

BMJ Open Disabling chronic conditions in childhood and socioeconomic disadvantage: a systematic review and meta-analyses of observational studies

Nicholas J Spencer, Clare M Blackburn, Janet M Read

To cite: Spencer NJ, Blackburn CM, Read JM. Disabling chronic conditions in childhood and socioeconomic disadvantage: a systematic review and meta-analyses of observational studies. *BMJ Open* 2015;5:e007062. doi:10.1136/bmjopen-2014-007062

► Prepublication history and additional material is available. To view please visit the journal (<http://dx.doi.org/10.1136/bmjopen-2014-007062>).

Received 30 October 2014

Revised 23 July 2015

Accepted 30 July 2015



CrossMark

Warwick Medical School,
University of Warwick,
Coventry, UK

Correspondence to

Professor Nicholas J Spencer;
n.j.spencer@warwick.ac.uk

ABSTRACT

Objective: To determine the association of socioeconomic disadvantage with the prevalence of childhood disabling chronic conditions in high-income countries.

Study design: Systematic review and meta-analyses.

Data sources: 6 electronic databases, relevant websites, reference lists and experts in the field.

Study selection: 160 observational studies conducted in high-income countries with data on socioeconomic status and disabling chronic conditions in childhood, published between 1 January 1991 and 31 December 2013.

Data extraction and synthesis: Abstracts were reviewed, full papers obtained, and papers identified for inclusion by 2 independent reviewers. Inclusion decisions were checked by a third reviewer. Where reported, ORs were extracted for low versus high socioeconomic status. For studies reporting raw data but not ORs, ORs were calculated. Narrative analysis was undertaken for studies without data suitable for meta-analysis.

Results: 126 studies had data suitable for meta-analysis. ORs for risk estimates were: all-cause disabling chronic conditions 1.72 (95% CI 1.48 to 2.01); psychological disorders 1.88 (95% CI 1.68 to 2.10); intellectual disability 2.41 (95% CI 2.03 to 2.86); activity-limiting asthma 2.20 (95% CI 1.87 to 2.85); cerebral palsy 1.42 (95% CI 1.26 to 1.61); congenital abnormalities 1.41 (95% CI 1.24 to 1.61); epilepsy 1.38 (95% CI 1.20 to 1.59); sensory impairment 1.70 (95% CI 1.39 to 2.07). Heterogeneity was high across most estimates ($I^2 > 75%$). Of the 34 studies without data suitable for meta-analysis, 26 reported results consistent with increased risk associated with low socioeconomic status.

Conclusions: The findings indicate that, in high-income countries, childhood disabling chronic conditions are associated with social disadvantage. Although evidence of an association is consistent across different countries, the review provides limited evidence to explain the association; future research, using longitudinal data, will be required to distinguish low socioeconomic status as the cause or consequence of childhood disabling chronic conditions and the aetiological pathways and mechanisms.

Strengths and limitations of this study

- The extensive literature reviewed used a rigorous methodology, and the consistent findings across different country settings suggest the conclusions are robust.
- The high degree of heterogeneity in the pooled estimates represents a threat to their validity; however, the majority of the estimates were robust to sensitivity analysis.
- This review, using both quantitative and qualitative data synthesis, is the first to draw together a large body of studies on the relationship of socioeconomic disadvantage with disabling chronic conditions in childhood in high income countries.

INTRODUCTION

Disabling chronic conditions in childhood are a major global public health issue in high-income as well as low-income countries. Estimates of these conditions in most high-income countries fall between 3.5% and 8.0% of children aged 0–18 years, with some countries reporting that prevalence is increasing.¹ Although children with these conditions can lead rich and fulfilling lives, many experience poor educational outcomes,² social adversity,³ lower levels of social participation⁴ and sometimes pain.⁴ Reducing the prevalence of these conditions in childhood, and the impact on children and their families is, therefore, desirable. Disability is increasingly seen as a ‘dynamic interaction between health conditions and contextual factors, both personal and environmental’,³ with social and genetic factors coming together in complex ways to increase a child’s risk of developing a chronic disabling condition.⁵

The first World Report on Disability³ identifies poverty and socioeconomic disadvantage as possible cause and consequence of

disability. This report, however, focuses on adults in developed countries and does not consider the evidence for this association in childhood. Low socioeconomic status (SES) is likely to be both a cause and consequence of disability in childhood, but if and where the low SES sits on the causal pathway remains unclear. Although many studies have examined the association between childhood disabling chronic conditions and SES, to date there has been no published systematic review of studies examining the association in high-income countries. As a result, there is no synthesised evidence on risk, or assessment of the quality of this research. The only available systematic review of literature on this association in low-income and middle-income countries indicated that the evidence was inconsistent and inconclusive, and that many studies had a high/medium risk of bias.⁶

To address this important evidence gap, we undertook a systematic review and meta-analyses of studies in high-income countries to examine the association of SES with childhood disabling chronic conditions. In this paper, the term disabling chronic conditions refers to the range of conditions and impairments lasting at least 6 months that limit a child's normal daily activity. We examine the role of SES in all-cause disabling chronic conditions and in a range of condition groups. As the first systematic review in this area, it provides rigorous evidence on the association between disabling chronic conditions in childhood and SES that will contribute to understanding how to reduce the prevalence and impact of these diverse and complex conditions in childhood.

The main focus of this paper is a quantitative synthesis of the data with meta-analyses of studies that report either ORs or raw data from which these can be estimated. A brief narrative analysis of those studies that could not be entered into meta-analysis is included.

METHODS

Search strategy and selection criteria

We searched MEDLINE, PsycINFO, ASSIA, EMBASE, Web of Science and EconLit for studies reported between 1 January 1991 and 31 December 2013. For each database, a search strategy using a combination of free text and controlled vocabulary terms was developed (see example in [box 1](#)). We used search terms for the exposure of interest (socioeconomic disadvantage) and the outcomes of interest (childhood disabling chronic conditions). Searches of relevant national and international government and non-government organisations' internet sites were conducted, and reference lists of included studies were screened.

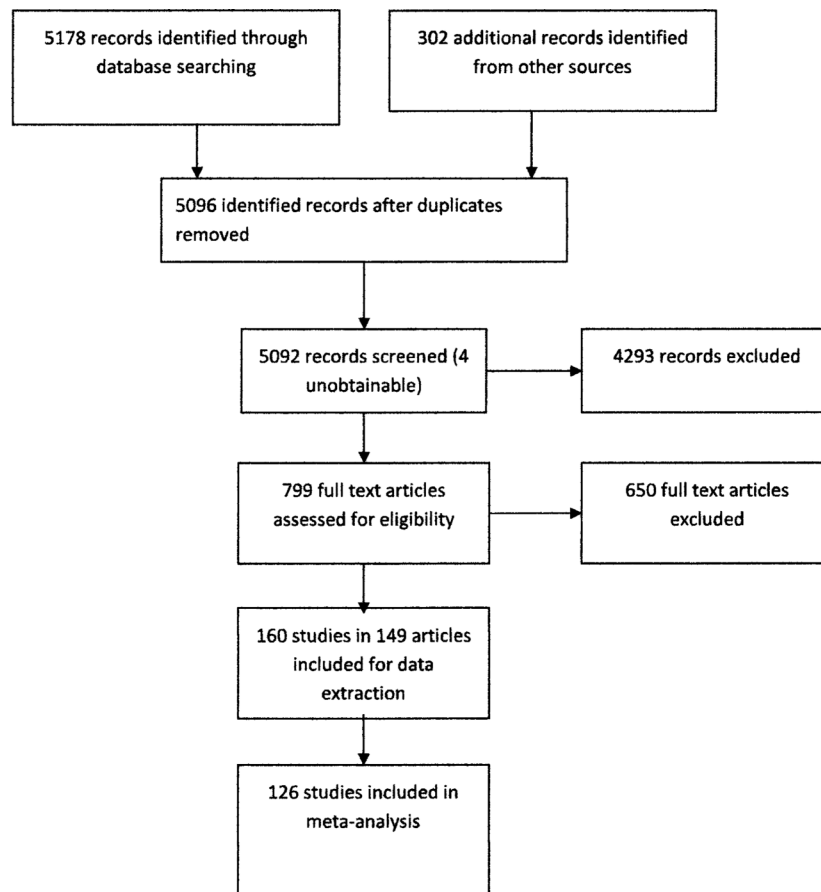
We contacted international experts to identify studies not captured in other searches. English language publications only were included. A total of 5480 titles and abstracts, and 799 full-text articles and reports were independently screened by two reviewers (JMR and NJS). Of the full-text articles and reports, data were extracted onto standard forms for potentially relevant studies by

one reviewer (NJS) and checked by a second reviewer (CMB; weighted $k=0.91$). Differences of opinion were resolved in discussion with the third reviewer (JMR). [Figure 1](#) shows the flow chart of study selection.

Box 1 Sample search strategy: Ovid Medline

1. exp Socioeconomic Factors/(276257)
2. social disadvantage.ab.ti. (370)
3. social deprivation.ab.ti. (722)
4. low income.ab.ti. (11585)
5. social exclusion.ab.ti. (410)
6. lone parenthood.ab.ti. (24)
7. parental disability.ab.ti. (15)
8. 1 or 2 or 3 or 4 or 5 or 6 or 7 (281054)
9. childhood disability+ACo-.ab.ti. (201)
10. exp Disabled children/(3092)
11. chronic illness+ACo-.ab.ti. (7432)
12. asthma.ab.ti. (86271)
13. cerebral palsy.ab.ti. (10905)
14. epilepsy.ab.ti. (52945)
15. hearing impairment.ab.ti. (4631)
16. visual impairment.ab.ti. (4265)
17. congenital abnormalit+ACo-.ab.ti. (4285)
18. ((long-term illness+ACo- or long-standing illness+ACo-) and limiting).ab.ti. (126)
19. activity limiting illness+ACo-.ab.ti. (1)
20. exp+ACI-Attention Deficit and Disruptive Behavior Disorders +ACI-/(17055)
21. emotional disorders.mp.orex Child Behavior Disorders/epidemiology (1066)
22. +ACo-Mental Retardation/(28678)
23. +ACo-Learning Disorders/(7918)
24. +ACo-Communication Disorders/(875)
25. or/9-24 (224506)
26. 8 and 25 (7275)
27. (addiction+ACo- or addicted or drug taking or smoking).mp. (172219)
28. exp Substance-Related Disorders/(310751)
29. alcohol+ACo-.ab.ti. (176708)
30. +ACo-Substance-Related Disorders/epidemiology or +ACo-Smoking/epidemiology or +ACo-Opioid-Related Disorders/epidemiology or +ACo-Alcoholism/ep (3642)
31. exp HIV/(67947)
32. exp Acquired Immunodeficiency Syndrome/(68867)
33. or/27-32 (665725)
34. 26 not 33 (6435)
35. expcanada/or exp united states/or exp japan/or exp +ACI-republic of korea+ACI-/or expaustralia/or expaustria/or expbelgium/or expczech republic/or exphungary/or exppoland/or expslovakia/or expslovenia/or expfinland/or france/or expgermany/or exp great britain/or expgreece/or expiceland/or exp ireland/or expitaly/or expluxembourg/or expnetherlands/or expportugal/or expdenmark/or expnorway/or expsweden/or expspain/or expswitzerland/or exp new zealand/or exp Israel/(1985719)
36. 34 and 35 (2806)
37. limit 36 to (english language and humans) (2583)
38. limit 37 to yr+ADOAlg-1985 -Current+ACI- (2318)
39. limit 38 to +ACI-all child (0 to 18 years)+ACI- (1514)
40. l/39 ed+ADO-20101123-20110208 (30)

Figure 1 Flow chart of study selection.



Studies were included if the design was cross-sectional, case-control, cohort, register-based or based on routinely collected data derived from a whole population and reported empirical, individual level data on the association of SES with disabling chronic conditions in childhood (box 2). Studies that were based on selected populations (eg, inner-city dwellers or minority ethnic groups only) and those not reporting results for children separately from adults were excluded as were those in which the duration or activity limitation of the condition was not specified. We excluded studies in which the disabling chronic condition was reported as a continuous variable.

Studies were assessed for quality by one reviewer (NJS) and checked by a second reviewer (CMB). Differences of opinion were settled by discussion. We extended the Newcastle-Ottawa Scales⁷ to assess risk of bias for each of the five study types: cross-sectional, case-control, cohort, register-based and routinely collected data. Standard criteria for assessing risk of bias for each of the study types are shown in online supplementary appendix 1. Major confounding variables, referred to in online supplementary appendix 1, were child's age, child's sex, race/ethnicity and lone parenthood.

Types of disabling chronic conditions and SES measures

Children included in the studies had a range of disabling chronic conditions characterised by duration longer than 6 months and associated limitation of normal daily

activity. Conditions were grouped as follows: all-cause disabling chronic conditions; psychological disorders; intellectual disability; sensory impairments; congenital abnormalities; specific conditions, such as asthma, cerebral palsy and epilepsy; and a miscellaneous group of conditions with insufficient numbers for entry into meta-analysis (table 1). SES measures were grouped as follows: parental education level, income, occupational class, area-based SES measures, poverty, housing tenure, workless household, composite SES measures, miscellaneous measures (table 2). Low SES was defined as the most disadvantaged group for which prevalence was reported in each study.

Data analysis

Quantitative data synthesis

We extracted crude or adjusted ORs with 95% CIs by SES measures from studies in which these were reported. Where studies reported a disabling chronic condition by more than one SES measure, we included the measure associated with the highest OR in the initial meta-analysis and undertook sensitivity analysis using the SES measure with the lowest OR. For studies reporting raw data, crude ORs with 95% CIs were calculated for comparison of children with disabilities with children without disabilities. Where results were reported separately for boys and girls, ORs for all children were recalculated from raw data. For studies in which neither ORs

Box 2 Inclusion and exclusion criteria

Inclusion

- ▶ Cross-sectional, cohort, case–control studies and those based on condition registers and routine data published between 1 January 1991 and 31 December 2013
- ▶ Studies conducted in high-income OECD countries as defined by the World Bank*
- ▶ Empirical data on the association of socioeconomic status (SES) with disabling chronic conditions in children reported
- ▶ Conditions lasting at least 6 months AND associated with limitation in normal daily activity reported
- ▶ Studies based on whole population data or samples representative of whole populations

Exclusion

- ▶ Studies published before 1991 and after 2013
- ▶ Studies conducted in countries not on the World Bank OECD high-income list*

Reviews

- ▶ Association of SES with disabling chronic conditions not reported
- ▶ Reported conditions not defined by duration AND activity limitation
- ▶ Population subgroups only reported
- ▶ Sample not representative of whole population

Mortality studies

- ▶ Studies reporting all age data with no data on children as a separate group
- ▶ Studies reporting non-individual level episode data
- ▶ Studies reporting outcomes as non-dichotomised, continuous variables
- ▶ Studies using aggregated SES measures which include major confounders of the relationship with disabling chronic conditions, such as ethnicity and lone parenthood.

*See World Bank classification of countries by income at <http://data.worldbank.org/about/country-and-lending-groups>

nor raw data were reported, the investigators were contacted to request data. Pooled ORs with 95% CIs for the risk of low SES were calculated using a random-effects model using the function for summary meta-analysis in StatsDirect (V.2.7.8). Heterogeneity in pooled data was estimated using the I^2 statistic and risk of bias using the Egger¹⁵⁵ and Begg-Mazumdar tests.¹⁵⁶ Forest plots were generated showing ORs with 95% CIs for each study and the overall random-effects pooled estimate. For pooled estimates with a high I^2 statistic, sensitivity analyses, aimed at explaining some or all of the heterogeneity, were undertaken by re-running the meta-analyses comparing studies with specific characteristics which were identified a priori as the most likely to contribute to heterogeneity (eg, geographical area of study (the USA vs the rest), studies with high vs medium/low risk of bias; studies reporting crude ORs only versus adjusted ORs; different SES measures used in same study; different age ranges).

Narrative data analysis

Studies not reporting ORs with 95% CIs or raw data from which these could be calculated were not entered

into the meta-analyses. We undertook narrative analysis of these studies. A simple count of studies with results consistent and inconsistent with the pooled estimates was made, and the latter were analysed in more detail.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation or writing of the report. All authors had full access to all data in the study and had final responsibility for the decision to submit for publication.

RESULTS

Our search identified 160 studies with relevant data reported in 149 papers (see figure 1 and online supplementary appendix 2). Ninety studies were cross-sectional, 25 cohort, 21 based on routine data, 16 case–control and 8 based on disease registers (see online supplementary appendix 1). The types of disabling chronic condition reported are listed in table 1. Psychological disorders were the most frequently reported conditions (72 studies) followed by all-cause disabling chronic conditions (29 studies) and intellectual disability (25 studies). A combined total of more than 889 618 children with disabling chronic conditions were included in the studies, in which sample sizes varied between 50 and 41 928 607. All but one study⁶³ reported data on both sexes, although data on the association with SES were reported separately for boys and girls in some studies. Ages of the children included in the studies were mainly between 0 and 18 years; 11 included young people aged 19–21 years. Eighty-six studies were carried out in the WHO European region (the UK 55; Finland 8; Denmark 3; Norway 3; Sweden 1; two or more Nordic countries 5; Holland 3; Germany 3; Spain 3; Italy 1; Belgium 1), 63 in the WHO region of the Americas (the USA 53; Canada 10) and 11 in the WHO Western Pacific Region (Australia 9; New Zealand 2).

Risk of bias was low in 13 studies of which 6 were based on routinely collected data, 4 case–control, 1 cohort and 2 register-based studies. No cross-sectional studies had low risk of bias. The majority (58%) had a medium risk of bias and 53 studies had a high risk. Non-adjustment for major confounding variables was the most common source of bias affecting 75% of studies. Outcomes were parent-reported in most cross-sectional and cohort studies with only five cross-sectional and five cohort studies reporting independent blind assessment of the outcome. In the remaining three study types, 67% of cases were independently clinically identified. Insufficient information was given in five of the cross-sectional and cohort studies on the representativeness of the study sample and of the controls in four case–control studies. Denominator populations were clearly defined in all but one of the register-based and routine data-based studies (see online supplementary appendix 1).

Table 1 Groups of disabling chronic conditions (DCC) and included conditions

DCC group	Number of included studies	Number of affected children	Conditions included in the group
All-cause disabling chronic conditions	29 studies ^{1 2 8–30}	76226* affected children	Combined categories of all chronic conditions with associated activity limitation, including physical, sensory and psychological disabilities or long-term health problems
Psychological disorders	72 studies ^{11 16 18 31–94}	72277* affected children	All-cause psychological disorder, attention deficit hyperactivity disorder, autistic spectrum disorder, emotional disorder, oppositional defiant disorder, conduct disorder, internalising and externalising behaviour problems, obsessive compulsive disorder, chronic fatigue syndrome
Intellectual disability	25 studies, ^{52 60 69 71 84 95–113}	633235* affected children	Children with IQ <70 or equivalent measure—7 of these studies report mild and moderate/severe disability
Sensory impairments	12 studies ^{11 51 71 84 88 112 114–119}	11994* affected children	Hearing impairment and visual impairment
Cerebral palsy	8 studies ^{84 120–126}	16084 affected children	Non-acquired and acquired cerebral palsy
Epilepsy	9 studies ^{11 31 104 112 127–131}	13562* affected children	Recurrent epileptic seizures excluding febrile seizures
Asthma	13 studies ^{11 51 132–141}	6407 affected children	Asthma with activity limitation and/or asthma requiring hospital admission
Congenital anomalies identifiable at birth	14 studies ^{110 142–153}	41956* affected children	Neural tube defects compatible with life, cleft lip and palate, other congenital and chromosomal abnormalities
Miscellaneous conditions (insufficient numbers for meta-analysis)	4 studies ^{85 104 112 154}	8954 children	Crohn's disease, Down's syndrome, diabetes mellitus, heart disease

*Indicates incomplete totals as some studies reported no data on number of participants.

Quantitative data synthesis

One hundred and twenty-six studies had data suitable for meta-analysis. Risk and pooled random-effects estimates for groups of disabling chronic conditions are shown in figures 2–9 and table 3. The pooled ORs for the different groups of disabling chronic conditions by low SES were as follows: 1.72 for 20 studies reporting all-cause disabling chronic conditions, 1.88 for 55 studies reporting psychological disorders, 2.41 for 21 studies reporting intellectual disability, 2.20 for 13 studies reporting activity limitation or hospital admission for asthma, 1.42 for 6 studies reporting cerebral palsy, 1.41 for 13 studies of congenital abnormalities, 1.38 for 6 studies of epilepsy and 1.70 for 9 studies of sensory impairments. The I^2 statistic was >75% for all, but the pooled estimates for cerebral palsy, epilepsy and sensory impairments. Pooled estimates were available for specific psychological disorders (attention deficit hyperactivity disorder (ADHD; 1.63 (1.42 to 1.86)), conduct disorder (1.93 (1.58 to 2.38)) and emotional disorder (2.03 (1.67

to 2.47)), and for mild (3.94 (2.26 to 6.86)) and moderate/severe (2.19 (1.84 to 2.64)) intellectual disability (forest plots not shown)).

Bias indicators were non-significant for all groups of disabling chronic conditions except for psychological disorders for which the Egger test was significant ($p=0.0012$) but not the Begg-Mazumdar test ($p=0.97$). Sensitivity analyses showed no significant differences in pooled estimates based on specific characteristics of studies for all disabling chronic condition groups except asthma and psychological disorders (see online supplementary appendix 3). The pooled OR for asthma for studies reporting crude ORs only (3.00 (95% CI 2.89 to 3.11)) was significantly higher than that for those reporting adjusted ORs (1.75 (95% CI 1.35 to 2.36)). For psychological disorders, the pooled OR for studies including only children <12 years of age was significantly higher than that for studies including older children (pooled ORs 2.48 (95% CI 2.07 to 2.97) and 1.77 (1.55 to 2.03), respectively).

Table 2 Socioeconomic status (SES) measures

SES measure group*	Number of studies	Specific measures included in group
Parental education	56 studies	Maternal education; paternal education; highest parental educational level; years of education; qualifications achieved
Income	49 studies	Household income; equivalised household income using OECD method; urban income
Poverty	42 studies	Relationship to Federal Poverty Line (USA); <60% of national median income (UK); receipt of social safety net benefits
Occupational class	37 studies	UK Registrar General's social class; UK National Statistics Socio-economic Classification; other country classifications (Finland, Denmark, Sweden, Holland); Bilshen Occupational Scale (Canada)
Area-based SES measures	35 studies	UK deprivation indices (Townsend; Carstairs); Acorn area classification (UK); census-derived area income measures (USA and Canada); Socio-economic Indicators for Area—SEIFA (Australia); inner city vs suburbs
Housing tenure	11 studies—all UK	Rented vs owner-occupied accommodation
Workless household	9 studies	Households with no working adult
Composite individual level SES measures	7 studies	Winkler index; occupation and education of both mothers and fathers; occupation and education of both parents and household income; social disadvantage index (occupation; housing tenure; car ownership)
Other	8 studies	Material hardship (unable to afford essential items); debt; car ownership; family affluence scale

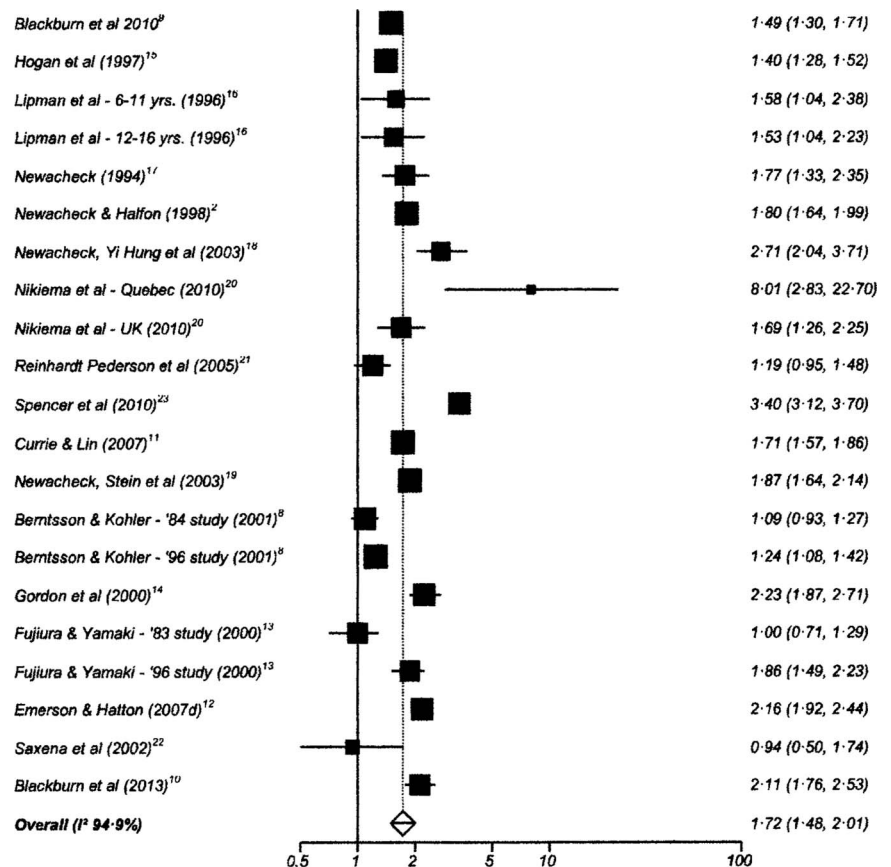
*Thirty-seven per cent of studies reported more than one SES measure. OECD, Organisation for Economic Co-operation and Development.

Narrative data analysis

Data from 34 studies were not suitable for meta-analysis. Of the eight studies reporting all-cause disabling chronic conditions, three reported findings suggesting no

association with low SES. Ford *et al.*²⁶ based on data from the baseline study of 15 year-olds included in the prospective West of Scotland Twenty-07 study, report an association of limiting long-standing illness among boys with low

Figure 2 Risk estimates of low socioeconomic status in children with all-cause disabling chronic conditions.



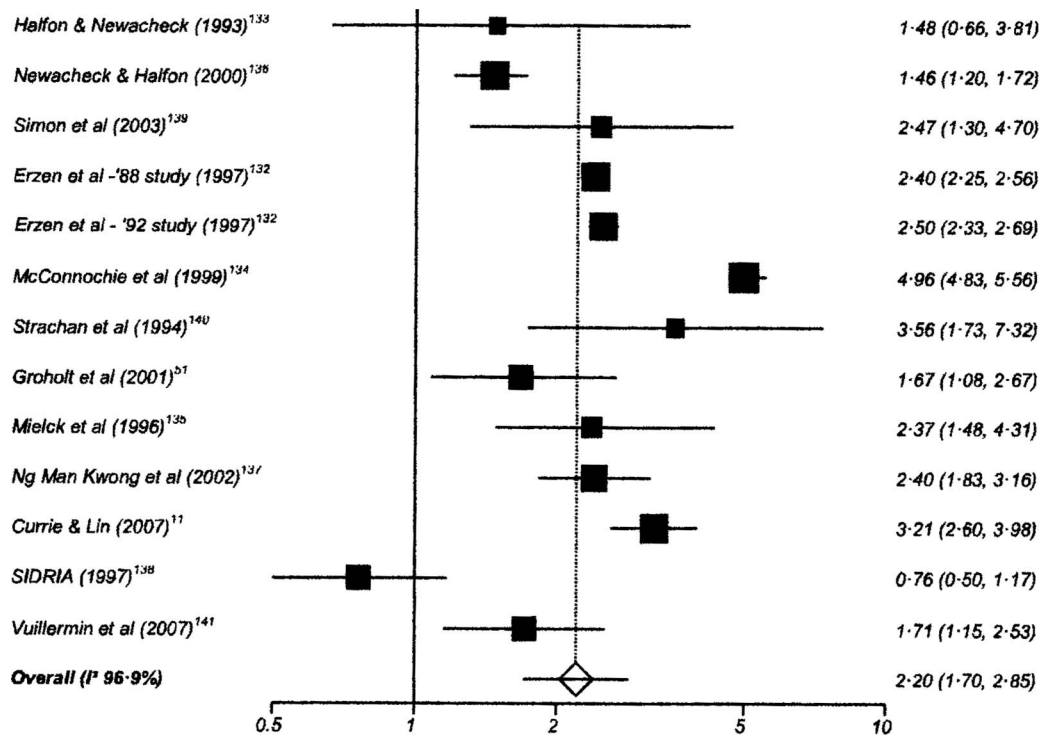


Figure 3 Risk estimates of low socioeconomic status in children with asthma.

parental social class ($p < 0.05$), but not for girls. In a review article, West²⁹ reports data on 18 year-olds from the West of Scotland Twenty-07 study showing no significant differences in prevalence of all limiting long-standing illness among either males or females by social class, but a higher prevalence among low social class boys of severe limiting long-standing illness (defined as 'quite a lot' or 'very great deal' of restriction), but not among girls. These studies both carry a high risk of bias (see online supplementary

appendix 1) and the reporting of parental social class by young people may not be reliable. West and Sweeting³⁰ reported little evidence of SES differences in limiting long-standing illness among boys and girls aged 11, 13 and 15 years in the West of Scotland 11–16 Cohort study. This study used a number of SES measures reported by parents; however, it has a high risk of bias.

Five of the studies not suitable for meta-analysis reporting on psychological disorders found no

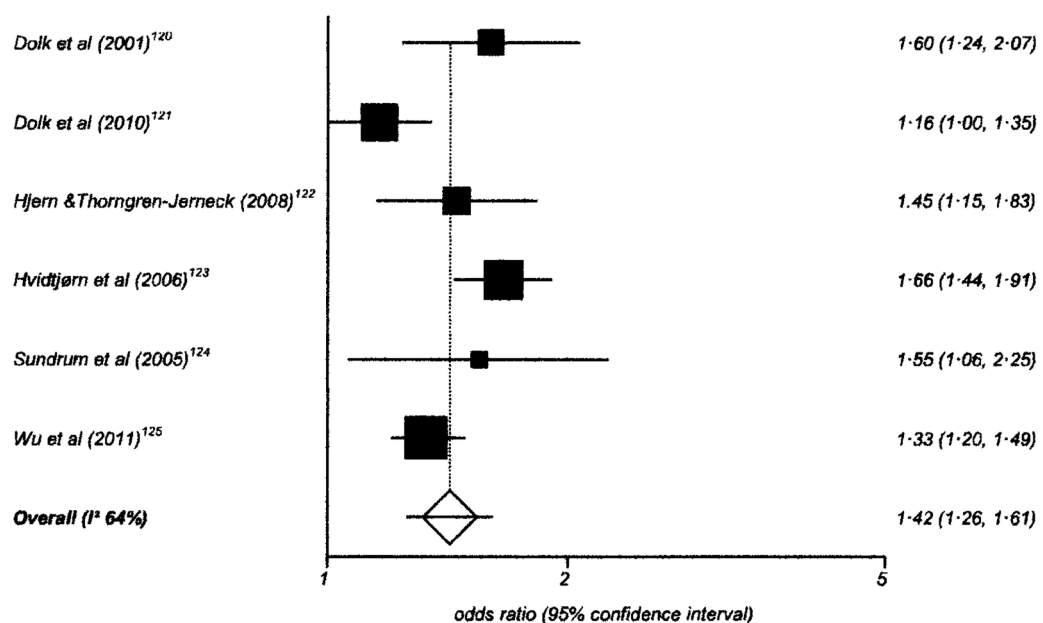


Figure 4 Risk estimates of low socioeconomic status in children with cerebral palsy.

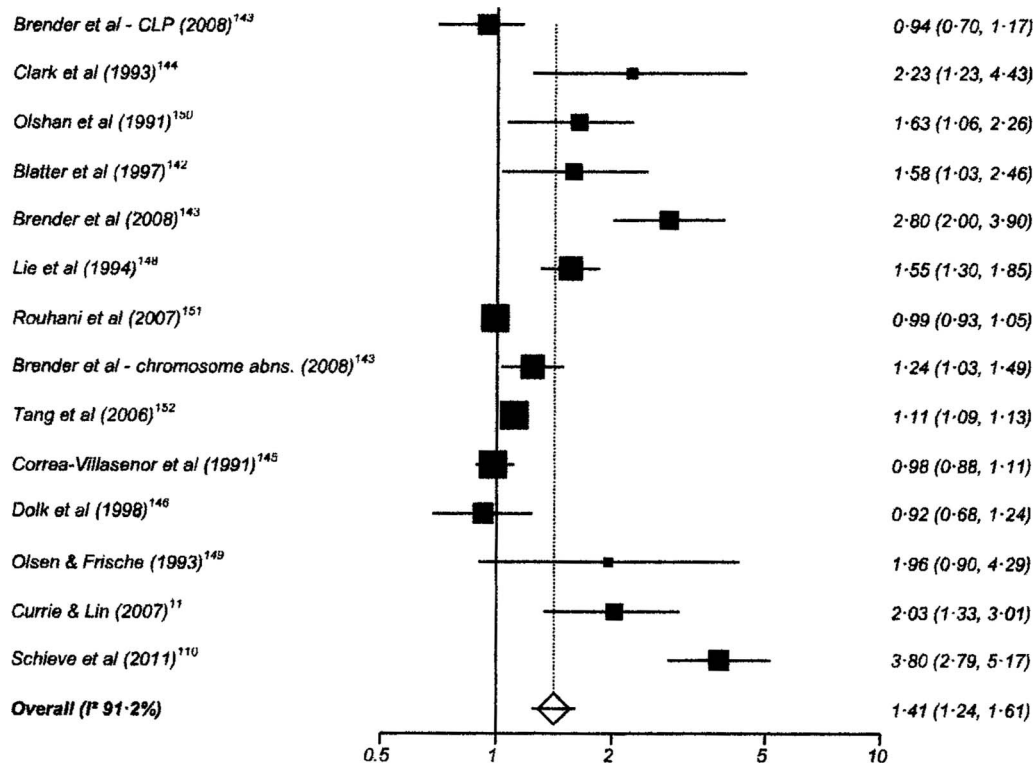


Figure 5 Risk estimates of low socioeconomic status in children with congenital abnormalities.

association with low SES. A reverse SES gradient for ADHD is reported by Hoffman *et al*⁸⁷ based on a cohort initially designed to study the association between exposure to tetrachloroethylene (PCE)-contaminated public drinking water and the risk of reproductive and developmental disorders. Exclusions from the original cohort plus no information about the attrition rate may have led to a non-representative sample for this analysis. The study has a high risk of bias. Khanam *et al*⁸⁸ found no

significant association of low income with ADHD among 8-year-old children enrolled in the kindergarten cohort of the Longitudinal Study of Australian Children. The regression models included many socially related variables that could be mediators of the low-income ADHD, thus suggesting the possibility of overcontrolling for SES. The study has a medium risk of bias. No association of behavioural problems at 3 years of age with SES was reported by Sonuga-Barke *et al*⁹³ from a cross-sectional

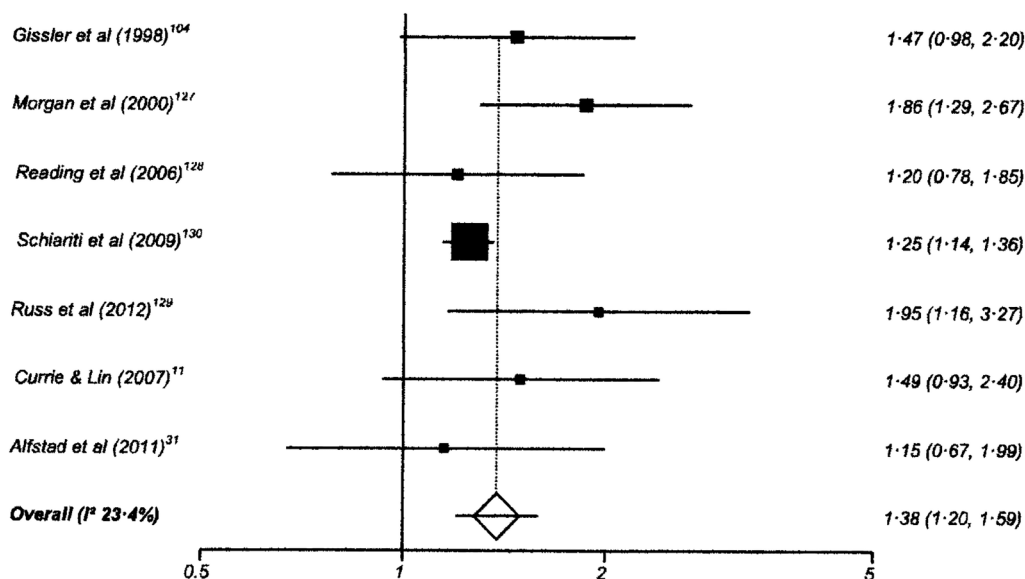


Figure 6 Risk estimates of low socioeconomic status in children with epilepsy.

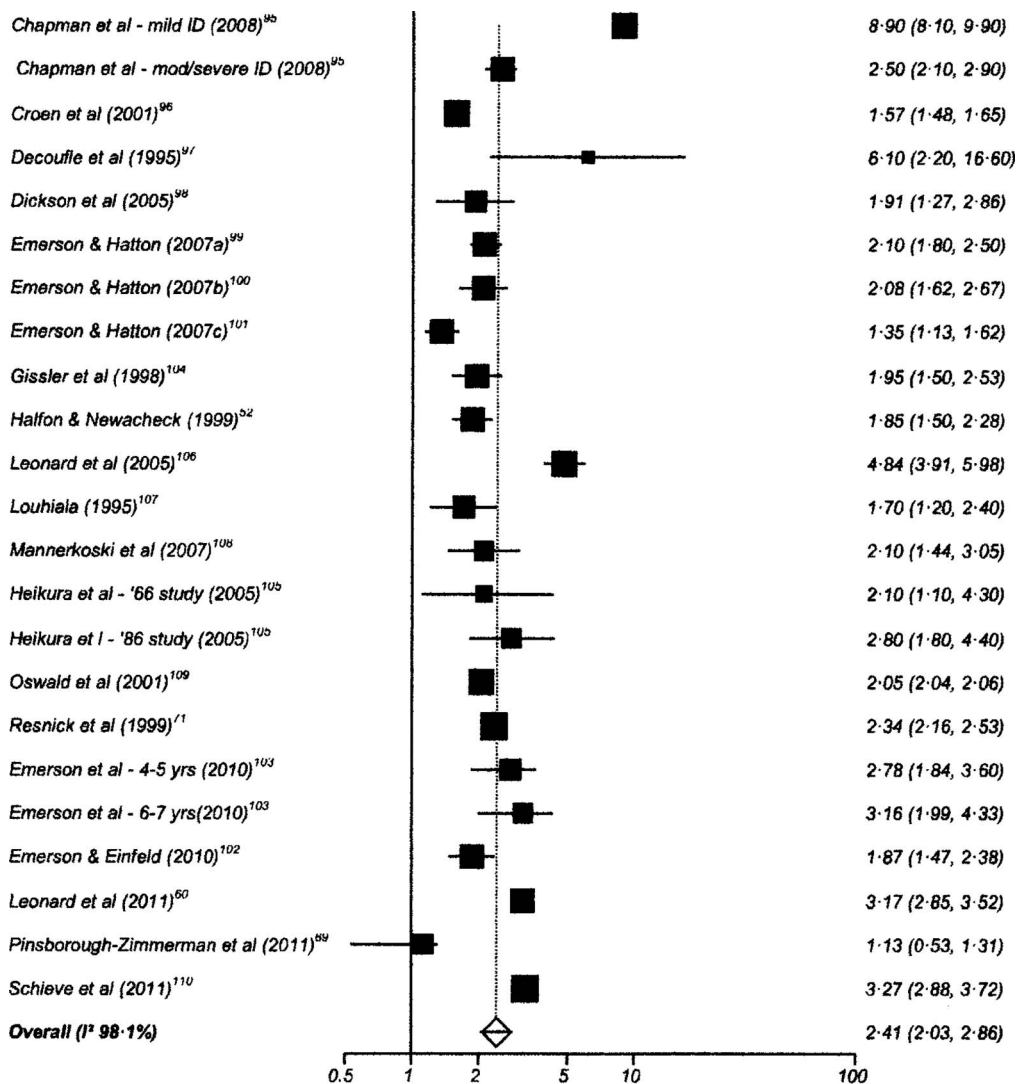


Figure 7 Risk estimates of low socioeconomic status in children with intellectual disability (ID).

study based on developmental clinics run by family doctors in an area of south England. In addition to having a high risk of bias, low SES families may have been under-represented in the sample due to socially patterned differential uptake of developmental checks at 3 years. Boyle *et al*⁸⁴ reported no significant difference in prevalence of ADHD among children aged 3–17 years by poverty or low maternal education. This study, which has a medium risk of bias, was based on a large, aggregated sample from the US National Health Interview Surveys (NHIS) for the years 1997–2008. Blackwell and Tonthat,³³ and Bloom *et al*³⁵ reporting on samples from the NHIS for the years 1998 and 2001, respectively, also showed no association with poverty or parental education, although significant associations were noted for the years 1999³⁴ and 2006.³⁶

Khanam *et al*⁸⁸ and Boyle *et al*⁸⁴ reported no association of sensory impairments with low SES. As indicated above, the inclusion of many socially related variables in the regression model in Khanam's paper may have been overcontrolled for SES. By contrast, Boyle *et al*⁸⁴ did not

control for potential confounders. Boyle *et al*⁸⁴ also reported no association of cerebral palsy with either poverty or maternal education. There were no studies unsuitable for meta-analysis of intellectual disability or congenital abnormalities that reported no association of the outcome with low SES. All studies of asthma had data suitable for meta-analysis.

Discussion

This is the first systematic review and meta-analyses of studies reporting on the relationship between childhood disabling chronic conditions and low SES in high-income countries. The results of the meta-analyses show that a range of childhood disabling chronic conditions are associated with low SES.

The review shows the association of the most common childhood disabling chronic conditions with low SES. Psychological disorders and intellectual disabilities are among the most common and intractable conditions, and impacts on children, their families and health, social and education services are substantial. The odds

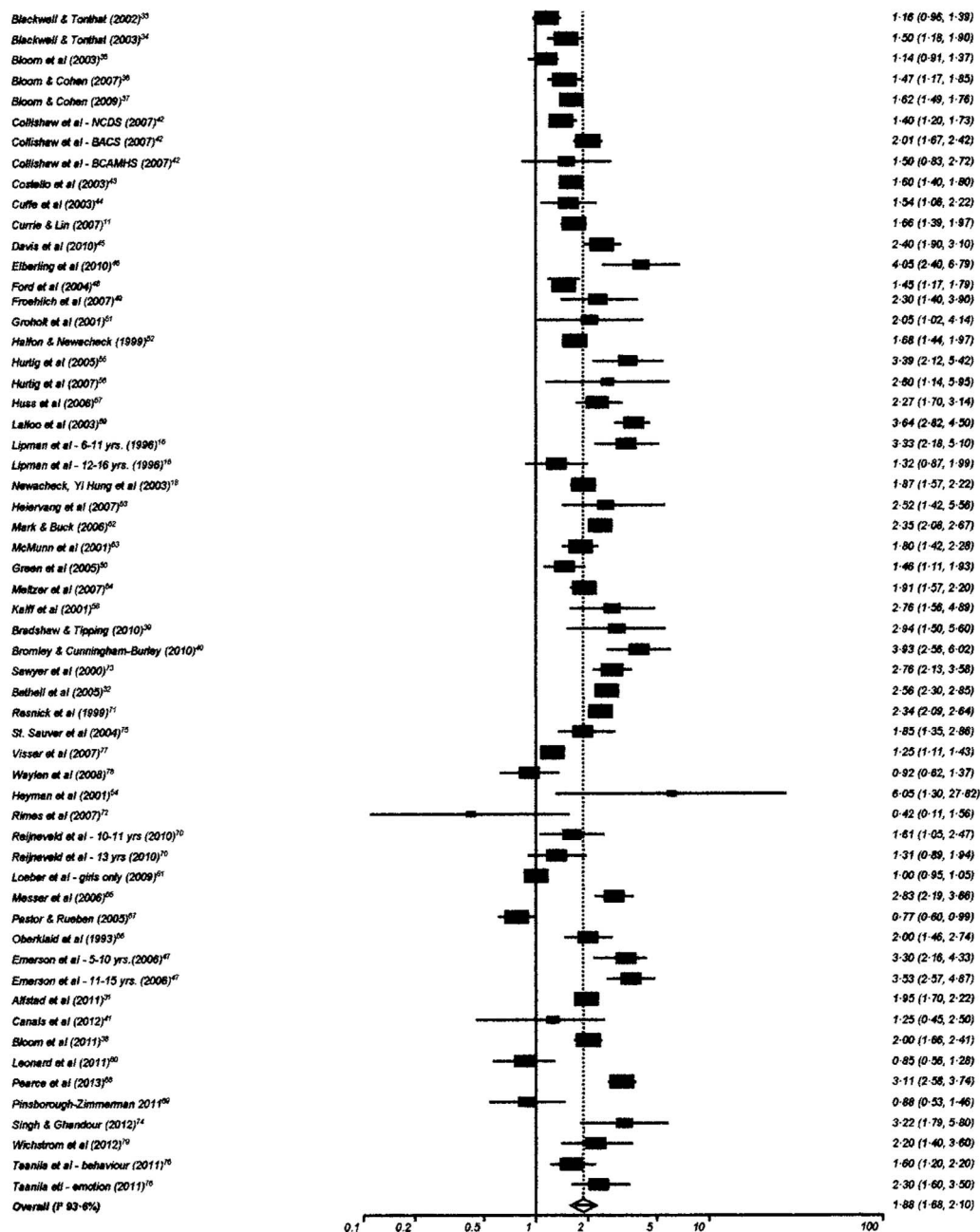


Figure 8 Risk estimates of low socioeconomic status in children with psychological disorders.

of these being reported among low SES households are around twice those for high SES households.

Asthma is one of the most prevalent chronic conditions in childhood in high-income countries. A recent systematic review and meta-analysis reported low SES associated with a higher prevalence of asthma in 63% of studies with a pooled estimate of 1.38 (95% CI 1.37 to 1.39).¹⁵⁷ We included only studies reporting on asthma severe enough to cause activity limitation and/or hospital admission, and found a strong association with SES. To date, the evidence on the association of cerebral palsy and epilepsy with low SES has also been unclear, and likely to be related to study methodologies.^{124 128} Pooled estimates for both in this review, however, support a significant association.

Confirmation of the association of disabling chronic conditions with low SES using systematic review methodology and generation of pooled estimates of risk is important. Further research, however, is needed to explain this association in high-income countries. One possible explanation is that poor social and environmental conditions in pregnancy and early childhood are on the causal pathway to childhood disabling chronic conditions. Some included papers discuss the poor social conditions that might lead to conditions, such as activity-limiting asthma,¹³³ and the role of socially patterned problems in pregnancy in the aetiology of cerebral palsy¹²⁰ and congenital abnormalities.^{145 149} Questions of causality, however, can only be addressed using cohort studies with low risk of bias. The majority of studies in

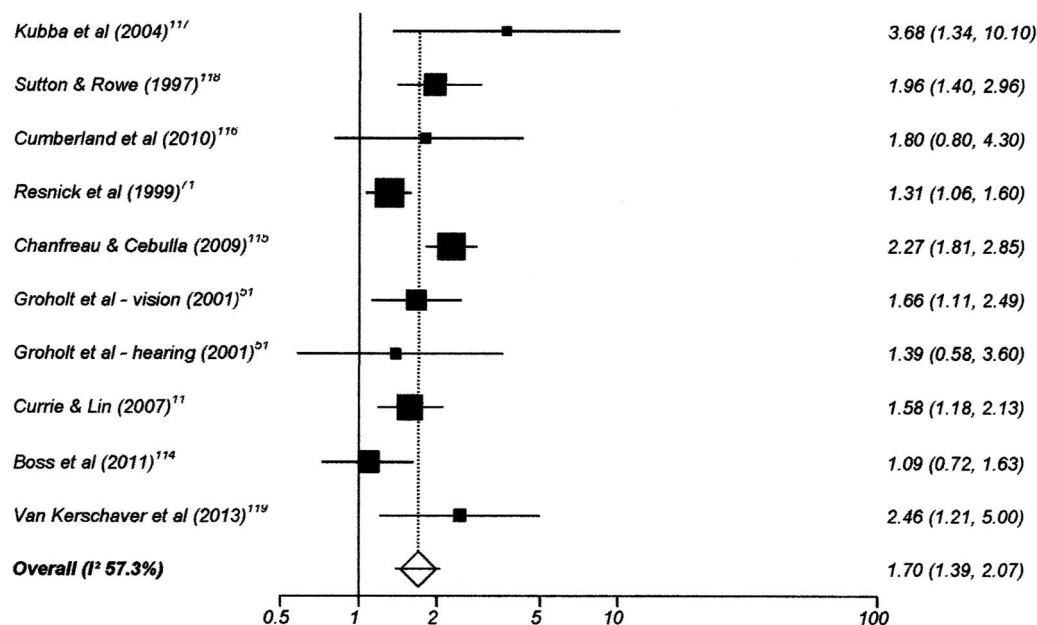


Figure 9 Risk estimates of low socioeconomic status in children with sensory disabilities.

this review were cross-sectional. Of the 21 cohort designs we identified, only 1 was assessed as having a low risk of bias. Low parental education is likely to precede the onset of a child's disabling condition and its association with a range of conditions (see online supplementary appendix) lends support to the explanation that SES is on the causal pathway. The reverse causation explanation is that caring for a child with a disabling chronic condition leads to low SES by limiting household income and increasing household costs. Anderson *et al*¹⁵⁸ show the impact on family finances and work of having a child with intellectual and/or developmental disability.

The review has several methodological issues and limitations which should be considered when interpreting the findings. Definitions of disability vary widely as do measures used to identify those with disabilities in populations. In line with the focus of the World Report on Disability³ and International Classification of Functioning, Disability and Health,¹⁵⁹ we only included in this review studies reporting on conditions that were both long term and activity limiting. Therefore, studies

which used broader definitions of disability were excluded, possibly limiting the scope of the review. The use of expanded MeSH terms for SES may have led to studies being missed; however, the SES measures identified (table 2) include a comprehensive range. There is no internationally agreed definition of 'low SES', as different measures are required for different purposes and are meaningful in particular national contexts. The included studies, therefore, use a variety of SES measures and this may be one of the factors contributing to the high level of heterogeneity in the pooled estimates. In sensitivity analyses, however, pooled estimates did not change significantly when different SES measures were used. Many included studies also had a high risk of bias and this is also likely to have contributed to heterogeneity. In particular, in some studies, the failure to adjust for potential confounding factors may have resulted in overestimation of the strength of the association. This was supported by the sensitivity analysis for severe asthma that showed a significantly higher pooled estimate for studies that did not adjust for confounders compared with those that did. There were no similar

Table 3 Pooled random effects estimates for low socioeconomic status by groups of disabling chronic conditions

Disabling chronic condition	Studies	OR (95% CI)	Heterogeneity (I ² statistic)
All-cause disabling chronic conditions	20	1.72 (1.48 to 2.01)	95.0% (94.7% to 95.7%)
Psychological disorders	55	1.88 (1.68 to 2.10)	93.6% (92.6% to 94.3%)
Intellectual disability	21	2.41 (2.03 to 2.86)	98.1% (97.9% to 98.3%)
Activity-limitation or hospital admission for asthma	13	2.20 (1.87 to 2.85)	96.9% (96.2% to 97.4%)
Cerebral Palsy	6	1.42 (1.26 to 1.61)	64.0% (0% to 83.1%)
Congenital abnormalities	13	1.41 (1.24 to 1.61)	91.2% (87.6% to 93.4%)
Epilepsy	6	1.38 (1.20 to 1.59)	23.4% (0% to 67.5%)
Sensory impairment	9	1.70 (1.39 to 2.07)	57.3% (0 to 77.2%)

findings, however, for other conditions. As the sensitivity analyses explain little of the heterogeneity, it is likely that factors we have not been able to measure are responsible. In addition, different sources of information are used to identify a child as having a disabling chronic condition and this may also have contributed to the heterogeneity in the pooled estimates.

This systematic review and meta-analyses make an important contribution to knowledge of the association of childhood disabling chronic conditions with socio-economic disadvantage in high-income countries. Although caution should be exercised in interpreting the findings due to unexplained heterogeneity and the high risk of bias in many studies, the review indicates that these challenging conditions are more prevalent among children in disadvantaged households in a range of high-income countries. While explanations about the causes of this association are to be found in the literature, further high-quality research in cohort studies with adequate sample sizes is required to more fully address the aetiology of the associations identified by this review.

Our findings have implications for social, economic and health policy. The higher prevalence of these conditions among socioeconomically disadvantaged children in richer nations with very different policy environments represents a major challenge to governments seeking to reduce health inequalities and promote the rights of disabled children. Reducing the association between socio-economic disadvantage and disabling chronic conditions in childhood is likely to require multidimensional strategies. These might include those proposed in the WHO report on social determinants of health that aim to reduce socioeconomic disadvantage in the early years,¹⁶⁰ as well as policies that ensure that households with children with disabling chronic conditions have adequate financial support and access to health, education and social care services to meet their needs.

Acknowledgements The authors thank Diane Clay and Samantha Johnson for their assistance with literature searches.

Contributors CMB, NJS and JMR designed the study. CMB was lead researcher on the project and supervised its implementation. NJS, CMB and JMR coordinated the search strategy, and jointly established the criteria for study selection, data extraction and quality assessment. JMR and NJS undertook the initial inclusion and exclusion of abstracts. NJS extracted data from potentially relevant full-text papers onto standard extraction forms which were checked by CMB. NJS planned and did the meta-analyses. NJS, CMB and JMR wrote the report. All authors reviewed the study findings, and read and approved the final version before submission.

Funding This study was funded by the Economic and Social Research Council (grant number RES-062-23-2883).

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <http://creativecommons.org/licenses/by/4.0/>

REFERENCES

- Halfon N, Houtrow A, Larson K, *et al*. The changing landscape of disability in childhood. *Future Child* 2012;22:13–42.
- Newacheck PW, Halfon N. Prevalence and impact of disabling chronic conditions in childhood. *Am J Public Health* 1998;88:610–17.
- Bank WHO. *World Report on Disability*. Geneva, 2011.
- Fauconnier J, Dickinson H, Beckung E, *et al*. Participation in life situations of 8–12 year old children with cerebral palsy: cross sectional European study. *BMJ* 2009;338:b1458.
- Hjern A, Weitoft G, Lindbald F. Social adversity predicts ADHD-medication in school children: a national cohort study. *Acta Paediatr* 2010;99:920–4.
- Simkiss D, Blackburn C, Mukoro M, *et al*. Childhood disability and socio-economic circumstances in low and middle income countries: a systematic review. *BMC Pediatr* 2011;11:119.
- Wells G, Shea B, O'Connell D, *et al*. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Health Research Institute, 1999.
- Berntsson LT, Kohler L. Long-term illness and psychosomatic complaints in children aged 2–17 years in the five Nordic countries. Comparison between 1984 and 1996. *Eur J Public Health* 2001;11:35–42.
- Blackburn CM, Spencer NJ, Read JM. Prevalence of childhood disability and the characteristics and circumstances of disabled children in the UK: secondary analysis of the Family Resources Survey. *BMC Pediatr* 2010;10:21.
- Blackburn CM, Spencer NJ, Read JM. Is the onset of disabling chronic conditions in later childhood associated with exposure to social disadvantage in earlier childhood? A prospective cohort study using the ONS Longitudinal Study for England and Wales. *BMC Pediatr* 2013;13:101.
- Currie J, Lin W. Chipping away at health: more on the relationship between income and child health. *Health Aff* 2007;26:331–44.
- Emerson E, Hatton C. The socio-economic circumstances of children at risk of disability in Britain. *Disability & Society* 2007;22:568–80.
- Fujiura G, Yamaki K. Trends in demography of childhood poverty and disability. *Exceptional Child* 2000;66:187–200.
- Gordon D, Parker R, Loughran F, *et al*. *Disabled children in Britain: a re-analysis of the OPCS disability surveys*. London: The Stationery Office, 2000.
- Hogan DP, Msall ME, Rogers ML, *et al*. Improved disability population estimates of functional limitation among American children aged 5–17. *Matern Child Health J* 1997;1:203–16.
- Lipman EL, Offord DR, Boyle MH. What if we could eliminate child poverty? The theoretical effect on child psychosocial morbidity. *Soc Psychiatry Psychiatr Epidemiol* 1996;31:303–7.
- Newacheck PW. Poverty and childhood chronic illness. *Arch Pediatr Adolesc Med* 1994;148:1143–9.
- Newacheck PW, Yi Hung Y, Park MJ, *et al*. Disparities in adolescent health and health care: does socioeconomic status matter? *Health Serv Res* 2003;38:1235–52.
- Newacheck PW, Stein REK, Bauman L, *et al*. Disparities in the prevalence of disability between black and white children. *Arch Pediatr Adolesc Med* 2003;157:244.
- Nikiema B, Spencer N, Seguin L. Poverty and chronic illness in early childhood: a comparison between the United Kingdom and Quebec. *Pediatrics* 2010;125:e499–507.
- Reinhardt Pedersen C, Madsen M, Kohler L. Does financial strain explain the association between children's morbidity and parental non-employment? *J Epidemiol Community Health* 2005;59:316–21.
- Saxena S, Elishoo J, Majeed A. Socioeconomic and ethnic group differences in self reported health status and use of health services by children and young people in England: cross sectional study. [Erratum appears in *BMJ*. 2003 Aug 9;327(7410):325]. *BMJ* 2002;325:520.
- Spencer NJ, Blackburn CM, Read JM. Prevalence and social patterning of limiting long-term illness/disability in children and young people under the age of 20 years in 2001: UK census-based cross-sectional study. *Child Care Health Dev* 2010;36:566–73.
- Cooper H, Arber S, Smaje C. Social class or deprivation? Structural factors and children's limiting longstanding illness in the 1990s. *Sociol Health Illn* 1998;20:289–311.
- Currie J, Stabile M. Socioeconomic status and child health: why is the relationship stronger for older children? *Am Econ Rev* 2003;93:1813–23.
- Ford G, Ecob R, Hunt K, *et al*. Patterns of class inequality in health through the lifespan: class gradients at 15, 35 and 55 years in the west of Scotland. *Soc Sci Med* 1994;39:1037–50.
- Grundy E. Disability in Great Britain: results from the 1996/97 disability follow-up to the family resources survey. London:

- Department of Social Security, Corporate Document Services, 1999.
28. Maskill C, Hodges I, Burns P, *et al.* *Living with disability in New Zealand. A descriptive analysis of results from the 2001 Household Disability Survey and the 2001 Disability Survey of Residential Facilities.* Wellington, New Zealand: Ministry of Health, 2004.
 29. West P. Health inequalities in the early years: is there equalisation in youth? *Soc Sci Med* 1997;44:833–58.
 30. West P, Sweeting H. Evidence on equalisation in health in youth from the West of Scotland. *Soc Sci Med* 2004;59:13–27.
 31. Alfstad KA, Clench-Aas J, Van Roy B, *et al.* Psychiatric symptoms in Norwegian children with epilepsy aged 8–13 years: effects of age and gender? *Epilepsia* 2011;52:1231–8.
 32. Bethell C, Read D, Blumbe S. Mental health in the United States: health care and well being of children with chronic emotional, behavioral, or developmental problems—United States, 2001. *MMWR Morb Mortal Wkly Rep*, 2005. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5439a3.htm> (accessed).
 33. Blackwell DL, Tonthat L. Summary health statistics for U.S. children: National Health Interview Survey, 1998. *Vital Health Stat* 2002;(208):1–46.
 34. Blackwell DL, Tonthat L. Summary health statistics for U.S. children: National Health Interview Survey, 1999. *Vital Health Stat* 2003;(210):1–50.
 35. Bloom B, Cohen RA, Vickerie JL, *et al.* Summary health statistics for U.S. children: National Health Interview Survey, 2001. *Vital Health Stat* 2003;(216):1–54.
 36. Bloom B, Cohen RA. Summary health statistics for U.S. children: National Health Interview Survey, 2006. *Vital Health Stat* 2007;(234):1–79.
 37. Bloom B, Cohen RA, Freeman G. Summary health statistics for U.S. children: National Health Interview Survey, 2008. *Vital Health Stat* 2009;(244):1–81.
 38. Bloom B, Cohen RA, Freeman G. Summary health statistics for U.S. children: National Health Interview Survey, 2010. *Vital Health Stat* 2011;(250):1–80.
 39. Bradshaw P, Tipping S. *GROWING UP IN SCOTLAND: children's social, emotional and behavioural characteristics at entry to primary school.* Edinburgh: The Scottish Government, 2010:60.
 40. Bromley C, Cunningham-Burley S. Growing up in Scotland: health inequalities in the early years. Edinburgh: The Scottish Government; 2010.
 41. Canals J, Hernandez-Martinez C, Cosi S, *et al.* The epidemiology of obsessive-compulsive disorder in Spanish school children. *J Anxiety Disord* 2012;26:746–52.
 42. Collishaw S, Goodman R, Pickles A, *et al.* Modelling the contribution of changes in family life to time trends in adolescent conduct problems. *Soc Sci Med* 2007;65:2576–87.
 43. Costello EJ, Compton SN, Keeler G, *et al.* Relationships between poverty and psychopathology: a natural experiment. *JAMA* 2003;290:2023–9.
 44. Cuffe SP, Moore CG, McKeown RE. Prevalence and correlates of ADHD symptoms in the national health interview survey. *J Atten Disord* 2005;9:392–401.
 45. Davis E, Sawyer MG, Lo SK, *et al.* Socioeconomic risk factors for mental health problems in 4–5-year-old children: Australian Population Study. *Acad Pediatr* 2010;10:41–7.
 46. Elberling H, Linneberg A, Olsen EM, *et al.* The prevalence of SDQ-measured mental health problems at age 5–7 years and identification of predictors from birth to preschool age in a Danish birth cohort: the Copenhagen Child Cohort 2000. *Eur Child Adolesc Psychiatry* 2010;19:725–35.
 47. Emerson E, Graham H, Hatton C. Household income and health status in children and adolescents in Britain. *Eur J Public Health* 2006;16:354–60.
 48. Ford T, Goodman R, Meltzer H. The relative importance of child, family, school and neighbourhood correlates of childhood psychiatric disorder. *Soc Psychiatry Psychiatr Epidemiol* 2004;39:487–96.
 49. Froehlich TE, Lanphear BP, Epstein JN, *et al.* Prevalence, recognition, and treatment of attention-deficit/hyperactivity disorder in a national sample of US children. *Arch Pediatr Adolesc Med* 2007;161:857–64.
 50. Green H, Executive SS. *Mental health of children and young people in Great Britain, 2004.* Palgrave Macmillan, 2005.
 51. Groholt EK, Stigum H, Nordhagen R, *et al.* Children with chronic health conditions in the Nordic countries in 1996—Influence of socio-economic factors. *Arbuid Child Health* 2001;7:177–89.
 52. Halfon N, Newacheck PW. Prevalence and impact of parent-reported disabling mental health conditions among U.S. children. *J Am Acad Child Adolesc Psychiatry* 1999;38:600–9; discussion 10–3.
 53. Heiervang E, Stormark KM, Lundervold AJ, *et al.* Psychiatric disorders in Norwegian 8-to 10-year-olds: an epidemiological survey of prevalence, risk factors, and service use. *J Am Acad Child Adolesc Psychiatry* 2007;46:438–47.
 54. Heyman I, Fombonne E, Simmons H, *et al.* Prevalence of obsessive—compulsive disorder in the British nationwide survey of child mental health. *Br J Psychiatry* 2001;179:324–9.
 55. Hurtig T, Taanila A, Ebeling H, *et al.* Attention and behavioural problems of Finnish adolescents may be related to the family environment. *Eur Child Adolesc Psychiatry* 2005;14:471–8.
 56. Hurtig T, Ebeling H, Taanila A, *et al.* ADHD and comorbid disorders in relation to family environment and symptom severity. *Eur Child Adolesc Psychiatry* 2007;16:362–9.
 57. Huss M, Holling H, Kurth B-M, *et al.* How often are German children and adolescents diagnosed with ADHD? Prevalence based on the judgment of health care professionals: results of the German health and examination survey (KIGGS). *Eur Child Adolesc Psychiatry* 2008;17(Suppl 1):52–8.
 58. Kalff AC, Kroes M, Vles JS, *et al.* Neighbourhood level and individual level SES effects on child problem behaviour: a multilevel analysis. *J Epidemiol Community Health* 2001;55:246–50.
 59. Lalloo R, Sheiham A, Nazroo JY. Behavioural characteristics and accidents: findings from the Health Survey for England, 1997. *Accid Anal Prev* 2003;35:661–7.
 60. Leonard H, Glasson E, Nassar N, *et al.* Autism and intellectual disability are differentially related to sociodemographic background at birth. *PLoS ONE* 2011;6:e17875.
 61. Loeber R, Hipwell A, Battista D, *et al.* Intergenerational transmission of multiple problem behaviors: prospective relationships between mothers and daughters. *J Abnorm Child Psychol* 2009;37:1035–48.
 62. Marks GB, Correll PK, Williamson M. Asthma in Australia 2005. *Med J Aust* 2005;183:445–6.
 63. McMunn AM, Nazroo JY, Marmot MG, *et al.* Children's emotional and behavioural well-being and the family environment: findings from the Health Survey for England. *Soc Sci Med* 2001;53:423–40.
 64. Meltzer H, Vostanis P, Goodman R, *et al.* Children's perceptions of neighbourhood trustworthiness and safety and their mental health. *J Child Psychol Psychiatry* 2007;48:1208–13.
 65. Messer J, Goodman R, Rowe R, *et al.* Preadolescent conduct problems in girls and boys. *J Am Acad Child Adolesc Psychiatry* 2006;45:184–91.
 66. Oberklaid F, Sanson A, Pedlow R, *et al.* Predicting preschool behavior problems from temperament and other variables in infancy. *Pediatrics* 1993;91:113–20.
 67. Pastor PN, Reuben CA. Racial and ethnic differences in ADHD and LD in young school-age children: parental reports in the National Health Interview Survey. *Public Health Rep* 2005;120:383–92.
 68. Pearce A, Lewis H, Law C. The role of poverty in explaining health variations in 7-year-old children from different family structures: findings from the UK Millennium Cohort Study. *J Epidemiol Community Health* 2013;67:181–9.
 69. Pinborough-Zimmerman J, Bilder D, Bakian A, *et al.* Sociodemographic risk factors associated with autism spectrum disorders and intellectual disability. *Autism Res* 2011;4:438–48.
 70. Reijneveld SA, Veenstra R, de Winter AF, *et al.* Area deprivation affects behavioral problems of young adolescents in mixed urban and rural areas: the TRAILS study. *J Adolesc Health* 2010;46:189–96.
 71. Resnick MB, Gueorguieva RV, Carter RL, *et al.* The impact of low birth weight, perinatal conditions, and sociodemographic factors on educational outcome in kindergarten. *Pediatrics* 1999;104:e74.
 72. Rimes KA, Goodman R, Hotopf M, *et al.* Incidence, prognosis, and risk factors for fatigue and chronic fatigue syndrome in adolescents: a prospective community study. *Pediatrics* 2007;119:e603–e9.
 73. Sawyer MG, Arney FM, Baghurst P, *et al.* The mental health of young people in Australia. Canberra: Commonwealth Department of Health and Aged Care, 2000.
 74. Singh GK, Ghandour RM. Impact of neighborhood social conditions and household socioeconomic status on behavioral problems among US children. *Matern Child Health J* 2012;16(Suppl 1): S158–69.
 75. St Sauver JL, Barbaresi WJ, Katusic SK, *et al.* Early life risk factors for attention-deficit/hyperactivity disorder: a population-based cohort study. *Mayo Clin Proc* 2004;79:1124–31.
 76. Taanila A, Yliherva A, Kaakinen M, *et al.* An epidemiological study on Finnish school-aged children with learning difficulties and behavioural problems. *Int J Circumpolar Health* 2011;70:59–71.

77. Visser SN, Lesesne CA, Perou R. National estimates and factors associated with medication treatment for childhood attention-deficit/hyperactivity disorder. *Pediatrics* 2007;119(Suppl 1):S99–106.
78. Waylen A, Ford T, Goodman R, *et al.* Can early intake of dietary omega-3 predict childhood externalizing behaviour? *Acta Paediatr* 2009;98:1805–8.
79. Wichstrom L, Berg-Nielsen TS, Angold A, *et al.* Prevalence of psychiatric disorders in preschoolers. *J Child Psychol Psychiatry* 2012;53:695–705.
80. Akinbami LJ, Liu X, Pastor PN, *et al.* Attention deficit hyperactivity disorder among children aged 5–17 years in the United States, 1998–2009. *NCHS Data Brief* 2011;(70):1–8.
81. Andres MA, Catala MA, Gomez-Beneyto M. Prevalence, comorbidity, risk factors and service utilisation of disruptive behaviour disorders in a community sample of children in Valencia (Spain). *Soc Psychiatry Psychiatr Epidemiol* 1999;34:175–9.
82. Apouey B, Geoffard PY. Family income and child health in the UK. *J Health Econ* 2013;32:715–27.
83. Barnes M, Chanfreau J, Tomaszewski W. *Growing up in Scotland: the circumstances of poor children summary report.* Scottish Government; 2010.
84. Boyle CA, Boulet S, Schieve LA, *et al.* Trends in the prevalence of developmental disabilities in US children, 1997–2008. *Pediatrics* 2011;127:1034–42.
85. Currie A, Shields MA, Price SW. The child health/family income gradient: evidence from England. *J Health Econ* 2007;26:213–32.
86. Dopfner M, Breuer D, Wille N, *et al.* BELLA study group. How often do children meet ICD-10/DSM-IV criteria of attention deficit/hyperactivity disorder and hyperkinetic disorder? Parent-based prevalence rates in a national sample—results of the BELLA study. *Eur Child Adolesc Psychiatry* 2008;17(Suppl 1):59–70.
87. Hoffman K, Webster TF, Weinberg JM, *et al.* Spatial analysis of learning and developmental disorders in upper Cape Cod, Massachusetts using generalized additive models. *Int J Health Geogr* 2010;9:7.
88. Khanam R, Nghiem HS, Connelly LB. Child health and the income gradient: evidence from Australia. *J Health Econ* 2009;28:805–17.
89. Meltzer H, Gatward R, Corbin T, *et al.*, Statistics DOF. Persistence, onset, risk factors and outcomes of childhood mental disorders: TSO London; 2003.
90. Miech RA, Caspi A, Moffitt TE, *et al.* Low socioeconomic status and mental disorders: a longitudinal study of selection and causation during young adulthood 1. *AJS* 1999;104:1096–131.
91. Ogundele MO, De Doysa R. Is ADHD a disease of affluence? A local authority experience in north-west of England. *Arch Dis Child* 2011;96:A25–6.
92. Simpson GA, Barbara Bloom M, Cohen RA, *et al.* US children with emotional and behavioral difficulties: data from the 2001, 2002, and 2003 National Health Interview Surveys. *Infants Young Child* 2005;12:13.
93. Sonuga-Barke E, Stevenson J, Thompson MJ. Mental health of preschool children and their mothers in a mixed urban/rural population. II. Family and maternal factors and child behaviour. *Br J Psychiatry* 1996;168:21–5.
94. Wade TJ, Pevalin DJ, Brannigan A. The clustering of severe behavioural, health and educational deficits in Canadian children: preliminary evidence from the National Longitudinal Survey of Children and Youth. *Can J Public Health* 1999;90:253–9.
95. Chapman DA, Scott KG, Stanton-Chapman TL. Public health approach to the study of mental retardation. *Am J Ment Retard* 2008;113:102–16.
96. Croen LA, Grether JK, Selvin S. The epidemiology of mental retardation of unknown cause. *Pediatrics* 2001;107:E86.
97. Decoufle P, Boyle CA. The relationship between maternal education and mental retardation in 10-year-old children. *Ann Epidemiol* 1995;5:347–53.
98. Dickson K, Emerson E, Hatton C. Self-reported anti-social behaviour: prevalence and risk factors amongst adolescents with and without intellectual disability. *J Intellect Disabil Res* 2005;49(Pt 11):820–6.
99. Emerson E, Hatton C. Mental health of children and adolescents with intellectual disabilities in Britain. *Br J Psychiatry* 2007;191:493–9.
100. Emerson E, Hatton C. Contribution of socioeconomic position to health inequalities of British children and adolescents with intellectual disabilities. *Am J Ment Retard* 2007;112:140–50.
101. Emerson E, Hatton C. Poverty, socioeconomic position, social capital and the health of children and adolescents with intellectual disabilities in Britain: a replication. *J Intellect Disabil Res* 2007;51:866–74.
102. Emerson E, Einfeld S. Emotional and behavioural difficulties in young children with and without developmental delay: a bi-national perspective. *J Child Psychol Psychiatry* 2010;51:583–93.
103. Emerson E, Shahtahmasebi S, Lancaster G, *et al.* Poverty transitions among families supporting a child with intellectual disability. *J Intellect Dev Disabil* 2010;35:224–34.
104. Gissler M, Rahkonen O, Jarvelin MR, *et al.* Social class differences in health until the age of seven years among the Finnish 1987 birth cohort. *Soc Sci Med* 1998;46:1543–52.
105. Heikura U, Taanila A, Hartikainen AL, *et al.* Variations in prenatal sociodemographic factors associated with intellectual disability: a study of the 20-year interval between two birth cohorts in Northern Finland. *Am J Epidemiol* 2008;167:169–77.
106. Leonard H, Petterson B, De Klerk N, *et al.* Association of sociodemographic characteristics of children with intellectual disability in Western Australia. *Soc Sci Med* 2005;60:1499–513.
107. Louhiala P. Risk indicators of mental retardation: changes between 1967 and 1981. *Dev Med Child Neurol* 1995;37:631–6.
108. Mannerkoski MK, Aberg LE, Autti TH, *et al.* Newborns at risk for special education placement: a population-based study. *Eur J Paediatr Neurol* 2007;11:223–31.
109. Oswald DP, Coutinho MJ, Best AM, *et al.* Impact of sociodemographic characteristics on the identification rates of minority students as having mental retardation. *Ment Retard* 2001;39:351–67.
110. Schieve LA, Boulet SL, Kogan MD, *et al.* A population-based assessment of the health, functional status, and consequent family impact among children with Down syndrome. *Disabil Health J* 2011;4:68–77.
111. Anderson CJ, Vogel LC. Employment outcomes of adults who sustained spinal cord injuries as children or adolescents. *Arch Phys Med Rehabil* 2002;83:791–801.
112. Case A, Lubotsky D, Paxson C. Economic status and health in childhood: the origins of the gradient. *Am Econ Rev* 2002;92:1308–34.
113. Emerson E, Robertson J, Wood J. Emotional and behavioural needs of children and adolescents with intellectual disabilities in an urban conurbation. *J Intellect Disabil Res* 2005;49:16–24.
114. Boss EF, Niparko JK, Gaskin DJ, *et al.* Socioeconomic disparities for hearing-impaired children in the United States. *Laryngoscope* 2011;121:860–6.
115. Chanfreau J, Cebulla A. *Educational attainment of blind and partially sighted pupils.* London: Royal National Institute for the Blind, 2009.
116. Cumberland PM, Pathai S, Rahi JS; Millennium Cohort Study Child Health G. Prevalence of eye disease in early childhood and associated factors: findings from the millennium cohort study. *Ophthalmology* 2010;117:2184–90.e1–3.
117. Kubba H, MacAndie C, Ritchie K, *et al.* Is deafness a disease of poverty? The association between socio-economic deprivation and congenital hearing impairment. *Int J Audiol* 2004;43:123–5.
118. Sutton GJ, Rowe SJ. Risk factors for childhood sensorineural hearing loss in the Oxford region. *Br J Audiol* 1997;31:39–54.
119. Van Kerschaver E, Boudewyns AN, Declau F, *et al.* Socio-demographic determinants of hearing impairment studied in 103,835 term babies. *Eur J Public Health* 2013;23:55–60.
120. Dolk H, Pattenden S, Johnson A. Cerebral palsy, low birthweight and socio-economic deprivation: inequalities in a major cause of childhood disability. *Paediatr Perinat Epidemiol* 2001;15:359–63.
121. Dolk H, Pattenden S, Bonellie S, *et al.* Socio-economic inequalities in cerebral palsy prevalence in the United Kingdom: a register-based study. *Paediatr Perinat Epidemiol* 2010;24:149–55.
122. Hjern A, Thorngren-Jerneck K. Perinatal complications and socio-economic differences in cerebral palsy in Sweden—a national cohort study. *BMC Pediatr* 2008;8:49.
123. Hvidtjorn D, Grove J, Schendel DE, *et al.* Cerebral palsy among children born after in vitro fertilization: the role of preterm delivery—a population-based, cohort study. *Pediatrics* 2006;118:475–82.
124. Sundrum R, Wallace A, Logan S, *et al.* Cerebral palsy and socio-economic status: a retrospective cohort study. *Arch Dis Child* 2005;90:15–9.
125. Wu YW, Xing G, Fuentes-Afflick E, *et al.* Racial, ethnic, and socioeconomic disparities in the prevalence of cerebral palsy. *Pediatrics* 2011;127:e674–81.
126. Yeargin-Allsopp M, Van Naarden Braun K, Doernberg NS, *et al.* Prevalence of cerebral palsy in 8-year-old children in three areas of the United States in 2002: a multisite collaboration. *Pediatrics* 2008;121:547–54.
127. Kozyrskyj AL, Prasad AN. The burden of seizures in Manitoba children: a population-based study. *Can J Neurol Sci* 2004;31:48–52.

128. Morgan CLI, Ahmed A, Kerr MP. Social deprivation and prevalence of epilepsy and associated health usage. *J Neurol Neurosurg Psychiatry* 2000;69:13–17.
129. Reading R, Haynes R, Beach R. Deprivation and incidence of epilepsy in children. *Seizure* 2006;15:190–3.
130. Russ SA, Larson K, Halfon N. A national profile of childhood epilepsy and seizure disorder. *Pediatrics* 2012;129:256–64.
131. Schiariti V, Farrell K, Hoube JS, *et al*. Period prevalence of epilepsy in children in BC: a population-based study. *Can J Neurol Sci* 2009;36:36–41.
132. Erzen D, Carriere KC, Dik N, *et al*. Income level and asthma prevalence and care patterns. *Am J Respir Crit Care Med* 1997;155:1060–5.
133. Halfon N, Newacheck PW. Childhood asthma and poverty: differential impacts and utilization of health services. *Pediatrics* 1993;91:56–61.
134. McConnochie KM, Russo MJ, McBride JT, *et al*. Socioeconomic variation in asthma hospitalization: excess utilization or greater need? *Pediatrics* 1999;103:e75.
135. Mielck A, Reitmeir P, Wjst M. Severity of childhood asthma by socioeconomic status. *Int J Epidemiol* 1996;25:388–93.
136. Newacheck PW, Halfon N. Prevalence, impact, and trends in childhood disability due to asthma. *Arch Pediatr Adolesc Med* 2000;154:287–93.
137. Ng Man Kwong G, Das C, Proctor AR, *et al*. Diagnostic and treatment behaviour in children with chronic respiratory symptoms: relationship with socioeconomic factors. *Thorax* 2002;57:701–4.
138. SIDRA. Asthma and respiratory symptoms in 6–7 yr old Italian children: gender, latitude, urbanization and socioeconomic factors. SIDRIA (Italian Studies on Respiratory Disorders in Childhood and the Environment). *Eur Respir J* 1997;10:1780–6.
139. Simon PA, Zeng Z, Wold CM, *et al*. Prevalence of childhood asthma and associated morbidity in Los Angeles County: impacts of race/ethnicity and income. *J Asthma* 2003;40:535–43.
140. Strachan DP, Anderson HR, Limb ES, *et al*. A national survey of asthma prevalence, severity, and treatment in Great Britain. *Arch Dis Child* 1994;70:174–8.
141. Vuillermin PJ, South M, Carlin JB, *et al*. Asthma among school children in the Barwon region of Victoria. *Med J Aust* 2007;187:221–4.
142. Blatter BM, Hermens R, Bakker M, *et al*. Paternal occupational exposure around conception and spina bifida in offspring. *Am J Ind Med* 1997;32:283–91.
143. Brender JD, Suarez L, Langlois PH. Parental occupation, Hispanic ethnicity, and risk of selected congenital malformations in offspring. *Ethn Dis* 2008;18:218–24.
144. Clark J, Mossey P, Sharp L, *et al*. Socioeconomic status and orofacial clefts in Scotland, 1989 to 1998. *Cleft Palate Craniofac J* 2003;40:481–5.
145. Correa-Villaseñor A, McCarter R, Downing J, *et al*. White-black differences in cardiovascular malformations in infancy and socioeconomic factors. *Am J Epidemiol* 1991;134:393–402.
146. Dolk H, Busby A, Armstrong B, *et al*. Geographical variation in anophthalmia and microphthalmia in England, 1988–94. Commentary: clustering of anophthalmia and microphthalmia is not supported by the data. *BMJ* 1998;317:905–10.
147. Farley TF, Hambidge SJ, Daley MF. Association of low maternal education with neural tube defects in Colorado, 1989–1998. *Public Health* 2002;116:89–94.
148. Lie H, Borjeson M, Lagerkvist B, *et al*. Children with myelomeningocele: the impact of disability on family dynamics and social conditions. A Nordic study. *Dev Med Child Neurol* 1994;36:1000–9.
149. Olsen J, Frische G. Social differences in reproductive health. *Scand J Public Health* 1993;21:90–7. NS—include
150. Olshan AF, Teschke K, Baird PA. Paternal occupation and congenital anomalies in offspring. *Am J Ind Med* 1991;20:447–75.
151. Rouhani P, Fleming L, Fraas J, *et al*. Pilot study of socioeconomic class, nutrition and birth defects in Spain. *Matern Child Health J* 2007;11:403–5.
152. Tang Y, Ma C-X, Cui W, *et al*. The risk of birth defects in multiple births: a population-based study. *Matern Child Health J* 2006;10:75–81.
153. Friel JK, Frecker M, Fraser FC. Nutritional patterns of mothers of children with neural tube defects in Newfoundland. *Am J Med Genet* 1995;55:195–9.
154. Ponsonby A-L, Catto-Smith AG, Pezic A, *et al*. Association between early-life factors and risk of child-onset Crohn's disease among Victorian children born 1983–1998: a birth cohort study. *Inflamm Bowel Dis* 2009;15:858–66.
155. Egger M, Davey Smith G, Schneider M, *et al*. Bias in meta-analysis detected by a simple graphical test. *BMJ* 1997;315:629–34.
156. Begg C, Muzumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics* 1997;50:1088–101.
157. Uphoff E, Cabieses B, Pinart M, *et al*. A systematic review of socioeconomic position in relation to asthma and allergic diseases. *Eur Respir J* 2015;46:364–74.
158. Anderson L, Larson S, Lakin C, *et al*. Children with disabilities: social roles and family impacts in the NHIS-D. *DD data brief* 2002;4 (1 NS—include).
159. Organisation WH. *International classification of functioning, disability and health—children and youth version*. Geneva: World Health Organisation, 2007.
160. Marmot M, Friel S, Bell R, *et al*. Closing the gap in a generation: health equity through action on the social determinants of health. *Lancet* 2008;372:1661–9.