between childhood trauma and psychopathology. *Annual Review of Psychology*, *68*(1), 517–544. https://doi.org/10.1146/annurev-psych-010416-044208

Daré, L. O., Bruand, P. E., Gérard, D., Marin, B., Lameyre, V., Boumédiène, F., & Preux, P. (2019). Co-morbidities of mental disorders and chronic physical diseases in developing and emerging countries: A meta-analysis. *BMC Public Health*, *19*(1), 304. https://doi.org/10.1186/s12889-019-6623-6

De Los Reyes, A., Augenstein, T. M., Wang, M., Thomas, S. A., Drabick, D. A., Burgers, D. E., & Rabinowitz, J. (2015). The validity of the multi-informant approach to assessing child and adolescent mental health. *Psychological Bulletin*, *141*(4), 858–900. https://doi.org/10.1037/a0038498

Doherty, A. M., & Gaughran, F. (2014). The interface of physical and mental health. *Social Psychiatry and Psychiatric Epidemiology*, *49*(5), 673–682. https://doi.org/10.1007/s00127-014-0847-7

Elliott, C. D. (1996). *The British ability scales II*. NFER-NELSON Publishing Company.

Elovainio, M., Vahtera, J., Pentti, J., Hakulinen, C., Pulkki-Raback, L., Lipsanen, J., Virtanen, M., Keltikangas-Jarvinen, L., Kivimaki, M., Kahonen, M., Viikari, J., Lehtimaki, T., & Raitakari, O. (2020). The contribution of neighborhood socioeconomic disadvantage to depressive symptoms over the course of adult life: A 32-year prospective cohort study. *American Journal of Epidemiology*, *189*(7), 679–689. https://doi.org/10.1093/aje/kwaa026

European Environment Agency (2000). CORINE land cover 2000. Retrieved from https://www.eea.europa.eu/publications/COR0-landcover

Flouri, E., Mavroveli, S., & Midouhas, E. (2013). Residential mobility, neighbourhood deprivation and children's behaviour in the UK. *Health and Place*, *20*, 25–31. https://doi.org/10.1016/j.healthplace.2012.12.002

Flouri, E., Mavroveli, S., & Tzavidis, N. (2012). Cognitive ability, neighborhood deprivation, and young children's emotional and behavioral problems. *Social Psychiatry and Psychiatric Epidemiology*, *47*(6), 985–992. https://doi.org/10.1007/s00127-011-0406-4

Flouri, E., Midouhas, E., & Francesconi, M. (2020). Neighbourhood deprivation and child behaviour across childhood and adolescence. *Longitudinal and Life Course Studies*, *11*(2), 203–227. https://doi.org/10.1332/175795919X15722477076216

Flouri, E., Midouhas, E., & Joshi, H. (2014a). Family poverty and trajectories of children's emotional and behavioural problems: The moderating roles of self-regulation and verbal cognitive ability. *Journal of Abnormal Child Psychology*, *42*(6), 1043–1056. https://doi.org/10.1007/s10802-013-9848-3

Flouri, E., Midouhas, E., & Joshi, H. (2014b). The role of urban neighbourhood green space in children's emotional and behavioural resilience. *Journal of Environmental Psychology*, *40*, 179–186. https://doi.org/10.1016/j.jenvp.2014.06.007

Flouri, E., Midouhas, E., & Joshi, H. (2015). Family and neighbourhood risk and children's problem behaviour: The moderating role of intelligence. *Intelligence*, *53*, 33–42. https://doi.org/10.1016/j.intell.2015.08.003

Flouri, E., Midouhas, E., Joshi, H., & Sullivan, A. (2016). Socioeconomic disadvantage and children's behaviour problems: The role of early aspirations. *Longitudinal and Life Course Studies*, *7*(2), 144–164. https://doi.org/10.14301/llcs.v7i2.364

Flouri, E., Tzavidis, N., & Kallis, C. (2010). Adverse life events, area socioeconomic disadvantage and psychopathology and resilience in young children: The importance of risk factors' accumulation & protective factors specificity. *European Child and Adolescent Psychiatry*, *19*(6), 535–546. https://doi.org/10.1007/s00787-009-0068-x

Fone, D., White, J., Farewell, D., Kelly, M., John, G., Lloyd, K., Williams, G., & Dunstan, F. (2014). Effect of neighbourhood deprivation and social cohesion on mental health inequality: A multilevel population-based longitudinal study. *Psychological Medicine*, *44*(11), 2449–2460. https://doi.org/10.1017/S0033291713003255

Gariepy, G., Honkaniemi, H., & Quesnel-Vallee, A. (2016). Social support and protection from depression: Systematic review of current findings in Western countries. *British Journal of Psychiatry*, *209*(4), 284–293. https://doi.org/10.1192/bjp.bp.115.169094

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, *38*(5), 581–586. https://doi.org/10.1111/j.1469-7610.1997.tb01545.x

Grund, S., Lüdtke, O., & Robitzsch, A. (2023). Handling missing data in cross-classified multilevel analyses: An evaluation of different multiple imputation approaches. *Journal of Educational and Behavioural Statistics*, *48*(4), 454–489. https://doi.org/10.3102/10769986231151224

Helbich, M. (2018). Toward dynamic urban environmental exposure assessments in mental health research. *Environmental Research*, *161*, 129–135. https://doi.org/10.1016/j.envres.2017.11.006

Kendler, K. S., Martin, N. G., Heath, A. C., & Eaves, L. J. (1995). Self-report psychiatric symptoms in twins and their nontwin relatives: Are twins different? *American Journal of Medical Genetics*, *60*(6), 588–591. https://doi.org/10.1002/ajmg.13206

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L., Walters, E. E. & Zaslavsky, A. M. (2002) Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, *32*, 959–976. https://doi.org/10.1017/S0033291702006074

Kim-Cohen, J., Moffitt, T. E., Caspi, A., & Taylor, A. (2004). Genetic and environmental processes in young children's resilience and vulnerability to socioeconomic deprivation. *Child Development*, *75*(3), 651–668. https://doi.org/10.1111/j.1467-8624.2004.00699.x

Kolubinski, D. C., Frings, D., Nikčević, A. V., Lawrence, J. A., & Spada, M. M. (2018). A systematic review and meta-analysis of CBT interventions

based on the Fennell model of low self-esteem. *Psychiatry Research*, *267*, 296–305. https://doi.org/10.1016/j.psychres.2018.06.025

Korrelboom, K., IJdema, T., Karreman, A., & van der Gaag, M. (2022). The effectiveness of transdiagnostic applications of competitive memory training (COMET) on low self-esteem and comorbid depression: A meta-analysis of randomized controlled trials. *Cognitive Therapy and Research*, *46*(3), 532–543. https://doi.org/10.1007/s10608-021-10286-6

Kröger, H., Pakpahan, E., & Hoffmann, R. (2015). What causes health inequality? a systematic review on the relative importance of social causation and health selection. *The European Journal of Public Health*, *25*(6), 951–960. https://doi.org/10.1093/eurpub/ckv111

Laceulle, O. M., Vollebergh, W. A., & Ormel, J. (2015). The structure of psychopathology in adolescence: Replication of a general psychopathology factor in the TRAILS study. *Clinical Psychological Science*, *3*(6), 850–860. https://doi.org/10.1177/2167702614560750

Latham, R. M., Arseneault, L., Alexandrescu, B., Baldoza, S., Carter, A., Moffitt, T. E., Newbury, J. B., & Fisher, H. L. (2022). Violent experiences and neighbourhoods during adolescence: Understanding and mitigating the association with mental health at the transition to adulthood in a longitudinal cohort study. *Social Psychiatry and Psychiatric Epidemiology*, *57*(12), 2379–2391. https://doi.org/10.1007/s00127-022-02343-6

Leckie, G., & Charlton, C. (2013). Runmlwin - a program to run the MLwiN multilevel modelling software from within Stata. *Journal of Statistical Software*, *52*(11), 1–40. https://doi.org/10.18637/jss.v052.i11

Leventhal, T., & Brooks-Gunn, J. (2000). The neighbourhoods they live in: The effects of neighbourhood residence on child and adolescent outcomes. *Psychological Bulletin*, *126*(2), 309–337. https://doi.org/10.1037//0033-2909.126.2.309

Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, *71*(3), 543–562. https://doi.org/10.1111/1467-8624.00164

Marmot, M. (2010). Fair society, healthy lives: The marmot review. London: Strategic review of health inequalities in England post-2010. University College London.

Masten, A. S., Best, K. M., & Garmezy, N. (1990). Resilience and development: Contributions from the study of children who overcome adversity. *Development and Psychopathology*, *2*(4), 425–444. https://doi.org/10.1017/S0954579400005812

McElroy, E., Tibber, M., Fearon, P., Patalay, P., & Ploubidis, G. B. (2023). Socioeconomic and sex inequalities in parent-reported adolescent mental ill-health: Time trends in four British birth cohorts. *Journal of Child Psychology and Psychiatry*, *64*(5), 758–767. https://doi.org/10.1111/jcpp.13730

Meltzer, H., Vostanis, P., Goodman, R., & Ford, T. (2007). Children's perceptions of neighbourhood trustworthiness and safety and their mental health. *Journal of Child Psychology and Psychiatry*, *48-10*(12), 1208–1213. doi:10.1111/j.1469-7610.2007.01800.x

Meng, X., Fleury, M. J., Xiang, Y. T., Li, M., & D'arcy, C. (2018). Resilience and protective factors among people with a history of child maltreatment: A systematic review. *Social Psychiatry and Psychiatric Epidemiology*, *53*(5), 453–475. https://doi.org/10.1007/s00127-018-1485-2

Moffitt, T. E., & E-Risk Study Team. (2002). Teen-aged mothers in contemporary Britain. *Journal of Child Psychology and Psychiatry*, *43*(6), 727–742. https://doi.org/10.1111/1469-7610.00082

Mouratidis, K. (2020). Neighborhood characteristics, neighborhood satisfaction, and well-being: The links with neighborhood deprivation. *Land Use Policy*, *99*, 104886. https://doi.org/10.1016/j.landusepol.2020.104886

Noble, M., Wright, G., Smith, G., & Dibben, C. (2006). Measuring multiple deprivation at the small area level. *Environment and Planning A: Economy and Space*, *38*(1), 169–185. https://doi.org/10.1068/a37168

Office for National Statistics. (2011). The English Indices of Deprivation 2010. Retrieved from https://assets.publishing.service.gov.uk/media/5a7f42a940f0b6230268e6b3/English_Indices_of_Deprivation_2015_-_Statistical_Release.pdf

Office for National Statistics. (2013). Indices of Deprivation across the United Kingdom. Retrieved from https://webarchive.nationalarchives.gov.uk/ukgwa/20141119170512/http://neighbourhood.statistics.gov.uk/dissemination/Info.do?page = analysisandguidance/analysisarticles/indices-of-deprivation.htm.

Office for National Statistics (2015). The English Indices of Deprivation 2015. Retrieved from https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

Office for National Statistics. (2023). Average household income, UK: Financial year ending 2022. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/householddisposableincomeandinequality/financialyearending2022

Office of the Deputy Prime Minister. (2001). *Generalised land use database statistics for England*. ODPM Publications.

Orth, U., & Robins, R. W. (2022). Is high self-esteem beneficial? Revisiting a classic question. *American Psychologist*, *77*(1), 5–17. https://doi.org/10.1037/amp0000922

Payne, R. A., & Abel, G. A. (2012). UK indices of multiple deprivation-a way to make comparisons across constituent countries easier. *Health Statistics Quarterly*, *53*, 22–37.

Pearce, J., Cherrie, M., Shortt, N., Deary, I., & Ward Thompson, C. (2018). Life course of place: A longitudinal study of mental health and place. *Transactions of the Institute of British Geographers*, *43*(4), 555–572. https://doi.org/10.1111/tran.12246

Peverill, M., Dirks, M. A., Narvaja, T., Herts, K. L., Comer, J. S., & McLaughlin, K. A. (2021). Socioeconomic status and child psychopathology in the United States: A meta-analysis of population-based studies. *Clinical Psychology Review*, *83*, 101933. https://doi.org/10.1016/j.cpr.2020.101933

Pianta, R. C. (1995). *Child-parent relationship scale*. University of Virginia.

Plewis, I. (2007). *The Millennium Cohort Study: Technical Report on Sampling* 4th Edition. Centre for Longitudinal Studies, University of London.

Polling, C., Khondoker, M., study team, SELCoH., Hatch, S. L., & Hotopf, M. (2014). Influence of perceived and actual neighbourhood disorder on common mental illness. *Social Psychiatry and Psychiatric Epidemiology*, *49*(6), 889–901. https://doi.org/10.1007/s00127-013-0813-9

Rogers, W. (1994). Regression standard errors in clustered samples. *Stata Technical Bulletin*, *3*(13), 19–23.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton University Press.

Rutter, M. (1985). Resilience in the face of adversity: Protective factors and resistance to psychiatric disorder. *British Journal of Psychiatry*, *147*(6), 598–611. https://doi.org/10.1192/bjp.147.6.598

Schaefer, J. D., Moffitt, T. E., Arseneault, L., Danese, A., Fisher, H. L., Houts, R., Sheridan, M. A., Wertz, J., & Caspi, A. (2018). Adolescent victimization and early-adult psychopathology: Approaching causal inference using a longitudinal twin study to rule out noncausal explanations. *Clinical Psychological Science*, *6*(3), 352–371. https://doi.org/10.1177/2167702617741381

Sharma, S., Mustanski, B., Dick, D., Bolland, J., & Kertes, D. A. (2019). Protective factors buffer life stress and behavioral health outcomes among high-risk youth. *Journal of Abnormal Child Psychology*, *47*(8), 1289–1301. https://doi.org/10.1007/s10802-019-00515-8

Sharp, C., Wright, A. G., Fowler, J. C., Frueh, B. C., Allen, J. G., Oldham, J., & Clark, L. A. (2015). The structure of personality pathology: Both general ('g') and specific ('s') factors? *Journal of Abnormal Psychology*, *124*(2), 387–398. https://doi.org/10.1037/abn0000033

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., de Pablo, G. S., Shin, J. I., Kirkbride, J. B., Jones, P., Kim, J. H., Kim, J. Y., Carvalho, A. F., Seeman, M. V., Correll, C. U., & Fusar-Poli, P. (2021). Age at onset of mental disorders worldwide: Large-scale meta-analysis of 192 epidemiological studies. *Molecular Psychiatry*, *27*(1), 281–295. https://doi.org/10.1038/s41380-021-01161-7

Sourander, A., Helstelä, L., & Helenius, H. (1999). Parent-adolescent agreement on emotional and behavioral problems. *Social Psychiatry and Psychiatric Epidemiology*, *34*(12), 657–663. https://doi.org/10.1007/s001270050189

Stafford, M., & Marmot, M. (2003). Neighbourhood deprivation and health: Does it affect us all equally? *International Journal of Epidemiology*, *32*(3), 357–366. https://doi.org/10.1093/ije/dyg084

Staring, A. B. P., Van den Berg, D. P. G., Cath, D. C., Schoorl, M., Engelhard, I. M., & Korrelboom, C. W. (2016). Self-esteem treatment in anxiety: A randomized controlled crossover trial of eye movement desensitization and

reprocessing (EMDR) versus competitive memory training (COMET) in patients with anxiety disorders. *Behaviour Research Therapy*, *82*, 11–20. https://doi.org/10.1016/j.brat.2016.04.002

Sui, Y., Ettema, D., & Helbich, M. (2022). Longitudinal associations between the neigbourhood social, natural, and built environment and mental health: A systematic review with meta-analyses. *Health and Place*, *77*, 102893. https://doi.org/10.1016/j.healthplace.2022.102893

Townsend, P. (1987). Deprivation. *Deprivation. Journal of Social Policy*, *16*(2), 125–146. https://doi.org/10.1017/S0047279400020341

Trouton, A., Spinath, F. M., & Plomin, R. (2002). Twins early development study (TEDS): A multivariate, longitudinal genetic investigation of language, cognition and behavior problems in childhood. *Twin Research*, *5*(5), 444–448. https://doi.org/10.1375/twin.5.5.444

Visser, K., Bolt, G., Finkenauer, C., Jonker, M., Weinberg, D., & Stevens, G. W. J. M. (2021). Neighbourhood deprivation effects on young people's mental health and well-being: A systematic review of the literature. *Social Science and Medicine*, *270*, 113542. https://doi.org/10.1016/j.socscimed.2020.113542

Wang, J., Mann, F., Lloyd-Evans, B., Ma, R., & Johnson, S. (2018). Associations between loneliness and perceived social support and outcomes of mental health problems: A systematic review. *BMC Psychiatry*, *18*(1), 1–16. https://doi.org/10.1186/s12888-018-1736-5

Watts, A. L., Greene, A. L., Bonifay, W., & Fried, E. I. (2024). A critical evaluation of the p-factor literature. *Nature Reviews Psychology*, *3*(2), 108–122. https://doi.org/10.1038/s44159-023-00260-2

World Health Organization. (2022), Mental disorders. https://www.who.int/news-room/fact-sheets/detail/mental-disorders

Zuccotti, C. V. (2019). Ethnicity and neighbourhood attainment in England and Wales: a study of second generations' spatial integration. *Population, Space and Place*, *25*(7), e2252. https://doi.org/10.1002/psp.2252

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