**DRIVERS: Addressing the strategic Determinants to Reduce health Inequality Via 1) Early childhood development, 2) Realising fair employment, and 3) Social protection**

# Final Scientific Report WP2 on social inequities in early child health and development – Appendix 1-5

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## Appendix 1: Task 2.1 Systematic review: Social inequalities, early child development and early child health

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**Abstract**

*Background:* The period of early childhood is increasingly recognised as the most crucial period of lifespan development. External influences during this period are known to have a profound effect on an individual's health and development for the entire life course. Hence, achieving 'equity from the start' must be an essential component of any attempt to improve health outcomes overall and, in particular, address health inequities. By aiming to improve the social environment in which children grow up, live and learn, health and developmental inequalities which span the entire life course could be reduced. To achieve this, it is fundamental that a comprehensive knowledge exists on which social the most profound influences on early childhood health/development, hence being the drivers of the observed inequalities.

*Aim:* To systematically collect, document and review all the relevant available evidence on associations between social factors early childhood health and development in Europe, in order to enable the identification of the important social factors which drive such inequalities. Identifying the social factors which drive such inequalities will facilitate more efficient interventional initiatives in the future.

*Methods:* The Medline database and the FP7-funded CHICOS child cohort inventory were systematically searched in order to identify all European studies published in peer-reviewed journals within the last 10 years.

*Results:* Over 21,000 studies and 76 European child cohort datasets were searched, identifying a total of 183 studies from 31 European countries, which were included in the final review. Neighbourhood deprivation, lower parental income/wealth, educational attainment, and occupational social class, higher parental job strain / heavy physical occupational demands, lack of housing tenure, and material deprivation in the household were identified as being the main social factors associated with a wide range of child health and developmental outcomes.

*Conclusions:* A wide range of social factors at the neighbourhood and household level are associated with multiple adverse child health and developmental outcomes. These factors are an important driver of health inequality since they set children on disadvantageous life course health trajectories, hence acting as drivers of the observed health inequalities.

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## 1. INTRODUCTION

The period of early childhood, defined as the period between prenatal development to eight years of age, is increasingly recognised as the most crucial period of lifespan development.[1] During this period, the foundations are laid for every individual's physical and mental capacities, hence influencing their subsequent growth, health, and development throughout the life course. Early childhood is also considered the period of the life course which is the most highly sensitive to external influences,[2] thus implying that social, and other, influences during this period are likely to have the most profound effect on an individual's health and development. In certain aspects of health and development, the potential adverse effects of such influences, such as suboptimal infant brain growth, are even likely to be irreversible.[3] Hence, intervening to improve early childhood health and development outcomes is increasingly being suggested as a priority, as potential interventions are: i) expected to have a stronger impact on an individual's life course health and development, and ii) achieve higher returns than later interventions.[4,5]

In recognition of the importance of early childhood, the Commission on Social Determinants of Health (CSDH) *Closing the gap in a generation* report suggests that 'equity from the start' should be an essential component of any attempt to improve health outcomes overall and, in particular, address health inequities.[6] By aiming to improve the social and economic environment in which children grow up, live and learn, health and developmental inequalities which span the entire life course could be reduced. In order to achieve this, it is fundamental to develop a comprehensive knowledge base on which social and economic factors have the most profound influences on early childhood health and developmental outcomes, hence being the drivers of the observed inequalities in child health and development.

The two most established theories explaining early childhood development, Urie Bronfenbrenner's *Ecological systems model* and Arnold Sameroff's *Transactional model of development*, if combined, posit that all social and biological factors relating to the family / household (representing the child's micro-system), the neighbourhood (meso-system), and the broader socio-political environment (macro-system) interact in shaping children's' health and development.[7,8] Although a large number of European-based studies exist which examine the relationship between specific social factors operating at the different levels and health and developmental outcomes in early childhood, no study to date has attempted to systematically collate and synthesize the overall evidence provided from this large, but widely dispersed, evidence base.

The purpose of this review is to fill this important knowledge gap through a systematic search, documentation, review, and synthesis of all the relevant available evidence in the European region. Such a review will enable the identification of the important social factors operating at the household, neighbourhood, and country level (through evaluating the presence of any important between-country differences) which drive such inequalities. Identifying the wide range of proximal and distal social factors which are likely to be driving inequalities in early childhood will facilitate more clinically- and cost-effective, evidence-based, and equitable interventional initiatives in the future.

## 2. AIMS AND OBJECTIVES

The overall aim of this systematic review is to identify the relevant existing evidence on the relationship between social characteristics and early childhood health and development outcomes in the European region. This will be achieved through assessing the evidence on the association between household-, neighbourhood- and country-level social factors with health and physical, cognitive and socio-emotional development in early childhood.

## 3. METHODS – LITERATURE SEARCH AND REVIEW STRATEGY

The systematic review followed the PRISMA guidelines for systematic reviews.[9] In order to identify and include all relevant high quality studies, hence increasing the probability of drawing valid conclusions, the following operational definitions and specific eligibility criteria were set.

### 3.1 Operational definitions

<u>Early childhood:</u> The World Health Organisation Early Child Development Knowledge Network definition of 'prenatal development up to 8 years of age' was used.[1]

<u>Social factors:</u> The term 'social factors' was operationally defined to reflect the full spectrum of (potential) socio-economic disadvantage experienced in early childhood. For this purpose, the Indices of Multiple Deprivation (IMD) were selected as the framework defining the boundaries of what may constitute a 'social factor'.[10] The IMD were constructed by the Social Disadvantage Research Centre, University of Oxford, and consist of seven separate 'Deprivation Domains', of which one ('health deprivation and disability') was excluded since this study aims to examine the effect of 'social factors' on (child) health. The remaining six deprivation indices comprise the range of factors considered in this review as the 'social factors' in which a child grows up / develops: i) parental income, ii) parental employment, iii) parental education, skills and training, iv) access / barriers to housing and services, v) crime, vi) the living environment.

<u>Early childhood health:</u> The full range of possible health measures / outcomes were considered.

<u>Early childhood development:</u> This encompassed the wide range of developmental outcomes, covering physical, cognitive, and socio-emotional development (an inventory of the three developmental domains of early childhood development and their respective sub-domains is presented in Table 1).

| **Table 1** Domains and sub-domains of early childhood development | |
|---|---|
| **Domains** | **Sub-domains** |
| **Physical**<br>Development and growth in size, strength, and muscle coordination | • Organ development/maturation (e.g., cortical development)<br>• Sensation (visual, auditory, taste, olfactory development)<br>• Motor (fine and gross motor development)<br>• Control of bowel and bladder function |
| **Cognitive**<br>Development related to changes in thinking, remembering, and communicating | • Intelligence (e.g., memory, categorisation, problem-solving)<br>• Perception<br>• Language / communication |
| **Socio-emotional**<br>Development related to changes in how children interact with others and manage their emotions | • Attachment<br>• Temperament<br>• Emotion<br>• Social relations (and play) |

Source: Table compiled from Cook & Cook[11], Slater & Lewis[12], and Charlesworth[13]

### 3.2 Search strategy and eligibility criteria

Period of publication: Studies eligible for inclusion in the review had to be: i) published during the last 10 years (period of publication from 1 July 2002 to 30 June 2012), AND ii) use data collected, on average, from 1995 and onwards. This is because the distributions, and influences, of social factors have been documented to change over time, and this study aims to reflect the contemporary situation.

Language of publication: English.

Geographical region: WHO European region (53 countries in total).

Publication domain: A national or international peer-reviewed journal.

Sources searched for study identification / data extraction: One scientific literature database (Medline) and one child cohort inventory (CHICOS) were searched in order to identify relevant studies:

i) Medline: A bibliographic database of life sciences and biomedical information. Compiled by the United States National Library of Medicine (NLM).

ii) CHICOS child cohort inventory: An FP7 funded European child cohort inventory, which includes 76 child cohorts from 21 European countries.

The detailed search strategy performed for each source is presented in Table 2.

**Table 2** Description of search strategy employed for study identification

| Source | Search strategy employed |
|---|---|
| **Medline** (Bibliographic database) | **Aim: to perform a general, wide-ranging, search that will identify studies from both well-established and less-frequently utilised datasets, covering all potential European regions and countries**<br>The following search command was run in Medline:<br>("child"[MeSH Terms] OR "infant"[MeSH Terms] OR "child*"[All Fields] OR "infan*"[All Fields]) AND ("Socioeconomic Factors"[MeSH] OR "Social Class"[Mesh] OR "Social Environment"[Mesh] OR "Social Welfare"[Mesh] OR "Poverty"[Mesh] OR "Poverty Areas"[Mesh] OR "Population Density"[Mesh] OR "inequity"[All Fields] OR "inequities"[All Fields] OR "inequality"[All Fields] OR "inequalities"[All Fields] OR "gradient"[All Fields] OR "adversity"[All Fields] OR "poverty"[All Fields] OR "depriv*"[All Fields] OR "income"[All Fields] OR "ownership"[All Fields] OR "employ*"[All Fields] OR "unemploy*"[All Fields] OR "allowance"[All Fields] OR "incapacity"[All Fields] OR "crim*"[All Fields] OR "neighbourhood"[All Fields] OR "homeless"[All Fields] OR "housing"[All Fields] OR "crowd*"[All Fields] OR "air quality"[All Fields] OR "pollution"[All Fields] OR "traffic"[All Fields]) AND ("Child Development"[Mesh] OR "Developmental Disabilities"[Mesh] OR "Child Development Disorders, Pervasive"[Mesh] OR "develop*"[All Fields] OR "growth"[All Fields] OR "healh"[All Fields] OR "ill"[All Fields] OR "clinical"[All Fields] OR "delay*"[All Fields] OR "disability*"[All Fields] OR "cognit*"[All Fields] OR "mental"[All Fields] OR "ability*"[All Fields] OR "skill*"[All Fields] OR "school readiness"[All Fields]) AND ("2002/07/01"[PDAT] : "2012/06/30"[PDAT]) AND English[lang] |
| **CHICOS** (Child cohort inventory) | **Aim: to perform a more targeted search of European-based child cohorts only**<br>All 76 child cohorts included in the CHICOS inventory were examined through:<br>i) a search of each cohort study's online publication list (where one was available).<br>ii) entering the name of each cohort study as a separate search term in Medline, hence identifying all available peer-reviewed publications. |

Study sample size: Only studies with a sample of ≥500 children in their final adjusted analyses were considered for the review.

Type of evidence provided: Studies which included quantitative assessments of associations between social factors in early life and health / development outcomes in early childhood.

## 4. RESULTS – SOCIAL FACTORS IN EARLY LIFE AND HEALTH AND DEVELOPMENT IN EARLY CHILDHOOD

The literature search strategy provided the following results:

- Medline: 21,036 studies. All studies were screened based on title and abstract content, after which 20,815 were excluded and 221 were considered for further review. Of these studies, 93 were included in the final review.
- CHICOS inventory: 90 additional studies (not identified by the Medline search) were identified from the CHICOS inventory search and included in the final review.

Hence, a total of 183 studies were included which covered a wide range of European geographical regions / countries (33 countries in total) (Table 3). The majority of studies were based on datasets from Western and Northern Europe: UK (29% of identified studies), Sweden (9%), Netherlands (8%), Denmark (8%), Norway (6%) and Germany (6%).

**Table 3** Geographical representation of included studies and association-types evaluated

| Country | Studies | Neighbourhood level | | Household level | |
|---|---|---|---|---|---|
| | | Health | Development | Health | Development |
| Austria | 2 | ● | | ● | |
| Belarus | 1 | | | ● | |
| Belgium | 3 | | | ● | |
| Czech Republic | 2 | | | ● | |
| Cyprus | 3 | ● | | ● | |
| Denmark | 18 | ● | | ● | ● |
| Estonia | 2 | ● | | ● | ● |
| Finland | 8 | | | ● | |
| France | 9 | ● | | ● | ● |
| Germany | 13 | ● | | ● | ● |
| Greece | 7 | ● | | ● | ● |
| Hungary | 3 | | | ● | |
| Ireland | 3 | | | ● | |
| Italy | 5 | ● | | ● | |
| Kazakhstan | 1 | ● | | ● | |
| Kyrgyzstan | 1 | ● | | ● | |
| Latvia | 1 | ● | | ● | |
| Netherlands | 20 | ● | | ● | ● |
| Norway | 15 | | | ● | ● |
| Poland | 2 | | | ● | |
| Portugal | 1 | | | ● | |
| Romania | 2 | | | ● | |
| Russia | 3 | | | ● | |
| Serbia | 1 | | | | ● |
| Slovenia | 2 | | | ● | |
| Spain | 5 | ● | | ● | |
| Sweden | 22 | ● | | ● | ● |
| Switzerland | 1 | | | ● | |
| Turkey | 6 | | | ● | |
| UK | 69 | ● | ● | ● | ● |
| Ukraine | 4 | ● | | ● | |
| Uzbekistan | 1 | ● | | ● | |

The majority of the identified studies examined household-level social factors and child health outcomes, while fewer studies focused on neighbourhood-level social factors or child development outcomes. Studies which examined associations between neighbourhood-level social factors and child development outcomes were performed only in the UK (Table 4).

### 4.1 Evidence on neighbourhood-level social factors

A total of 52 studies were identified which included evaluations of associations between neighbourhood-level social factors and early childhood health and development outcomes. Of these, 32 focused on measures of neighbourhood-level deprivation / quality of the neighbourhood only, 18 on population density / level of urbanization, and 2 on both.

*Deprivation / quality of neighbourhood*

To define neighbourhood deprivation, different measures of deprivation at the neighbourhood level were utilised, most of which were composite measures of area level unemployment, low social class, low income, and lack of car ownership.

Of the 34 studies which included evaluations of neighbourhood-level deprivation / quality of the neighbourhood, 27 studies identified significant associations with adverse health and developmental outcomes (Table 4),[14-40] 5 studies did not report any significant association with any of the evaluated outcomes,[41-45] and 2 studies identified significant associations in the opposite direction of that expected.[46,47]

Of the studies which focused only on neighbourhood deprivation, almost all identified significant associations with adverse health and developmental outcomes in early childhood, with only four studies indicating no association with any of the evaluated outcomes,[41-43,45] and one study showing an association in the opposite direction of that which was expected[38].

Two studies which focused specifically on associations with proximity to major green spaces, surrounding greenness, and access to a garden in the neighbourhood, identified associations with increased risk of overweight,[43] and lower birth weight (but only in mothers with the lowest education level)[19].

The remaining studies focused on: i) the safety of the neighbourhood, indicating that living in an unsafe area was associated with increased risk of cognitive developmental delay,[23] ii) the friendliness of the neighbourhood, indicating that living in a friendly neighbourhood was associated with elevated BMI,[46] and iii) the level of maternal social capital, not reporting any significant associations[44].

| **Table 4** Adverse early childhood outcomes associated with neighbourhood-level deprivation / low quality neighbourhood | |
|---|---|
| **Health outcomes*** | **Developmental outcomes*** |
| Preterm birth (4 studies) | Delay in cognitive development |
| Small for gestational age (4 studies) | Lower level of receptive language |
| Birth weight (reduced/low/very low) (6 studies) | Inferior motor skills |
| Overweight / obesity (2 studies) | Primary reflex persistence |
| Undernutrition | Conduct problems |
| Sudden Infant Death Syndrome | Peer problems |
| Sleep disordered breathing | |
| Acute respiratory failure and bronchiolitis | |
| Asthma / multiple wheeze | |
| Dental caries | |
| Head injury / unintentional injury | |
| Leukaemia | |
| Neonatal intensive care admission rate | |

* Significant association reported in one study unless specified

*Population density / level of urbanization*

Twenty studies included evaluations of level of urbanization / population density, of which 12 identified associations with adverse health and development outcomes: 8 with urban / high-population density areas,[40,48-54] 3 with rural / low-population density areas,[47,55,56] and 1 with both (for different outcomes)[57] (Table 5). The remaining 8 studies did not report any significant associations with any of the evaluated outcomes.[58-65]

| **Table 5** Adverse early childhood outcomes associated with population density / level of urbanisation | |
|---|---|
| **Urban / high-population density areas** | **Rural / low-population density areas** |
| Congenital malformations (chromosomal, circulatory, urinary) | Congenital malformations (cleft lip, cleft palate, skin, breast, other) |
| Intrauterine growth restriction | Leukaemia |
| Very low birth weight | Overweight |
| Asthma / Wheeze | Inattention problems |
| Cough | |
| Rhinitis | |
| Eczema | |
| Down syndrome | |
| Head injury | |
| Excessive infant crying | |

* Significant association reported in one study unless specified

### 4.2 Evidence on household-level social factors

A total of 159 studies were identified which included evaluations of associations between household-level social factors and early childhood health and development outcomes. The majority of studies evaluated associations between multiple household-level social factors and child outcomes (a total of 279 household-level social factors were evaluated).

*Parental social class / socio-economic status*

Parental social class / socio-economic status was defined by occupation in almost all identified studies which examined this social factor. The identified studies employed different definitions of occupational social class: i) paternal or maternal social class (separately), or ii) a combination of both parents' social class to derive a 'household social class' (typically by including only the highest social class of either parent / carer).

Overall, in the 55 studies which included evaluations of parental social class / socio-economic status, 35 studies identified significant associations with a wide range of adverse health and developmental outcomes (Table 6),[23,33,41,42,66-96] 16 studies did not report any significant associations with any of the evaluated outcomes,[43,97-111] and 4 studies identified significant associations in the opposite direction of that expected [46,112-114].

**Table 6** Adverse early childhood outcomes associated with parental social class / socio-economic status

| Health outcomes | Development outcomes |
|---|---|
| Preterm birth (2 studies) | Cognitive delay |
| Small for gestational age (2 studies) | Inferior non-verbal cognition |
| Intrauterine growth restriction | Lower intelligence scores |
| Birth weight (reduced / low) (6 studies) | Cognitive deficiency (mild, severe) |
| Short birth length | Language delay |
| Overweight / obesity (3 studies) | Lower verbal ability (2 studies) |
| Waist circumference ≥90th percentile | Inferior motor ability |
| Congenital abnormalities (ocular, respiratory) | Psychopathology (2 studies) |
| Asphyxia | |
| Leukaemia | |
| Cerebral palsy | |
| Coeliac disease | |
| Asthma (2 studies) / wheeze (3 studies) | |
| Rhinitis | |
| Sleep disordered breathing symptoms | |
| Atopic dermatitis | |
| Eye conditions / hypermetropia (3 studies) | |
| Dental caries | |
| Unintentional injury | |
| Long-term limiting illness / disability | |
| Perinatal mortality | |

* Significant association reported in one study unless specified

*Parental income / wealth*

The identified studies employed different definitions of parental income / wealth: i) family / household income, ii) perceived financial status, iii) the presence or absence of financial difficulties or concerns, income poverty, or number of times in financial hardship in the family / household, and vi) receipt of income support or social welfare / benefit/s.

Overall, out of the 41 studies which included evaluations of parental income / wealth, 25 studies identified significant associations with a wide range of adverse health and developmental outcomes (Table 7),[23,25,58,62,83,108,110,115-132] while 16 studies did not report any significant associations with any of the evaluated outcomes [43,49,103,104,112,133-143].

**Table 7** Adverse early childhood outcomes associated with parental income / wealth

| **Health outcomes** | **Development outcomes** |
|---|---|
| Preterm birth (2 studies) | Lower score/delay in cognitive development (4 studies) |
| Small for gestational age | Delayed language development |
| Reduced birth weight for gestational age | Lower verbal and non-verbal ability scores |
| Reduced birth weight (2 studies) | Lower 'school readiness' scores |
| Overweight / obesity (2 studies) | Lower spatial ability scores |
| Underweight | Inferior behavioural development |
| Asthma (4 studies), wheeze (2 studies) | Externalising and internalising problems |
| Psychiatric diagnosis | Socio-emotional difficulties |
| Mental health problems | Difficult infant temperament |
| Autistic Spectrum Disorder | |
| Severe but undiagnosed autistic traits | |
| Spontaneous abortion | |
| Dental caries | |
| 'Poor health' | |
| Hospital-attended injuries | |
| Limiting long-standing illness | |

* Significant association reported in one study unless specified

*Parental education*

Parental education was defined in the identified studies in two ways: i) maternal and / or paternal education (the highest educational level attained), or ii) combinations of the highest educational attainment of both parents (typically, by using the highest educational level attained in the household by either parent).

Overall, of the 105 studies which included evaluations of parental education, 68 studies identified significant associations with adverse health and developmental outcomes (Table 8),[18,23,25,29,33,41,42,52,54,55,57,58,61,62,64,65,70,72,77,80,84,101,107,108,110,115,117-119,123-125,130,131,133,135,136,138,141,143-171] 31 studies did not report any significant associations with any of the evaluated outcomes,[29,35,43,46,56,59,60,63,94,98,99,102,103,105,106,116,126,128,134,139,172-182] and 6 studies identified significant associations in the opposite direction of that expected [113,114,142,183-185]. Within the above findings, comparable findings were reported for both maternal and paternal education as, in studies which evaluated maternal and paternal education separately, 6 studies reported significant associations for maternal education only,[41,61,80,130,136,153] 4 for paternal only,[18,117,150,159] while 5 reported significant associations for both [77,84,119,138,155].

**Table 8** Adverse early childhood outcomes associated with parental education

| Health outcomes | Development outcomes |
|---|---|
| Preterm birth (4 studies)<br>Small for gestational age (2 studies)<br>Reduced / low / very low birth weight / birth weight for gestational age (8 studies)<br>Shorter birth length, stunting, reduced height<br>Intrauterine growth restriction (2 studies)<br>Slower foetal growth (head, abdomen, femur)<br>Reduced head circumference growth<br>Elevated BMI, overweight, obesity (14 studies)<br>Waist circumference ≥90th percentile<br>Percentage of body fat ≥90th percentile<br>Congenital malformations<br>Asthma / asthma symptoms (4 studies)<br>Wheeze (3 studies)<br>Cold and symptoms, respiratory infections<br>Sleep disordered breathing symptoms<br>Pediculosis / scabies infestation<br>Hospitalisation for infectious diseases<br>Psychiatric disorder<br>'Severe but undiagnosed autistic traits'<br>ADHD-like symptoms<br>Anorexia<br>Constipation<br>Induction of beta-cell antibodies levels<br>Dental caries<br>Poor general health<br>Accidents / injuries (unintentional / home) / death due to injury (4 studies)<br>Increased use of health / doctor services / consultations / in-hospital care (2 studies)<br>Hospitalisations (due to digestive disorders / respiratory diseases)<br>Stillbirth/neonatal/postnatal mortality (3 studies)<br>Sudden Intrauterine Unexplained Death | Inferior / delayed cognition (4 studies)<br>Delayed language development and related outcomes (5 studies)<br>Inferior fine motor development<br>Increased emotional symptoms<br>Increased conduct problems<br>Behavioural difficulties<br>Difficult infant temperament<br>Attention problems<br>Inferior socio-emotional development<br>Psychopathology (2 studies) |

* Significant association reported in one study unless specified

*Parental employment*

The identified studies evaluated a wide range of measures related to parental employment: i) measures of paternal and / or maternal employment status (e.g., unemployment, living in a workless household, ever employed in paid work, duration of employment), and ii) measures related to parental job strain / physical work demands (such as work hours per week, hours standing / walking / kneeling / bending / lifting weights at work, receiving paid sickness and / or maternity leave / benefits after birth), performing shift / night work / irregular working hours.

Overall, of the 41 studies which included evaluations of parental employment, 25 studies identified significant associations with adverse health and developmental outcomes (Table 9),[20,23,25,43,52-54,60,83,87,88,90,124,136,138,153,172,179,186-192] 15 studies did not report any significant associations with any of the evaluated outcomes,[61,63,80,94,103-105,110,118,126,128,140,175,180,193] and one study reported significant associations in the opposite direction of that expected [131].

**Table 9** Adverse early childhood outcomes associated with parental employment outcomes

| **Parental unemployment** | **High level of job strain** |
|---|---|
| Preterm birth (3 studies) | Preterm birth (3 studies) |
| Small for gestational age | Post-term birth |
| Reduced birth weight for gestational age | Small for gestational age (2 studies) |
| Low / very low birth weight (3 studies) | Reduced birth weight (4 studies) |
| Congenital abnormalities (ocular) | Small head circumference |
| Excessive infant crying | Excessive infant crying (2 studies) |
| Long-term limiting illness / disability | Coeliac disease |
| Sudden Infant Death Syndrome | Overweight (2 studies) |

* Significant association reported in one study unless specified

A further analysis of the above findings highlights that, within these results, differences were observed between studies which focused on: i) paternal / maternal unemployment, ii) not being in paid employment (but not unemployed), iii) living in a workless household and studies which focused on measures related to parental job strain / physical work demands. Within the group of studies which evaluated paternal / maternal unemployment (16 studies in total), the majority (11 studies) reported significant associations,[20,52,53,87,88,90,124,138,186,188,189] while the remaining 5 reported non-significant associations [60,61,110,126,128]. However, the opposite pattern was observed for studies which evaluated not being in paid employment (13 in total), with the majority of studies (8 studies) reporting non-significant associations,[63,80,94,104,105,140,175,180] one study reporting a significant association in the opposite direction of that expected,[131] while only 4 studies identified significant associations [54,83,136,153]. Only two studies evaluated associations with a workless household, both reporting significant associations.[23,25] Within the group of studies which evaluated measures related to parental job strain / physical work demands (14 studies in total), 10 reported significant associations with adverse child health and developmental outcomes,[43,60,88,172,179,187,188,190-192,] while 4 reported non-significant associations [103,110,118,193].

*Housing tenure*

The identified studies used different definitions of housing tenure: i) owning / not owning a house, ii) renting a house, iii) living in a council house / social housing, or iv) sharing a house / apartment.

Overall, of the 10 studies which included evaluations of housing tenure (all but one of which were based on UK data), 7 studies identified significant associations with adverse health and developmental outcomes (Table 10),[23,71,95,107,131,148,194] while 3 studies did not report any significant associations with any of the evaluated outcomes [46,99,108].

**Table 10** Adverse early childhood outcomes associated with housing tenure

| **Lack of home ownership** | **Living in council rented housing** |
|---|---|
| Reduced birth weight | Cognitive delay |
| Unintentional home injury | Utilisation of health services / consultations |
| Asthma | Hypermetropia |
| Wheeze | |
| Eye disease | |

* Significant association reported in one study unless specified

*Household crowding*

The identified studies used different definitions of household crowding: i) number of persons per room in the house, ii) living in a small living space, iii) number of rooms in the house, or iv) number of people sharing a room with the child.

Overall, of the 13 studies which included evaluations of household crowding, 5 studies identified significant associations with adverse health and developmental outcomes (Table 11),[39,176,183,194,195] 7 studies did not report any significant associations with any of the evaluated outcomes,[29,46,60,61,80,122,196] and one study identified significant associations in the opposite direction of that expected [107]. Table 11 suggests that the identified associations tend to relate to diseases that are communicable / infectious.

**Table 11** Adverse early childhood outcomes associated with household crowding

| **Living in a crowded household** |
|---|
| Reduced birth weight (2 studies) |
| Reduced height |
| Bronchitis |
| Bronchial asthma |
| Frequency of colds, coughs, and sneeze attacks |

| |
|---|
| Eczema<br>H. influenzae and H. influenzae type b<br>IgE sensitization |

* Significant association reported in one study unless specified

*Material deprivation*

Identified studies primarily utilised two types of definitions for material deprivation: i) a measure of material 'hardship' / 'disadvantage', and / or ii) living in inadequate housing (e.g., lacking fundamental household resources).

Overall, in the 12 studies which included evaluations of material deprivation, 8 studies identified significant associations with adverse health and developmental outcomes (Table 12),[23,48,58,70,72,102,106,134] 3 studies did not report any significant associations with any of the evaluated outcomes,[30,46,137] and one study identified significant associations in the opposite direction of that expected [107].

| **Table 12** Adverse early childhood outcomes associated with material deprivation | |
|---|---|
| **Material hardship / disadvantage** | **Living in inadequate housing** |
| Cognitive delay<br>Poor weight gain | Stunting<br>Asthma<br>Wheeze (2 studies)<br>Cough<br>Rhinitis<br>Sleep disordered breathing symptoms<br>Eczema<br>Enuresis / infrequent bed-wetting |

* Significant association reported in one study unless specified

*Other – Access to a garden*

Only two studies evaluated household social factors which could not be assigned to the above categories. Both studies evaluated whether having access to a garden was associated with measures of overweight / weight gain, reporting non-significant findings.[43,103]

### 4.3 Overall evidence

Overall, across the wide range of multiple social factors evaluated, the majority of identified studies revealed significant associations in the direction which was expected, highlighting the potential influence of social factors on multiple child health and developmental outcomes (Table 13).

| **Table 13** Overview of the 333 evaluated associations in the 183 included studies | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Significant association/s reported** | | **No significant association/s reported** | | **Significant association/s** (in opposite direction of that expected) | | **Total number of studies** |
| | N | % of total | N | % of total | N | % of total | N |
| **Neighbourhood-level** | | | | | | | |
| Deprivation | 27 | 79 | 5 | 15 | 2 | 6 | 34 |
| Population density | 12 | 60 | 8 | 40 | 0 | 0 | 20 |
| Total | 39 | 72 | 13 | 24 | 2 | 4 | 54 |
| **Household-level** | | | | | | | |
| Parental social class | 35 | 64 | 16 | 29 | 4 | 7 | 55 |
| Parental income/wealth | 25 | 61 | 16 | 39 | 0 | 0 | 41 |
| Parental education | 68 | 65 | 31 | 29 | 6 | 6 | 105 |
| Parental employment | 25 | 61 | 15 | 37 | 1 | 2 | 41 |
| Housing tenure | 7 | 70 | 3 | 30 | 0 | 0 | 10 |
| Household crowding | 5 | 38 | 7 | 54 | 1 | 8 | 13 |
| Maternal deprivation | 8 | 67 | 3 | 25 | 1 | 8 | 12 |
| Other | 0 | 0 | 2 | 100 | 0 | 0 | 2 |
| Total | 173 | 62 | 93 | 33 | 13 | 5 | 279 |

A geographical classification of the reported associations highlights that the general trend across countries is for the reported associations to be significant, although specific country-level differences can be identified. For example, a trend in the opposite direction is observed for studies performed in Turkey and Ukraine, where 3 out of 10, and 3 out of 11 studies, respectively, reported non-significant associations (Table 14).

**Table 14** Geographical classification of the evaluated associations (number of significant associations / total number of evaluated associations)

| Country | Evaluations performed | Neighbourhood level | | Household level | |
|---|---|---|---|---|---|
| | | Health | Development | Health | Development |
| Austria | 4 | 0/1 | | 3/3 | |
| Belarus | 2 | | | 2/2 | |
| Belgium | 3 | | | 2/3 | |
| Czech Republic | 2 | | | 1/2 | |
| Cyprus | 3 | 2/2 | | 1/2 | |
| Denmark | 31 | 0/1 | | 20/29 | 1/1 |
| Estonia | 3 | 0/1 | | 1/1 | 1/1 |
| Finland | 11 | | | 10/11 | |
| France | 15 | 1/1 | | 4/6 | 3/8 |
| Germany | 22 | 0/1 | | 15/20 | 1/1 |
| Greece | 13 | 2/3 | | 5/7 | 2/3 |
| Hungary | 4 | | | 4/4 | |
| Ireland | 4 | | | 3/4 | |
| Italy | 8 | 2/2 | | 6/6 | |
| Kazakhstan | 5 | 0/2 | | 3/3 | |
| Kyrgyzstan | 5 | 0/2 | | 3/3 | |
| Latvia | 2 | 1/1 | | 1/1 | |
| Netherlands | 30 | 3/4 | | 14/24 | 2/2 |
| Norway | 20 | | | 13/17 | 3/3 |
| Poland | 2 | | | 2/2 | |
| Portugal | 2 | | | 0/2 | |
| Romania | 3 | | | 3/3 | |
| Russia | 4 | | | 4/4 | |
| Serbia | 1 | | | | 1/1 |
| Slovenia | 2 | | | 2/2 | |
| Spain | 7 | 1/1 | | 4/6 | |
| Sweden | 31 | 3/5 | | 14/25 | 0/1 |
| Switzerland | 2 | | | 0/2 | |
| Turkey | 10 | | | 3/10 | |
| UK | 131 | 21/23 | 4/6 | 49/80 | 22/22 |
| Ukraine | 11 | 0/1 | | 2/10 | |
| Uzbekistan | 4 | 0/1 | | 3/3 | |

## 5. DISCUSSION – IMPLICATIONS FOR SOCIAL INEQUALITIES IN EARLY CHILDHOOD HEALTH AND DEVELOPMENT IN EUROPE

### 5.1 Summary of findings

The 183 studies included in this review evaluated associations of a total of 333 social factors at the neighbourhood and household level with health and developmental outcomes in early childhood. Overall, the results of these studies provide strong evidence that neighbourhood deprivation, lower parental income/wealth, lower educational attainment, lower occupational social class, parental unemployment, higher parental job strain / heavy physical occupational demands, lack of housing tenure, and material deprivation in the household are all independently associated with a wide range of adverse health and developmental outcomes in early childhood. Insufficient evidence of a consistent association with adverse child health and development was identified only for two social factors: household crowding and one of the parents not being in paid employment. Additional studies are necessary to further evaluate associations between neighbourhood-level social factors and child development outcomes. These findings appear to hold across the majority of European countries.

### 5.2 Implications for scientific knowledge, policy and practice

Overall, the findings of this study, when taken together, carry important implications for scientific knowledge, policy and practice.

In terms of scientific knowledge, these findings provide a number of clear messages:

- *Most* social factors, at *both the neighbourhood and household level*, appear to have an influence on early childhood health and development.

- This influence extends across a wide range of adverse health and developmental outcomes in early life, from compromised physical growth and development (physical, cognitive, and socio-emotional) to congenital anomalies, infections, allergies, mental illness, overweight / obesity, injury, morbidity, and mortality.

- This influence spans the entire continuum of early life, since associations were identified covering all the major periods of early life, from prenatal to 8 years of age (pre-, peri-, and post-natal periods, infancy / toddlerhood periods, pre-school period)

- The social gradient in health and developmental outcomes observed throughout the remaining life course (middle and later childhood, adolescence, adulthood, old age) may be partly explained by gradients which started appearing in early childhood.

These findings infer important implications for policy and practice:

These findings indicate that growing up in social disadvantage implies an overall health and developmental disadvantage for children, which, in turn, has been suggested to set individuals on disadvantageous health and development trajectories for the rest of their life course.[197] In addition, existing evidence suggests that early onset of a disease / disorder usually comes with a higher health and financial cost burden. For example, a wide body of research suggests that childhood onset conduct disorder involves more enduring vulnerabilities that lead to much more chronic and pervasive problems throughout the life course than the adolescent subtype.[198] Hence, these findings provide further evidence to support the idea that emphasis should be given, from policy makers and practitioners, to providing preventive measures or intervening at this early stage of the life course, as it would reduce both the increased subsequent risk and cost.[5] Although the potential benefits of early life prevention / intervention have not yet been fully evaluated, a key evidence base in now gradually being established indicating both the clinical and cost effectiveness of such an approach.[199]

The finding that multiple social factors, operating at different societal levels (neighbourhood, household), are potential sources of health / developmental disadvantage in early life, highlights the complex embedding, clustering and cumulative nature of disadvantage, but also indicates the multiplicity of targets that potential interventions should consider if they are to be effective. It provides support to previous work which explained how advantage and risk is embedded within families, neighbourhoods and social classes[200,201] and emphasized the necessity of interventional approaches to be intersectoral, targeting multiple social (and other) factors operating at different levels in order to achieve health equity.[6]

### 5.3 Strengths and limitations of this review

This review is the largest systematic investigation of the association between social factors and adverse childhood health and developmental outcomes in Europe.

A number of factors strengthen the validity and reliability of findings reported in this review:

- Contemporary and, therefore, relevant and timely evidence: only studies published after 2002 with data collected after 1995 were considered.
- Large study samples: to increase reliability of findings, only studies that included samples of ≥500 children in their final adjusted analyses were considered.
- Higher quality of scientific studies: to limit the inclusion of less-rigorous scientific studies, only studies published in national or international peer-reviewed journals were considered.
- Comprehensive nature of definitions and outcomes: the term ‘social factors’ was operationally defined to reflect the full spectrum of (potential) socio-economic disadvantage experienced in early childhood, as well as the different societal levels at which they may operate. In addition, included studies used a range of different definitions to evaluate each social factor (e.g., parental education was defined in different ways between studies: highest level of education achieved, parent achieved basic education, etc). Similarly, the complete range of health outcomes (including health services utilization) and developmental domains (physical, cognitive, socio-emotional) were included.
- Exclusion of associations potentially explained by confounding: studies were considered only if they used adjustments for confounding in their social factor – health/development outcome analyses, hence reducing the possibility that the identified associations are explained by other, non-social, confounding factors.

- General and specific search strategy: the search strategy combined a wide-ranging search of a bibliographic database with a more targeted search of a European child cohort database.
- Evidence covering all European regions: included studies provided evidence from a total of 31 different European countries, covering all European regions (western Europe, Scandinavian, Mediterranean, Balkan states, central and eastern Europe).

Several limitations characterize the findings reported in this review:

- Evidence is primarily western and northern European: although evidence from a wide range of European countries is provided, this evidence is derived primarily from western and northern European countries (~85% of included studies are from six western and northern European countries: UK, Sweden, Netherlands, Denmark, Norway, Germany).
- Insufficient adjustment for non-social confounding: although only studies which performed some adjustment for potential confounding were considered, this adjustment was by no means exhaustive, meaning that many studies (due to bad study design or lack of data on every potential confounder) did not perform the full range of potentially necessary adjustments. Hence, in many cases, reported associations may be confounded by other, non-social factors which were not adjusted for.
- Publication bias towards significant findings: considering the tendency to under-report non-significant findings,[202] the proportion of studies which reported significant associations between social factors and health and developmental outcomes in early life may be an overestimate.

## 6. CONCLUSION

This study was the largest systematic investigation of the association between social factors and adverse childhood health and developmental outcomes in Europe. A total of 183 studies provided strong evidence that multiple adverse social factors operating at both the household and neighbourhood level are associated with a wide range of adverse health and developmental outcomes, from the prenatal period to the end of early childhood. Overall, when taken together, these findings suggest that the social gradient in health and developmental outcomes observed throughout the remaining life course may be partly explained by gradients initiated in early childhood. These findings suggest prevention, early intervention and inter-sectoral approaches to tackle the complex embedding, clustering and cumulative nature of social disadvantage observed in early life.

# 7. APPENDIX – RESULTS OF THE SYSTEMATIC LITERATURE SEARCH

## 7.1 Neighbourhood-level social characteristics

### 7.1.1 Deprivation / quality of neighbourhood

**Table A.1** Studies assessing the association between **neighbourhood-level social characteristics (i. Deprivation / quality of neighbourhood)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Agyemang, 2009 [14] | Netherlands | 7,883 mothers and their newborns | Neighbourhood income, neighbourhood level of unemployment/receipt of social security benefits | Preterm birth, SGA, miscarriage/perinatal death | Lower income and higher level of unemployment/on social security benefits were both associated with increased odds for SGA. |
| Armstrong, 2003 [15] | UK | 74,500 children (3.25y-3.5y) | Deprivation of area of residence (based on the 'Carstairs Deprivation category' – a composite measure of household overcrowding, male unemployment, low social class, and car ownership) | Obesity(BMI>98$^{th}$ centile), undernutrition (BMI<2$^{nd}$ centile) | Higher levels of deprivation were associated with increased risk of undernutrition and obesity. |
| Blomquist, 2007 [16] | Sweden | 4,407 children (4y) | Socioeconomic status at the municipality level (based on occupation, educational level, and income level) | Overweight and obesity | Municipalities with lower occupational status level, educational level, or income level were associated with increased risk for overweight and obesity. |
| Bundred, 2003 [17] | UK | 48,452 births | Neighbourhood deprivation - Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car | Birth weight | Higher deprivation score was associated with reduced birth weight. |

| | | | | | |
|---|---|---|---|---|---|
| | | | ownership, non-home ownership, household overcrowding) | | |
| Cesaroni, 2003 [18] | Italy | 3,440 children (6y-7y) | Socio-economic index (educational level, occupational category, percentage of unemployed men of working age, percentage of one person families, percentage of families with five or more persons, crowding index (persons/room), and percentage of dwellings rented or owned), income-area index (per-capital income in area) | Severe asthma, hospitalization for asthma | Lower socio-economic index and income-area index were both associated with increased odds for hospitalization for asthma. |
| Dadvand, 2012 [19] | Spain | 8,246 newborns | Surrounding greenness, proximity to major green spaces | Length of gestation, birth weight | None of the indicators of green exposure were associated with length of gestation or birth weight. In newborns of mothers with the lowest education level who had a higher score of surrounding greenness, an increase in birth weight was identified. |
| Delpisheh, 2006 [20] | UK | 4,537 births | Neighbourhood Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Low birth weight, preterm birth, SGA | A higher deprivation score was associated with increased odds of LBW and SGA. |
| Dibben, 2006 [21] | UK | 306,067 births | Area income deprivation (measured through the income domain of the IMD) | Low birth weight, very low birth weight | Area income deprivation was associated with increased odds of low birth weight and very low birth weight. |

| | | | | | |
|---|---|---|---|---|---|
| Ellwood, 2004 [22] | UK | 3,731 children (5y) | Area deprivation - Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Dmft (decayed/missing/filled teeth), caries in deciduous upper incisors, and extracted teeth because of caries | Deprivation was associated with increased mean dmft, dmft>0, dmft≥4, caries in deciduous upper incisors, and extracted teeth because of caries. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Neighbourhood deprivation, safety of area of residence | Severe and less severe cognitive delay (3y) | High neighbourhood deprivation, and living in an unsafe area were associated with increased risk for severe and less severe delay in the child's cognitive development. |
| Flouri, 2010a [41] | UK | 9,630 children (3y) | IMD rank of area of residence | Psychopathology (measured through SDQ) | Non-significant association. |
| Flouri, 2010b [42] | UK | 4,618 children (3y) | IMD rank of area of residence | Psychopathology (pro-social behaviour, emotional symptoms, conduct problems, hyperactivity, peer problems) | Non-significant association. |
| Flouri, 2012 [24] | UK | 9,735 children (3y) | Neighbourhood deprivation | Emotional and behavioural problems | Neighbourhood deprivation was associated with children's peer problems, but not with prosocial behaviour, emotional symptoms, conduct problems, and hyperactivity. The children's verbal and nonverbal cognitive ability moderated this association. |
| Fomby, 2011 [25] | UK | 10,532 children (5y) | Measures of neighbourhood quality (e.g., always lived in poor quality neighbourhood) | School readiness (5y) (assessed through cognitive performance – problem solving, spoken vocabulary, | Always having lived in a poor quality neighbourhood was associated with increased conduct problems. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | special ability (BAS) and children's behaviour – emotion symptoms, conduct problems (SDQ)) | |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Quality of neighbourhood, friendliness of neighbourhood, cleanliness of neighbourhood, crime level in neighbourhood | Elevated BMI (BMI>85$^{th}$ percentile) | Living in a friendly neighbourhood was associated with elevated BMI. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Level of disadvantage in area, availability of places where children can play safely, level of satisfaction with area where family lives, bad neighbourhood conditions (e.g., noisy neighbours, rubbish, vandalism, pollution), early access to food shops and supermarkets | Overweight (3y) | Non-significant association. |
| Hawkins, 2009b [26] | UK | 8,154 children (3y) | Perceived measures of the neighbourhood environment (easy access to food shops and supermarkets, neighbourhood condition, satisfaction with area where family lives, whether there are any places where children can play safely, access to a garden), objective measures of the neighbourhood environment (Deprivation at the ward level (IMD), Deprivation at the super output area | Overweight | Only lack of access to a garden (in the neighbourhood) was associated with increased risk of overweight (OR 1.31). |

| | | | | | |
|---|---|---|---|---|---|
| | | | level (IMD)) | | |
| Janghorbani, 2006 [27] | UK | 3,834 newborns | Neighbourhood deprivation (measured with the Townsend Deprivation Score - an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Preterm birth | Increased neighbourhood deprivation was associated with increased risk of preterm birth. |
| Jenkins, 2009 [28] | UK | 138,444 births | Area deprivation level | Neonatal intensive care admission rate, congenital malformations, premature birth, SGA | A J-shaped relationship was observed between area deprivation level and neonatal intensive care admission rate, with the most deprived areas having, on average, a 19% rate above the regional average. Premature birth and SGA were highest in the areas with the highest deprivation level. |
| Kritsotakis, 2011 [44] | Greece | 536 mother-newborn pairs | Maternal social capital (participation in the community, feelings of safety, value of life and social agency, tolerance of diversity) | Preterm birth, small weight for gestational age, foetal weight growth restriction, weight, length and head circumference | Non-significant association between individual maternal social capital in mid-pregnancy and birth outcomes. |
| Kuehni, 2007 [29] | UK | 6,080 children (1y-4y) | Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Wheeze (viral, multiple) (1y, 2y-4y) | Living in a more deprived area was associated with increased odds for multiple wheeze at 1y and 2y-4y. |

| | | | | | |
|---|---|---|---|---|---|
| Kuehni, 2008 [30] | UK | 6,742 children (1y-4y) | Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Sleep disordered breathing (measured through snoring) | Living in a more deprived area was associated with increased odds for snoring (only in whites). |
| McPhillips, 2007 [31] | UK | 515 children (4y-5y and 7y-8y) | The Northern Ireland Multiple Deprivation Measure (NIMDM) - a measure of overall 'social deprivation' (a composite measure based on levels of family income, employment, education, health and disability, proximity to services, living environment, and crime and disorder). | Motor ability (manual dexterity, ball skills, balance) (measured through the 'movement ABC test'), persistence of primary reflex (measured through the 'Schilder Test'), receptive language ability (measured through the 'British Picture Vocabulary Scale'), reading ability, ADHD | 'Social deprivation' was associated with inferior motor skill in all three motor skills measured through the ABC test at 5y, but only in manual dexterity at 8y. 'Social deprivation' was associated with increased risk of primary reflex persistence and lower levels of receptive language. |
| O'Donnell, 2010 [32] | UK | 4,641 infants (<1y) | Townsend Deprivation Score (an overall score derived from measures of unemployment, non-car ownership, non-home ownership, household overcrowding) | Admission to a Paediatric Intensive Care Unit (PICU) with acute respiratory failure including bronchiolitis, mortality after admission for acute respiratory failure or bronchiolitis, length of PICU stay | Living in a deprived area was associated with increased risk for admission to a PICU for both acute respiratory failure and bronchiolitis. Non-significant association for mortality after acute respiratory failure admission or bronchiolitis, or length of PICU stay. |
| Olsen, 2010 [45] | Denmark | 6,090 infants (0-8m) | Social status of municipality | Weight faltering (0-8m) | Non-significant association. |

| | | | | | |
|---|---|---|---|---|---|
| Pearce, 2010 [33] | UK | 18,114 children (9m, 3y) | Area deprivation level | Unintentional injury (9m and 3y) | Living in the most deprived area was associated with increased risk of unintentional injury only in children within the 'receiving informal childcare' group. |
| Sanderson, 2002 [34] | UK | 24,776 infants | Level of poverty in area (based on % of families in postcode who receive housing benefit and/or income support) | Sudden Infant Death Syndrome (SIDS) | Increased OR of SIDS (OR 2.33) in 'areas of poverty'. |
| Sellström , 2007 [35] | Sweden | 327,901 newborns | Neighbourhood economic status | Birth weight | Poor neighbour economic status was associated with lower birth weight. |
| Smith, 2006 [36] | UK | 84,391 births | Deprivation of area of residence (based on the 'Carstairs Deprivation category' – a composite measure of household overcrowding, male unemployment, low social class, and car ownership) | Preterm birth | Living in the most deprived area was associated with increased risk for preterm birth. |
| Smith, 2007 [37] | UK | 549,618 births | Area deprivation (% of children under 16 in low-income families, at the ward-level) | Very preterm birth, extremely preterm birth | Living in a more deprived area was associated with increased risk of very preterm birth and extremely preterm birth. |
| Stiller, 2008 [47] | UK | 1,788 children (0-4y) (study focused on ages 0-15y, but results within the 0-4y period are reported and, hence, included in this review) | Deprivation of area of residence (based on the 'Carstairs Deprivation category' – a composite measure of household overcrowding, male unemployment, low social class, and car ownership) | Acute lymphoblastic leukaemia (ALL) | Living under less deprivation was associated with increased incidence of leukaemia. |

| | | | | | |
|---|---|---|---|---|---|
| Traviss, 2012 [38] | UK | 1,716 infants (6m) | Neighbourhood socio-economic deprivation (of mother's residence (measured by the Index of Multiple Deprivation – IMD) | Abdominal circumference (birth, 6m), gestational age | Higher level of neighbourhood socio-economic deprivation was associated with lower abdominal circumference at 6m. |
| Wright, 2004 [39] | UK | 560 children (0-4y) | Townsend Deprivation Score | Weight (birth, 6m, 12m), height (4y), BMI (4y) | Increased deprivation was associated with lower weight at birth, 6m and 12m, lower height at 4y, but not lower BMI at 4y. |
| Yates, 2006 [40] | UK | 344,600 children (0-5y) | Neighbourhood socio-economic deprivation (measured by the Index of Multiple Deprivation – IMD – a composite of employment, income, education, skills and training, health, deprivation and disability, geographical access to services, and housing) | Moderate to severe head injury (attendance in an emergency department) (0-5y) | Socioeconomic deprivation was associated with increased risk for head injury in urban areas, but with decreased risk for head injury in mixed/rural areas. |

### 7.1.2 Population density / level of urbanization

**Table A.2** Studies assessing the association between **neighbourhood-level social characteristics (ii. Population density / level of urbanization)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Bomela, 2009 [58] | Uzbekistan<br>Kyrgyzstan<br>Kazakhstan | 1,989 children (0-3y) | Rural/urban area of residence | Underweight, stunting | Non-significant association. |
| Bornehag, 2005 [48] | Sweden | 10,851 children (1y-6y) | Urban / rural residence | Wheezing, cough, asthma, rhinitis, eczema | Living in an urban/suburban residence was associated with increased risk of cough, rhinitis and eczema. |
| Bulk-Bunschoten, 2002 [59] | Netherlands | 3,256 infants (1-4m) | Degree of urbanization | Weight gain at 4m | Non-significant association. |
| Cordier, 2004 [49] | France | 564,608 births | Population density | Congenital malformations | Higher population density was associated with increased risk of chromosomal malformations. |
| Ebela, 2011 [57] | Latvia | Unspecified (but >500 newborns, hence included) | Level of urbanization | Congenital malformations | Mothers residing in rural areas were more likely to have a newborn with cleft lip and cleft palate and other congenital anomalies (congenital skin, breast malformations, congenital malformation syndromes involving several systems, etc.) than those residing in urban areas.<br><br>Mothers residing in rural areas were at |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | lower risk to have a newborn with congenital malformations of the circulatory system and deformities of the urinary system. |
| Kolokotroni, 2011 [50] | Cyprus | 4,944 children (7y-8y) | Level of urbanization | Wheeze (current, ever had wheeze), asthma, eczema, allergic Rhinoconjuctivitis (current), hay fever | Living in an urban area was associated with asthma diagnosis and current wheeze. |
| Ludvigsson, 2005 [60] | Sweden | 15,867 children (4y) | Level of urbanization | Coeliac disease | Non-significant association. |
| Ludvigsson, 2006 [61] | Sweden | 8,341 children (2.5y) | Level of urbanization | Gastrointestinal symptoms (constipation, diarrhoea, anorexia, abdominal pain, meteorism, vomiting) | Non-significant association. |
| McNally, 2008 [51] | UK | 1,440 children (exact age undefined, but within early childhood period) | Population density of area of residence (at time of delivery) | Down syndrome, Edwards syndrome, Patau syndrome | Clustering of children with Down syndrome was observed in more densely populated areas. |
| Nobile, 2007 [52] | Italy | 600 newborns | Level of urbanization | Low birth weight, very low birth weight, low birth weight and preterm | More urban areas were associated only with very low birth weight. |
| Palili, 2011 [55] | Greece | 8,158 children (7y) | Level of urbanization | ADHD-like symptoms (inattention, hyperactivity, impulsivity) | Living in a rural area was associated with inattention problems. |
| Reijneveld, 2002 [53] | Netherlands | 3,179 children (1-6m) | Level of urbanization | Excessive infant crying | Living in a moderately highly urbanized area were associated with excessive infant crying. |

| | | | | | |
|---|---|---|---|---|---|
| Savva, 2005 [56] | Cyprus | 1,412 children (2y-6y) | Level of urbanization | Overweight, obesity, underweight, stunting, wasting | Living in rural areas was associated with overweight. |
| Städtler, 2003 [62] | Austria | 516 children (6y-7y) | Level of urbanization | Caries | Non-significant association. |
| Steur, 2011 [63] | Netherlands | 1,687 children (8y) | Level of urbanization | Overweight (8y) | Non-significant association. |
| Stiller, 2008 [47] | UK | 1,788 children (0-4y) (study focused on ages 0-15y, but results within the 0-4y period are reported and, hence, included in this review) | Level of urbanization, population density | Acute lymphoblastic leukaemia (ALL) | Residing in a rural area was associated with increased incidence of leukaemia. |
| Tikkaja, 2009 [64] | Estonia | 148,521 infants (0-2y) | Residence in a city/large town | Mortality due to injury | Non-significant association. |
| Toschke, 2003 [65] | Germany | 4,974 children (5y-6y) | Population density at region of residence | Childhood overweight and obesity | Non-significant association. |
| Tsimbos, 2011 [54] | Greece | 103,266 births | Degree of urbanization | Low birth weight, intrauterine growth restriction | Living in a big metropolitan area were associated only with intrauterine growth restriction. |
| Yates, 2006 [40] | UK | 344,600 children (0-5y) | Level of urbanization | Moderate to severe head injury (attendance in an emergency department) (0-5y) | Living in an urban area was found to be associated with increased risk for moderate to severe head injury. |

## 7.2 Indicators of household socio-economic circumstances

### 7.2.1 Parental social class

**Table A.3** Studies assessing the association between **Indicators of household socio-economic circumstances (i. Parental social class)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Adam, 2005 [66] | France | 3,105 children (6y) | Maternal occupational social class, paternal occupational social class | Caries experience | Lower maternal or paternal occupational social class was associated with children's caries experience. |
| Almqvist, 2005 [67] | Sweden | 4,089 infants (4y) | Parental occupational social class | Asthma, rhinitis, eczema, wheeze (early onset transient wheeze, late onset wheeze, early onset persistent wheeze, allergic sensitization (aeroallergens, food allergens) | Lower occupational social class was associated with increased odds of asthma, rhinitis, and early onset persistent wheeze. |
| Alper, 2006 [97] | Turkey | 858 children (7y) | Parental socio-economic status | Wheezing symptoms | Non-significant association. |
| Bakoula, 2006 [98] | Greece | 8,130 children (7y) | Parental occupational social class | Recurrent complaints of pain (headache, abdominal pain, limb pain) | Non-significant association. |
| Bala, 2010 [88] | Serbia | 643 children (4y-6y) | Indicators of parental socio-economic status | Anthropometric measurements, motor abilities | Indicators of parental socio-economic were not associated with children's anthropometric measurements and motor abilities, with the exception of motor |

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| | | | | | ability at 6y. |
| Beaino, 2011 [69] | France | 1,503 children (5y) | Parental socio-economic status (highest occupational status of father or mother) | Overall cognitive ability (5y) | Lower parental socio-economic status was associated with increased odds of both mild and severe cognitive deficiency. |
| Blair, 2004 [99] | UK | 11,718 infants (0-9m) | Parental social class | Weight gain (from 0-9m) | No significant associations were identified. |
| Bonuck, 2011 [70] | UK | 12,447 children (0-6.75y) | Paternal occupational social class | Sleep disordered breathing symptoms (mouth-breathing, snoring, apnea) | Lower paternal occupational social class was associated with increased sleep disordered breathing symptoms. |
| Cumberland, 2010 [71] | UK | 14,981 children (3y) | Household occupational social class | Eye disease (visual impairment; eye condition with no visual impairment reported) | Lower household occupational social class was associated with 'eye condition with no visual impairment reported', but not with 'visual impairment'. |
| Damgaard, 2008 [100] | Denmark Finland | 2,496 newborns (0-3m) | Maternal occupational social class | Congenital cryptorchidism | Non-significant association. |
| Delobel-Ayoub, 2006 [101] | France | 1,675 children (3y) | Household occupational social class | Behavioural difficulties (Total score of Strengths and Difficulties Questionnaire – SDQ) | Non-significant association. |
| Emerson, 2009 [72] | UK | 12,689 children (3y) | Main carer's occupational social class | Cognitive delay | Lower occupational social class of the main carer (OR 1.96) was associated with increased risk for cognitive delay at 3y. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Parental occupational social status | Severe and less severe cognitive delay (3y) | Low parental occupational social status was associated with increased risk for severe and less severe delay in the child's cognitive development. |

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| Emond, 2007 [102] | UK | 11,900 infants (0-9m) | Parental social class | Poor weight gain | Non-significant association. |
| Fairley, 2005 [73] | UK | 1,282,172 births | Parental occupational social class | Low birth weight | Lower parental occupational social class was associated with lower birth weight. |
| Fairley, 2006 [74] | UK | 1,282,172 births | Parental occupational social class | Low birth weight, preterm birth, SGA | Lower parental occupational social class was associated with lower birth weight. |
| Flouri, 2010a [41] | UK | 9,630 children (3y) | Maternal occupational social class, paternal occupational social class | Psychopathology (measured through SDQ) | Only lower maternal occupational social class was associated with increased risk of psychopathology. |
| Flouri, 2010b [42] | UK | 4,618 children (3y) | Family socio-economic disadvantage (a summative index of overcrowding, lack of home ownership, receipt of income support, income poverty, and lack of access to a car / van) | Psychopathology (pro-social behaviour, emotional symptoms, conduct problems, hyperactivity, peer problems) | Family socio-economic disadvantage was associated with pro-social behaviour, conduct problems, peer problems. |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Maternal social class | Elevated BMI (BMI>85$^{th}$ percentile) | Higher maternal social class was associated with elevated BMI. |
| Gissler, 2003 [75] | Finland | 565,863 newborns | Maternal occupational social class | Preterm birth, low birth weight, SGA, perinatal mortality | Lower maternal occupational social class was associated with increased offs of preterm birth, low birth weight, SGA, and perinatal mortality. |
| Griffiths, 2010 [103] | UK | 11,653 children (3y-5y) | Maternal occupational social class | Rapid weight gain (from 3y-5y) | Non-significant association. |
| Guedeney, 2008 [104] | France | 640 infants (14m-18m) | Maternal occupational social class, paternal occupational social class | Social/relational withdrawal behaviour | Non-significant association. |

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| Guedeney, 2012 [105] | France | 1,586 infants (1y) | Maternal occupational social class | Social/relational withdrawal behaviour in infants (derived from Alarm Distress Baby Scale – ADBB) | Non-significant association. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Maternal occupational social class | Overweight (3y) | Non-significant association. |
| Hjern, 2008 [76] | Sweden | 804,854 children (exact age undefined, but within early childhood period) | Household socioeconomic status (based on occupation) | Cerebral palsy, perinatal risk factors (extremely preterm birth, asphyxia, SGA) | Lower household socioeconomic status was associated with increased risk of cerebral palsy, extremely preterm birth, asphyxia, and SGA). |
| Howe, 2012 [77] | UK | 12,366 children (0-8y) | Household occupational social class | Birth length, height trajectory from birth to 8y (study focused on ages 0-10y, but trajectories within the 0-8y period are reported and, hence, included in this review) | A gradient was observed in birth length across categories of household occupational social class (lower socio-economic indicators associated with shorter birth length). Socio-economic differences in childhood growth were small and only resulted in minimal widening of the height inequality with increasing age. |
| Hryhorczuk, 2009 [106] | Ukraine | 2,030 children (6y-8y) | Maternal social class (self-reported) | Wheeze | Non-significant association. |
| Krombholz, 2006 [78] | Germany | 1,194 children (3,5y-7y) | Parental occupational social class | Intelligence (CFT1), verbal ability (Peabody Picture Vocabulary Test), motor skills (motor coordination, physical fitness, manual dexterity) | Lower parental occupational social class was associated with lower verbal ability and intelligence scores. |

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| Kurukulaaratchy, 2004 [79] | UK | 1,218 children (1y,2y,4y) | Parental social class | Early-onset and late-onset persistent wheeze | Low parental social class was associated with increased risk for early onset persistent wheeze. |
| Lamerz, 2005 [80] | Germany | 1,979 children (6y) | Social strata index | Childhood obesity | Being in the lowest social strata index was associated with increased risk for childhood obesity. |
| Linneberg, 2006 [112] | Denmark | 34,793 infants (1.5y) | Maternal occupational social class | Wheeze, atopic dermatitis | Lower maternal occupational social class was associated with reduced odds of atopic dermatitis |
| Majeed, 2008 [81] | UK | 8,271 children (7y) | Parental occupational social class | Vision problems (hypermetropia, severe hypermetropia, amblyopia, convergent squint) | Lower occupational social class was associated with increased risk of hypermetropia and 'all conditions combined'. Associations with severe hypermetropia, amblyopia, convergent squint separately were non-significant. |
| Manikkavasagan, 2010 [113] | UK | 12,509 children (5y) | Maternal occupational social class | Chickenpox infection | Lower maternal occupational social class was associated with reduced risks of chickenpox infection. |
| Moser, 2003 [82] | UK | 603,467 births | Paternal occupational social class | Low birth weight | Lower paternal occupational social class was associated with lower birth weight. |
| Panico, 2007 [83] | UK | 14,630 children (3y) | Household occupational social class (highest in household) | Asthma, wheezing | Lower occupational social class was associated with increases risk of asthma and wheeze. |
| Patel, 2011 [84] | Belarus | 13,889 children (6.5y) | Household occupational social class (based on highest occupation in household) | Overweight/obese, waist circumference (≥90$^{th}$ percentile), % body fat (≥90$^{th}$ percentile) | Lower household occupational social class was associated with increased risk for overweight/obesity and waist circumference ≥90$^{th}$ percentile. |

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| Pathai, 2010 [85] | UK | 14,980 children (3y) | Household occupational social class | Childhood strabismus (isolated, neurodevelopmental) | Household occupational social class was associated with neurodevelopmental strabismus (U-shaped relationship). Non-significant association for isolated strabismus. |
| Pearce, 2010 [33] | UK | 18,114 children (9m, 3y) | Maternal occupational social class | Unintentional injury (9m and 3y) | Lower maternal occupational social class was associated with increased risk for unintentional injury. |
| Pearce, 2012 [107] | UK | 14,378 children (3y) | Maternal occupational social class | Unintentional home injury (between 9m-3y) | Non-significant association. |
| Petrill, 2004 [86] | UK | 7,781 twin pairs (4) | Family socio-economic status | Verbal cognitive development, non-verbal cognitive development | Lower family socio-economic status was associated with reduced scores of verbal and non-verbal of cognitive development. |
| Puhó, 2008 [87] | Hungary | 61,160 newborns | Maternal occupational social class | Isolated ocular congenital abnormalities | Lower maternal occupational social class was associated with increased odds of isolated ocular congenital abnormalities. |
| Reime, 2006 [88] | Germany | 182,444 births | Maternal occupational social class | Pre- and full-term low birth weight | Lower maternal occupational social class was associated with increased odds of pre- and full-term low birth weight. |
| Romon, 2005 [89] | France | 1,963 children (5y-6y) | Paternal occupational social class | Childhood BMI, overweight, and obesity | The largest increase in BMI, prevalence of obesity and prevalence in overweight between 1989 and 1999 was observed in the lowest social class. |
| Russell, 2011 [108] | UK | 13,981 infants (1y) | Maternal occupational social class | Autistic traits (3y-4y) | Non-significant association. |
| Spencer, 2010 [90] | UK | 55,592 children (0-4y) | Parental occupational social class (based on the main household | Childhood long-term limiting illness/disability | Lower occupational social class was associated with increased risk of long- |

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| | | | respondent) | | term limiting illness/disability. |
| Spix, 2009 [91] | Germany | 1,928 children (<5y) | Household social status | Leukaemia, CNS tumours | Higher household social class was associated with reduced odds of leukaemia. |
| Stein, 2008 [92] | UK | 944 children (3y) | Family socio-economic status (an overall score derived from measures of parental socio-economic class, parental education, and family income) | Language development (assessed with the Reynell Developmental Language Scale – RDLS) | Lower family socio-economic status had both direct and indirect negative effects on children's language development. |
| Tümen, 2011 [109] | Turkey | 727 children (2y-5y) | 'Socio-economic indicators' | Traumatic dental injuries | Non-significant association. |
| Varela, 2009 [93] | Denmark | 81,435 pregnant mothers and their newborns | Parental occupational social class (maternal and paternal combined) | Congenital anomalies | Lower parental occupational social class was associated with increased risk for congenital anomalies of the respiratory system. |
| Villalbí, 2007 [94] | Spain | 2,297 newborns | Maternal occupational social class | Preterm birth, low birth weight, IUGR (<2$^{nd}$ percentile in birth weight by gestational age) | Lower maternal occupational social class was associated with increased odds for low birth weight and IUGR. |
| Voigt, 2004 [110] | Germany | 4,376 births | Parental occupational social class | Birth weight, preterm birth | Non-significant association. |
| Wickman, 2003 [111] | Sweden | 3,692 infants (2y) | Parental socio-economic status | Wheeze (ever had wheeze, recurrent wheeze), asthma | Non-significant association. |
| Wijlaars, 2011 [114] | UK | 2,402 families and their infant twins (0- | Household socio-economic status | Birth weight, infant weight gain | Lower socio-economic status was associated with higher weight (3m), |

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| | | 3m) | | | greater change in weight from 0-3m, and higher chance of rapid growth. |
| Williams, 2008 [95] | UK | 7,825 children (7y) | Parental occupational social class | Vision problems (strabismus, past/present amblyopia, hypermetropia) | Lower occupational social class was associated with increased risk for hypermetropia. Non-significant associations for amblyopia and strabismus. |
| Wingren, 2012 [96] | Sweden | 792,401 singletons (0-2y) | Socio-economic position | Coeliac disease | Low socio-economic position was associated with Coeliac disease in boys (OR 1.37), but not in girls (OR 0.87). |

### 7.2.2 Parental income/wealth

**Table A.4** Studies assessing the association between **Indicators of household socio-economic circumstances (ii. Parental income/wealth)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Bocca-Tjeertes, 2011 [133] | Netherlands | 1,123 children (4y) born moderately prematurely (32-35 6/7 weeks gestational age) | Family income | Growth restriction | Non-significant association. |
| Bomela, 2009 [58] | Uzbekistan Kyrgyzstan Kazakhstan | 1,989 children (0-3y) | Household wealth index | Underweight, stunting | Lower household wealth index was associated with childhood underweight. |
| Brophy, 2009 [115] | UK | 17,561 children (5y) | Family income | Obesity (5y) | Lower family income was associated with obesity. |
| Butler, 2008 [134] | UK | 9,561 children (4.5y) | Family financial difficulties | Nocturnal enuresis, infrequent bed-wetting | Non-significant association. |
| Ciftci, 2006 [135] | Turkey | 1,134 children (4y-6y) | Family income | Pediculosis and scabies | Non-significant association. |
| Cordier, 2004 [49] | France | 564,608 births | Family income | Congenital malformations | Non-significant association. |
| Elberling, 2010 [116] | Denmark | 3,501 children (5y-7y) | Household income | Mental health problems (SDQ – Strengths and difficulties Questionnaire) | Lower household income was associated with mental health problems in childhood. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Income poverty, welfare benefit receipt | Severe and less severe cognitive delay (3y) | Income poverty and welfare benefit receipt were both associated with |

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| | | | | | increased risk for severe and less severe delay in the child's cognitive development. |
| Fomby, 2011 [25] | UK | 10,532 children (5y) | Household poverty (derived from: equivalent household income below 60 percent of median income nationally, receipt of income support, few household assets, and subjective poverty) | School readiness (5y) (assessed through cognitive performance – problem solving, spoken vocabulary, special ability (BAS) and children's behaviour – emotion symptoms, conduct problems (SDQ)) | Household poverty was associated with lower cognitive performance scores. |
| Gleason, 2011 [117] | Romania | 1,003 children (18-60m) | Family income | Mental health problems | Higher family income was negatively associated with psychiatric diagnosis. |
| Griffiths, 2010 [103] | UK | 11,653 children (3y-5y) | Household income | Rapid weight gain (from 3y-5y) | Non-significant association. |
| Guedeney, 2008 [104] | France | 640 infants (14m-18m) | Family receiving social welfare | Social/relational withdrawal behaviour | Non-significant association. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Household income | Overweight (3y) | Non-significant association. |
| Jansen, 2009a [118] | Netherlands | 3,546 pregnant women and their newborns | Financial concerns in family | Birthweight | Having financial concerns was associated with lower birthweight. |
| Jansen, 2009b [119] | Netherlands | 4,055 infants (6m) | Family income | Temperament | Low family income was associated with more difficult infant temperament. |
| Kelly, 2011 [120] | UK | 15,382 children (3-5y) | Family income | Socio-emotional development, verbal and non-verbal abilities, spatial | Low family income was associated with increased likelihood of socio-emotional difficulties at age 3y and 5y and had lower |

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| | | | | ability, ‘school readiness’ | mean scores in ‘school readiness’, verbal and non-verbal abilities, and spatial ability. |
| Kiernan, 2008 [121] | UK | 13,877 children (3y) | Family economic deprivation (an overall score derived from measures of income-poverty, financial difficulties, and housing tenure) | Cognitive score, externalizing problems, internalizing problems | Economic deprivation had both direct and indirect negative effects on children’s cognitive scores, externalizing problems, and internalizing problems. |
| Koutra, 2012 [136] | Greece | 605 infants (18m) | Perceived financial status (reported by mother) | Neurodevelopment (cognitive, receptive communication, expressive communication, fine motor, gross motor, social-emotional) (Bayley-III) | Non-significant association. |
| Kurugöl, 2003 [137] | Turkey | 920 children (<5y) | Family income | Rotavirus gastroenteritis | Non-significant association. |
| Larsson, 2009 [122] | Sweden | 4,779 children (6y-8y) | Financial problems | Autistic Spectrum Disorders (ASD) | Having financial problems (OR 2.48 to 3.18) was associated with increased risk of ASD. |
| Linneberg, 2006 [112] | Denmark | 34,793 infants (1.5y) | Household income | Wheeze, atopic dermatitis | Non-significant association. |
| Matijasevich,2012 [123] | UK | 13,678 mothers and their newborns | Family income | Preterm birth, IUGR | Lower family income was associated with higher incidence of preterm birth. |
| Morgen, 2008 [138] | Denmark | 75,890 newborns | Household income | Preterm birth | Non-significant association. |
| Mortensen, 2009b [124] | Denmark | 1,409,339 births | Household income poverty | Birthweight for gestational age | Lower household income was associated with reduced birthweight for gestational |

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| | | | | | age. |
| Mortensen, 2010 [125] | Denmark Finland | 1,511,790 births | Household income | Preterm birth, SGA | Income inequalities were identified for both preterm birth and SGA. |
| Myhre, 2012 [126] | Norway | 26,087 children (3y) | Financial problems (reported by mothers) | Hospital-attended injuries | Having financial problems was associated with increased odds of hospital-attended injuries. |
| Nikiéma, 2010 [127] | UK | 14,556 children (3y) | Receipt (and duration of) of income support and social welfare | Long-standing illness, limiting long-standing illness, asthma | Receipt (and duration of) of income support and social welfare was associated with higher risk of long-standing illness, limiting long-standing illness, and asthma. |
| Norsker, 2012 [128] | Denmark | 89,829 pregnant women and their fetuses | Maternal income | Spontaneous abortion (foetal death within the first 22w of pregnancy) | Lower income was associated with spontaneous abortion. |
| Oguzkaya-Artan, 2007 [139] | Turkey | 683 children (5y-7y) | Household income | Haemophilus influenzae, haemophilus influenzae type b | Non-significant association. |
| Panico, 2007 [83] | UK | 14,630 children (3y) | Household income, receipt of benefits | Asthma, wheezing | Lower income and the family receiving benefits were both associated with increased risk of asthma and wheeze. |
| Propper, 2007 [129] | UK | 10,684 children (6m-6.75y) | Financial hardship (current financial hardship, number of times in financial hardship) | Poor child health (morther-reported, being in top 20% of children in number of symptoms of poor health), asthma, overweight/obese (top 10% of BMI) | Financial hardship was associated with increased risk of poor child health, asthma, and being overweight/obese. |

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| Russell, 2011[108] | UK | 13,981 infants (1y) | Financial hardship in family | Autistic traits (3y-4y) | The family facing financial hardship was found to be associated with 'severe but undiagnosed autistic traits'. |
| Schjølberg, 2011 [130] | Norway | 42,107 infants (18m) | Family income | Delayed language development (late language emergence) (18m) | Lower family income was associated with delayed language development. |
| Städtler, 2003 [62] | Austria | 516 children (6y-7y) | Family income | Caries | Lower family income was associated with presence of caries in children. |
| Sydsjö, 2006 [140] | Sweden | 3,727 mothers and their newborns (only pregnancies after 1990 were included) | Receipt of social benefits during pregnancy | Birth weight | Non-significant association. |
| Thrane, 2005 [141] | Denmark | 5,024 infants (0-2y) | Household income | Hospitalization for infectious diseases | Non-significant association. |
| van Rossem, 2010 [142] | Netherlands | 2,954 infants (36m) | Household income | Body Mass Index | Non-significant association. |
| Violato, 2009 [131] | UK | 7,945 children (9y, 3y, 5y) | Household income | Asthma, wheezing | Lower household income was associated with increased risk of asthma and wheezing. |
| Violato, 2011 [132] | UK | 15,116 families and their children (3y, 5y) | Household income | Cognitive development, behavioural development | A weak direct effect of family income on childhood cognitive and behavioural development was identified. |
| Voigt, 2004 [110] | Germany | 4,376 births | Household income | Birth weight, preterm birth | Lower household income was associated with reduced birth weight. |

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| Wigen, 2011a [143] | Norway | 1,348 children (5y) | Family income | Caries experience | Non-significant association. |

### 7.2.3 Parental education

**Table A.5** Studies assessing the association between **Indicators of household socio-economic circumstances (iii. Parental education)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Arntzen, 2008 [144] | Denmark Finland Norway Sweden | 5,002,943 newborns (followed up to 1y) | Maternal education | Neonatal mortality (0-<4w), post-neonatal mortality (4w-1y) | Lower maternal education was associated with increased risk of both neonatal and post-neonatal mortality in all four countries. |
| Bakoula, 2006 [98] | Greece | 8,130 children (7y) | Parental education | Recurrent complaints of pain (headache, abdominal pain, limb pain) | Non-significant association. |
| Becker, 2011 [145] | UK | 10,358 children (3y-5y) | Parental education (highest educational attainment of mother or father) | Vocabulary | Lower parental education was associated with reduced children's score on a standardised vocabulary test. Children of lower educated parents improved their vocabulary less between 3y-5y. |
| Blair, 2004 [99] | UK | 11,718 infants (0-9m) | Parental education | Weight gain (from 0-9m) | Non-significant association. |
| Bocca-Tjeertes, 2011 [133] | Netherlands | 1,123 children (4y) born moderately prematurely (32-35 6/7 weeks gestational age) | Maternal education | Growth restriction | A low level of maternal education was associated with poor head-circumference growth (OR 5.3) but association with weight or height growth restriction was non-significant. |
| Bomela, 2009 [58] | Uzbekistan Kyrgyzstan | 1,989 children (0-3y) | Maternal education | Underweight, stunting | Lower maternal education was associated with childhood stunting. |

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| | Kazakhstan | | | | |
| Bonuck, 2011 [70] | UK | 12,447 children (0-6.75y) | Maternal education | Sleep disordered breathing symptoms (mouth-breathing, snoring, apnea) | Lower maternal education was associated with increased sleep disordered breathing symptoms. |
| Bonzini, 2009 [172] | UK | 1,327 mothers and their newborns | Maternal education | Preterm birth, SGA, head circumference, abdominal circumference | Non-significant association. |
| Brophy, 2009 [115] | UK | 17,561 children (5y) | Maternal education | Obesity (5y) | Lower maternal education was associated with obesity. |
| Bulk-Bunschoten, 2002 [59] | Netherlands | 3,256 infants (1-4m) | Maternal education | Weight gain at 4m | Non-significant association. |
| Butler, 2008 [134] | UK | 9,561 children (4.5y) | Parental education | Nocturnal enuresis, infrequent bed-wetting | Non-significant association. |
| Cesaroni, 2003 [18] | Italy | 3,440 children (6y-7y) | Paternal education, maternal education | Severe asthma, hospitalization for asthma | Lower paternal education was associated with increased odds for severe asthma and hospitalization for asthma. |
| Ciftci, 2006 [135] | Turkey | 1,134 children (4y-6y) | Maternal education | Pediculosis and scabies | Lower maternal education was associated with increased risk for pediculosis and scabies infestation in children. |
| de Hoog, 2011 [146] | Netherlands | 3,156 infants (2y) | Maternal education | Overweight | Lower maternal education was associated with increased odds for overweight. |
| Dejin-Karlsson, 2004 [173] | Sweden | 826 births | Maternal education | SGA | Non-significant association. |

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| Delobel-Ayoub, 2006 [101] | France | 1,675 children (3y) | Maternal education | Behavioural difficulties (Total score of Strengths and Difficulties Questionnaire – SDQ) | Lower maternal education was associated with increased behavioural difficulties. |
| du Prel, 2006 [183] | Germany | 28,888 children (6y) | Parental education (highest educational attainment level of father or mother) | Birth weight, measures of lung function, height, overweight, bronchitis, frequency of colds, coughs and sneeze attacks, allergies, diagnosis of eczema | Lower parental education was associated with increased risk of lower birth weight, reduced height, and overweight, but reduced risk of bronchitis, frequency of colds and sneeze attacks, allergies and diagnosis of eczema. |
| Ebela, 2011 [57] | Latvia | Unspecified (but >500 newborns, hence included) | Maternal education | Congenital malformations | Lower maternal education was associated with increased odds of congenital malformations. |
| Elberling, 2010 [116] | Denmark | 3,501 children (5y-7y) | Maternal education | Mental health problems (SDQ – Strengths and difficulties Questionnaire) | Non-significant association. |
| Eller, 2009 [184] | Czech Republic | 534 children (6y) | Parental education | Atopic dermatitis (0-6y) | High parental education (only at birth) was associated with increased odds of atopic dermatitis (OR 1.62). |
| Emerson, 2009 [72] | UK | 12,689 children (3y) | Maternal education | Cognitive delay | Lower maternal education (OR 2.82) was associated with increased risk for cognitive delay at 3y. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Maternal education | Severe and less severe cognitive delay (3y) | Low maternal educational attainment was associated with increased risk for severe and less severe delay in the child's cognitive development. |

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| Emond, 2007 [102] | UK | 11,900 infants (0-9m) | Parental education | Poor weight gain | Non-significant association. |
| Flouri, 2010a [41] | UK | 9,630 children (3y) | Maternal education, paternal education | Psychopathology (measured through SDQ) | Only lower maternal education was associated with increased risk of psychopathology. |
| Flouri, 2010b [42] | UK | 4,618 children (3y) | Maternal education | Psychopathology (pro-social behaviour, emotional symptoms, conduct problems, hyperactivity, peer problems) | Low maternal education was associated with emotional symptoms, conduct problems, hyperactivity, peer problems. |
| Fomby, 2011 [25] | UK | 10,532 children (5y) | Maternal education | School readiness (5y) (assessed through cognitive performance – problem solving, spoken vocabulary, special ability (BAS) and children's behaviour – emotion symptoms, conduct problems (SDQ)) | Low maternal education was associated with lower cognitive performance scores, increased emotion symptoms and increased conduct problems. |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Maternal education | Elevated BMI (BMI>85$^{th}$ percentile) | Non-significant association. |
| Frøen, 2002 [147] | Norway | 660 infants (1y) | Maternal education | Sudden infant death syndrome (SIDS), sudden intrauterine unexplained death (SIUD) | Lower maternal education was associated with increased odds of SIUD. |
| Gleason, 2011 [117] | Romania | 1,003 children (18-60m) | Maternal education, paternal education | Mental health problems | Only lower paternal education level was associated with child psychiatric disorder. |

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| Griffiths, 2010 [103] | UK | 11,653 children (3y-5y) | Maternal education | Rapid weight gain (from 3y-5y) | Non-significant association. |
| Guedeney, 2012 [105] | France | 1,586 infants (1y) | Maternal education, paternal education | Social/relational withdrawal behaviour in infants (derived from Alarm Distress Baby Scale – ADBB) | Non-significant association. |
| Hagendorens, 2005 [174] | Belgium | 810 infants (1y) | Parental education | IgE sensitization, atopic dermatitis, wheezing | Non-significant association. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Maternal education | Overweight (3y) | Non-significant association. |
| Hay, 2005 [148] | UK | 13,167 children (0-4.75y) | Maternal education | Use of health services (consultations with any symptom) | For children aged 0-29m, lower maternal education was associated with increased risk of consultations. |
| Howe, 2011 [149] | UK | 12,246 children | Maternal education | Ponderal index (0-2y), BMI (study focused on ages 0-10y, but trajectories within the 0-8y period are reported and, hence, included in this review) | There was little socio-economic patterning of PI from 0-2y. Differences by maternal education in children's BMI began to emerge by 4y, and widened with increasing age. |
| Howe, 2012 [77] | UK | 12,366 children (0-8y) | Maternal education, paternal education | Birth length, height trajectory from birth to 8y (study focused on ages 0-10y, but trajectories within the 0-8y period are reported and, hence, included in this review) | A gradient was observed in birth length across categories of maternal education and paternal education (lower education associated with shorter birth length). Differences in childhood growth by education were small, and only resulted in minimal widening of the height inequality with increasing age. |

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| Hryhorczuk, 2009 [106] | Ukraine | 2,030 children (6y-8y) | Maternal education | Wheeze | Non-significant association. |
| Huus, 2007 [150] | Sweden | 4,242 children (5y) | Maternal education, paternal education | Overweight, obesity | Lower paternal education was associated with increased odds for overweight and obesity at 5y. |
| Jansen, 2009a [118] | Netherlands | 3,546 pregnant women and their newborns | Maternal education | Birth weight | A low level of maternal education was associated with lower birth weight. |
| Jansen, 2009b [119] | Netherlands | 4,055 infants (6m) | Maternal education, paternal education | Temperament | Lower maternal and paternal education were both associated with more difficult infant temperament. |
| Jansen, 2009c [151] | Netherlands | 3,830 pregnant women and their newborns | Maternal education | Preterm birth | A low level of maternal education was associated with higher ORs (1.1) for preterm birth. |
| Koller, 2009 [152] | Germany | 9,353 children (6y) | Level of education in household (at the school district level) | Overweight | OR for childhood overweight was higher (OR 1.35) in school districts with the highest percentage of 'low education households'. |
| Koopman, 2002 [153] | Netherlands | 4,146 children (2y) | Maternal education, paternal education | Wheeze at least once, recurrent wheezing, night cough without a cold, runny nose without a cold, runny nose with itchy/watery eyes | Lower maternal education was associated with having a runny nose without a cold, a runny nose with itchy/watery eyes and with having had wheeze at least once. |
| Koutra, 2012 [136] | Greece | 605 infants (18m) | Maternal education, paternal education | Neurodevelopment (cognitive, receptive communication, expressive communication, fine motor, gross motor, social-emotional) (Bayley-III) | Lower maternal education was associated with lower scores in cognitive, receptive communication, expressive communication, fine motor, and social-emotional domains. |

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| Kuehni, 2007 [29] | UK | 6,080 children (1y-4y) | Paternal education | Wheeze (viral, multiple) (1y, 2y-4y) | Low paternal education was associated with increased odds of multiple wheeze at 1y and viral wheeze at 2y-4y. |
| Kuehni, 2008 [30] | UK | 6,742 children (1y-4y) | Maternal education, paternal education | Sleep disordered breathing (measured through snoring) | Non-significant association. |
| Kurth, 2010 [175] | Switzerland | 7,765 mother-infant pairs | Maternal education | Infant crying problems (during the postpartum period) | Non-significant association. |
| Lamerz, 2005 [80] | Germany | 1,979 children (6y) | Maternal education, paternal education | Childhood obesity | Lower maternal education was associated with increased risk for childhood obesity. |
| Langnäse, 2003 [154] | Germany | 1,326 children (5y-7y) | Parental education (highest educational attainment of mother or father) | BMI (1y, 2y, 5y-7y), overweight (1y, 2y, 5y-7y), birth weight | Lower parental education was associated only with BMI at 5y-7y. |
| Lindbæk, 2003 [176] | Norway | 1,884 children (4y-5y) | Maternal education, paternal education | Bronchial asthma | Non-significant association. |
| Little, 2003 [177] | Ukraine | 1,621 singleton births | Maternal education | Mean placental weight ratio | Non-significant association. |
| Ludvigsson, 2005 [60] | Sweden | 15,867 children (4y) | Maternal education, paternal education | Coeliac disease | Non-significant association. |
| Ludvigsson, 2006 [61] | Sweden | 8,341 children (2.5y) | Maternal education, paternal education | Gastrointestinal symptoms (constipation, diarrhoea, anorexia, abdominal pain, meteorism, vomiting) | Lower maternal education was associated with increased odds of constipation (OR 1.56) and anorexia (OR 1.64). |
| Mangrio, 2011 [178] | Sweden | 9,289 infants (8m) | Maternal education | In-hospital and doctor care | Infants of less-educated mothers (received ≤9 years of education) had increased odds of in-hospital care |

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| | | | | | (OR=1.34) and overall doctor care (OR=1.28) since birth. After adjustment for unfavourable parental behaviour factors, the association became non-significant. |
| Manikkavasagan, 2010 [113] | UK | 12,509 children (5y) | Maternal education | Chickenpox infection | Lower maternal education was associated with reduced risk of chickenpox infection. |
| Matijasevich, 2012 [123] | UK | 13,678 mothers and their newborns | Maternal education | Preterm birth, IUGR | Lower maternal education was associated with higher incidence of IUGR. |
| Morgen, 2008 [138] | Denmark | 75,890 newborns | Maternal education, paternal education | Preterm birth | Lower maternal and paternal education was associated with increased risk of preterm birth. |
| Mortensen, 2008 [155] | Denmark Finland Norway Sweden | 4,169,046 births | Maternal education, paternal education | Birth weight, SGA, LGA | In all countries, gradients in indicators of foetal growth by parental education existed. Low maternal or paternal education was associated with lower birthweight, increased risk of SGA, and decreased risk of LGA. Maternal education had a stronger association on outcomes than paternal education. |
| Mortensen, 2009a [156] | Denmark | 75,085 newborns | Maternal education | Birth weight | Lower maternal education was associated with reduced birth weight. |
| Mortensen, 2009b [124] | Denmark | 1,409,339 births | Maternal education | Birth weight for gestational age | Lower maternal education was associated with reduced birth weight for gestational age. |
| Mortensen, 2010 [125] | Denmark Finland | 1,511,790 births | Maternal education | Preterm birth, SGA | Educational inequalities were found for both preterm birth and SGA. |

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| Moschonis, 2008 [157] | Greece | 2,374 children (6m-5y) | Maternal education | Overweight (6m-5y) | Lower maternal education was associated with increased risk of overweight only in children aged 3y-5y. |
| Myhre, 2012 [126] | Norway | 26,087 children (3y) | Maternal education | Hospital-attended injuries | Non-significant association. |
| Niedhammer, 2009 [179] | Ireland | 1,124 newborns | Maternal education | Birth weight, preterm birth, SGA | Non-significant association. |
| Nobile, 2007 [52] | Italy | 600 newborns | Maternal education | Low birth weight, very low birth weight, low birth weight and preterm | Lower maternal education was associated only with increased odds of very low birth weight. |
| Norsker, 2012 [128] | Denmark | 89,829 pregnant women and their fetuses | Maternal education | Spontaneous abortion (foetal death within the first 22w of pregnancy) | Non-significant association. |
| Oguzkaya-Artan, 2007 [139] | Turkey | 683 children (5y-7y) | Maternal education, paternal education | Haemophilus influenzae, haemophilus influenzae type b | Non-significant association. |
| Palili, 2011 [55] | Greece | 8,158 children (7y) | Parental education | ADHD-like symptoms (inattention, hyperactivity, impulsivity) | Lower parental education was associated with all examined ADHD-like symptoms. |
| Patel, 2011 [84] | Belarus | 13,889 children (6.5y) | Maternal education, paternal education | Overweight/obese, waist circumference (≥90$^{th}$ percentile), % body fat (≥90$^{th}$ percentile) | Lower maternal education and paternal education were both associated with increased risk for overweight/obesity, waist circumference ≥90$^{th}$ percentile, and of % body fat ≥90$^{th}$ percentile. |
| Pearce, 2010 [33] | UK | 18,114 children (9m, 3y) | Maternal education | Unintentional injury (9m and 3y) | Lower maternal education was associated with increased risk for unintentional injury. |

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| Pearce, 2012 [107] | UK | 14,378 children (3y) | Maternal education | Unintentional home injury (between 9m-3y) | Lower maternal education was associated with increased risk of unintentional home injury between 9m and 3y. |
| Petersen, 2009 [158] | Denmark Finland Sweden Norway | 4,708,469 newborns | Maternal education | Preterm birth | Mothers with <10 years of education had increased risks of very and moderately preterm birth in all four countries. |
| Pigeot, 2009 [159] | Belgium Cyprus Italy | 1,738 children (4y-5y) | Maternal education, paternal education | Overweight/obesity | Only for Italian boys, lower paternal education was associated with increased odds of overweight/obesity. |
| Ribeiro, 2011 [160] | Norway | 38,298 children (3y) | Maternal education | Attention problems (Child Behavior Checklist - CBCL), language ability (Ages and Stages Questionnaires – ASQ) | Lower maternal education was associated with increased attention problems at 1.5y. |
| Rodrigues, 2007 [180] | Portugal | 4,068 mothers and their newborns | Maternal education | Preterm birth, SGA | Non-significant association. |
| Rom, 2012 [161] | Denmark Finland Norway Sweden | 3,156,989 pregnancies | Maternal education | Stillbirth | Educational gradients were found in all countries, but were not significant, aside from Sweden, where lower maternal education was associated with increased risk of stillbirth. |
| Ruijsbroek, 2011 [162] | Netherlands | 2,963 children (0-8y) | Maternal education | Common childhood health problems | Low maternal education was associated with more asthma symptoms (OR 1.27), poorer general health (OR 1.36), more frequent respiratory infections (OR 1.57), more overweight (OR 1.42), and more obesity (OR 2.82). |

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| Russell, 2011 [108] | UK | 13,981 infants (1y) | Maternal education | Autistic traits (3y-4y) | Lower maternal education was associated with 'severe but undiagnosed autistic traits'. |
| Savva, 2005 [56] | Cyprus | 1,412 children (2y-6y) | Maternal education, paternal education | Overweight, obesity, underweight, stunting, wasting | Non-significant association. |
| Schjølberg, 2011 [130] | Norway | 42,107 infants (18m) | Maternal education, paternal education | Delayed language development (late language emergence) (18m) | Lower maternal education was associated with delayed language development. |
| Schnabel, 2009 [163] | Germany | 3,097 infants (0-2y) | Parental education | Hospitalizations (total number of hospitalizations, due to digestive diseases, due to respiratory diseases, due to accidents and injuries) | Lower parental education was associated with increased hospitalizations due to digestive diseases, respiratory diseases (between 19m-24m), and accidents and injuries (between 7m-12m). A medium level parental education was associated with increased total number of hospitalizations. |
| Schults, 2012 [164] | Estonia | 592 infants (8-16m) | Maternal education | Vocabulary and gestures | Low maternal education level was associated with reduced production of common nouns and predicates. |
| Sellström , 2007 [35] | Sweden | 327,901 newborns | Maternal education | Birth weight | Non-significant association. |
| Silva, 2010 [165] | Netherlands | 3,545 pregnant women | Maternal education | Foetal weight, head circumference, abdominal circumference, femur length | A low level of maternal education was associated with slower growth of the head, abdomen, and femur. The negative effect was greatest for head circumference. |

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| Silva, 2012 [185] | Netherlands | 2,972 mothers and their infants (2y) | Maternal education | Height growth | A low level of maternal education was associated with shorter height at 2m, but with greater height growth between 1-18m. By 14m, infants born to mothers with low level of education were taller. |
| Städtler, 2003 [62] | Austria | 516 children (6y-7y) | Parental education | Caries | Lower parental education was associated with presence of caries in children. |
| Steur, 2011 [63] | Netherlands | 1,687 children (8y) | Maternal education, paternal education | Overweight (8y) | Non-significant association. |
| Thrane, 2005 [141] | Denmark | 5,024 infants (0-2y) | Maternal education | Hospitalization for infectious diseases | Lower maternal education was associated with increased risk for hospitalization for infectious diseases.. |
| Tikkaja, 2009 [64] | Estonia | 148,521 infants (0-2y) | Maternal education | Mortality due to injury | Lower maternal education was associated with increased risk for death due to injury. |
| Toschke, 2003 [65] | Germany | 4,974 children (5y-6y) | Parental education (highest level obtained by either parent) | Childhood overweight and obesity | Lower parental education was associated with increased risk for both childhood overweight and obesity. |
| Tsimbos, 2011 [54] | Greece | 103,266 births | Maternal education | Low birth weight, intrauterine growth restriction | Lower maternal education was associated with both low birth weight and intrauterine growth restriction. |
| van den Berg, 2012 [181] | Netherlands | 3,821 newborns | Maternal education | Preterm birth, low birth weight, SGA | Non-significant association. |
| van Rossem, 2010 [142] | Netherlands | 2,954 infants (36m) | Maternal education | Body Mass Index | Relative to infants born to mothers with the highest educational level, infants born to mothers with a lower educational level had lower BMI at 24m and 36m. Prevalence of overweight was lower in |

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| | | | | | infants from mothers with a mid-low educational level. |
| Villalbí, 2007 [94] | Spain | 2,297 newborns | Maternal education | Preterm birth, low birth weight, IUGR (<2nd percentile in birth weight by gestational age) | Non-significant association. |
| Violato, 2009 [131] | UK | 7,945 children (9y, 3y, 5y) | Maternal education | Asthma, wheezing | Lower maternal education was associated with increased risk of asthma and wheezing (5y). |
| Voigt, 2004 [110] | Germany | 4,376 births | Parental education | Birth weight, preterm birth | Lower parental education was associated with reduced birth weight. |
| von Kries, 2002 [166] | Germany | 6,484 children (5y-7y) | Parental education (highest level obtained by either parent) | Childhood overweight and obesity | Lower parental education was associated with childhood overweight but not with obesity. |
| Wahlberg, 2005 [167] | Sweden | 6,000 infants (1y) | Maternal education | Beta-cell autoantibodies levels (IA-2A, GADA) | Lower maternal education was associated with increased risk for induction of both types of beta-cell autoantibodies. |
| Westerlund, 2008 [182] | Sweden | 1,091 infants (18m) | Maternal education | Expressive vocabulary | Non-significant association. |
| Wigen, 2009 [168] | Norway | 523 children (5y) | Maternal education | Caries experience | Low maternal education was associated with risk for caries experience. |
| Wigen, 2010 [169] | Norway | 523 children (5y) | Parental education (both parents educational levels combined) | Oral health (enamel caries, dentine caries) | Low parental education was associated with increased risk of both enamel and dentine caries. |
| Wigen, 2011a [143] | Norway | 1,348 children (5y) | Maternal education | Caries experience | Lower maternal education was associated with risk for caries experience. |

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| Wigen, 2011b [170] | Norway | 1,348 children (5y) | Maternal education | Caries experience | Lower maternal education was associated with risk for caries experience. |
| Wijlaars, 2011 [114] | UK | 2,402 families and their infant twins (0-3m) | Maternal education | Birth weight, infant weight gain | Lower maternal education was associated with higher weight (3m), greater change in weight from 0-3m, and higher chance of rapid growth. |
| Zambrana, 2012 [171] | Norway | 44,921 children (1.5y, 3y) | Maternal education | Language comprehension (1.5y, 3y, change between 1.5y and 3y) | Lower maternal education was associated with inferior language comprehension at 1.5y, 3y and the change between 1.5y and 3y. |

### 7.2.4 Parental employment

**Table A.6** Studies assessing the association between **Indicators of household socio-economic circumstances (iv. Parental employment)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
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| Bonzini, 2009 [172] | UK | 1,327 mothers and their newborns | Maternal occupational activity (hours worked, standing/walking, kneeling/squatting, bending trunk forward, lifting weights, night shifts) | Preterm birth, SGA, head circumference, abdominal circumference | The mother working ≥40h/week was associated with small head circumference. Mothers whose work involved trunk bending >1h/day were associated with preterm birth. |
| Carpenter, 2004 [186] | Austria Belgium Denmark France Germany Hungary Ireland Italy Netherlands Norway Poland Russia Slovenia Spain Sweden UK Ukraine | 3,156 infants | Unemployment (paternal/partner) | Sudden infant death syndrome (SIDS) | Paternal/partner unemployment was associated with increased odds of SIDS. |
| Delpisheh, 2006 [20] | UK | 4,537 births | Unemployment (Both parents not in paid employment) | Low birth weight, preterm birth, SGA | Both parents being unemployed was associated with increased odds of being LBW, a preterm birth, or SGA. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Living in a workless household | Severe and less severe cognitive delay (3y) | Living in a workless household was associated with increased risk for severe and less severe delay in the child's cognitive development. |

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| Fomby, 2011 [25] | UK | 10,532 children (5y) | Measures of parents employment status (e.g., no workers in the household) | School readiness (5y) (assessed through cognitive performance – problem solving, spoken vocabulary, special ability (BAS) and children's behaviour – emotion symptoms, conduct problems (SDQ)) | The absence of any workers in the household was associated with lower cognitive performance scores and increased emotion symptoms. |
| Griffiths, 2010 [103] | UK | 11,653 children (3y-5y) | Current maternal employment status (hours worked per week) | Rapid weight gain (from 3y-5y) | Non-significant association. |
| Guedeney, 2008 [104] | France | 640 infants (14m-18m) | Maternal occupational status, paternal occupational status | Social/relational withdrawal behaviour | Non-significant association. |
| Guedeney, 2012 [105] | France | 1,586 infants (1y) | Maternal employment status during pregnancy | Social/relational withdrawal behaviour in infants (derived from Alarm Distress Baby Scale – ADBB) | Non-significant association. |
| Hawkins, 2008 [187] | UK | 13,113 children (3y) | Maternal employment (mother's and partners duration of employment, hours per week mother or partner worked, any maternal or partner's employment after birth) | Overweight (3y) | Any maternal employment after birth and hours worked per week were associated with increased risk of overweight. This relationship was only significant for children from households with a high annual income. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Maternal hours of work | Overweight (3y) | Maternal work ≥21 hours/week was associated with increased risk of overweight. |
| Jansen, 2009a [118] | Netherlands | 3,546 pregnant women and their newborns | Maternal working hours | Birthweight | Non-significant association. |

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| Jansen, 2010 [188] | Netherlands | 6,111 pregnant women and their newborns | Employment status (including a measure of unemployment) | Birth weight, preterm birth, SGA, Apgar score | After adjustment for confounders, there were no statistically significant differences in risks of adverse pregnancy outcomes between employed and unemployed women. Among unemployed women, women receiving disability benefit had an increased risk of preterm birth (OR 2.64) compared to housewives. Offspring of students and women receiving disability benefit had a significantly lower mean birth weight than offspring of housewives. In employed women, long working hours (>or=40 h/week) were associated with a decrease in offspring's mean birth weight. |
| Koopman, 2002 [153] | Netherlands | 4,146 children (2y) | Maternal employment status (having a paid job), paternal employment status (having a paid job) | Wheeze at least once, recurrent wheezing, night cough without a cold, runny nose without a cold, runny nose with itchy/watery eyes | The father not having a paid job was associated with wheeze at least once, recurrent wheezing, night cough without a cold, runny nose without a cold, runny nose with itchy/watery eyes. The mother not having a paid job was associated with having a runny nose without a cold, and a runny nose with itchy/watery eyes. |
| Koutra, 2012 [136] | Greece | 605 infants (18m) | Maternal employment status | Neurodevelopment (cognitive, receptive communication, expressive communication, fine motor, gross motor, social-emotional) (Bayley-III) | The mother not working was associated with lower scores in receptive communication, expressive communication, and gross motor domains. |

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| Kurth, 2010 [175] | Switzerland | 7,765 mother-infant pairs | Paid maternity leave after birth, mother's intent to return to paid work after birth | Infant crying problems (during the postpartum period) | Non-significant association. |
| Lamerz, 2005 [80] | Germany | 1,979 children (6y) | Maternal employment status, paternal employment status | Childhood obesity | Non-significant association. |
| Ludvigsson, 2005 [60] | Sweden | 15,867 children (4y) | Maternal work during pregnancy, paternal employment status | Coeliac disease | Employment >3m during pregnancy increased odds of coeliac disease. |
| Ludvigsson, 2006 [61] | Sweden | 8,341 children (2.5y) | Maternal employment status, paternal employment status | Gastrointestinal symptoms (constipation, diarrhoea, anorexia, abdominal pain, meteorism, vomiting) | Non-significant association. |
| Morales-Suárez-Varela, 2011 [189] | Denmark | 63,296 pregnant mothers and their newborns | Maternal employment status (employed, unemployed, receiving sickness or maternity benefits, on a study grant, supported by family, receiving other kinds of support) | Foetal loss, preterm birth, very preterm birth, SGA, congenital anomalies | Mothers receiving unemployment benefit were associated with increased risk of preterm birth and having a small for gestational age child. Women receiving sickness or maternity benefit had an increased risk of multiple birth, preterm, and very preterm birth, while those receiving an unreported type of support had an increased risk of preterm birth. |
| Morgen, 2008 [138] | Denmark | 75,890 newborns | Maternal occupation, paternal occupation | Preterm birth | Paternal unemployment was associated with increased risk of preterm birth. |
| Mortensen, 2009b [124] | Denmark | 1,409,339 births | Unemployment | Birth weight for gestational age | Higher unemployment was associated with reduced birth weight for gestational age. |
| Myhre, 2012 [126] | Norway | 26,087 children (3y) | Maternal unemployment | Hospital-attended injuries | Non-significant association. |

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| Niedhammer, 2009 [179] | Ireland | 1,124 newborns | Maternal employment status, maternal working hours, shift work, physical work demands, cumulative index of occupational factors (comprised of four occupational factors above) | Birth weight, preterm birth, SGA | Working under a non-permanent contract was associated with increased odds of preterm birth. Working at a physically-demanding job was associated with lower birth weight. Mothers whose work was characterised by 2+ of the evaluated occupational factors were at increased odds of lower weight, preterm birth and SGA. |
| Nobile, 2007 [52] | Italy | 600 newborns | Paternal occupation, maternal employment status | Low birth weight, very low birth weight, low birth weight and preterm | Unemployed mothers were at a significantly higher risk only for having a very low birth weight newborn. |
| Norsker, 2012 [128] | Denmark | 89,829 pregnant women and their fetuses | Maternal employment status | Spontaneous abortion (foetal death within the first 22w of pregnancy) | Non-significant association. |
| Panico, 2007 [83] | UK | 14,630 children (3y) | Maternal employment status | Asthma, wheezing | The mother not working was associated with increased risk of asthma and wheeze. |
| Puhó, 2008 [87] | Hungary | 61,160 newborns | Maternal unemployment | Isolated ocular congenital abnormalities | Unemployment was associated with increased odds of isolated ocular congenital abnormalities. |
| Reijneveld, 2002 [53] | Netherlands | 3,179 children (1-6m) | Parental employment status | Excessive infant crying | Being unemployed or working <16h/week was associated with excessive infant crying. |
| Reime, 2006 88 | Germany | 182,444 births | Maternal employment status | Pre- and full-term low birth weight | Maternal unemployment, and working in a manual and non-manual job were associated with increased risk of low birth weight. |

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| Rodrigues, 2007 [180] | Portugal | 4,068 mothers and their newborns | Maternal employment status | Preterm birth, SGA | Non-significant association. |
| Saurel-Cubizolles, 2004 [190] | Czech Republic Finland France Germany Greece Hungary Ireland Italy Netherlands Poland Romania Russia Slovenia Spain Sweden Turkey UK | 5,145 preterm and 7,911 term births | Maternal employment | Preterm birth | Employed women did not have an excess risk of preterm birth. Among working women, an excess risk was found for women working >42 hours/week (OR 1.33), standing >6 hours/day (OR 1.26), and for having low job satisfaction (OR 1.27). In countries with a lower overall level of prenatal health and a common practice of long prenatal leaves, associations were stronger. |
| Spencer, 2010 [90] | UK | 55,592 children (0-4y) | Long-term parental unemployment | Childhood long-term limiting illness/disability | Long-term unemployment was associated with an OR of 2.50. |
| Steur, 2011 [63] | Netherlands | 1,687 children (8y) | Maternal employment status, paternal employment status | Overweight (8y) | Non-significant association. |
| Sydsjö, 2006 [140] | Sweden | 3,727 mothers and their newborns (only pregnancies after 1990 were included) | Maternal occupation | Birth weight | Non-significant association. |
| Tsimbos, 2011 [54] | Greece | 103,266 births | Maternal employment status | Low birth weight, intrauterine growth restriction | Being a housewife/not economically active was associated only with intrauterine growth restriction. |
| van der Wal, 2007 [191] | Netherlands | 4,976 infants (3m-6m) | Level of maternal job strain | Excessive crying | A high level of maternal job strain was associated with excessive infant crying. |

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| Van Dijk, 2012 [193] | Netherlands | 2,939 children (5y) | Level of maternal job strain | BMI, fat mass index, waist circumference | Non-significant association. |
| Villalbí, 2007 [94] | Spain | 2,297 newborns | Maternal occupational status (housewife vs paid work) | Preterm birth, low birth weight, IUGR (<2nd percentile in birth weight by gestational age) | Non-significant association. |
| Violato, 2009 [131] | UK | 7,945 children (9y, 3y, 5y) | Maternal employment status | Asthma, wheezing | Full-time maternal employment was associated with increased risk for asthma (3y) and wheezing (5y). |
| Voigt, 2004 [110] | Germany | 4,376 births | Parental occupational status (full-time, part-time), parental unemployment, irregular working hours | Birth weight, preterm birth | Non-significant association. |
| Zhu, 2004 [192] | Denmark | 40,237 women and their newborns | Maternal employment | Birth weight, length of gestation | Non-significant association between any types of shift work and daytime work for length of gestation or birth weight at term. Fixed night work had a higher risk of post-term birth (OR 1.35). Fixed evening work had a higher risk of full-term low birth weight (OR 1.80). Shift work as a group showed an excess of SGA babies (OR 1.09). The risk of post-term birth was modified by maternal occupation. Industrial workers with fixed night work had a higher risk of post-term birth. |

### 7.2.5 Housing tenure

**Table A.7** Studies assessing the association between **Indicators of household socio-economic circumstances (v. Housing tenure)** and health and development in early childhood

| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
|---|---|---|---|---|---|
| Blair, 2004 [99] | UK | 11,718 infants (0-9m) | Housing tenure | Weight gain (from 0-9m) | Non-significant association. |
| Cumberland, 2010 [71] | UK | 14,981 children (3y) | Housing tenure | Eye disease (visual impairment; eye condition with no visual impairment reported) | Housing tenure (being in the 'renting/other' category) was associated with both outcomes. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Living in social housing | Severe and less severe cognitive delay (3y) | Living in social housing was associated with increased risk for severe and less severe delay in the child's cognitive development. |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Housing tenure | Elevated BMI (BMI>85$^{th}$ percentile) | Non-significant association. |
| Grjibovski, 2004 [194] | Russia | 1,399 newborns | Housing tenure (living in own vs shared apartment) | Birth weight, ponderal index | Living in a shared apartment was associated with reduced birth weight, but not with ponderal index. |
| Hay, 2005 [148] | UK | 13,167 children (0-4.75y) | Housing tenure | Use of health services (consultations with any symptom) | For children between <6m and 18m-41m, living in a council house was associated with increased risk of consultations. |

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|---|---|---|---|---|---|
| Pearce, 2012 [107] | UK | 14,378 children (3y) | Housing tenure | Unintentional home injury (between 9m-3y) | Housing tenure (not owning house) were associated with increased risk of unintentional home injury between 9m and 3y. |
| Russell, 2011 [108] | UK | 13,981 infants (1y) | Housing tenure | Autistic traits (3y-4y) | Non-significant association. |
| Violato, 2009 [131] | UK | 7,945 children (9y, 3y, 5y) | Housing tenure | Asthma, wheezing | Not owning a house were both associated with increased risk of asthma and wheezing (5y). |
| Williams, 2008 [95] | UK | 7,825 children (7y) | Housing tenure | Vision problems (strabismus, past/present amblyopia, hypermetropia) | Living in council rented housing were both associated with increased risk for hypermetropia. |

### 7.2.6 Household crowding

| **Table A.8** Studies assessing the association between **Indicators of household socio-economic circumstances (vi. Household crowding)** and health and development in early childhood | | | | | |
|---|---|---|---|---|---|
| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
| Cullinan, 2004 [196] | UK | 547 children (5.5y) | Household crowding | Atopic wheeze, allergic sensitization (only dust mite association was measured) | Non-significant association. |
| du Prel, 2006 [183] | Germany | 28,888 children (6y) | Small living space | Birth weight, measures of lung function, height, overweight, bronchitis, frequency of colds, coughs and sneeze attacks, allergies, diagnosis of eczema | Children living in households with a small living space were associated with increased risk of lower birth weight, reduced height, bronchitis, frequency of colds, coughs, and sneeze attacks, and diagnosis of eczema. |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Household crowding | Elevated BMI (BMI>85$^{th}$ percentile) | Non-significant association. |
| Grjibovski, 2004 [194] | Russia | 1,399 newborns | Household crowding | Birth weight, ponderal index | A crowded household was associated with reduced birth weight, but not with ponderal index. |
| Kuehni, 2007 [29] | UK | 6,080 children (1y-4y) | Household crowding | Wheeze (viral, multiple) (1y, 2y-4y) | Non-significant association. |
| Lamerz, 2005 [80] | Germany | 1,979 children (6y) | Household crowding | Childhood obesity | Non-significant association. |

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| Larsson, 2009 [122] | Sweden | 4,779 children (6y-8y) | Home size | Autistic Spectrum Disorders (ASD) | Non-significant association. |
| Lindbæk, 2003 [176] | Norway | 1,884 children (4y-5y) | Number of rooms in house | Bronchial asthma | Living in a house with <5 rooms was associated with increased odds of bronchial asthma. |
| Ludvigsson, 2005 [60] | Sweden | 15,867 children (4y) | Household crowding | Coeliac disease | Non-significant association. |
| Ludvigsson, 2006 [61] | Sweden | 8,341 children (2.5y) | Household crowding | Gastrointestinal symptoms (constipation, diarrhoea, anorexia, abdominal pain, meteorism, vomiting) | Non-significant association. |
| Oguzkaya-Artan, 2007 [139] | Turkey | 683 children (5y-7y) | Number of people sharing a room with the child | Haemophilus influenzae, haemophilus influenzae type b | The child sharing a room with ≥4 people was associated with increased risk for H. influenzae and H. influenza type b. |
| Pearce, 2012 [107] | UK | 14,378 children (3y) | Household crowding | Unintentional home injury (between 9m-3y) | Lower household crowding was associated with increased risk of unintentional home injury between 9m and 3y. |
| Torrent, 2006 [195] | Spain UK | 937 children (4y) | Household crowding | IgE sensitization (4y) | Household crowding was associated with increased risk of IgE sensitization. |

### 7.2.7 Material deprivation

| **Table A.9** Studies assessing the association between **Indicators of household socio-economic circumstances (vii. Material deprivation)** and health and development in early childhood | | | | | |
|---|---|---|---|---|---|
| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
| Bomela, 2009 [58] | Uzbekistan<br>Kyrgyzstan<br>Kazakhstan | 1,989 children (0-3y) | Type of toilet facility, type of water facility | Underweight, stunting | Lack of piped water facilities in the household was associated with childhood stunting. |
| Bonuck, 2011 [70] | UK | 12,447 children (0-6.75y) | Living in inadequate housing | Sleep disordered breathing symptoms (mouth-breathing, snoring, apnea) | Living in inadequate housing was associated with increased sleep disordered breathing symptoms. |
| Bornehag, 2005 [48] | Sweden | 10,851 children (1y-6y) | Type of dwelling, age of building, type of ventilation system, type of flooring material, measures of dampness in housing (water leakage, floor moisture, visible dampness, condensation on windows). | Wheezing, cough, asthma, rhinitis, eczema | Living in a multi-family house or an older building were found to be associated with increased risk of wheezing, cough, asthma, rhinitis, eczema. Living in housing without a natural ventilation system was associated with increased risk of rhinitis and eczema. PVC-flooring was associated with increased risk of cough, rhinitis and eczema. Living in a residence with linoleum flooring was associated with increased risk of rhinitis. The measures of dampness were associated with increased risk of wheezing, cough, asthma, rhinitis, and eczema. |

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| Butler, 2008 [134] | UK | 9,561 children (4.5y) | Presence of basic resources in house, housing adequacy (derived from household crowding and homelessness status), presence of housing defects (presence of mould, leaking roof, and vermin infestation) | Nocturnal enuresis, infrequent bed-wetting | Presence of housing defects was associated with increased risk for infrequent bed-wetting and nocturnal enuresis. |
| Emerson, 2009 [72] | UK | 12,689 children (3y) | Level of persistent material disadvantage | Cognitive delay | A higher level of persistent material disadvantage (OR 2.72) was associated with increased risk for cognitive delay at 3y. |
| Emerson, 2010 [23] | UK | 15,808 children (0-3y) | Material hardship | Severe and less severe cognitive delay (3y) | Material hardship was associated with increased risk for severe and less severe delay in the child's cognitive development. |
| Emond, 2007 [102] | UK | 11,900 infants (0-9m) | Lack of private transport | Poor weight gain | Lack private transport was associated with poor weight gain from 0-8m. |
| Friedman, 2009 [46] | Ukraine | 883 children (3y) | Presence of roof leaks, availability of yard, garden space, private bath/shower, kitchen, telephone | Elevated BMI (BMI>85$^{th}$ percentile) | Non-significant association. |
| Hryhorczuk, 2009 [106] | Ukraine | 2,030 children (6y-8y) | Inadequate heating in home, water penetrating in home, presence of mould | Wheeze | Inadequate heating and water penetrating into the home were both associated with increased odds of wheeze. |
| Kuehni, 2008 [30] | UK | 6,742 children (1y-4y) | Availability of electric cooking in household, availability of central heating in household | Sleep disordered breathing (measured through snoring) | Non-significant association. |

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| Kurugöl, 2003 [137] | Turkey | 920 children (<5y) | Presence of piped water in household, presence of lavatory in household | Rotavirus gastroenteritis | Non-significant association. |
| Pearce, 2012 [107] | UK | 14,378 children (3y) | Measures of housing quality (housing score – number of indicators of poor housing, household crowding, access to garden availability of central heating, presence of dampness / condensation), safety equipment use (number of home safety equipment used at home, use of fireguard, use of safety gate, use of electric socket covers, use of smoke alarm) | Unintentional home injury (between 9m-3y) | A higher housing quality score and lack of use of home safety equipment were associated with increased risk of unintentional home injury between 9m and 3y. |

### 7.2.8 Other – Access to a garden

| **Table A.10** Studies assessing the association between **Indicators of household socio-economic circumstances (viii. Other – Access to a garden)** and health and development in early childhood | | | | | |
|---|---|---|---|---|---|
| First author, year | Country | Sample (Child age) | Social Factor assessed | Outcome assessed | Main Findings |
| Griffiths, 2010 [103] | UK | 11,653 children (3y-5y) | Access to a garden | Rapid weight gain (from 3y-5y) | Non-significant association. |
| Hawkins, 2009a [43] | UK | 12,188 children (3y) | Access to a garden | Overweight (3y) | Non-significant association. |

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**Appendix 2: Task 2.2 Systematic review of parenting interventions in European countries aiming to reduce social inequalities in children's health and development**

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# Abstract

## Background

Early child development influences many aspects of wellbeing, health, competence in literacy and numeracy, criminality, and social and economic participation throughout the life course. Children from disadvantaged groups have less possibilities of achieving full development. By providing a positive start for all children across the social gradient, improved developmental outcomes will be seen during later childhood and throughout their lives. The objective of this systematic review was to identify interventions during early childhood in countries from the World Health Organisation European Region in 1999–2013 which reduced inequalities in children's health and development.

## Methods

A systematic review was carried out adhering to the PRISMA guidelines. The review examined universal, targeted and proportionate universalism interventions, programs and services using an electronic search strategy in PubMed and the International Bibliography of the Social Sciences [IBSS] databases. A further search was performed in the grey literature. Interventions were included only if they were aimed at children or their parents and had been evaluated.

## Results

We identified 23 interventions in total: 6 in the PubMed data base, 5 in IBSS and 12 in grey literature. All but 1 intervention-delivered in Sweden-were carried out in the United Kingdom and the Republic of Ireland. These aimed to improve parenting abilities, however, some had additional components such as: day-care provision, improving housing conditions and speech or psychological therapies. Programmes offering intensive support, information and home

visits using a psycho-educational approach and aimed at developing parent's and children's skills showed more favourable outcomes. These were parenting behaviours, overall children's health and higher level of fine motor skills and cognitive functioning. Child injuries and abuse were also reduced. Two interventions were universally proportionate and all others were aimed at a specific target population.

**Conclusions**

Interventions with better outcomes and a higher level of evidence combined workshops and educational programmes for both parents and children beginning during early pregnancy and included home visits by specialised staff. Further evaluation and publication of early years interventions should be carried out also within a wider range of countries than just the UK and Ireland.

## Keywords

Review, Early intervention, Parenting, Inequalities, Health, Child development

## Background

During child growth, neuron connections produce cognitive, motor, emotional, behavioural and social developmental skills [1]. Childhood risks associated with poverty or similar adverse conditions, such as lack of stimulation or excessive stress, affect brain development. The risks begin prenatally by influencing the foetal brain through exogenous factors that produce maternal stress [2]. Early child development [ECD] will influence many aspects of wellbeing, health, competence in literacy and numeracy, criminality and social and economic participation throughout the life course [3-5].

The early acquisition of skills is part of a developmental continuum and commences well before formal schooling [6]. By the time the child enters school, development will have already been influenced by family, neighbourhood and the broader societal level [7]. Family socioeconomic status [SES] is associated with a multitude of development outcomes [8], for example, it has been described that children of mothers with mental health problems were more likely to have negative behavioural, emotional, and peer outcomes [9]. Low family SES also produces obesity in childhood and adolescence and may exert a strong influence on socioeconomic status [10]. Children from disadvantaged groups are less likely to achieve a good level of development and have worse health outcomes [11]. Neighbourhood deprivation and the physical context also influence early child development [12,13] and children from family backgrounds that pose multiple threats to their development tend to do better growing up in mixed socioeconomic neighbourhoods [14].

These different qualities of experience create social gradients in human developmental trajectories across the life course [15-17]. As described elsewhere, children from the 1970 British birth cohort survey assessed by tests of intellectual, emotional and personal development who were in the bottom SES quartile at 22 months were still there at age 10. High-SES children showed considerably more upward mobility and were more likely to be in the top quartile by age 10, even if they were in the bottom quartile at 22 months [18].

Evidence from intervention studies suggest that performance in the different domains of Early Child Development [ECD]-described as the development of physical, socio-emotional and language-cognitive capacities in the early years-[19] can be modified in ways which improve health, well-being, and competence in the long-term [8]. By providing a positive start across the social gradient, children will benefit from improved developmental outcomes during later childhood and throughout their life course as significant improvements in all domains of child development will influence later school achievement [20]. The overarching conceptual framework for this study: "Action across the life course"-as described in the Strategic Review of Health Inequalities in England post-2010-[21] shows that disadvantage starts before birth and accumulates throughout life. Therefore, action to reduce health inequalities must start during gestation and be carried out through the life of the child and into adulthood. This may be made effective by providing evidence-based interventions and delivery systems [20,21].

Studies which have shown the importance of parenting activities across income groups and the social gradient [15] fostered through ECD programmes are not limited to cognitive gains, but also include physical, social, and emotional gains, all of which are determinants of health over the life course [3]. The quality of parent–child relationships is significantly associated with many outcomes relating to child health and development, including learning and social skills, mental health and health behaviours and remain influential into adulthood for social and behavioural outcomes. Parenting programmes offer valuable opportunities to positively influence child health and well-being through health-promoting environments, establishing good health behaviours, providing support for families and creating resilience [22]. Examples of early years programmes delivered in the USA have been well documented: "The Perry Preschool Project" delivered during 1962–1967 and the "High/Scope Preschool Curriculum Study" (1967–1970) which showed positive outcomes for test scores, high school completion, lower arrests and criminality, teenage pregnancies and higher home ownerships. The "Carolina Abecedarian Project" (1972–1985) and the "Syracuse Family Development Research Program" (1969–1975) had an impact on improving development and IQ scores [19,23].

The economic return to these programs is high, especially when considering alternative policies that target children from disadvantaged environments or the policies targeting the young adults who emerge from them [24]. There is sufficient scientific rationale for early intervention [25], as social inequalities develop before birth it is more effective to deliver interventions not only in the early stages of the child's life [26], but also before birth and has been established as a priority at the UN Convention on the Rights of the Child [7].

It has been argued as a principal recommendation in a previous study, that future reviews should focus on identifying interventions [17] and to our knowledge, there are few scientific reviews of interventions to tackle health and developmental inequalities in early child development focusing only on European studies. The majority include intervention studies carried out in the US, Canada and Australia or in low income and high burden countries [27,28]. The WHO European Region includes countries with close to the best health and narrowest health gaps in comparison to other continents and has benefited from a sustained period of social cohesion, developed welfare states and high-quality education and health services [29]. However, inequalities still remain and are increasing in some countries, therefore the different set of conditions across Europe offers the possibility of evaluating evidence on the effectiveness of early interventions on families' socio-economic conditions as well as the physical functioning and development of children in the early stages of their lives.

By reviewing this evidence, the objective of this systematic review was to identify relevant existing literature on interventions carried out during early childhood in countries within the Region during the years 1999–2013 which address children's health and development. The review forms part of the DRIVERS Project (2012–2014) – a three-year research project funded by the European Union 7th Framework Programme focusing on three of the key drivers to reduce health inequities: early childhood development, employment and working conditions and welfare, income and social protection. It assesses the impact of policies and programmes to develop new methods and evidence and provide policy recommendations and advocacy guidance to reduce health inequalities within Europe. The research builds on the recommendations of the Commission on Social Determinants of Health (CSDH) [11], The Strategic Review of Health Inequalities in England post-2010 [21] and The Review of Social Determinants and the Health Divide in the World Health Organisation European Region [29] and seeks to contribute to the EU 2020 initiatives [30].

## Methods

### Data sources

The review examined the literature on early childhood interventions which have been defined elsewhere as experiences from conception to the start of statutory school [31]. The study followed the Centre for Reviews and Dissemination guidance for undertaking reviews [32] adhering to the PRISMA guidelines [33]. We applied the PICOCS (Population, Interventions, Comparisons, Outcomes, Context, Study Design) guidelines [34], to develop the search terms.

We carried out a search in PubMed's database and the International Bibliography of the Social Sciences (IBSS) database to include research from the medical and social sciences. Table 1 shows the search strategies used in both databases. A further search was made in the following online grey literature databases and search engines: the National Institute for Health and Care Excellence's (NICE) evidence database, the System for Information on Grey Literature in Europe (SIGLE) and Google. We used the keywords: "early years interventions to reduce inequalities in child health and development". The inclusion criteria were: the studies included could be from any country in the World Health Organisation European Region; the interventions, programmes or services had to have undergone a formal evaluation, describing the methods used to evaluate the programme or intervention. Study designs included were: Randomised Control Trials (RCT), experimental and quasi-experimental studies, before and after evaluations and qualitative research assessments. Interventions had to show outcomes in child health and developmental domains and/or parenting as international evidence has supported that programmes and services at this stage of life are aimed at parents as well as children [31]. We included papers published in peer reviewed journals and reports in grey literature, published between January 1999-the publication year of the earliest article identified-and December 2013 and no articles were excluded due to language criteria. We excluded studies aimed at children over eight years of age; the latest compulsory age for schooling in the WHO European Region [35], as early years and childhood disadvantage is linked to disadvantage in adulthood, and poor adult health [4]. Therefore the review focused on interventions delivered during the early years, however some programmes had follow-ups during later stages. Systematic reviews which included interventions delivered outside WHO European Region were also excluded.

**Table 1 Search strategies for PubMed and IBSS**

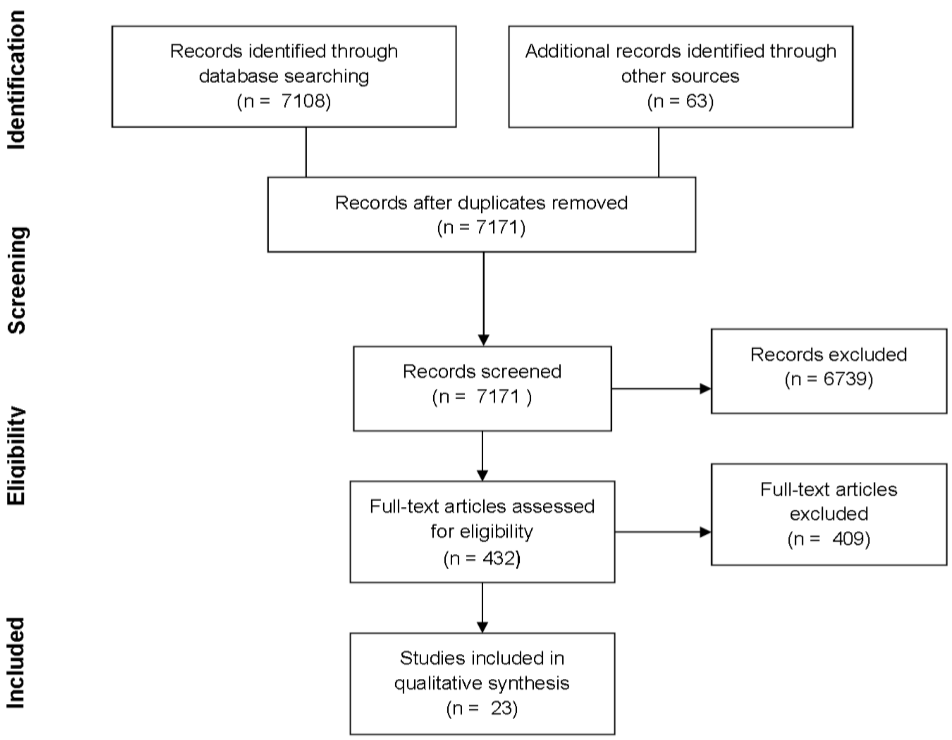
| | |
|---|---|
| Search Strategy PubMed | [[[[[[[[[[[[[[[[[[[[[Policy[Title/Abstract]] OR intervention[Title/Abstract] OR parenting[Title/Abstract] OR community health planning[Title/Abstract] OR charities[Title/Abstract] OR child day care centres[Title/Abstract] OR foster home care[Title/Abstract] OR food assistance[Title/Abstract] OR government financing[Title/Abstract] OR tax exemption[Title/Abstract] OR family support[Title/Abstract] OR child health centres[Title/Abstract] AND [[[[[Child[Title/Abstract]] OR infant[Title/Abstract]] OR newborn[Title/Abstract]] OR early childhood[Title/Abstract]] OR prenatal[Title/Abstract]] AND [[[[[[depriv*[Title/Abstract]] OR determinant*[Title/Abstract]] OR disparit*[Title/Abstract]] OR ineq*[Title/Abstract]] OR develop*[Title/Abstract]] OR health[Mesh] OR equit*[Title/Abstract] OR equalit*[Title/Abstract]]]] NOT [[[[[[[Americas[All fields]] OR India[All fields]] OR Asia, Southeastern[All fields]] OR Asia, Western[All fields]] OR Far East[All fields]] OR Australia[All fields]] OR Africa[All fields]]] NOT [Australian[All fields] OR Indi*[All fields] OR Uganda[All fields] OR Japan[All fields] OR Nigeri*[All fields]]]] NOT Chin*]] NOT USA] NOT United States of America] NOT Canada] NOT North America]] NOT Malawi]] NOT Keny*]] NOT Developing countries] NOT Bangladesh] NOT Philippines] NOT Pakistan]] NOT U.S] NOT America] NOT American |
| Search Strategy IBSS | [ti[policy] OR ti[intervention] OR ti[parenting] OR ti[community health planning] OR ti[charities] OR ti[daycare centres] OR ti[foster home care] OR ti[food assistance] OR ti[government funding] OR ti[tax exempt] OR ti[family supports] OR ti[child care centres] OR ab[policy] OR ab[intervention] OR ab[parenting] OR ab[community health planning] OR ab[charities] OR ab[daycare centres] OR ab[foster home care] OR ab[food assistance] OR ab[government funding] OR ab[tax exempt] OR ab[family supports] OR ab[child care centres]] AND [ti[child] OR ti[infant] OR ti[newborn] OR ti[early childhood] OR ti[prenatal] OR ab[child] OR ab[infant] OR ab[newborn] OR ab[early childhood] OR ab[prenatal]] AND [ti[depriv*] OR ti[determinant*] OR ti[disparit*] OR ti[ineq] OR ti[develop*] OR ti[health] OR ti[equit*] OR ti[equalit*] OR ab[depriv*] OR ab[determinant*] OR ab[disparit*] OR ab[ineq] OR ab[develop*] OR ab[health] OR ab[equit*] OR ab[equalit*]] |

## Study selection

Figure 1 shows the flow diagram mapping the number of records selected, included and excluded. The search carried out in PubMed retrieved 2361 articles, and the screening of the 2361 titles and abstracts was carried out by one reviewer (JM). After the first screening, 273 studies were selected and read by one reviewer (JM), leaving 6 studies which met the selection criteria. In this process the entire article was read revealing that the majority of the preselected studies described interventions which also included late childhood or adolescents or took place outside Europe and were therefore excluded. A second search was performed in IBSS which retrieved 4747 articles. The first screening of the titles and abstracts was carried out by one reviewer (JM). After the first screening, 159 studied were selected and read by one reviewer (JM), leaving 5 studies which met the selection criteria, for the same reason as described above. Four reports describing various early childhood interventions were retrieved from the grey literature. Two presented information on interventions which met our abovementioned selection criteria and two were excluded as there was not sufficient specific information on the evaluation. Finally twelve interventions published in the grey literature were selected.

**Figure 1 Flow diagram of the number of records identified, included and excluded.**

**Figure 1. Flow diagram of the number of records identified, included and excluded**




Flow diagram adapted from: Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. [26]

## Data extraction, variables and analysis

The following information was extracted from each of the studies retrieved: the title and authors of the study and the year it was published, name of the intervention and country where it was delivered. Type of study design and objectives described, the domains of child development mentioned, target population and scope of the intervention, final sample size and age of the participants if these were children, were also included. Additional information was extracted on premises where it took place, staff which delivered the intervention and which activities were carried out, the evaluation performed, measured outcomes and results. This information was stored in a database as a complementary file. As the studies found were very diverse, these were summarised for comparison in Table 2 under the following headings: type of study design, intervention details and activities, target population, description of the sample including number of people in the intervention and control groups and age of the participants where pertinent. Information on the type of intervention-whether it was targeted or universal-was provided as well as its impact categorised as: a) developmental outcomes, b) parenting, c) health outcomes and d) outcomes of the intervention.

## Table 2 Outcomes of the interventions by evaluation design

| Design | Intervention details/Activities | Target | Evaluation sample description | Type | Impact | Outcomes |
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| **RCT** | "The Positive Parenting Programme" [Triple P] developing parenting skills through: media, tip sheets, parent groups, self- directed and one to one activities, 5 intensity levels tailored to need | In Scotland, UK, evaluated among children 0-3 | Various studies, sample sizes from 16 to 806 | Proportionate universal | Parenting Health and development | Favourable outcomes in child behavior. Abuse and injuries were reduced [19] |
| | "Preparing for Life" [PFL] improving school readiness from pregnancy until beginning of school by providing public health information, a support worker, materials and workshops. High treatment groups receive home visits from PFL trained mentors | Pregnant mothers and children living in disadvantaged communities in Ireland recruited between 2008-2010 | High treatment: 115, low: 118. 0-7 | Targeted. Different treatment levels | Health | Limited improvement for maternal health behaviours. Favourable for parenting behaviours, higher immunisation rates, appropriate infant feeding patterns, better overall health. Children in the high treatment group showed higher level of fine motor skills and cognitive functioning [22] |
| | "Childhood Development Initiative-Early years" care and education programme delivered by specialised staff starting when children are aged 2–3. Parents participate in the Parents Plus Community Course and there is provision of quality childcare, home visits and activities for parents based on their specific needs are offered | All families living in an area of social disadvantage in Dublin, Republic of Ireland | When children were aged 2½-3, delivered in 2 waves, lasting 2 years | Targeted | Development | Fewer IG (Intervention Group) children had behavioural problems or high hyper-activity levels but not statically significant. They also scored significantly higher than the control group at mid and end phase on The Early Childhood Environmental Rating Scales. The Parents Plus Community Course was shown to improve the children's home learning environment 2 years after the course was attended [22] |
| | "The Growing Child Parenting Programme" parent-directed child-centred monthly learning programme delivered through age-specific information and practical learning activities supported by tailored resources.<br>Home delivered by trained visitors | Parents of children of children aged from birth to 5 years across Ireland, 2008-2009 | IG: 216, CG: 208, | Proportionate universal | Development | The evaluation reported some positive effect on the domains of development but no statistically significant improvements at the present stage, however it showed greater parental efficacy [22] |

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| | "Community Mothers Program" home visits by community mothers guided by a 'family development nurse' once a month. It focuses on health, nutrition and overall child development by emphasising on empowerment, parent capacity building and behavioural approaches illustrating alternatives in coping with child-rearing problems | First-time parents in deprived areas, Ireland and the UK [1983–present] | IG: 141, CG: 121. Age: 0-1 | Targeted | Parenting Health | Significant more visits to the library, no significant difference in immunisation, dental checks, diet, breastfeeding or attendance to accident and emergency rooms. Intervention mothers were significantly more likely to check homework every night and more likely to disagree with the statement 'children should be smacked for persistently bad behaviour' [19] |
| | "The Social Support and Family Health Study": postnatal support provided by seven home visits and additional telephone contacts | Women living in deprived districts who gave birth: 1/1/99-30/9/99, London, UK | Community group intervention: 184, health visitor int.:183, CG:364 | Targeted | Parenting and health | There was no evidence of impact on child injury, maternal smoking or maternal depression of either intervention. There were different patterns of health service use and less anxious experiences of motherhood among IG women [36] |
| | Specialist home health visits received counselling on managing eating problems and parent–child interactions | Children with failure to thrive, most families depended on social welfare April 1994 -February 1996, UK | IG: 42, CG: 41. Age: 4–30 months | Targeted | Development Health care | Specialist health visitor intervention conferred no additional benefits but improved coordination in health care services use[37] |
| **Quasi-experiments with control group** | "Let's Play in Tandem", a compensatory education programme delivered by parents through play to foster one-on-one verbal interactions, a joint focus of attention, and scaffolding of the children's learning providing children with prompts, demonstrations and encouragements | Socio-economically disadvantaged pre-schoolers from a "Sure Start" sample in Wales, UK | IG:30, CG:30, Mean age: 36.7 month | Targeted | Development | The intervention group outperformed matched controls in tests of academic knowledge, receptive vocabulary, inhibitory control and school readiness [19] |
| | "Incredible Years" weekly meetings during 12 weeks, 18–22 sessions training children on social skills, teacher training | Families with children at risk of conduct disorder, UK [2001-present] | Wales 153 families, Oxford: IG:44, CG:32 | Targeted | Development | Intervention children exhibited fewer negative and submissive conducts and higher rates of positive-affect behaviours [19] |

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| | "Sure Start" outreach, child care and home visits, support, healthcare advice, adding value to existing services | Low SES children, intensity varied in sites. UK, [2001–present] | IG: 5883, CG: 1879 | Targeted | Parenting Development | Favourable outcomes in independence, social behaviour, reduced risk of negative parenting and a better home-learning environment. No improvements in language, immunisations or accidents [19] |
| | "Eager and Able to Learn" developmental movement experiences delivered in a group setting; a home learning package; workshops for parents and children; comprehensive training for the practitioners by Early Years specialists; 5 on-site support visits | Piloted in 14 settings, 2008–2009, Northern Ireland, UK | 454 children 2–3 years old | Targeted | Development | Significant improvements in social and emotional development. Negative effect on emergent literacy skills. Positive parenting outcomes [22] |
| | Targeted work with parents by provision and fitting of safety equipment in addition to a population-wide education and information campaign provided across the whole locality | Families with children within disadvantaged Sure Start areas, UK | Children under five in the intervention ward. Assessment at two years | Targeted | Health | Over two years the proportion of children attending an A&E department reduced at a faster rate in the intervention wards [38] |
| | "First Parent Health Visitor Scheme" approximately 10 home visits by visitors beginning at third trimester until 8 months old | First time parents in deprived areas in the UK [1989–1998] | IG: 205, CG: 254 | Targeted | Health | Significantly fewer accidents in the past 12 months [22] |
| | Intervention to prevent burn and scald injuries at home by individual-based information with an empowerment approach | Low SES mothers selected by health care services in Sweden | 99 mothers of children under 7 months | Targeted | Health | The intervention had a significant impact on improving precautions, in relation to the comparison group [39] |
| **Mixed-methods** | Support and advice on breastfeeding by trained nurses on breastfeeding techniques | Mothers 5–12 days after delivery in Redbridge trust, UK | All mothers in the trust area | Targeted | Parenting Health | Mother's perceptions were that they would not have continued without support and prevalence went from 60.5% to 67.45% [40] |
| | "Family Nurse Partnership" Using a psycho-educational approach it provides on-going, intensive support to young, first-time mothers and their babies trained nurses provide home visits from early pregnancy until child is 2 | Low Socio Economic Status [SES] mothers, UK | Formative evaluation | Targeted | Health and development | Piloted at ten site, evaluations was still underway when the report was published [19] |

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| | Freephone parenting help line for parents: carers called back and offered additional services if the call taker felt that the parent may benefit | Parents who contacted a national parenting help line, 1999, UK | 97 parents received support, 99 awaiting | Targeted | Parenting | Parents felt that their abilities had improved across the domains, particularly with regard to their ability to understand their children's needs and their confidence in their parenting abilities. They scored more favourably on the General Health Questionnaire [41] |
| | "The Speech and Language Therapy" provided training and support developing an interagency organisational structure for inter professional collaboration between Early Years practitioners and speech and language therapists | Early Years [EY] staff and parents Dublin, Republic of Ireland | 3 primary schools and 10 EY services: 77 parents, staff and others | Targeted | Development | 12% of the boys and 28% of the girls were discharged with their speech and language within normal limits. Around half of the children required on-going therapy. Parents reported that their children were more ready for school as a result of the intervention and that their child was less likely to be bullied [22] |
| | "Ready Steady Grow" a programme to improve health and wellbeing to promote and support the parent–infant relationships. The centre based Parent–Child Psychological Support Programme component is delivered through 6 visits by the parent and baby over a 15-month period by specialist staff | Parents and children in designated deprived area, Dublin, Republic of Ireland | 23 interviews and 58 surveys with stakeholders | Targeted | Parenting Development | Increased global and language development. No significant decrease in parenting stress and no effect on motor and personal-social development [22] |
| **Qualitative methods assesments** | Day care with highly qualified staff | Socially disadvantaged families at a EY centre, UK | IG: 11, CG: 10 mothers | Targeted | Parenting | Women who received a day care place at the centre were more likely to be in paid employment [42] |
| | The Developing Everyone's Learning and Thinking Abilities [DELTA] parenting programme | Services for children in need and their families, Northern Ireland, UK | 46 individual interviewees 32 parents participated in focus groups. 154 postal questionnaires | Targeted | Parenting Development | 75% felt more confident as parents, 65% that it enhanced their child's learning. 58% felt that it increased their knowledge on health issues [43] |
| | Limerick Lullaby project: music and singing providing an additional tool for communication | Women in a deprived area with an uncomplicated pregnancy, Republic of Ireland | 6 women age 29-35 | Targeted | Parenting | Mothers described it improved connection, communication, stress reduction, confidence building and foetal attachment [44] |

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| Baby "FAST" strengthening family relationships through a structured curriculum comprising arts and craft-based activities, small group discussion, a community meal and infant foot massage | Teenage mothers in a deprived area, London, UK | Seven teenage mothers and fathers | Targeted | Parent and | Qualitative research showed positive results in consolidating intergenerational bonds and trust [45] |

## Results

### Description of intervention characteristics

We identified 23 interventions in total: 6 in the PubMed data base, 5 in IBSS and 12 in the grey literature. All but 1 intervention-delivered in Sweden-were provided in the United Kingdom and the Republic of Ireland (22). The studies identified were RCTs (7), quasi-experiments with control group (7) followed by mixed methods (5) and qualitative evaluations (4). These aimed to improve parenting abilities, however, some had additional components such as: day-care provision (3), improving housing conditions (2) and speech or psychological therapies (5). The majority of the interventions had an impact on domains of child development (14), on parent–child bonding (15) or on children's health and injury prevention (11), however interventions could have an impact on more than one area. Two studies were universally proportionate interventions, and all others were aimed at children and families living in deprived areas.

### Intervention outcomes according to their study design

Table 2 shows the intervention studies identified categorised into four types of evaluation: RCTs, quasi-experiments with control group, studies with a mixed methods approach and qualitative methods assessments. The studies vary regarding their activities, targets, sample sizes and measured outcomes. Below, the programmes, their principal activities and outcomes are described according to their study design and type of outcome.

### Randomised controlled trials

#### *Favourable parenting, health and developmental outcomes*

Within the RCTs, the "Family Nurse Partnership" (FNP) [19], "The Positive Parenting Programme" (Triple P) [19] and "Preparing for Life" (PFL) [22] provided mothers living in deprived areas and their children with home visits delivered by trained nurses and visitors from early pregnancy until the child was 2, 3 and until school age, respectively. They offered intensive support using a psycho-educational approach and provided public health information, materials and workshops to develop parenting skills and child development. Triple P and PFL offer different levels of treatment and intensity. The programmes showed favourable outcomes for parenting behaviours, higher immunisation rates, appropriate infant feeding patterns and better overall health. In PFL, children in the high treatment group showed higher level of fine motor skills and cognitive functioning. Child injuries, abuse and neglect were also reduced. The "Childhood Development Initiative-Early Years" (CDI) care and education programme also provided specialised home visits and activities based on their specific needs. The CDI Initiative was targeted at parents with 2–3 year olds and provided quality day-care. Children in the Intervention Group (IG) scored higher on the Early Childhood Environmental Rating Scales, and the home learning environment was shown to improve [22].

***Favourable for parenting outcomes***

The "Growing Child Parenting Programme" a parent-directed programme supported by tailored resources and home visits, showed no statistically significant improvements at the present stage, however it showed greater parental efficacy [22]. The "Community Mothers Program" provided home visits by community volunteers once a month and focused on parent capacity building. Its evaluation showed there were significantly more visits to the library and parents did not agree with physical punishment [19].

***Favourable for health service use outcomes***

"The Social Support and Family Health Study" [36] and an intervention for children with failure to thrive [37] received postnatal support provided by specialist home visits and additional telephone contacts. Both programmes showed improved coordination and patterns in health care services use and "The Social Support and Family Health Study" which also provided further telephone assistance, showed that women in the IG had less anxious motherhood experiences.

**Quasi-experiments with control group**

***Favourable outcomes for cognitive development and school readiness***

"Let's Play in Tandem" [46] is delivered by parents through play to foster one-on-one verbal interactions, demonstrations and encouragements for three year olds. IG children outperformed the control group in academic knowledge, receptive vocabulary, inhibitory control and school readiness.

### *Favourable outcomes for socio-emotional development and parenting*

"Incredible Years", "Sure Start" [19], "Eager and Able to Learn" [22] provided children with training on social skills, support, workshops and advice for parents in addition to home visits. IG children who received the intervention exhibited fewer submissive behaviours. Parents showed a lower risk of negative parenting.

### *Favourable outcomes for reducing accidents and injuries*

One programme provided in Sure Start areas in the UK offered targeted work involving parents in fitting safety equipment and provided an education and information campaign [38]. The "First Parent Health Visitor Scheme" and an intervention to prevent burns and scalding delivered in Sweden, also offered individual based information through trained visitors. Results showed there were significantly fewer accidents, visits to the Accident and Emergency (A&E) departments and interventions had an impact on improving safety conditions and precautions [19,39].

## Mixed-methods

The types of activities and outcomes of the interventions evaluated by mixed methods varied: support offered by trained nurses and advice on breastfeeding [40] had positive outcomes as mothers stated they would not have continued without support. A phone parenting line [41] gave parents assistance and offered other additional services and they felt their parenting abilities had improved; they scored more favourably on the on the General Health Questionnaire than parents waiting for the service. "The Speech and Language Therapy" [22] provided training and support to Early Years practitioners, teachers and parents to promote speech and language development; approximately half of the children required on-going therapy, parents reported their children being more prepared for school.

## Qualitative research methods

### *Favourable parenting outcomes*

Day-care with qualified staff was provided in an Early Years centre in a deprived area in London, UK. It was education-led, flexible in catering to families' needs, and of a very high quality. Data collected through in-depth interviews suggested that the flexibility of day care provided was particularly important in allowing women to return to paid employment [42]. The Developing Everyone’s Learning and Thinking Abilities [DELTA] parenting programme [43], the Limerick Lullaby project [44], and the Baby “FAST” [45] pilot study all aiming to strengthen family relationships and mother and child bonding through music and arts and crafts, had positive outcomes in parenting abilities and their confidence as parents and fostering intergenerational bonds.

## Discussion

This review identified eleven intervention studies published in peer reviewed journals in Pubmed and IBSS databases and twelve identified in NICE's database. It showed that all but two interventions targeted children and families living in deprived areas. These were aimed at providing parents with emotional support and parenting skills or resources and materials enabling them as active agents in the interventions. They were delivered in families’ homes by specialised home visitors or multidisciplinary staff and in clinics by health care professionals or in community centres and churches through workshops and individual sessions. All selected interventions had undergone an evaluation.

The interventions with better outcomes combined various activities such as workshops and educational programmes for both parents and children beginning during early pregnancy and included home visits by specialised staff. These provided parents with training and material resources to enable them as active agents in intervention delivery; for example, PFL [22] or “Let’s Play in Tandem” [46] showed more positive results than “The Social Support and Family Health Study” [36] or the intervention aimed at children with failure to thrive which were based almost exclusively on home visits. However, “Sure Start” [19] and “Eager and Able to Learn” [22] with similar programmes and structures had mixed outcomes. It has been described in previous evaluation reports that “Sure Start” research teams faced methodological challenges and the number of Sure Start Local Programmes (SSLPs) increased substantially, reducing the opportunity to identify suitable comparison areas [47]. Programmes with better outcomes also included elements such as interagency participation. An example of these is “Incredible Years” a preventive intervention successful in reducing behavioural problems and negative parenting in highly disadvantaged community based settings delivered by regular Sure Start staff. Furthermore, interventions delivered by specialised professional home visitors, such as the CDI [22] had more impact on positive parenting and reducing negative and submissive conducts in children than programmes delivered by volunteers or other non-professional home visitors like the “Community Mothers Program” [19]. They also had better outcomes than programmes such as “The Speech and Language Therapy” (SLT) and “Ready Steady Grow” (RSG) [22], delivered after birth during shorter periods. RSG, aimed at children 3–18 months showed more favourable outcomes for speech and language development than SLT, delivered to children 2–6 years old. Other interventions with favourable outcomes in improving child behaviour and reducing abuse and neglect such as “Triple P” [19], for example, were tailored to meet the child and family’s needs and offered different levels and intensity of activities and support.

Targeted work with parents through provision and fitting of safety equipment providing information such as the “First Parent Health Visitor Scheme” [19], showed reduced accident rates and increased precautions, however these interventions were targeted at very specific outcomes and used less rigorous methods and comparison groups than the above mentioned interventions with wider scopes and sample sizes. The “Developing Everyone’s Learning and Thinking Abilities [DELTA] parenting programme” [43], “Limerick Lullaby Project” [44] and “Baby Fast” [45] focused on mother and child bonding had positive outcomes and were evaluated using qualitative research methods. Some RCTs and quasi-experiments with a control group had more primary and secondary outcomes with no significant differences but had larger sample sizes and in particular the first may have a stronger level of evidence [48]. As it has been described elsewhere, small imbalanced sample sizes may reduce the power to detect differences and makes the study vulnerable to chance variation [49].

Some of the interventions identified are also implemented in countries such as Australia, Canada and the United States of America (USA). The Family–Nurse Partnership has shown long-term beneficial effects in the USA. It was evaluated by three RCTs and showed higher reading and mathematics tests scores in IG children. Long term evaluations showed children had fewer sexual partners, less smoking and drinking ingestion of dangerous substances. Injuries and abuse were also reduced as was criminality during later years. In the UK, the FNP has recently undergone a formative evaluation: nurses’ and mother’s feedback was very positive and provided support for the argument that group FNP-delivered to mothers who were not eligible for FNP-has been received well over the whole time period of the programme and good links were being made with other services [50]. However, if further evaluations are carried out, the results may not be as positive as those in the USA because the health visitor system and a universally accessible primary care system are already in place in the UK [19]. The evaluation of "Sure Start" Australia discovered that that there were very little detectable difference between the Sure Start Local Programmes and Start-to-be communities on most of the dimensions measured by the evaluation [51], similarly to "Sure Start" in the UK.

"Incredible Years" UK which showed favourable outcomes for socio-emotional development and behaviour replicated the results [52] found by Webster-Stratton's evaluation of "Head Start" in the USA: intervention children were observed to exhibit significantly fewer conduct problems, less noncompliance and more positive affect than control children. One year later, most of the improvements were maintained [53]. Therefore, interventions with similar components were able to obtain the same results in a different context. The long-term outcomes of these programmes are important as children who show early persistent signs of antisocial behaviour are at greater risk of later juvenile delinquency and social exclusion with higher societal costs [52].

The majority of interventions identified were targeted at children living in deprived areas; the interventions were aimed at reducing social inequalities in children's health and development by improving outcomes across the different domains among the most deprived populations. Previous studies suggest that the living conditions for young families should allow mothers to start pregnancy in a health-promoting environment as inequalities in health and development become set relatively early in life. Parents, teachers, health policies and services provide key guidance leading to the development of healthy outcomes [54]. To achieve equity from the start, it is important to foster the acquisition of cognitive and non-cognitive skills, which are strongly associated with educational achievement and with a whole range of other outcomes including better employment, income and physical and mental health [21]. Delivering programmes and interventions in disadvantaged areas will possibly help reduce health inequalities in later life, adulthood and throughout the lifecourse. These may also help reduce the intergenerational transmission of health inequalities as social and economic inequities affecting previous generations present an important influence on children's life-course, and affects their life chances and health. Growing up in relative poverty has a strong influence on health and other outcomes throughout life [29]. However it has also been argued that while targeted pre-school education programmes have been found to have long-lasting effects on the social trajectories of poor children, improving their educational levels and employment prospects, their life chances remain significantly poorer than those of advantaged children not in receipt of targeted support [55].

From a critical point of view, only two interventions offered a proportionate universal approach by targeting need within universal delivery. Nearly all interventions identified were targeted, offering selective provision of services to children showing early manifestations of a problem or were at-risk of developing a problem early in life, as defined by the Organisation for Economic Co-operation and Development [56]. These were aimed at reducing inequalities in health and development among people living in deprived areas but not at levelling the social gradient in health. Within the gradient, health is progressively better the higher the socioeconomic position of people and communities. Therefore, it is important to design policies that act across the whole gradient and to address the people at the bottom of the social gradient and the people who are most vulnerable as described in the Review of social determinants and the health divide in the WHO European Region [29]. In similar reviews the authors found that most of the parent/infant stimulation programs dealt with “high-risk” children or interventions which focused almost exclusively on downstream initiatives in deprived areas [57]. Furthermore, the studies which were not targeted did not describe in their findings whether they had a differential impact for disadvantaged groups. However, by focusing only on high-risk families’ health outcomes, interventions are less likely to reduce inequalities across the social gradient and may not provide the best conditions for all children in which to develop and reach their full potential [21,58]. Effective programmes should be universally available, with particular efforts made to ensure that all populations are reached, including the traditionally hard to reach [59].

In this review, interventions were based on improving parenting skills. Much of the published literature on early years interventions focuses on providing parents with support to improve their child rearing skills. These promote parenting behaviours which improve child cognitive development and help improve child attachment as positive effects of well-developed interventions, as described elsewhere, persist beyond schooling and into adulthood. While these parenting interventions are important, it is also necessary to address the conditions of daily life which make positive parenting difficult [29]. This requires policies aimed at children through an explicit, multi-dimensional and integrated strategy [26] and investment in reducing child poverty, improved living conditions and quality of housing, for example [11].

High quality child care has been described as being crucial for children's development [29,60] and is seen as service provision in some countries: 85% of mothers with children in preschool were in paid employment in the early 1990s in Sweden, for example. In other countries it receives limited public funding, the quality and type of services being more diverse and access to high quality child care restrictive for families with lower incomes [31]. However, only three studies assessing the impact of child care were identified in this review. Previous reviews - based on intervention descriptions - found that children's centres were increasing in number in the UK, as part of a strategy of social investment [61,62]. Studies by Melhuish and colleagues found that high quality children's centres appeared to reduce socioeconomic inequalities, as children from less advantaged backgrounds benefited more than those from more advantaged backgrounds. Preschool participation was associated with strong benefits for later educational and job outcomes [63,64]. Similarly, Feinstein [6] found that RCT studies showed a clear benefit for disadvantaged children who attended high quality pre-school childcare provision. Effective pre-school provision in England and Northern Ireland has shown evidence of longer-term benefits for all children and as described in Currie [31] this evidence has influenced policy in countries such as Australia, Norway and the Republic of Korea. Furthermore, the "Abecedarian Project" and the "Perry Preschool Project" delivered in the USA which showed very positive results as described earlier had high-quality childcare and education components and were highly resourced [59].

**Limitations and strengths**

The search strategy was designed to include as much relevant information as possible but there may be other documents describing interventions to reduce social inequalities in health which have not been collected in this review. The limited number of retrieved studies shows that although the number of publication in this field has increased over the years in Europe, there are still relatively few papers published in scientific journals. Furthermore, as only evaluated studies were selected this study is possibly only providing a partial picture of the interventions being delivered.

The results focused predominantly on countries in the UK and The Republic of Ireland compared to the Nordic countries, France, Germany and Italy and other parts of Europe which were not represented in the literature. No papers were excluded due to a language criterion. However, language may be a barrier to publication for non-English speaking countries and local interventions may not be of interest to international peer reviewed journals.

To our knowledge, this is the first systematic review attempting to identify early years interventions throughout Europe that are effective in addressing inequalities in health and development and their social determinants. The evidence collected may be useful for researchers or decision makers and programme managers involved in the design and development of interventions and their delivery. The procedures used ensured the validity of data extraction and would not have hindered capturing as many published articles as possible from different contexts in Europe in whatever language they were written. As we only included interventions that had been evaluated, we were able to assess their effectiveness. Only one of the selected interventions had a negative impact on one developmental domain and only two had non-significant outcomes for some of the activities. However, this is likely to reflect publication bias against publishing wholly non-significant findings.

**Conclusions**

Interventions were heterogeneous in their study population and sample size targets, outcome measures and furthermore, there was a large divergence in the quality of their study design. Interventions with better outcomes and a higher level of evidence combined workshops and educational programmes for both parents and children beginning in early pregnancy and included home visits by specialised staff. More literature reviews focusing on the grey literature are needed to develop a larger evidence base on early childhood interventions. Further evaluation of early years interventions should be carried out especially in countries outside the UK within the European context. This review may be a useful tool to provide evidence on effective interventions for specific early childhood development and health outcomes.

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## Appendix 3: Task 2.3 Maternal education and early childhood health: A DRIVERS meta-analysis in 12 European cohorts

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**Short title:** Maternal education and early childhood health in Europe

**Abbreviations:** CI – confidence interval; CZ-ELSPAC – The European Longitudinal Study of Pregnancy and Childhood, Czech Republic; DRIVERS – Determinants to Reduce Health Inequity Via Early Childhood, Realising Fair Employment, and Social Protection; ES-INMA – The Environment and Childhood Project, Spain; ESP – European Standard Population; FI-NFBC8586 – The Northern Finland Birth Cohort 1985/1986 Study, Finland; FR-EDEN – The Study of Pre- and Post-natal Determinants of Child Growth, Development, and Health; GR-GBC – The Greek Birth Cohort, Greece; IOTF – International Obesity Task Force; ISCED – International Standard Classification of Education; IT-GASPII – The Gene and Environment Prospective Study on Infancy in Italy, Italy; LMP – last menstrual period; NL-ABCD – The Amsterdam Born Children and their Development Study, Netherlands; NO-HUMIS – The Norwegian Human Milk Study, Norway; PT-G21 – The Generation XXI Study, Portugal; RII – Relative Index of Inequality; SE-ABIS – The All Babies in Southeast Sweden, Sweden; SII – Slope Index of Inequality; SGA – small for gestational age; UK-MCS – The Millennium Cohort Study, United Kingdom; UA-FCOU – The Family and Children of Ukraine Study, Ukraine

**What's Known on This Subject**

Low levels of maternal education have been found to be associated with adverse health and development in offspring throughout early childhood. However, few studies have systematically assessed this at the European level, and it is unclear whether associations are consistent between European countries.

**What This Study Adds**

This study showed that children born to mothers with low education were more likely to be born preterm and small for their gestational age, and to be asthmatic and overweight at preschool age at the regional level, but associations were not consistent between the selected 12 European countries.

**Abstract**

**Background:** Early childhood development is a major priority in efforts to reduce health inequalities across Europe with important implications for the health of future generations. There is limited combined evidence on inequalities in early childhood across a range of European countries.

**Methods:** Prospective cohort data from 12 European countries were used. Maternal education was collected at the time of birth and health and co-variate data were measured at subsequent follow-ups to the age of 8. Regression models were estimated within each cohort and meta-analyses were conducted to compare and measure heterogeneity between cohorts.

**Results:** Mother's education was linked to an appreciable risk of preterm and small for gestational age (SGA) births, and childhood asthma and overweight across 12 European countries. The excess risk of preterm births associated with low maternal education was 1.58 (1.33-1.88) and 2.03 (1.00-3.07) in relative and absolute terms (RII/SII) for all cohorts combined. Similar effects were found for SGA births, but absolute inequalities were greater with an SII score of 3.29 (1.83-4.74). RII and SII scores for asthma were 1.46 (1.26-1.71) and 2.41 (0.67-4.16) respectively. Inequalities in overweight were evident in RII and SII scores of 1.56 (1.23-1.96) and 6.97 (3.95-9.98). Inequalities were persistently larger in France, the Netherlands and the United Kingdom than other countries for all outcomes.

**Conclusions:** This study highlights the value of comparative cohort analysis to better understand the relationship between social inequalities and health in early childhood in different settings across Europe.

## Introduction

Early child development is defined as the development of physical, socio-emotional, and language-cognitive capacities that occurs between the prenatal period and 8 years of age; and is well-recognised as the most important stage of the life course.[1,2] Children facing disadvantages at the family, neighbourhood and the broader societal level are less likely to achieve optimum health and development and have poorer health in later life.[3-5]

Maternal education has been shown to be related to early childhood health in a number of studies.[6-8] Various mechanisms, such as older age at first birth, larger birth intervals, greater use of positive parenting practices and uptake of social and health care services, and fewer structural and material barriers – may benefit children of mothers with higher levels of education. These mothers may have an enhanced facility to navigate their familial and socio-economic environment, and may live in better household- and neighbourhood-level circumstances favourable to child health.[9]

Previous studies have mainly been limited to Western and Northern Europe.[10] As the extent of this relationship is unknown in other European countries, this study aims to examine the association between maternal education and early childhood health using data from 12 mother-child birth cohorts across Europe. The present paper's focus on child health intends to maximise the comparability of data from participating cohorts and to identify commonly prevalent outcomes across early childhood.

## Patients and Methods

### *Participants*

Twelve European birth cohorts provide data to this analysis: the European Longitudinal Study of Pregnancy and Childhood, Czech Republic (CZ-ELSPAC); the Northern Finland Birth Cohort 1985/1986 Study, Finland (FI-NFBC8586); the mother-child Study of Pre- and Post-natal Determinants of Child Growth, Development, and Health, France (FR-EDEN); the Greek Birth Cohort, Greece (GR-GBC); the Gene and Environment Prospective Study on Infancy in Italy, Italy (IT-GASPII); the Amsterdam Born Children and their Development Study, Netherlands (NL-ABCD); the Norwegian Human Milk Study, Norway (NO-HUMIS); the Generation XXI Study, Portugal (PT-G21); the Environment and Childhood Project, Spain (ES-INMA); the All Babies in Southeast Sweden, Sweden (SE-ABIS); the Millennium Cohort Study, United Kingdom (UK-MCS); and the Family and Children of Ukraine Study, Ukraine (UA-FCOU). Details of participating cohorts are summarised in Appendix 1.[11-27] Participants consisted of approximately 75,000 children at birth born between July 1985 and October 2006, and for whom comparable information about maternal education, child health and co-variate data were available.

### *Study Data*

Study protocols were approved by ethics committees for each cohort. All participating mothers provided consent for themselves and their children. Data on maternal characteristics and child health outcomes in early childhood (0-8 years) were provided from each cohort in accordance with the ethical procedures approved for each site. Available study data are defined below and described in Table 1.

Mother's education was ascertained during pregnancy or at birth. Years of schooling were available in FR-EDEN, GR-GBC, NL-ABCD, NO-HUMIS and PT-G21. Levels of completed schooling were collected in CZ-ELSPAC, FI-NFBC8586, IT-GASPII, ES-INMA, SE-ABIS and UA-FCOU. Highest obtained qualifications were obtained in UK-MCS. The International Standard Classification of Education (ISCED) is an international categorization managed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) to facilitate comparison of educational data across countries. The country-specific coding scheme provided by ISCED-1997 was used to classify mothers into the following categories: 1) Post-secondary non-tertiary to second stage of tertiary education (ISCED 4-6), 2) Upper secondary education (ISCED 3), and 3) Pre-primary to lower secondary or second stage of basic education (ISCED 0-2).[28]

Preterm births were defined as live births occurring prior to the gestational age of 37 weeks. In CZ-ELSPAC, FI-NFBC8586, FR-EDEN, NL-ABCD, NO-HUMIS, PT-G21, ES-INMA, SE-ABIS, UA-FCOU, gestational age was based on ultrasound records if available, or alternatively using the date of the mother's last menstrual period (LMP). In GR-GBC and IT-GASPII, this was determined only from LMP, and in the UK-MCS it was derived from the babies' estimated date of delivery.

Small for gestational age (SGA) births were defined according to the Alexander foetal growth reference,[29] which provides expected gender-specific distributions of birth weight according to gestational age for singleton live births in the United States. Babies were deemed cases if their weight fell below the 10$^{th}$ percentile of this national reference projected for their gestational age and gender.[29] Birth weight was medically assessed in most cohorts, except in SE-ABIS and UK-MCS which relied on parental reports.

Childhood asthma between 4 – 8 years was based on parental reports for this analysis. Parents were asked 'whether the child has ever had asthma' in most cohorts. In FR-EDEN, PT-G21 and UA-FCOU, data were based on parental response to 'whether the child had been diagnosed with asthma.'

Children's height and weight between 4 – 8 years were measured by trained personnel in all cohorts, with exception to GR-GBC. Corresponding data were based on parental reports in GR-GBC, but have been found to be comparable with measured height and weight in a sub-sample study.[30] Overweight cases were defined using the age- and gender-specific thresholds for body mass index ($kg/m^2$) recommended by the International Obesity Task Force (IOTF), according to the particular half age and gender distribution of each cohort.[31]

Potential study mediators and confounders included child sex, and mother's age, parity and ethnicity at birth, as well as smoking behaviour during pregnancy. Assessment of the last two aforementioned co-variates is described in Appendix 2.

*Statistical Analysis*

Analyses were restricted to singleton children who make up between 95.9% and 100% of the total sample across cohorts, depending on study design. As NO-HUMIS oversampled preterm births in one of their sites, these participants were excluded and analyses were limited to 77.2% of the original sample.

The country-specific distribution of mother's education was directly age-standardised using the WHO European Standard Population (ESP).[32] All analyses of UK-MCS employed survey weights to account for the cohort's sampling design.[26] The effect of maternal education upon child health outcomes was estimated to infer relative and absolute socio-economic inequalities in each sample using the Relative (and Slope) Index of Inequality (RII/SII) for each outcome. The regression-based indices consider both the size and distribution of socio-economic groups across the population, by evaluating morbidity risk according to the specific proportions of the population within the socio-economic hierarchy.

Given the extent of country differences in maternal education, these indices account for such differences as a source of variation in the magnitude of health inequalities and facilitate comparison of estimates between cohorts.[33-35] The RII is a summary measure of relative inequality, defined as the prevalence ratio of the child outcome between children at the lowest and those at the highest end of the maternal education hierarchy. The SII is the corresponding measure of absolute inequality, defined as the prevalence difference of the child outcome between the two ends of said hierarchy. A RII score greater than 1 (and a SII score greater than 0) indicates the presence of inequality between low and high positions. For both indices, higher scores denote a larger magnitude of inequality.

Generalised linear models were performed to obtain the RII and SII by respectively specifying a logarithmic or an identity link function. The educational categories were ranked from high to low and were assigned a value between 0 and 1, based on the cumulative percentage of the midpoint of their ranges.[36] Firstly, Models A were adjusted for child sex, maternal age and ethnicity. Secondly, Models B were additionally adjusted for maternal parity and smoking behaviour during pregnancy. Thirdly, cohort-specific estimates from Models B of each outcome were pooled together using meta-analysis procedures. As the effect of maternal education on child outcomes varied between cohorts, mean RII and SII scores at the European level were obtained using random-effects meta-analysis models. Heterogeneity of scores across cohorts were tested using the $Q$ test and the $I^2$ measure,[37] which confirmed the a priori expectation of heterogeneity between cohorts not attributable to within cohort variation. All analyses were carried out using Stata version 13 (Stata Corp, College Station, TX).

## Results

Sample characteristics are reported in Table 1. There were substantially more mothers with low education in ES-INMA (44%), and in GR-GBC and PT-G21 (65% +). Mothers with high education comprised at least 20% of mothers in FR-EDEN, NL-ABCD, UK-MCS, NO-HUMIS and SE-ABIS. One-third of mothers from UA-FCOU had reached high levels of education, and less than 5% had low education.

Preterm births ranged from 1.7% in CZ-ELSPAC to 6.8% in UK-MCS. SGA births showed wider differences, as prevalence was lowest in FI-NFBC8586, NO-HUMIS and SE-ABIS (4.6%-5.4%) and highest in ES-INMA and PT-G21 (12.7%-15.3%). Asthma prevalence was less than 2% in CZ-ELSPAC and UA-FCOU, but approached 10% or higher in FR-EDEN, NL-ABCD and UK-MCS. Overweight prevalence for a given age fell below 10% in FR-EDEN, NL-ABCD, CZ-ELSPAC and UA-FCOU. In UK-MCS, the prevalence was two-fold (21.6%) and similar to that observed in FI-NFBC8586 (17.0%), GR-GBC (24.1%) and IT-GASPII (33.6%).

Inequalities in preterm birth are presented in Table 2. Significant associations were observed in FR-EDEN, NL-ABCD, UK-MCS, FI-NFBC8586, SE-ABIS and ES-INMA. Evidence of these inequalities did not reach statistical significance in UA-FCOU, NO-HUMIS, IT-GASPII and PT-G21. Similar to preterm births, strong inequalities were revealed in SGA births in FR-EDEN, NL-ABCD, ES-INMA, SE-ABIS, and UK-MCS. Women with low education in PT-G21 and UA-FCOU were at a greater risk to have babies born SGA, but not at risk of having preterm births. Otherwise, significant RII and SII estimates for preterm births and SGA were predominantly equivalent between cohorts.

The mean RII and SII score of the risk of preterm birth was significant at 1.58 (1.33-1.88) and 2.03 (1.00-3.07) in relative and absolute terms combined for all cohorts (Figure 1).

The heterogeneity observed between the cohort-specific scores is supported by the *Q* test of 16.962 (df=11, p=0.109) and 24.943 (df=11, p=0.005), as well as the $I^2$ statistic of 23.3% and 51.9%, respectively for the RII and SII scores. The same was found for the SGA analysis (Figure 2). The pooled average RII and SII score was 1.60 (1.38-1.88) and 3.29 (1.83-4.74), but again emphasises high between-cohort heterogeneity in the RII according to the *Q* test of 19.244 (df=11, p=0.057) and the $I^2$ statistic of 42.8%, and in the SII given the *Q* test of 29.145 (df=11, p=0.002) and the $I^2$ statistic of 62.3%.

An excess burden of asthma amongst children of mothers with low education was present in three cohorts (FR-EDEN, NL-ABCD and UK-MCS) (Table 2) and remained so after full adjustment. Inequalities were found in all other cohorts, with exception to IT-GASPII, but these did not reach statistical significance. The significant mean RII and SII scores of 1.46 (1.26-1.71) and 2.41 (0.67-4.16) observed at the aggregate level are largely determined by three of the ten European cohorts (Figure 3).

The RII and SII showed strong and significant gradients in overweight prevalence in FR-EDEN, NL-ABCD, UK-MCS, CZ-ELSPAC, FI-NFBC8586 and PT-G21 (Table 2). Inequalities were negligible in GR-GBC and IT-GASPII, and positive associations in UA-FCOU and ES-INMA were insignificant. The combined effect of the risk of overweight across participating cohorts is 1.56 (1.23-1.96) and 6.97 (3.95-9.98) in relative and absolute terms (Figure 4). These estimates underscore country differences, given considerable heterogeneity reported in the *Q* test of 41.163 (df=9, p=<0.001) and 24.460 (df=9, p=0.004) and the $I^2$ statistic at 78.1% and 63.2%, respectively for the RII and SII.

## Discussion

Mother's education broadly exerted a strong influence on the likelihood of preterm and SGA births, asthma and overweight status, as shown by significant relative and absolute inequalities, observed for all cohorts combined. Inequalities were consistently apparent in France, the Netherlands and the UK, but negligible in Italy, Greece and Norway. Inequalities were mixed according to health outcomes studied in the Czech Republic, Ukraine, Finland, Sweden, Portugal and Spain. While these cohorts are not wholly nationally-representative, this is to our knowledge the most comprehensive European study of social inequalities in early child health.

Routine collection of mother's education at or near time of birth enabled us to select this socio-economic indicator and carry out this large-scale study. As education is more amenable for cross-country research than other markers of socio-economic position, such as occupational class, it does not significantly bias our findings.[38,39] Available for all women including working mothers and full-time homemakers outside of the labour market,[40] educational level is more likely to remain constant for many years of the child-rearing period and is less prone to misreporting than income or wealth.[41] Bias due to the country-specific ISCED classification may falsely enhance between-country differences, but such instances are likely random and unrelated to the underlying associations between maternal education and child health within countries. A more salient concern may be how the observed educational distribution compares to population-based data. Mothers with low education are remarkably few in Norway and Ukraine but high in Greece. These proportions match closely with national averages reported in the European Health for All Database (HFA-DB) during the years in which cohorts conducted their baseline assessments, and are thus representative of their countries in this respect.[32]

One self-reported and three outcomes measured by trained personnel using internationally standardised definitions, where possible, were studied. SGA births defined according to a national reference (United States)[29] may differentially influence prevalence estimates due to diverse foetal growth patterns in Europe.

Completeness of data (gestational age, birth weight) needed to ascertain health at birth was generally achieved in all countries as these data are customarily collected for all newborns. Health outcomes at birth were more commonly missing amongst children born to mothers with low education in the Czech Republic, Greece, Portugal and Sweden. A reverse pattern was found in France, Italy, the Netherlands, and Spain. No evident pattern of missingness by maternal education was found in the UK or Ukraine. Loss to follow-up at preschool age due to the longitudinal study design yields greater potential for bias to the asthma and overweight findings. Weak findings of inequalities in asthma may in part be due to such attrition and to possible reporting bias inherent in parental response. Continued participation at preschool age was generally lower in the Netherlands, Sweden, and Ukraine than elsewhere.

Results were firstly adjusted for individual characteristics, namely child sex, maternal age and ethnicity. As the role of maternal parity and smoking are behavioural factors which may influence inequalities differently across settings, these were included as additional adjustments to examine potential country differences subsequent to the initial results. Unreported analysis of these co-variates found a uniform relationship between maternal education and age at first birth as well as parity between countries. Associations between maternal education and maternal smoking were dissimilar in direction and magnitude and highlighted country differences.

This leads us to consider whether we may anticipate differences in the relationship between maternal education and early child health both between and within the selected 12

European countries. Very few multi-country studies on social inequalities in child health have been performed across Europe and individual-country studies do not address this gap in evidence due to differential study design and analysis.[10] Notwithstanding, extensive research on adult health inequalities has elucidated how national structures with particular income and welfare contexts, health care and social care systems, among others, differ between countries of Europe. These may also differentially impact inequalities in child health. Country comparisons are exacerbated by national differences in maternal education, the overall level of childhood health, as well as potential mediating pathways, such as women's participation in the labour market, gender-specific income and work-life related programmes, social norms which influence women's health and child-rearing behaviours, family arrangements, among many others.

Although the study provides clear ground to identify the extent of such differences, a methodological limitation may be due to the multi-purpose nature of cohorts with unique study designs, selected participants and periods covered. A further limitation is the reliance of mother's education over other family- and neighbourhood-level socio-economic markers. Where gradients were negligible, it is plausible that inequalities may be pronounced by another marker of a child's social environment. Future work of DRIVERS will examine multiple socio-economic markers for an in-depth analysis of maternal education and early childhood health and development in a selection of participating cohorts with available data.

**Conclusion**

This meta-analysis found that poor health is greater amongst children of mothers with low education across all cohorts combined from up to 12 European countries. Inequalities were strongest in France, the Netherlands and the United Kingdom. The study illustrates the need to improve child health and to reduce inequalities in child health across distinct European populations. The period of early childhood is crucial to children’s immediate and subsequent health and development and in generating social and health inequalities across the life course and between generations.

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**Table 1 – Overview and study characteristics of analytic cohort samples**

| Region | West | | | Central/East | | North | | | South | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country<br>Birth cohort | FR<br>EDEN | NL<br>ABCD | UK<br>MCS [b] | CZ<br>ELSPAC | UA<br>FCOU | FI<br>NFBC8586 | NO<br>HUMIS | SE<br>ABIS | GR<br>GBC | IT<br>GASPII | PT<br>G21 | ES<br>INMA |
| Year(s) of birth | 2003/<br>2006 | 2003/<br>2004 | 2001/<br>2002 | 1991/<br>1992 | 1993/<br>1996 | 1985/<br>1986 | 2003/<br>2006 | 1997/<br>1999 | 1983 | 2003/<br>2004 | 2005/<br>2006 | 1997/<br>2005 |
| N at birth[a] | 1903 | 7880 | 14630 | 6933 | 4118 | 8993 | 2035 | 15328 | 2044 | 636 | 8330 | 2466 |
| % boys (N) | 52.6<br>(1000) | 50.4<br>(3969) | 51.0<br>(7467) | 51.8<br>(3593) | 52.7<br>(2170) | 51.3<br>(4617) | 52.4<br>(1066) | 51.7<br>(7920) | 46.6<br>(953) | 50.8<br>(323) | 51.1<br>(4259) | 51.6<br>(1272) |
| % girls (N) | 47.5<br>(903) | 49.6<br>(3911) | 49.0<br>(7163) | 48.2<br>(3340) | 47.3<br>(1948) | 48.7<br>(4376) | 47.6<br>(969) | 48.3<br>(7408) | 53.4<br>(1091) | 49.2<br>(313) | 48.9<br>(4071) | 48.4<br>(1194) |
| Study participation at preschool age, % | 62.3 | 43.1 | 88.3 | 83.8 | 51.3 | 88.9 | -- | 55.9 | 91.0 | 74.4 | 81.0 | 70.7 |
| % boys | 62.9 | 43.8 | 88.3 | 84.3 | 51.0 | 88.3 | -- | 56.1 | 90.1 | 75.9 | 80.7 | 70.1 |
| % girls | 61.6 | 42.5 | 88.3 | 83.3 | 51.5 | 89.5 | -- | 55.6 | 91.8 | 72.8 | 81.2 | 71.3 |
| **Maternal characteristics at time of birth** | | | | | | | | | | | | |
| Educational classification (ISCED), %[c] | | | | | | | | | | | | |
| Post-secondary to tertiary (4-6) | 51.7 | 36.5 | 21.1 | 25.5 | 33.6 | 17.5 | 70.7 | 26.7 | 10.6 | 27.4 | 14.8 | 21.9 |
| Upper secondary (3) | 36.1 | 28.1 | 41.3 | 38.2 | 61.8 | 51.1 | 23.6 | 25.8 | 20.5 | 47.5 | 19.4 | 34.7 |
| Pre-primary to lower secondary (0-2) | 12.2 | 35.3 | 37.6 | 36.3 | 4.7 | 31.4 | 5.7 | 47.5 | 68.9 | 25.1 | 65.8 | 43. 3 |
| Age (years), mean | 29.5 | 30.7 | 28.9 | 25.3 | 23.8 | 27.8 | 29.9 | 30.2 | 25.8 | 32.9 | 29.0 | 31.4 |
| Ethnic minority, % | 4.0 | 29.7 | 10.8 | 1.1 | 0 | 0 | 11.4 | 0 | 0 | 6.0 | 3.3 | 6.0 |
| Multiparous, % | 55.4 | 44.7 | 56.7 | 50.0 | 29.8 | 66.0 | 60.4 | 61.5 | 56.3 | 41.4 | 43.4 | 46.0 |
| Smoking during pregnancy % | 24.1 | 9.5 | 34.2 | 21.2 | 11.8 | 19.7 | 11.9 | 11.2 | 17.0 | 11.0 | 23.4 | 31.4 |

| Region | West | | | Central/East | | North | | | South | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country<br>Birth cohort | FR<br>EDEN | NL<br>ABCD | UK<br>MCS [b] | CZ<br>ELSPAC | UA<br>FCOU | FI<br>NFBC8586 | NO<br>HUMIS | SE<br>ABIS | GR<br>GBC | IT<br>GASPII | PT<br>G21 | ES<br>INMA |
| **Health Outcomes** | | | | | | | | | | | | |
| Preterm birth, % | 5.8 | 5.7 | 6.8 | 1.7 | 5.8 | 4.4 | 3.4 | 3.7 | 4.7 | 4.4 | 7.5 | 4.6 |
| Small for gestational age, % | 11.4 | 7.4 | 10.9 | 11.7 | 7.8 | 4.8 | 5.4 | 4.6 | 8.5 | 9.1 | 12.7 | 15.3 |
| Asthma, % [d, e] | 11.6 | 9.1 | 14.3 | 1.9 | 1.8 | 3.1 | -- | 6.7 | -- | 8.2 | 4.4 | 2.7 |
| Overweight, % [d, f] | 7.8 | 9.5 | 21.6 | 11.7 | 7.3 | 17.0 | -- | -- | 24.1 | 33.6 | 20.7 | 19.4 |

**Table 2 – Relative and absolute inequalities in early childhood health according to maternal education (RII / SII)**

| Region | Birth cohort | RII (95% CI) | | SII (95% CI) | |
|---|---|---|---|---|---|
| | | Model A | Model B | Model A | Model B |
| **Preterm birth** | | | | | |
| West | FR-EDEN | 1.44 (0.70 – 2.98) | **2.26 (1.07 – 4.76)** | 2.12 (-2.09 – 6.33) | **4.85 (0.51 – 9.19)** |
| | NL-ABCD | **1.66 (1.11 – 2.48)** | **1.72 (1.15 – 2.60)** | **2.97 (0.66 – 5.27)** | 1.76 (-0.58 – 4.09) |
| | UK-MCS | **1.47 (1.07 – 2.01)** | **1.50 (1.08 – 2.07)** | **2.63 (0.54 – 4.72)** | **2.97 (0.71 – 5.23)** |
| Central/East | CZ-ELSPAC | 0.67 (0.19 – 2.38) | 0.49 (0.13 – 1.86) | -2.00 (-1.39 – 0.99) | -0.60 (-1.99 – 0.78) |
| | UA-FCOU | 1.88 (0.95 – 3.71) | 1.85 (0.90 – 3.78) | 3.56 (-0.08 – 7.21) | 3.71 (-0.18 – 7.61) |
| North | FI-NFBC8586 | **1.59 (1.07 – 2.35)** | **1.59 (1.05 – 2.39)** | **1.85 (1.67 – 3.54)** | **1.85 (0.10 – 3.60)** |
| | NO-HUMIS | 1.80 (0.58 – 5.64) | 2.44 (0.75 – 7.96) | 2.59 (-1.83 – 7.01) | 3.34 (-0.94 – 7.63) |
| | SE-ABIS | **1.43 (1.05 – 1.94)** | **1.57 (1.14 – 2.15)** | **1.31 (0.21 – 2.40)** | **1.60 (0.49 – 2.71)** |
| South | GR-GBC | 0.92 (0.43 – 1.95) | 0.90 (0.42 – 1.93) | 0.72 (-2.91 – 4.34) | -0.31 (-4.06 – 3.44) |
| | IT-GASPII | 1.83 (0.45 – 7.50) | 2.36 (0.58 – 9.57) | 2.76 (-3.38 – 8.90) | 4.02 (-2.17 –10.21) |
| | PT–G21 | 1.28 (0.95 – 1.72) | 1.28 (0.93 – 1.75) | 1.76 (-0.39 – 3.90) | 1.84 (-0.44 – 4.12) |
| | ES-INMA | **3.26 (1.57 – 6.77)** | **4.07 (1.84 – 9.01)** | **5.00 (1.97 – 8.02)** | **5.56 (2.47 – 8.65)** |
| **Small for gestational age** | | | | | |
| West | FR-EDEN | **1.75 (1.06 – 2.89)** | **1.81 (1.08 – 3.04)** | **6.16 (0.24 – 12.07)** | **6.19 (0.24 – 12.15)** |
| | NL-ABCD | **2.62 (1.85 – 3.71)** | **2.46 (1.73 – 3.51)** | **7.39 (4.78 – 9.99)** | **5.98 (3.44 – 8.53)** |
| | UK-MCS | **2.19 (1.79 – 2.70)** | **2.06 (1.63 – 2.60)** | **8.75 (6.38 – 11.13)** | **5.56 (3.07 – 8.05)** |
| Central/East | CZ-ELSPAC | 0.97 (0.66 – 1.43) | 1.02 (0.68 – 1.53) | -0.18 (-4.25 – 3.89) | -0.69 (-4.74 – 3.36) |
| | UA-FCOU | 1.50 (0.84 – 2.67) | **1.96 (1.04 – 3.69)** | 2.29 (-1.73 – 6.31) | **4.28 (0.26 – 8.30)** |
| North | FI-NFBC8586 | 1.46 (1.00 – 2.15) | 1.31 (0.87 – 1.96) | 1.73 (-0.02 – 3.49) | 0.85 (-0.81 – 2.51) |
| | NO-HUMIS | 1.22 (0.48 – 3.10) | 1.36 (0.52 – 3.58) | 1.12 (-4.14 – 6.39) | 2.85 (-2.39 – 8.09) |
| | SE-ABIS | **1.46 (1.11 – 1.93)** | **1.45 (1.09 – 1.93)** | **1.71 (0.49 – 2.93)** | **1.34 (0.22 – 2.46)** |
| South | GR-GBC | 0.95 (0.53 – 1.70) | 1.15 (0.64 – 2.07) | -0.47 (-5.25 – 4.31) | 1.93 (-2.77 – 6.63) |
| | IT-GASPII | 1.65 (0.64 – 4.27) | 1.85 (0.71 – 4.80) | 4.72 (-3.86 –13.30) | 5.84 (-2.81 – 14.50) |
| | PT–G21 | **1.26 (1.01 – 1.58)** | **1.44 (1.13 – 1.82)** | **2.90 (0.20 – 5.60)** | **3.80 (1.05 – 6.54)** |

| Region | Birth cohort | RII (95% CI) | | SII (95% CI) | |
|---|---|---|---|---|---|
| | | Model A | Model B | Model A | Model B |
| | ES-INMA | **1.79 (1.25 – 2.57)** | **1.78 (1.22 – 2.60)** | **8.31 (2.81 – 13.81)** | **6.73 (1.01 –12.46)** |
| **Asthma** | | | | | |
| West | FR-EDEN | **2.01 (1.09 – 3.71)** | **2.07 (1.10 – 3.89)** | **8.66 (1.11 – 16.21)** | **9.03 (1.29 – 16.77)** |
| | NL-ABCD | **1.83 (1.12 – 2.97)** | **1.65 (1.00 – 2.72)** | **6.83 (1.63 – 12.03)** | **5.90 (0.60 –11.19)** |
| | UK-MCS | **1.82 (1.51 – 2.19)** | **1.73 (1.44 – 2.09)** | **7.95 (5.47 – 10.43)** | **7.28 (4.75 – 9.81)** |
| Central/East | CZ-ELSPAC | 1.50 (0.54 – 4.19) | 1.56 (0.54 – 4.49) | 0.77 (-1.17 – 2.71) | 0.85 (-1.21 – 2.91) |
| | UA-FCOU | 1.93 (0.31 – 11.96) | 1.30 (0.19 – 8.87) | 1.09 (-1.92 – 4.10) | 0.43 (-2.79 – 3.65) |
| North | FI-NFBC8586 | 1.29 (0.79 – 2.11) | 1.29 (0.78 – 2.14) | 0.85 (-0.57 – 2.27) | 0.69 (-0.78 – 2.16) |
| | NO-HUMIS | -- | -- | -- | -- |
| | SE-ABIS | 1.34 (0.99 – 1.80) | 1.17 (0.86 – 1.58) | 1.88 (-0.10 – 3.87) | 0.74 (-1.21 – 2.69) |
| South | GR-GBC | -- | -- | -- | -- |
| | IT-GASPII | 0.68 (0.25 – 1.86) | 0.66 (0.24 – 1.83) | -4.62 (-12.63 – 3.38) | -4.68 (-12.92 – 3.56) |
| | PT–G21 | 1.26 (0.81 – 1.97) | 1.19 (0.74 – 1.91) | 1.21 (-0.57 – 2.98) | 0.82 (-1.04 – 2.68) |
| | ES–INMA | 1.24 (0.45 – 3.42) | 1.20 (0.41 – 3.52) | 0.58 (-2.11 – 3.27) | 0.49 (-2.35 – 3.33) |
| **Overweight** | | | | | |
| West | FR-EDEN | **3.37 (1.53 – 7.44)** | **2.97 (1.34 – 6.60)** | **9.95 (3.31 – 16.60)** | **8.41 (1.42 –15.40)** |
| | NL-ABCD | **4.48 (2.78 – 7.20)** | **3.93 (2.42 – 6.38)** | **15.30 (9.71 –20.88)** | **13.02 (7.14 – 18.91)** |
| | UK-MCS | **1.42 (1.22 – 1.65)** | **1.38 (1.17 – 1.63)** | **7.43 (4.21 – 10.64)** | **6.82 (3.40 – 10.25)** |
| Central/East | CZ-ELSPAC | **1.89 (1.27 – 2.82)** | **1.97 (1.29 – 2.99)** | **7.40 (2.79 – 12.01)** | **7.61 (2.78 – 12.43)** |
| | UA-FCOU | 0.49 (0.15 – 1.53) | 0.59 (0.16 – 2.10) | -2.90 (-11.67 – 5.86) | -1.72 (-11.02 – 7.59) |
| North | FI-NFBC8586 | **1.42 (1.15 – 1.76)** | **1.44 (1.16 – 1.80)** | **6.06 (2.45 – 9.67)** | **6.13 (2.45 – 9.80)** |
| | NO-HUMIS | -- | -- | -- | -- |
| | SE-ABIS | -- | -- | -- | -- |
| South | GR-GBC | 1.05 (0.76 – 1.46) | 1.17 (0.84 – 1.62) | 1.44 (-6.33 – 9.20) | 3.69 (-4.10 – 11.49) |
| | IT-GASPII | 1.11 (0.68 – 1.80) | 1.03 (0.63 – 1.68) | 4.39 (-12.07 – 20.85) | 1.34 (-15.30 – 17.98) |
| | PT-G21 | **2.13 (1.74 – 2.60)** | **2.03 (1.64 – 2.50)** | **15.02 (11.15 – 18.90)** | **14.25 (10.16 –18.35)** |
| | ES-INMA | 1.01 (0.70 – 1.45) | 0.93 (0.64 – 1.36) | 0.83 (-6.25 – 7.90) | -0.96 (-8.30 – 6.39) |

**Table 1 Notes:**

[a] Approximate sample sizes that health outcome data for the present analysis were ascertained.
[b] Descriptive data of the MCS sample use survey weights to account for the cohort study's sampling design.
[c] Educational levels in each country have been age-standardised to the WHO European Standard Population.
[d] The risk of of childhood asthma and overweight at preschool age were studied in 10 of the 12 participating cohorts due to study design and data availability.
[e] Assessment of childhood asthma was dependent upon cohort study design and varied between 4 (ES-INMA), 4-5 (PT-G21), 5 (FR-EDEN, UK-MCS), 6 (SE-ABIS), 6-8 (UA-FCOU), 7 (CZ-ELSPAC, FI-NFBC85/86, NL-ABCD) and 7-8 (IT-GASPII) years of age.
[f] Assessment of height and weight used to define childhood overweight varied between 4-5 (PT-G21, ES-INMA), 5 (FR-EDEN, UK-MCS), 5-6 (NL-ABCD) and 7 (CZ-ELSPAC, FI-NFBC85/86, GR-GBC, IT-GASPII, UA-FCOU) years of age.

**Table 2 Notes**:

Model A: Adjustment for child sex, maternal age and maternal ethnicity if applicable
Model B: Model A plus adjustment for maternal parity and maternal smoking

**Figure 1 – Country-specific and pooled RII and SII scores for the association between maternal education and preterm birth**

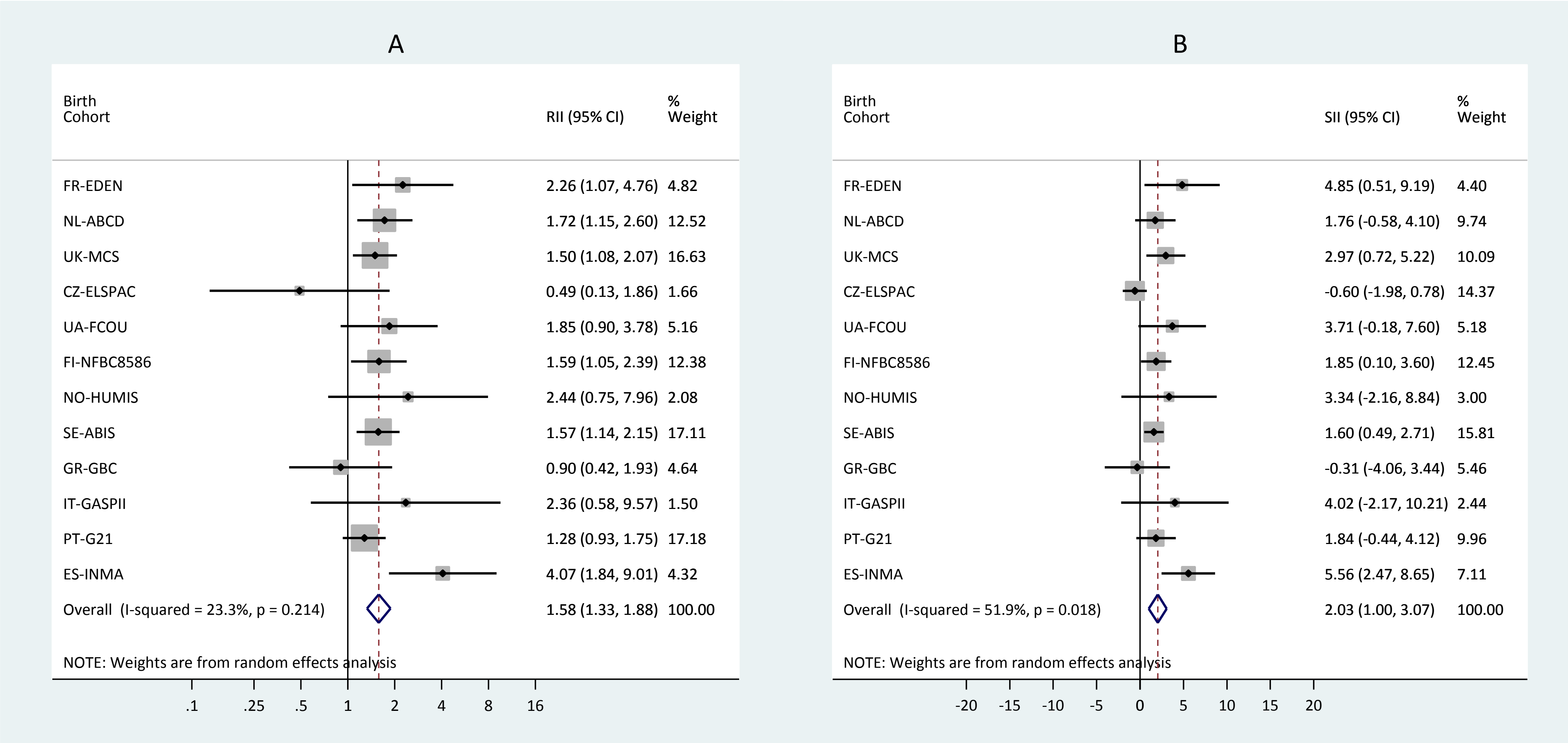


**Figure 2 – Country-specific and pooled RII and SII scores for the association between maternal education and SGA birth**

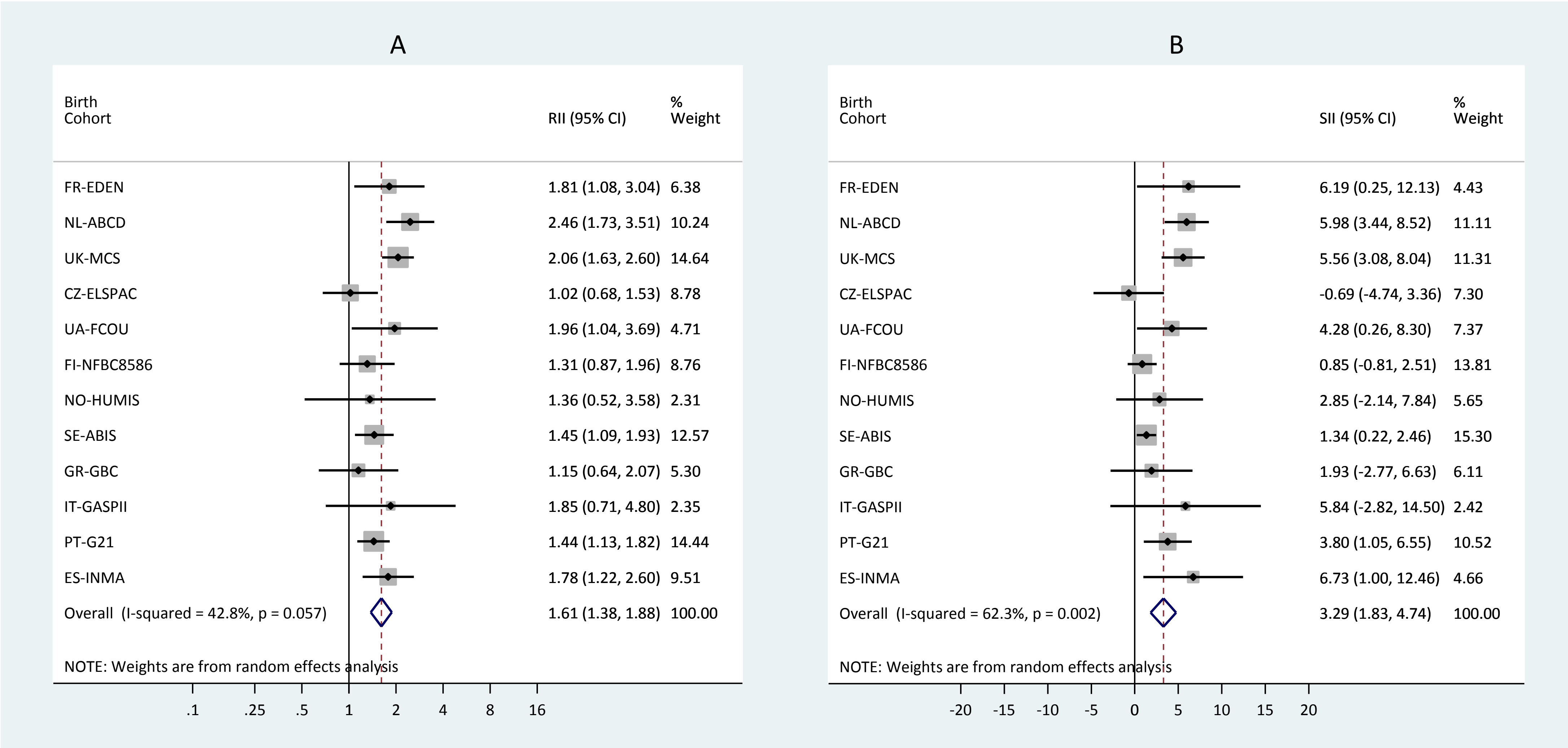


**Figure 3 – Country-specific and pooled RII and SII scores for the association between maternal education and childhood asthma**

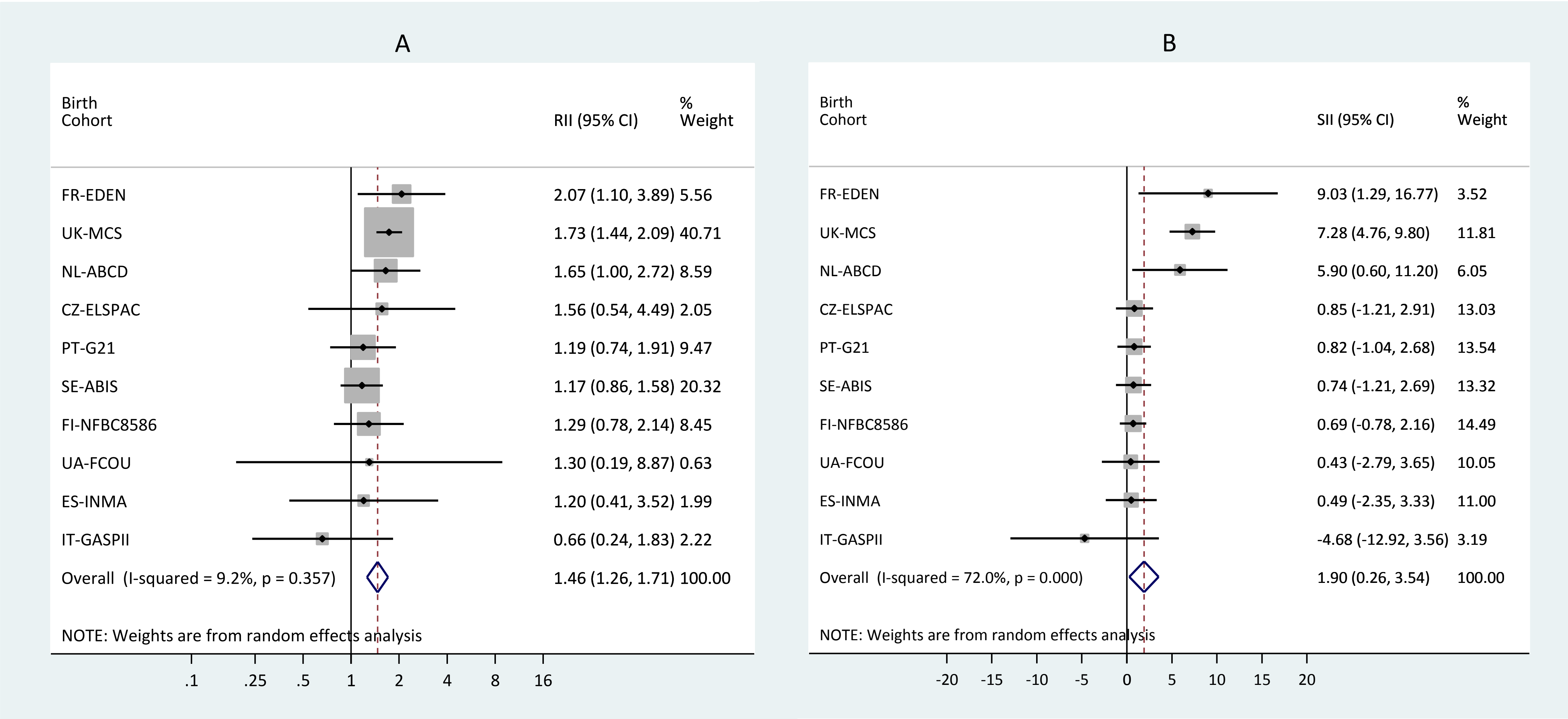
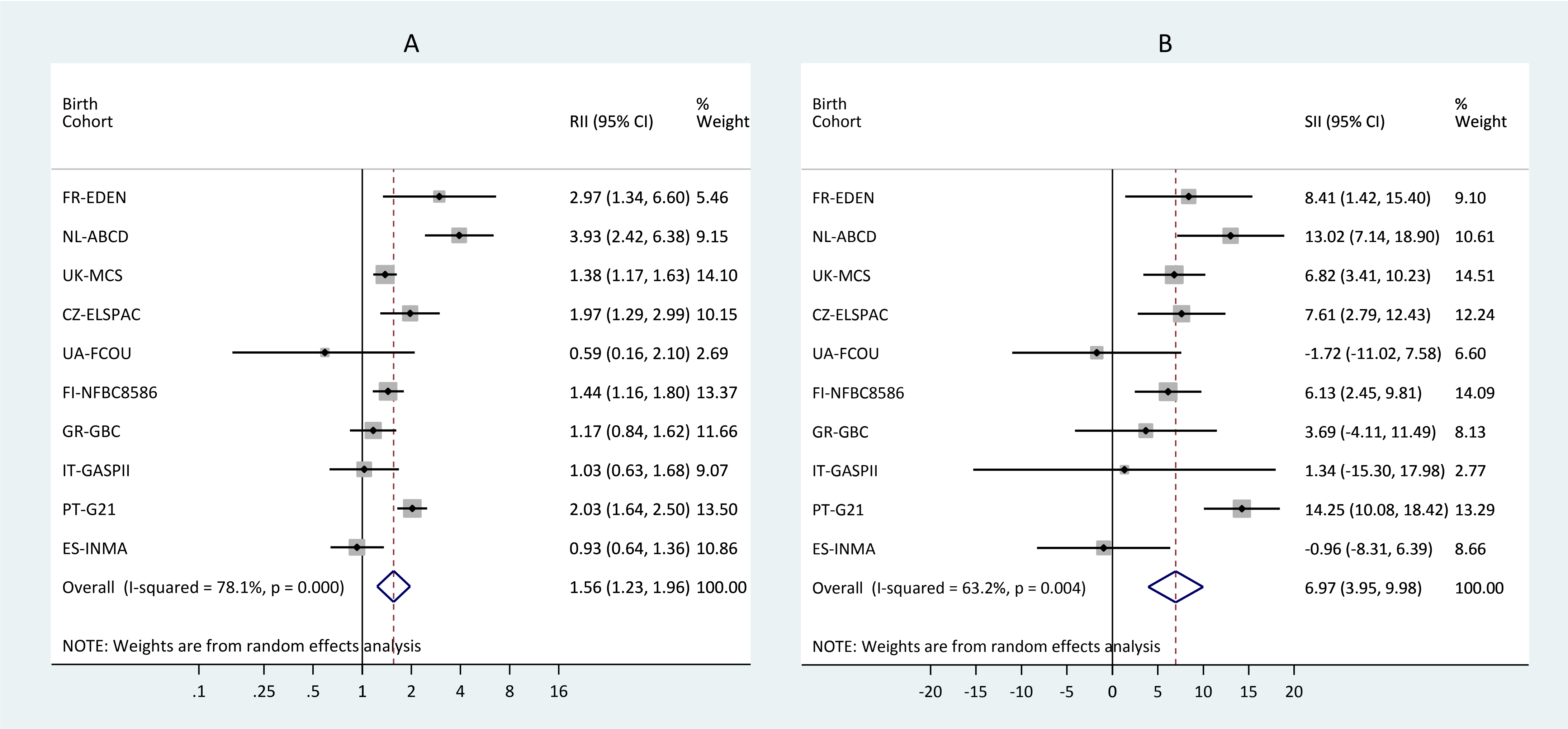


**Figure 4 – Country-specific and pooled RII and SII scores for the association between maternal education and childhood overweight**



## Appendix 1 – Study population by birth cohort

**Czech Republic - The European Longitudinal Study of Pregnancy and Childhood in the Czech Republic (CZ-ELSPAC).** The Czech component of the European Longitudinal Study of Pregnancy and Childhood is a regional-based cohort of child health in two cities in South Moravia (Brno and Znojmo). The study was initiated with a sample of 7,589 babies born in these cities from 1991 to 1992. Based on the ELSPAC study protocol, examinations surveyed cohort members at birth, 6 weeks, 6 month and 18 months, 3 years and biennially thereafter.[1,2]

**Finland - The Northern Finland Birth Cohort 1985/1986 (FI-NFBC8586).** The region-based cohort originates with babies born between 1 July 1985 to 30 June 1986 in the provinces of Oulu and Lapland. Enrolment took place across all maternity health centres in the provinces during the mother's antenatal visit prior to the 25th week of gestation. At baseline, 9,479 babies participated in the cohort and have been subsequently studied at 6-12 months and 7-8 years.[3,4]

**France - The Study of Determinants of Pre- and Post-natal Development, Psychomotor Development and Child Health (FR-EDEN).** Pregnant women in their second trimester or later were recruited from two obstetrics hospitals in the cities of Nancy and Poitiers. Singleton babies (n=1,893) born between 2003 and 2006 were studied at baseline and followed-up at 4, 8 and 12 months. Annual assessments were since performed until 5 years of age.[5,6]

**Greece - The Greek Birth Cohort (GR-GBC).** The nationally-representative cohort emanates from the population-based Greek National Perinatal Survey, which studied 11,048 babies born on April 1983. Recruitment was administered at the county-level and enabled coverage of state and private hospitals, rural health centres, and neonatal units. Following birth, a follow up survey took place at 7 years of age.[7,8]

**Italy - The Gene and Environment Prospective Study on Infancy in Italy (IT-GASPII).** Mothers were recruited at delivery in two large obstetrics hospitals in Rome between June 2003 and October 2004. A sample of 694 mothers and 709 babies were attained at birth. Further examinations were conducted at 10-15 days, 6 months, 15 months, 4 and 7 years.[9,10]

**The Netherlands - The Amsterdam Born Children and their Development Study (NL-ABCD).** Pregnant women living in Amsterdam were enrolled during their first prenatal visit to a general practitioner, midwife or gynaecologist between January 2003 and March 2004. Approximately 8,000 babies were studied at birth and over 6,000 mothers gave permission for long-term follow-up. Subsequent assessments at ages 5/6 and ages 7/8 were restricted to singleton children, who formed 98% of the cohort at baseline.[11]

**Norway - The Norwegian Human Milk Study (NO-HUMIS).** The regional cohort comprises babies born between February 2003 and October 2006 in 5 counties throughout Norway (Rogaland, Telemark, Troms, Finmark, and Oppland). Enrolment took place during routine health visits to the babies' home two weeks following birth, yielding a sample of approximately 2,600 newborns. Additional study of these newborns took place at 1, 2 and 8 years of age.[12]

**Portugal - The Generation XXI Study (PT-G21).** Women from the metropolitan area of Porto who gave birth at obstetrics clinics in the city's five public hospitals were invited to participate in the cohort study. A total of 8,647 babies born between May 2005 and August 2006 formed the initial sample. Further evaluation of a sub-sample occurred at 6, 15, 24 months and the entire cohort was studied between 4 and 5 years of age.[13]

**Spain - The Environment and Childhood Project (ES-INMA).** Of the regional network of 7 birth cohorts throughout Spain, four cohorts participate in the present paper with a sample of approximately 2,500 newborns. The Menorca cohort recruited pregnant women during prenatal visits at public and private general practice clinics from June 1997 to May 1998. The Valencia, Sabadell and Gipuzkoa cohorts invited participants during their first prenatal visit at the main city public hospital or health care centre on November 2003 – June 2005 (Valencia), July 2004 – July 2006 (Sabadell) and April 2006-January 2008 (Gipuzkoa). Follow ups since birth have taken place at 6 months (Menorca, Sabadell), 1-1.5 years, 2-2.5 years, 3 years (Menorca), and 4-5 years.[14]

**Sweden - The All Babies in Southeast Sweden Study (SE-ABIS).** The study, representative of Southeast Sweden, was initiated by invitation to all parents of babies born between October 1997 and October 1999. A sample of 16,058 participants was obtained at birth. Additional cohort data were provided at 1, 2.5 and 5 years of age.[15]

**United Kingdom – The Millennium Cohort Study (UK-MCS).** The nationally-representative cohort comprises babies born in England and Wales between 1 September 2000 and 31 August 2001, and in Scotland and Northern Ireland between 24 November 2000 and 11 January 2002. Participants and their families were eligible if they resided in selected electoral wards at 9 months of age, yielding a baseline sample of 18,819 babies. Follow-up studies have since taken place at 3, 5 and 7 years of age.[16]

**Ukraine – Families and Children of Ukraine (UA-FCOU).** About 8,000 pregnant women residing in 5 Ukrainian cities (Kyiv, Dniproderzhinsk, Mariupol, Ivano-Frankivsk, and Krasny Louch) were recruited in 1992 to join the Ukrainian component of the European Longitudinal Study of Pregnancy and Childhood (ELSPAC). Data collection followed the ELSPAC study protocol and traced babies and their families at 6 and 18 months, and 3, 5 and 7 years of age. The sample included in the present paper comprises children from Kyiv, Dniproderzhinsk and Mariupol, as these were available to the authors.[17]

## Appendix 2 – Maternal ethnicity and smoking behaviour by birth cohort

Mothers belonging to an ethnic minority group were present in 7 out of 12 participating cohorts. Ethnicity was defined by country of birth in FR-EDEN, IT-GASPII, NL-ABCD and ES-INMA. In NO-HUMIS, mothers were classified as Caucasian, Asian, African, Hispanic, Inuit, Romanian or Oceania. Mothers in PT-G21 were classified as Portuguese, Portuguese speaking, European migrant, Brazilian, or Other. In UK-MCS, mothers were classified as White, Mixed, Indian, Pakistani/Bangladeshi, Black/Black British, or Other.

Maternal smoking behaviour was assessed as smoking at any point during the 9 months of pregnancy in most cohorts. Smoking behaviour at the beginning of pregnancy was assessed in NO-HUMIS and in PT-G21 (1$^{st}$ trimester). Smoking behaviour immediately prior to known pregnancy was available in UK-MCS.

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# Appendix 4. Multilevel determinants of asthma in children – Evidence from the UK Millennium Cohort Study

(MSc dissertation for UCL degree in Health and society: Social Epidemiology submitted by Ngan T.K Nguyen under supervision of Joana Morrison and Hynek Pikhart)


**ABSTRACT**

**Background:** Socio-economic status (SES) is associated with a wide range of health outcome and development among children. Previous studies showed the role of individual-level and area-level SES on asthma onset. This study aims to examine whether childhood asthma is related to household SES and Index of Deprivations (IMD) independently in a birth cohort study.

**Methods:** Data on 12,844 children from the UK Millennium cohort study were used in this study. Multilevel modelling was used to examine the association of individual SES, IMD and childhood asthma-onset adjusted for potential confounders.

**Results:** Household income and IMD were important determinants of childhood asthma, even after adjusted for individual risk factors. Low birth weight, breast feeding and overweight/obesity were also related to asthma.

**Conclusions:** These finding approve the evidence base that living in low income household and deprived area are associated with childhood asthma. It also suggests the important of interventions which aim to reduce inequity in household income and social environment for the asthma prevention.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **IMD** | Index of Multiple Deprivations |
| **MCS** | Millennium Cohort Study |
| **NHS** | National Health Service |
| **NS-SEC** | National Statistics – Socio-Economic Classification |
| **NVQ** | National Vocational Qualification |
| **OECD** | Organisation for Economic Co-operation and Development |
| **OR** | Odds ratio |
| **SES** | Socio Economic Status |
| **UK** | United Kingdom |
| **US** | United State of American |

# CHAPTER 1. INTRODUCTION

Asthma is defined as a chronic disease characterized by recurrent attacks of breathlessness and wheezing. Asthma is one of the most common diseases, which has been reported to have an increasing prevalence in both developed and developing countries. It is estimated that approximately 300 million people suffer from asthma worldwide (Masoli et al., 2004) and furthermore it is becoming a particularly serious problem in children. The prevalence of childhood asthma is increasing rapidly in the UK; nearly 20% of children are diagnosed by a doctor (Kaur et al., 1998, Patel et al., 2008). In the Millennium Cohort study (MCS), the prevalence of asthma among children 3 and 5 years old is 12%, on average (Panico, 2012, Panico et al., 2007).

Based on the UK national databases, around 10% of primary care prescribing costs is for asthma and other allergic disorders treatment and NHS costs for asthma managing are over one billion UK pounds, yearly (Gupta et al., 2004). Children with asthma might be limited in daily life, social activities and school attention (Sennhauser et al., 2005). Furthermore, children with asthma also used more health care services with 2.8 times higher cost compared with children without asthma (Lozano et al., 1999).

As with many other health problems, socioeconomic factors have been linked with the onset of asthma, in this case, high socio-economic status (SES) could be a protective factor for individual health. However, various studies have shown that variation in asthma might not only be explained by individual level factor which might be also affected by neighbourhood characteristics. Previous studies also suggest that there is difference in childhood asthma prevalence by neighbourhood and even after controlling for individual characteristic. Neighbourhoods can influence asthma onset through physical environment, resources, psychological factors, health behaviours and access to health care. Thus, individual and neighbourhood level characteristics on social deprivation must be analysed simultaneously to determine whether children with low SES and living in deprived area increase the risk of asthma.

In this thesis, I will use data from the UK Millennium cohort study which consists of 12,844 children to examine the role of parental SES on the onset of asthma. Following the Index of Multiple Deprivation (IMD) from Census 2004 data will be used to define the contextual effect of occurrence of asthma. Furthermore, with the largest number of birth cohorts in the UK, 7 years of follow-up, rich information from both individual and contextual level, this is an excellent opportunity to apply multilevel modelling to understand how asthma onset in children 7 years of age is influenced by a combination of individual, household and neighbourhood determinants.

In the following chapter, I will summarize and critically evaluate the existing evidence on the association between asthma and SES at individual and contextual level. I will also discuss other exposures which are potential influences of these associations. Following this background information, the aims and objectives for this thesis will be stated in Chapter 3. I will describe the exposure, outcome variable, information about cohort and statistical methods in Chapter 4. The subsequent chapters will feature the results, discussions and conclusions of my thesis.

# CHAPTER 2. BACKGROUND

The disparities in asthma onset are significant but the exact cause of asthma has not been yet fully understood, however the current research suggests that these disparities are influenced by SES, gene–environment interactions, ethnicity as well as culture (Subbarao et al., 2009, Hill et al., 2011). Therefore, to further advance the understanding of asthma deprivation among children, multilevel modelling is appropriate approach (Wright and Subramanian, 2007, Canino et al., 2009). SES has been linked to a wide range of health outcomes; most studies have shown that lower SES is associated with higher rates of morbidity and mortality in children including asthma. Accordingly, the following review provides background information regarding the association between asthma and our key variables of interest including individual level and contextual factors.

## 2.1 Parental socioeconomic status as an individual level risk factor of asthma

There are a number of different methods used to measure SES at individual level. For children, parental SES is used as a proxy measurement which is defined by household income or parental occupation or educational level. Previous studies suggest that it is best to include many measures of individual SES in a multiple regression as each measure explains some variance of the outcome, especially three 'big 3 – income, education and occupation' (Cowan and Hauser, 2003).

There is an association of a wide range of social factors at individual level with adverse child health outcomes. Regarding household income, a birth cohort in Sweden shows no association between parental SES and asthma at age 2 (Wickman et al., 2003). However, most studies showed there was a health gradient by parental income;

children who lived in lower income household had a higher risk of suffering asthma (Ruijsbroek et al., 2011, Panico et al., 2007, Kozyrskyj et al., 2010, Violato et al., 2009, Seguin et al., 2007, Propper et al., 2007, Panico, 2012). Moreover, evidence shows that being exposed to poverty and the duration of poverty increase the risk of an asthma attack clearly. A Canada birth cohort presented the negative effect of poverty on asthma in children 5 - 41 months (Beatrice et al., 2012). Findings from MCS study showed that in the UK, the odds for ever had an asthma attack were higher in children at age 3 living in poverty, after controlling for maternal smoking, birth weight, mother education and other related factors (Nikiema et al., 2010).

Similarly, the education component of SES has strongly associated with the prevalence of respiratory infections among children, especially maternal education (Pawlinska-Chmara and Wronka, 2007, Ruijsbroek et al., 2011). Lower parental education also associated with increased risk of asthma and higher odds for severe asthma and hospitalisation for asthma (Violato et al., 2009, Cesaroni et al., 2003, Shankardass et al., 2007). This contrasts, however, with a study in Norway which showed no significant difference between bronchial asthma in children by maternal education (Lindbaek et al., 2003).

Other indicator related to parental SES is parental employment which is also a risk factor of chronic illnesses, in particular with asthma. A study of 7,945 children in the UK, Violato el al showed that not working maternal employment was associated with increased risk for asthma at 3 years of age and wheezing at 5 years of age (Violato et al., 2009), and similarly, lower occupational social class was associated with higher risk of asthma (Almqvist et al., 2005).

Parental SES is one of the most robust social factors but the mechanism of how SES affects child's health remains unclear. One explanation is the relationship between low SES and a low quality of home environment, higher exposure to parental tobacco smoke (Ungar et al., 2010), household pests and outdoor pollution (Kawachi and Berkman, 2003), in addition to living in areas which are more dangerous, more crowed (Evans, 2004) and have greater psychological stress (Adler and Snibbe, 2003).

### 2.2 Area-level SES as a contextual risk factor of asthma

Traditionally, studies on childhood asthma only focus on family and individual level risk factors. The influence of neighborhood factors on asthma is suggested in previous ecological studies as well as the association of health outcomes and neighborhood deprivation has been demonstrated in various studies.

Area-level SES is the status of the surrounding community or neighborhood, which often measured through population-based surveys. There are different neighborhood level variables used to measure deprivation such as census variable, Community Vitality Index (Gupta et al., 2009) or the Townsend Index (Watson et al., 1996), composite with different components including neighborhood income (Cesaroni et al., 2003), race and education (Gupta et al., 2008) as well as unemployment, social welfare (Li et al., 2013a) or single components like crime rate or violence (Sternthal et al., 2010, Shankardass et al., 2011). In the UK, the Index of Multiple Deprivation (IMD) is used as area-level measure, which made up of seven domains including income deprivation, training deprivation, barriers to housing and services, living environment deprivation and crime, is used to measure multiple areas at the small area level (Flouri et al., 2012, Hawkins et al., 2009). IMD is established as the "gold standard" in identifying small areas of deprivation (Niggebrugge et al., 2005).

Health status is related to SES across the socioeconomic gradient, children who live in the most deprived area have worse health than those living in less deprived areas (Pickett and Pearl, 2001, Sundquist et al., 2004, Cubbin and Winkleby, 2005, Cummins et al., 2005, Flouri et al., 2012, Haynes et al., 2003, Navalpotro et al., 2012, Verhaeghe and Tampubolon, 2012). Particularly, children living in low SES communities have a 70% higher risk of asthma after adjusting for ethnicity and household income (Claudio et al., 2006). Ecological studies showed an inconsistent role of neighborhood SES in the onset of asthma among children. Juhn et al conduct a study of children in Rochester and reported that children residing in the lowest income areas had a 40% lower risk of asthma (Juhn et al., 2005). In contrast, other studies found that increased risk of asthma or higher rate of asthma admission was observed in children living in a deprived community (Watson et al., 1996, Li et al., 2013b). Shankardass et al found an increased risk of asthma among children who attended a school receiving Title I fund (at least 40% student from low-income family) and living in communities with a higher rate of crime. (Shankardass et al., 2011).

Neighborhood factors might affect health either directly or indirectly thought such mechanisms as environmental factor, health behaviors, psychological exposures, stress, and access to health care (Pickett and Pearl, 2001, Kawachi and Berkman, 2003). Levels of deprivation may also influence risk of childhood asthma through social disintegration such as crime and unemployment (Kawachi et al., 1999, Sampson et al., 1997, Wright and Subramanian, 2007). For instance, in study among children 0-9 years old, community violence is associated with asthma after controlling for individual factors (Sternthal et al., 2010). Stafford et al suggest a collective resources model to explain the effect of socioeconomic factors on health. It means people in more deprived areas have worse health than those living in less deprived areas due to differences in material and social resources (Stafford and Marmot, 2003).

### Multilevel effects of SES on asthma

Many studies used single level regression to estimate the impact of neighborhood factors on health (Canino et al., 2009). However, individuals are nested within the area/neighborhood and each of the risk factors is likely distributed disproportionally across communities. Despite of no significant or much smaller effects of contextual effects were found in few studies (Saha et al., 2005, Cesaroni et al., 2003, Hawkins et al., 2009), examining the role of neighborhood risk factors is critical. Multilevel analysis is a model method which allows to evaluating the role of risk factors in both individual and area levels. A critical review of multilevel analyses of neighborhood context and health outcome also showed that the contextual effects were modest and much smaller than compositional effect (individual SES) (Pickett and Pearl, 2001). However, the agreement between individual and area – level SES measures is poor (Pardo-Crespo et al., 2013) and both individual and neighborhood deprivation increased the risk of poor health (Stafford and Marmot, 2003) thus, including either individual and area level SES is needed.

A study of 10,971 individuals aged 20-44 years in European Community respiratory health survey found influences of living in low-educational areas associated with asthma, even controlling individual educational level and social class (Basagana et al., 2004). Much research has shown the different results between single level and multilevel model (Cagney and Browning, 2004). For example, an open cohort of children aged 2-11 found that the rate of asthma increases with the level of neighborhood deprivation. In that study, the crude odds ratio of living in high deprivation neighborhood was 1.23 (95% CI: 1.16-1.30) than those living in areas with low deprivation; but no significant association was found after adjusting for maternal demographic characteristic and family income, maternal education (OR = 1.02 (95% CI: 0.97-1.06) (Li et al., 2013b). Thus, the relationship among asthma and individual risk factors might be considered from a neighborhood perspective. Additionally, a multilevel approach is needed to further advance our understanding of the role of the neighborhood level and individual level risk factors on health outcomes.

## 2.3 Other risk factors of asthma

### 8.1.1 2.3.1 Race/ethnicity

Ethnicity inequalities in health have been widely described; however the reason for these differences is still questionable (Goodman et al., 2008, Litonjua et al., 1999). Ethnic differences in asthma have been described in many studies. A systematic review of 13 studies in the UK showed that South Asian children had a lower frequency of having symptom and being diagnosed with asthma in comparison with Black and White children (Netuveli et al., 2005). Furthermore, the 1999 and 2004 Health Surveys for England reported a higher prevalence of wheezing Black Caribbean in compared to the general population (Kaur et al., 1998). Research in the US has also shown that Black children have higher prevalence of asthma than White children (Miller, 2000, McDaniel et al., 2006, Pearlman et al., 2006, Kitsantas et al., 2013). Consistent results in multilevel studies were also found (Sternthal et al., 2010).

Previous studies have yielded conflicting results whether racial or ethnic disparities have significant effect on childhood asthma after controlling for other factors. Recently, findings from the MCS found that once mediating factors such as family background and individual demographics, are taken into account this ethnic gap is reduced (Hansen et al., 2010). Similarly, Panico et al found the disadvantage in asthma for Black Caribbean children at 3 years of age was mostly explained by socio-economic factors (Panico et al., 2007). A cross-sectional study on more than 14,000 children under 18 years old in US found that the prevalence of asthma is particularly high among children with disadvantages for both racial status and SES; only among families with low income, there is higher prevalence of asthma in black children compared with white children (Smith et al., 2005). Therefore, in explaining the ethnic gap in asthma, it is important to take to the role of SES and family characteristics, as well as children´s demographic information into account.

### 2.3.2 Lone parenthood household

Most of the literature on lone parenthood shows that children from lone parent children consistently have worse health than two-parents household (Blackwell, 2010, CDC, 2010, Kitsantas et al., 2013, Panico, 2012). Using data from the UK MCS sweep 1 to sweep 3, Panico showed that children with a lone parent have a higher rate of asthma and wheezing (Panico, 2012). Scharte et al. conducts three cross-sectional surveys in Germany to examine the effect of living in a single mother household and health outcomes in children. Their study findings showed that there is a significant higher risk of poor health (Scharte et al., 2012), as the OR of having asthma is 2.06 (95%CI: 1.29-3.30). However, the risk of single-mother family is attenuated after controlling for socio-economic factors (Scharte and Bolte, 2013). Lone parent may be mediated through maternal hardship (Spencer, 2005) or reduced after adjusting for poverty (Pearce et al., 2013) and attenuated by material deprivation and maternal smoking (Spencer, 2005). The link between lone parent and asthma seems likely so it is required to be controlled to examine the role of SES in asthma onset.

### 2.3.3 Parental cigarette smoking

The association between parental smoking and the onset of asthma among children has been shown in many studies. Most of study, including both cross-sectional and cohort studies, found consistent results that there is an increased risk of asthma in children who are exposed to second-hand smoke (Stapleton et al., 2011, Kappelle and Brand, 2012, Britton, 2010, Pattenden et al., 2006, Jindal and Gupta, 2004, Lannero et al., 2006, Midodzi et al., 2010, Miller, 2001). However, the causal association between parental smoking and asthma has not yet been confirmed. In 2006, the US Surgeon General concluded that the evidence suggests this relationship but there is not sufficient to infer a causal relationship between parental smoking and childhood asthma' onset (CDC, 2006). On the other hand, there are other systematic reviews and meta-analysis studies which confirm the strong effect of parental/maternal smoking on asthma in children. There is a 21% to 81% increased risk of asthma among children exposed to pre-or postnatal passive smoke (Burke et al., 2012), furthermore, Neuman et al. also examined this association among 21,600 children in eight European cohort studies and found that likelihood of asthma onset increased significantly (Neuman et al., 2012). Findings from the International study of Asthma and Allergies in Childhood (ISAAC) programs in 32 countries among children aged 6-7 years old presented a clear dose-respond relationship between smoking and asthma symptoms (1-9 cigarettes/day: OR =1.27; 10-19 cigarettes/day: OR = 1.35; and 20+ cigarettes/day: OR = 1.56) (Mitchell et al., 2012).

All in all, taking the prenatal effect of smoking into account is critical in studies on asthma in children as "there is no risk-free level of exposure to second-hand smoke". (CDC, 2006) This effect is related to maternal and parental smoking separately (Mitchell et al., 2012) and a stronger effect is found in maternal smoking (Burke et al., 2012, Mitchell et al., 2012).

#### 2.3.4 Breastfeeding

Until now, the influence of breastfeeding on the childhood asthma remains controversial. In a meta-analysis of 12 prospective studies from 1966 to 1999, Gdalevich et al. found that breastfeeding had protective effect on asthma with an odds ratio of 0.70 (Gdalevich et al., 2001). Moreover, Odijk et al presents the same conclusion about the protective effect of breast feeding in their literature review (van Odijk et al., 2003). An updated meta-analysis stratified by family history of asthma showed the association of breast feeding and lower risk of asthma. There is a reduction of 40% and 27% in risk of asthma among children with and without family history of asthma, respectively (Ip et al., 2007). Evidence from the New Zealand birth cohort shows there is reduction of asthma prevalence in breastfeeding among children 2 to 6 years old (Silvers et al., 2009, Silvers et al., 2012). In addition, Kull et al. also presents evidence from a birth cohort in Sweden where in ages 4 and 8, breastfeeding has a protective effect (Kull et al., 2004, Kull et al., 2010).

Conversely, some studies have found that breast feeding has no effect or might even be a risk factor for asthma (Wright et al., 2001, Sears et al., 2002). In this sense, a longitudinal study in New Zealand found that breast feeding was associated with higher risk of asthma (OR = 2.40 and 1.83 in age of 9 and current asthma at 9-26 years old) (Sears et al., 2002). In 2011, Brew et al published a meta-analysis of 23 studies that found no evidence of a protective effect of breastfeeding against wheezing illness and asthma (Brew et al., 2011). The paradoxical effect of breast feeding could be due to different definitions of asthma and age ranges in various studies as the protective effects of breast feeding appear to be weaker in older ages.

#### 2.3.5 Birth weight and gestational age

The association between birth weight and asthma is still a controversial issue. Some studies have found no differences (Yang et al., 2013, Villamor et al., 2009, Ortqvist et al., 2009) whereas others have shown an increased risk of low birth weight and asthma (Brooks et al., 2001, Davidson et al., 2010, Darlow et al., 2000, Nepomnyaschy and Reichman, 2006). Similarly, many studies found low gestational age as a predictor of asthma in children (Raby et al., 2004, Miller, 2001, Metsala et al., 2008). In a systematic review, Jaakkola et al. found an increased risk of asthma among children born before 37 weeks (Jaakkola et al., 2006). Using MCS data, Boyle et al also showed higher odds of asthma in very preterm children (Boyle et al., 2012).

Birth weight has a strong correlation with gestational age. Asthma was higher among children with either low birth weight and premature birth (Dik et al., 2004), however, some studies found the association of asthma and birth weight under 2,500 g, but not with gestational age

(Brooks et al., 2001, Davidson et al., 2010, Sin et al., 2004) and vice versa (Ortqvist et al., 2009). Additionally, there is an elevated risk of asthma among pre-term birth children, independently to the effect of birth weight (Dik et al., 2004, Yuan et al., 2003). Thus, it is necessary to include both variables in studies on asthma.

#### 2.3.6 Overweight/Obesity

Association between obesity/overweight and asthma in children is still inconsistent as the mechanism of this association remains unclear. A systematic review and meta-analysis on overweight/obesity and the association with asthma found that there is a weak link (OR is under 2.0) between overweight and asthma in children as described in cross-sectional and case-control studies (Papoutsakis et al., 2013). Evidence from prospective studies, however, supported the hypothesis that obesity or overweight linked with asthma (Zhang et al., 2010, Scholtens et al., 2009, Menezes et al., 2007, Gold et al., 2003, Flaherman and Rutherford, 2006). Conversely, a study of 4 to 11 years old children in Canada suggested that there is no significant association between obesity and asthma (To et al., 2004).

In studying the association between obesity and asthma, gender should be taken into account because of inconsistent existing evidences (Ford, 2005). The effect of obesity is higher (Bibi et al., 2004, Chen et al., 2013) or is only present among boys (Menezes et al., 2007, Suglia et al., 2011, Priftis et al., 2007). However, a study in Taiwan found no role of sex but other factors such as birth weight, ethnicity and breast feeding as an interaction of the relationship between obesity and asthma (Yao et al., 2011). Chinn et al. used longitudinal data of primary school children from 1972 to 1994 in England and Scotland and found that trends in overweight/obesity did not explain the increase in asthma. However, obesity and overweight may be a marker for other factors associated with both asthma and overweight/obesity (Chinn and Rona, 2001).

The interaction between obesity and other factors are also needed to be concerned. Using data in a birth cohort, Jeong et al showed children with low birth weight and highest group of BMI at age 3 years had a very high OR (OR =16.35) for chronic respiratory illness (Jeong et al., 2010). The relationship between BMI and asthma in children and adolescents varies widely with ethnicity (Black et al., 2012). Furthermore, in a nested case control study, Mai el al. found that the association between the association of overweight and exclusive breast feeding with asthma among children disappears if one of the factors is absent (Mai et al., 2007).

### 2.3.7 Gender

During childhood, asthma is more likely to be reported or diagnosed in boys consistently (Dik et al., 2004, Bjornson and Mitchell, 2000, Pearlman, 2009, Davidson et al., 2010). Evidence from 1958 cohort studies on the incidence and prognosis of childhood asthma and wheezing illness show that male sex is a predictor for onset of asthma (Anderson et al., 1986). Findings from a birth cohort in Canada also showed that the risk of asthma was higher among boys than girls (Sin et al., 2004). Besides, there are gender difference on the relationship between asthma and other predictors including obesity (Chen et al., 2013) and gestational age (Raby et al., 2004). However, few studies noted no significant interaction between gender and any of the exposures variables (Ortqvist et al., 2009, Bjornson and Mitchell, 2000).

In this study, some potential confounder variables were not included such as air pollution, cooking methods and community stress because of unavailable data.

**Summary**

Previous literature has suggested that it is necessary to examine both individual and contextual social deprivation in any health model. However, combined effects of the socio-economic status of individual and neighborhood contexts on asthma have received little attention, these combined with advanced statistics techniques provide a favorable opportunity to deeply understand multilevel determinants of asthma among children. To our knowledge, there are no previous studies using the data from the MCS as well as a multilevel modeling to evaluate an ecological effect of neighborhood environment on the onset of asthma among children.

This study examines the influence of neighborhood and individual level factors on the prevalence of asthma among children born in the UK from 2000 to 2001.

# CHAPTER 3. AIMS AND OBJECTIVES

The aim of this study is to examine the impact of both individual level and neighborhood level characteristics on asthma onset among children in the UK.

Specific objectives of the study:

**Objective 1:** To examine the relationship between socio-economic status characterized by household income, main carer occupation class, main carer educational level and asthma in children. This objective will be addressed by testing the following hypothesis:

> Hypothesis 1: Children living in low SES household have a higher risk of asthma.

**Objective 2:** To examine the relationship between neighborhood deprivation represented by Index of Multiple deprivation and asthma in children. This objective will be addressed by testing the following hypothesis:

> Hypothesis 2: Children living in deprived area have increased risk of asthma.

**Objective 3:** To examine the effect of both area and individual deprivation on childhood asthma onset. This objective will be addressed by testing the following hypothesis:

> Hypothesis 3: Household SES and neighborhood deprivation are associated with asthma independently.

# CHAPTER 4. METHODS

This chapter will describe methods and data sources used in this thesis. First, a discussion of study population will be given. The description of individual, neighborhood variables and data sources will follow. A discussion of software used and specific statistical technique for this study will also be presented.

## 4.1 Study population

The Millennium Cohort Study is a representative longitudinal cohort study of all children born between the 1st of September 2000 and the 31st of August 2001 in England and Wales, and between the 24th of November 2000 and the 11th of January 2002 in Scotland and Northern Ireland.

The sample was clustered by electoral wards and is disproportionality stratified to over-represent areas with high percentage of ethnic group in England and areas with high child poverty. The sample wards over represent area with a selection from 9 strata. There were three strata which were 'ethnic minority', 'disadvantaged' and advantaged' for England while there were two strata 'advantaged' and 'disadvantage' for Wales, Scotland and Northern Ireland.

- 'Ethnic minorities' stratum: at least 30% of their total population are classified in two groups 'Black' or 'Asian' (in 1991 Census of Population)
- 'Disadvantage' stratum: children living in the poorest 25% of wards (in England and Wales) and the CPI is at least 38.4%
- 'Advantage' stratum: children living in wards other than those falling into the strata above.

Child Poverty Index (CPI) was defined as the percentage of children under 16 in an electoral ward living with families who were receiving at least one of following benefits in 1998: income support, jobseekers allowance, family credit and disability working allowance.

The sample was selected separately in each stratum in each country. In England and Scotland, the sample was selected by regions and ward size. In others countries, sample was ordered by ward size. Population size and number of births varied therefore the very small wards were combined to create 'super wards' with at least 24 expected births in years. In total, there were 398 wards.

The children included in the cohort were selected by using Child benefit records from the Department of Social Security. The exclusion criteria are: children died before age 9 months, emigrated from the UK or were not established as residents in the UK at age 9 months. At MCS sweep 1, when the children were 9 months of ages, 18,552 families were interviewed. The second and third rounds of the study were conducted when children were 3 and 5 years old. At the sweep 2, there were 692 families included to the study, so the total number of household in the studies is 19,244.

At MCS sweep 4, children were 7 years old, total families were reached were 13,857. The overall response rate for sweep 1, 2, 3 and 4 was 68%, 78%, 79% and 72%, respectively.

### 4.2 Data sources and variables

Cross-sectional data was collected from main and partner interview including demographic information, main and partner employment, education, income; household and children health information. At sweep 4, the main informant or the main carers were selected, more than 97% of the main carers being the children's natural mother. Information on measurement (height, weight) was collected by trained interviewers.

Birth weight, gestational age and breast feeding information were obtained at sweep 1 from the main interview.

In this thesis, I used data from parent interview at sweep 1 and sweep 4, anthropometry measurements at sweep 4 as well as linkage data from Census 2004.

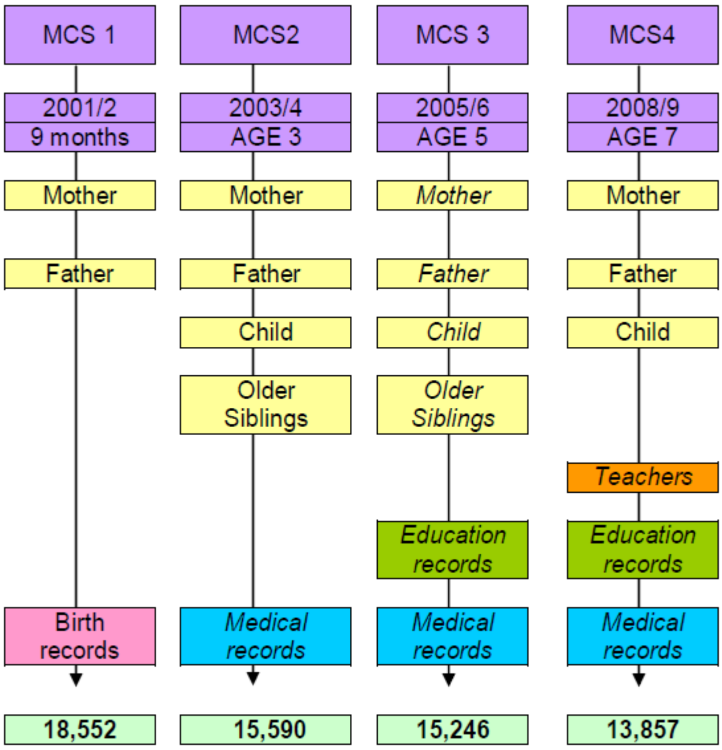


**Figure 4.1 MCS survey sample size** (Centre for Longitudinal Studies, 2012)

### 8.1.2 4.2.1 Outcome variables

The outcome in this study is asthma status of children age 7 in the last 12 months. Asthma attack was specifically defined in the question "Has [Cohort child's name] ever had asthma?"

### 8.1.3 4.2.2 Main explanatory variables

**SES at individual level**

***Household OECD Income quintiles***

At sweep 4, income data were collected in a single banded question and several detailed questions on different income measures such as gross earnings, net earnings, child benefit, earning from second job, state pension and so on. Missing income data was inputted using interval regression (Brown and Schoon, 2010). In this study, modified OECD scales for equivalisation and income weighted quintiles were used.

**Table 4.1 OECD household equivalence scales**(Centre for Longitudinal Studies, 2012)

| Equivalence scales before housing cost | OECD weight |
|---|---|
| First adult (Main respondent) | 0.67 |
| Spouse | 0.33 |
| Dependent child age between 14 <=18 years old | 0.33 |
| Child aged under 14 years | 0.20 |

***Main carer education level***

Educational qualifications were classed according to the National Vocational Qualification (NVQ) classification. Categories for analyses were NVQ 1, NVQ 2, NVQ 3, NVQ 4, and NVQ 5, overseas qualifications only and no qualifications. NVQ5 is equivalent to a graduate degree; NVQ3 is equivalent to two A-levels. There is no detailed information on overseas qualification, thus overseas qualifications were kept as separate categories.

***Main carer occupational class***

Information on the main carer's occupation was collected via questions and was classed according to the National Statistics Socio-Economic Classification (NS SEC); classifications are based on occupation, in combination with employment status. In this study, 5 category occupations were used, classed as: managerial and professional, intermediate occupations, small & self-employers, lower supervisory & technical occupations, semi routine and routine occupations.

A new category includes those which did not do any paid work as either an employee or self-employed when interviewed.

**IMD – contextual SES**

In the UK, information on deprivation was collected in the 2004 Census and furthermore, the Index of Multiple Deprivation (IMD) is an overall measure of multiple deprivations experienced by people living in an area and was calculated for every Lower layer Super Output Area (LSOA). It is made up of seven domains including income, training deprivation, barriers to housing and services, living environment deprivation and crime. IMD was used to rank the LSOAs from most to least deprived. The IMD deciles were created by splitting the LSOAs into ten groups of equal size and contain 10% of the total number of areas.

However, IMD is a relative measure of deprivation, which is a measure of deprivation not affluence, and therefore the area ranked as the least deprived is not necessarily the most affluent. A person lives in a highly deprived area does not mean that they will be deprived and there are some deprived people living in the least deprived areas.

### 8.1.4 4.2.3 Potential confounders

***Lone parental household***

Two or one parent(s)/ career(s) categories were coded from information of parent/carer in the child household at sweep 4. More than 70% of household have both natural parents.

***Ethnicity***

Cohort children’s six ethnic group categories includes ‘White’, ‘Mixed’, ‘Indian’, ‘Pakistani and Bangladeshi’, ‘Black or Black British’ and other ethnic group.

***Maternal smoking***

Information on the smoking status of the mother was collected via interview. Mother categories include natural, adopted, foster and step mother.

***Breastfeeding***

The main carer was asked whether the child was ever breastfed.

***Low and high birth weight***

Low birth weight was defined as a categorical variable according to the birth weight in gram of children, below the threshold of 2,500grams. Children with birth weight equal or over 4,000grams were defined as high birth weight. This information was collected from main carer at MCS sweep 1.

***Short gestational age***

Gestational age in weeks was collected from the main carer at the sweep 1. After which children under 37 weeks were defined as preterm or low gestational, as in many previous studies.

***Overweight/ obesity***

Trained interviewers measured the children's weight and height which were used to compute Body Mass Index (weight (kg) divided by height (metres) squared). Overweight and obesity were defined by the International Obesity Task Force (IOTF) cut-offs for BMI, which were age and sex specific.

***Gender***

Gender was categorized as male and female. The distribution of gender in this study was quite equal.

***Ward type***

There were 9 types of ward in the UK, including England advantage, England disadvantage, England ethnic, Wales advantage, Wales disadvantages, Scotland advantage, Scotland disadvantage, Northern Ireland advantage and Northern Ireland disadvantage. Un-weighted analysis was used in this study so this variable was included in multilevel models which examined the effect of SES at individual and contextual level on asthma.

## 4.3 Data management

**Data linkage**

There are two identifiers used to link data in this study. Interview data from fours weeps are linked by 'mcsid', which is a unique household identifier. This identifier is also used to link geographic data, including IMD. Cohort member number 'cnum' is an individual identifier for a cohort member.

**Sensitive analysis**

Data management was done before beginning the analysis, including dealing with missing data, checking for outliers and wrong values. There were 14,043 cohort children in the 13,857 productive families at sweep 4 of the MCS. A total of 166 families with twins, 10 with triplets and 13,681 with single cohort children participated. A main interview was conduct in 13,797 of 13,857 households. A total of 128 children were admitted to hospital because of asthma/wheezing at sweep 1, were dropped out of the sample. Thus, the total number of children was 13,915.

There was no information on asthma for 106 children. In the dataset, the total number of observation with at least one missing value was 1,071 (7.7%). To deal with missing data, we dropped 1,064 cases in total, so the analyses were performed on 12,844 children.

Finally, this study used data on **12,844** children in 398 wards.

***Differences between children with missing and non-missing data***

Comparing missing and non-missing children, there were no significant differences in asthma prevalence. However, missing values are higher among children in England, Pakistani, Black and other ethnic groups (including Chinese). Children whose main carer was no or oversea qualification only, without job or be lone parent/career, also more likely to have missing data.

## 4.4 Analytic strategy

In order to analyse the dataset, Stata 12 was used. A p-value less than 0.05 was considered statistically significant.

**Descriptive analysis**

Tabular technique was used to describe the main characteristics of this study population at two levels, individual and neighbourhood such as the proportion of asthma, distribution of family income.

**Bivariate analysis**

Bivariate association between each factors and asthma was evaluated before running multilevel regression models.

**Multilevel modelling**

Because of disproportionate sampling and children living in a same area are more similar than children living in others, the data were correlated. To deal with correlation, multi-level model was chosen to use.

Analysis strategy was employed based on the study's objectives. This process allowed a simultaneous consideration of individual nested within neighbourhood.

The first model or “empty” model was fitted with no explanatory variables. The empty model was used to determine whether there was the significant heterogeneity of childhood asthma prevalence among neighborhoods.

To evaluate study objectives following models would be tested:

*Objective 1:*

To evaluate the effect of household SES to asthma occurrence, models with individual SES factor were estimated. After that, the model 3 includes various individual characteristics was assessed to evaluate the association between asthma and individual characteristics. Interactions at the individual level were also examined.

*Objective 2:*

In model 4, IMD variable was included in the a model to estimate the risk of asthma in children who live in more deprived areas compared with children living in less deprived ones after adjusted for individual potential confounders.

*Objective 3:*

In the final model (model 5), explanatory variables in both levels which are individual SES, IMD at ward level and important explore variables (includes maternal smoking, gender, lone parental status and so on) were entered with random effect. Ward type variable and interactions were kept in the model (if available).

Table 4.2 presents a summary of models done in this study.

***Interaction***

Individual level and cross-level interactions were tested by likelihood ratio tests comparing the models including and excluding an interaction term. However, none of the interaction terms were found statistically significant.

**Table 4.2 Summary of the models**

| Model | Explanatory variable(s) |
|---|---|
| Model 1 | Null model = no explanatory variables |
| Model 2 | All explanatory variables at individual level |
| Model 3 | Household income + Main carer's occupation class + Main carer's educational level + Ethnicity + Lone parent + Ever had breastfed + low birth weight + Obesity/overweight + Gender + Maternal smoking + Ward type |
| Model 4 | IMD + Ethnicity + Lone parent + Ever had breastfed + low birth weight + Obesity/overweight + Gender + Maternal smoking + Ward type |
| Model 5 (Final model) | Model 3 + IMD |

**Weights**

In MCS, the selected sample was clustered, geographically and disproportionately stratified and weights were generated to estimate population quantities. This study, however, aims to estimate the regression coefficients so un-weighted methods were used with the stratum design variables as dummy variables as well as multilevel model to estimate the standard error properly. This choice follows suggestions proposed by creators of the study (Centre for Longitudinal Studies, 2012).

### 4.5 Ethical issues

Ethnic approval for the MCS was obtained from a Multi-center Research Ethnics Committee in the UK. Data for this analysis was publicly available for academic student and obtained from the UK Data Archive and Economic and Social Data Service.

### 4.6 Summary

In this chapter the MCS dataset used in these analyses was introduced, described and variables used in this study were also defined. The methodology also presented how missing data are considered and analytical method used in this study.

The next chapter will present main findings from this study.

# CHAPTER 5. RESULTS

## 5.1 Descriptive analysis

Table 1 presents descriptive demographics of children included in this study. There was approximately the same percentage of children in each gender. Of the 12,844 children, 16.12% children had ever had asthma. About one in five children lived with their family with one parent or career. There were about 20% children who were overweight or obese. More information about children's characteristics can be seen in Table 5.1.

### Table 5.1 Description of sample population

| Variable | Category | N (= 12,844) | Percentage |
|---|---|---|---|
| **Asthma** | Yes | 2,070 | 16.12 |
| | No | 10,774 | 83.88 |
| **Gender** | Male | 6,464 | 50.33 |
| | Female | 6,380 | 49.67 |
| **Ethnicity** | White | 10,873 | 84.65 |
| | Mixed | 341 | 2.65 |
| | Indian | 312 | 2.43 |
| | Pakistani and Bangladeshi | 764 | 5.95 |
| | Black or Black British | 400 | 3.11 |
| | Others | 154 | 1.20 |
| **Birth-weight** | Normal birth weight | 10,315 | 80.31 |
| | Low birth weight | 951 | 7.40 |
| | Height birth weight | 1,578 | 12.29 |
| **Short gestational age** | Yes | 1,117 | 8.70 |
| | No | 11,727 | 91.30 |
| **Ever tried breastfeed** | Yes | 8,975 | 69.88 |
| | No | 3,869 | 30.12 |
| **Obesity/Overweight** | Not overweight | 10,191 | 79.34 |
| | Overweight | 1,873 | 14.58 |
| | Obese | 780 | 6.07 |
| **Parents/Careers in household** | Two parents/ careers | 10,225 | 79.61 |
| | One parent/career | 2,619 | 20.39 |
| **Children exposure with smoke** | Yes | 1,633 | 12.71 |
| | No | 11,211 | 87.29 |
| **Maternal smoking** | Yes | 3,480 | 27.09 |
| | No | 9,364 | 72.91 |

### Table 5.2 Household and contextual socioeconomic status

| Variable | Category | N (= 12,844) | Percentage |
|---|---|---|---|
| OECD Income Weighted Quintiles | Lowest quintile | 2,554 | 19.88 |
| | Second quintile | 2,592 | 20.18 |
| | Third quintile | 2,620 | 20.40 |
| | Fourth quintile | 2,578 | 20.07 |
| | Highest quintile | 2,500 | 19.46 |
| Main carer occupational class | Higher managerial and professional | 3,140 | 24.45 |
| | Intermediate | 1,723 | 13.41 |
| | Small employers and own account workers | 720 | 5.61 |
| | Low supervisory and technical | 333 | 2.59 |
| | Semi-routine and routine | 2,306 | 17.95 |
| | Not working | 4,622 | 35.99 |
| Main carer educational level | NVQ level 1 | 877 | 6.83 |
| | NVQ level 2 | 3,395 | 26.43 |
| | NVQ level 3 | 1,971 | 15.35 |
| | NVQ level 4 | 3,998 | 31.13 |
| | NVQ level 5 | 877 | 6.83 |
| | Overseas qualification only | 346 | 2.69 |
| | No qualification | 1,380 | 10.74 |
| IMD | Bottom decile | 1,665 | 12.96 |
| | 10 - < 20% | 1,550 | 12.07 |
| | 20 - < 30% | 1,427 | 11.11 |
| | 30 - < 40% | 1,208 | 9.41 |
| | 40 - < 50% | 1,172 | 9.12 |
| | 50 - < 60% | 1,144 | 8.91 |
| | 60 - < 70% | 1,099 | 8.56 |
| | 70 - < 80% | 1,070 | 8.33 |
| | 80 - < 90% | 1,185 | 9.23 |
| | Highest decile | 1,324 | 10.31 |

Regarding to SES, nearly 40% of the main carer had the highest education level is NVQ level 4 or 5. There were more than 35% main carers who were not employed at the time of interview.

Among the main carers who were working, the highest percentage was people in the management and professional group.

### 5.2 Bivariate analysis

Figure 5.1, Figure 5.2 and Figure 5.3 show clear gradients of asthma prevalence by SES status. Higher asthma prevalence is found in the lowest quintile income household (19.26% vs. 13.16% in highest quintiles), no qualification (17.75%), overseas (19.65%) or level 1 NVQ (18.02%) compared with NVQ level 5 (13%). Households where the main carer was unemployed or semi-routine or routine have 17.81% children with asthma, higher significantly than those are management or professional (13.92%).

Figure 5.4 presents the asthma prevalence by IMD. Highest decide IMD means less deprived neighborhood had lowest percentage of asthma (11.78%). More deprived areas had higher prevalence of asthma significantly.

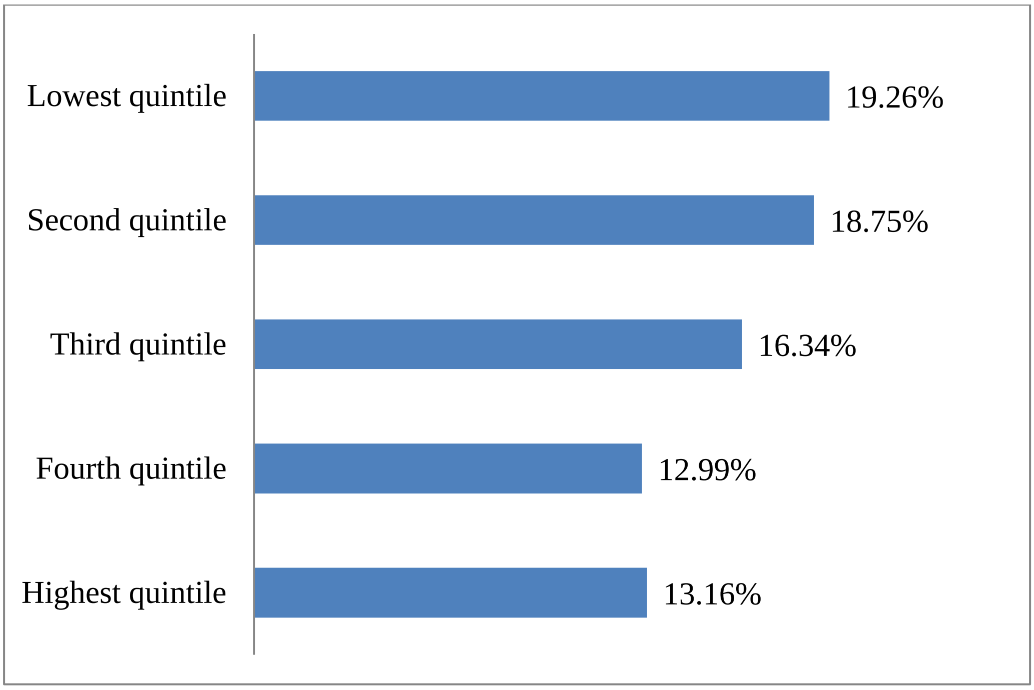


**Figure 5.1 Asthma prevalence by OECD income weighted quintiles**


**Figure 5.2 Asthma prevalence by main carer's current occupational class**

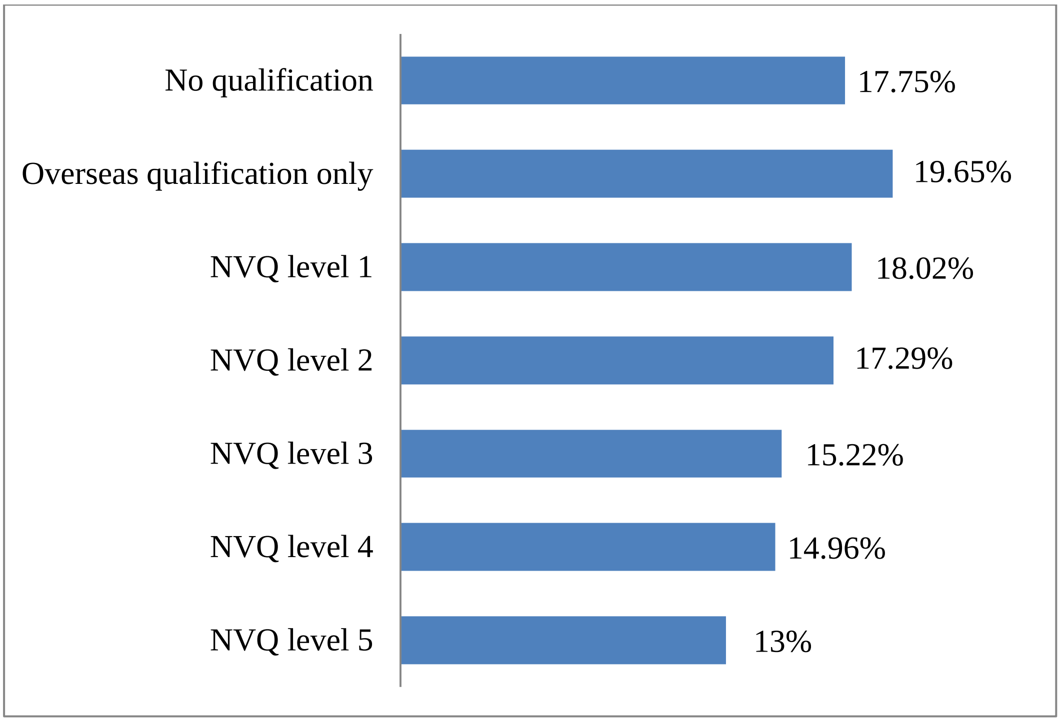


**Figure 5.3 Asthma prevalence by main carer's educational level**

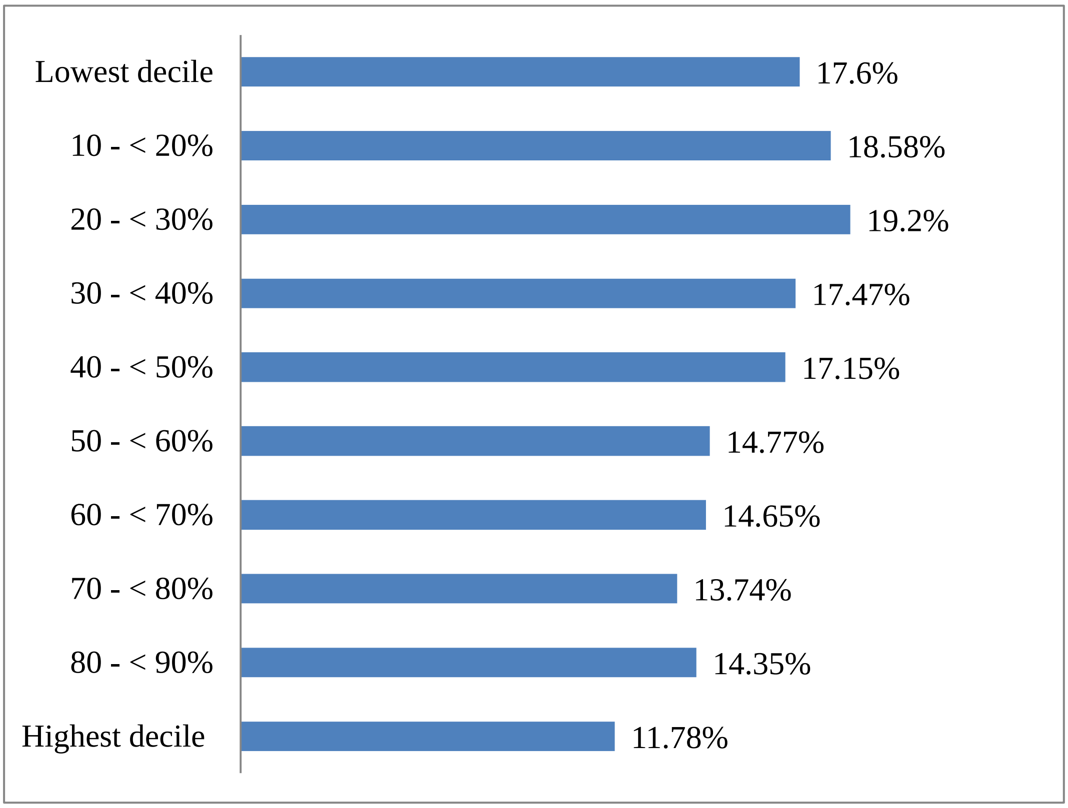


**Figure 5.4 Asthma prevalence by IMD**

Table 5.3 shows the factors assessed for associations with asthma onset (unadjusted model). There was a statistically significant difference in asthma prevalence in all predictors at the individual level except for ethnicity and high birth weight. Specifically, the prevalence of asthma among boys was significantly higher than girl (18.80% vs. 13.40%). The prevalence of asthma was 23.46% among children with obesity, 17.35% in over-weight children, which was significantly higher than normal weight children. Higher asthma prevalence was also found among children who lived in a household with one parent/career and children who have low birth weight, short gestational age and had never tried breast feeding.

**Table 5.3 Odds ratios of having asthma by individual and neighbourhood risk factors**

| Variable | Category | N | % | Unadjusted OR (95% CI) | p-value |
|---|---|---|---|---|---|
| **OECD Income Weighted Quintiles** | Highest quintile | 2,500 | 13.16 | 1 (ref) | - |
| | Fourth quintile | 2,578 | 12.99 | 0.99 (0.84-1.16) | 0.86 |
| | Third quintile | 2,620 | 16.34 | 1.29 (1.10-1.51) | 0.001 |
| | Second quintile | 2,592 | 18.75 | 1.52 (1.31-1.77) | <0.001 |
| | Lowest quintile | 2,554 | 19.26 | 1.57 (1.35-1.83) | < 0.001 |
| | Chi2 trend = 60.94; p < 0.001 | | | | |
| **Main carer occupational class** | Higher managerial and professional | 3,140 | 13.92 | 1 (ref) | - |
| | Intermediate | 1,723 | 13.41 | 0.96 (0.81-1.14) | 0.62 |
| | Small employers and own account workers | 720 | 16.25 | 1.20 (0.96-1.50) | 0.11 |
| | Low supervisory and technical | 333 | 16.52 | 1.22 (0.90-1.66) | 0.20 |
| | Semi-routine and routine | 2,306 | 17.65 | 1.33 (1.14-1.54) | <0.001 |
| | Not working | 4,622 | 17.81 | 1.34 (1.18-1.52) | <0.001 |
| **Main carer** | NVQ 5 | 877 | 13 | 1 (ref) | - |

| | | | | | |
|---|---|---|---|---|---|
| **educational level** | NVQ 4 | 3,998 | 14.96 | 1.18 (0.95-1.16) | 0.14 |
| | NVQ 3 | 1,971 | 15.22 | 1.20 (0.95-1.52) | 0.12 |
| | NVQ 2 | 3,395 | 17.29 | 1.40 (1.12-1.74) | 0.002 |
| | NVQ 1 | 877 | 18.02 | 1.47 (1.13-1.91) | 0.004 |
| | Oversea qualification only | 346 | 19.65 | 1.64 (1.18-2.28) | 0.003 |
| | No qualification | 1,380 | 17.75 | 1.44 (1.14-1.84) | 0.003 |
| **Ethnicity** | White | 10,873 | 16.13 | 1 (ref) | - |
| | Mixed | 341 | 19.35 | 1.25 (0.95-1.64) | 0.11 |
| | Indian | 312 | 15.06 | 0.92 (0.67-1.26) | 0.61 |
| | Pakistani and Bangladeshi | 764 | 15.31 | 0.94 (0.77-1.15) | 0.55 |
| | Black or Black British | 400 | 14.50 | 0.88 (0.66-1.17) | 0.38 |
| | Others | 154 | 18.18 | 1.16 (0.76-1.75) | 0.49 |
| **Lone parent** | No | 10,225 | 15.28 | 1 (ref) | - |
| | Yes | 2,619 | 19.40 | 1.33 (1.19-1.49) | <0.001 |
| **Maternal smoking** | No | 9,364 | 15 | 1 (ref) | - |
| | Yes | 3,480 | 19.11 | 1.34 (1.21-1.48) | <0.001 |

| | | | | | |
|---|---|---|---|---|---|
| **Ever had breastfed** | Yes | 8,975 | 15.01 | 1 (ref) | - |
| | No | 3,869 | 18.69 | 1.30 (1.18-1.44) | <0.001 |
| **Birth weight** | Normal | 10,315 | 15.93 | 1 (ref) | - |
| | Low birth weight | 951 | 20.50 | 1.36 (1.15-1.61) | <0.001 |
| | High birth weight | 1,578 | 14.70 | 0.91 (0.78-1.06) | 0.21 |
| **Preterm delivery** | No | 11,727 | 15.78 | 1 (ref) | - |
| | Yes | 1,117 | 19.61 | 1.30 (1.11-1.52) | 0.001 |
| **Obesity/Overweight** | Normal | 10,191 | 15.33 | 1 (ref) | - |
| | Overweight | 1,873 | 17.35 | 1.16 (1.02-1.32) | 0.03 |
| | Obesity | 780 | 23.46 | 1.69 (1.42-2.02) | <0.001 |
| **Ward type** | England - advantage | 3,537 | 14.36 | 1 (ref) | - |
| | England - disadvantage | 3,065 | 17.29 | 1.25 (1.09-1.42) | 0.001 |
| | England ethnic | 1,455 | 15.19 | 1.07 (0.90-1.27) | 0.45 |
| | Wales - advantage | 596 | 15.44 | 1.09 (0.86-1.39) | 0.49 |
| | Wales - disadvantage | 1,337 | 19.30 | 1.43 (1.21-1.68) | <0.001 |

| | | | | | |
|---|---|---|---|---|---|
| | Scotland - advantage | 819 | 11.84 | 0.80 (0.64-1.01) | 0.06 |
| | Scotland - disadvantage | 749 | 16.56 | 1.18 (0.95-1.47) | 0.12 |
| | Northern Ireland – advantage | 506 | 15.02 | 1.05 (0.81-1.37) | 0.69 |
| | Northern Ireland - disadvantage | 780 | 21.03 | 1.59 (1.30-1.93) | <0.001 |
| **Gender** | Boy | 6,464 | 18.80 | 1 (ref) | - |
| | Girl | 6,380 | 13.40 | 0.67 (0.61-0.74) | <0.001 |
| **IMD** | Highest decile | 1,324 | 11.78 | 1 (ref) | |
| | 80 - < 90% | 1,185 | 14.35 | 1.25 (0.99-1.58) | 0.06 |
| | 70 - < 80% | 1,070 | 13.74 | 1.19 (0.94-1.52) | 0.15 |
| | 60 - < 70% | 1,099 | 14.65 | 1.29 (1.01-1.63) | 0.04 |
| | 50 - < 60% | 1,144 | 14.77 | 1.30 (1.03-1.64) | 0.03 |
| | 40 - < 50% | 1,172 | 17.15 | 1.55 (1.24-1.94) | <0.001 |
| | 30 - < 40% | 1,208 | 17.47 | 1.58 (1.27-1.98) | <0.001 |
| | 20 - < 30% | 1,427 | 19.20 | 1.78 (1.44-2.20) | <0.001 |
| | 10 - < 20% | 1,550 | 18.50 | 1.71 (1.38-2.11) | <0.001 |
| | Bottom decile | 1,665 | 17.60 | 1.60 (1.30-1.97) | <0.001 |

### 5.3 Multilevel modelling

Model 1 (null model) showed that there was a significant variance in the proportion of asthma across the wards with the variance between wards is 0.11. Intra-class correlation is 0.015, thus 1.5% of variance at the second level (ward level). The likelihood ratio statistic is 29.75 giving $p<0.001$ suggests the null hypothesis that the residual between wards is zero is rejected and a multilevel model is required.

Model 2 (detail in Appendix 2) included all individual variables. This model showed that, there were six significant risk factors for asthma, namely family income, breast feeding, low birth weight, overweight/obesity, girl and living in disadvantage area in Northern Ireland. Other variables (education level, occupation of main carer, ethnicity, lone parental status, high birth weight, short gestational age, maternal smoking) were not significant predictors of asthma. In the next models (Model 3, 4, 5), high birth weight, short gestational age were not included because based on literature review performed for this study, these three variables are not substantial predictors of asthma.

Table 5.4 presents analytical results for study's objectives. In this table, multilevel models examine the effect of individual SES (Model 3), IMD (Model 4) and independent effect of these factors (Model 5) on asthma onset after controlling for individual potential confounders.

**Table 5.4 Multilevel regression models for the impact of individual and contextual SES on asthma, controlling for individual factors**

| Variable | Category | Model 3 | | Model 4 | | Model 5 | |
|---|---|---|---|---|---|---|---|
| | | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p |
| OECD Income Weighted Quintile | Highest quintile | 1 (ref) | - | | | 1 (ref) | - |
| | Fourth quintile | 0.94 (0.80-1.12) | 0.50 | | | 0.93 (0.78-1.10) | 0.37 |
| | Third quintile | 1.14 (0.96-1.36) | 0.13 | | | 1.10 (0.93-1.31) | 0.27 |
| | Second quintile | 1.27 (1.06-1.54) | 0.009 | | | 1.23 (1.02-1.48) | 0.03 |
| | Lowest quintile | 1.30 (1.06-1.59) | 0.01 | | | 1.25 (1.01-1.53) | 0.04 |
| Main carer occupational class | Higher managerial and professional | 1 (ref) | - | | | 1 (ref) | - |
| | Intermediate | 0.88 (0.73-1.05) | 0.16 | | | 0.87 (0.73-1.05) | 0.15 |
| | Small employers and own account workers | 1.11 (0.88-1.40) | 0.38 | | | 1.10 (0.88-1.40) | 0.38 |
| | Low supervisory and technical | 1.03 (0.75-1.42) | 0.84 | | | 1.02 (0.74-1.40) | 0.90 |
| | Semi-routine and routine | 1.09 (0.92-1.29) | 0.33 | | | 1.08 (0.91-1.28) | 0.38 |
| | Not working | 1.07 (0.91-1.25) | 0.37 | | | 1.07 (0.92-1.26) | 0.38 |
| Main carer educational | NVQ5 | 1 (ref) | - | | | 1(ref) | - |
| | NVQ 4 | 1.08 (0.87-1.35) | 0.47 | | | 1.08 (0.87-1.35) | 0.49 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **level** | NVQ 3 | 0.97 (0.76-1.25) | 0.83 | | | 0.96 (0.75-1.24) | 0.76 |
| | NVQ 2 | 1.07 (0.82-1.33) | 0.73 | | | 1.03 (0.81-1.31) | 0.79 |
| | NVQ 1 | 1.00 (0.75-1.33) | 0.99 | | | 0.98 (0.73-1.31) | 0.91 |
| | Oversea qualification only | 1.16 (0.81-1.66) | 0.41 | | | 1.15 (0.81-1.64) | 0.48 |
| | No qualification | 0.93 (0.71-1.23) | 0.63 | | | 0.93 (0.70-1.22) | 0.59 |
| **Ethnicity** | White | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | Mixed | 1.24 (0.93-1.66) | 0.12 | 1.23(0.93-1.64) | 0.16 | 1.22 (0.91-1.63) | 0.18 |
| | Indian | 1.04 (0.72-1.50) | 0.88 | 1.04 (0.73-1.50) | 0.82 | 1.02 (0.71-1.47) | 0.90 |
| | Pakistani and Bangladeshi | 0.96 (0.72-1.29) | 0.69 | 1.06 (0.80-1.40) | 0.71 | 0.96 (0.72-1.28) | 0.78 |
| | Black or Black British | 0.85 (0.61-1.18) | 0.38 | 0.86 (0.61-1.19) | 0.35 | 0.84 (0.60-1.17) | 0.31 |
| | Others | 1.19 (0.76-1.86) | 0.47 | 1.26 (0.81-1.96) | 0.31 | 1.18 (0.76-1.84) | 0.47 |
| **Lone parent** | No | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | Yes | 1.10 (0.97-1.25) | 0.15 | 1.18 (1.05-1.33) | 0.006 | 1.10 (0.97-1.25) | 0.14 |
| **Ever had breastfed** | Yes | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | No | 1.13 (1.01-1.27) | 0.03 | 1.14 (1.02-1.27) | 0.02 | 1.13 (1.01-1.26) | 0.04 |
| **Low birth weight** | No | 1 (ref) | - | 1 (ref) | | 1 (ref) | - |
| | Yes | 1.38 (1.17-1.64) | <0.001 | 1.39 (1.17-1.65) | < 0.001 | 1.39 (1.17-1.65) | <0.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Obesity/ Overweight** | Normal | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | Overweight | 1.19 (1.04-1.36) | 0.01 | 1.18 (1.03-1.35) | 0.016 | 1.19 (1.04-1.36) | 0.01 |
| | Obesity | 1.67 (1.39-2.00) | <0.001 | 1.66 (1.39-1.98) | <0.001 | 1.66(1.39-1.98) | <0.001 |
| **Gender** | Boy | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | Girl | 0.65 (0.59-0.71) | <0.001 | 0.65 (0.59-0.71) | <0.001 | 0.65 (0.59-0.71) | <0.001 |
| **Maternal smoking** | No | 1 (ref) | - | 1 (ref) | - | 1 (ref) | |
| | Yes | 1.09 (0.97-1.22) | 0.12 | 1.12(1.00- 1.25) | 0.05 | 1.09 (0.97-1.22) | 0.13 |
| **Ward type** | England Advantage | 1 (ref) | - | 1 (ref) | - | 1 (ref) | - |
| | England Disadvantage | 1.10 (0.93-1.29) | 0.29 | 1.05 (0.88-1.25) | 0.61 | 1.03 (0.87-1.23) | 0.73 |
| | England ethnic | 0.91 (0.69-1.20) | 0.52 | 0.88 (0.66-1.17) | 0.38 | 0.86 (0.65-1.15) | 0.32 |
| | Wales Advantage | 1.08 (0.82-1.43) | 0.58 | 1.11 (0.84-1.47) | 0.46 | 1.10 (0.83-1.45) | 0.52 |
| | Wales Disadvantage | 1.22 (0.99-1.49) | 0.05 | 1.19 (0.97-1.47) | 0.10 | 1.16 (0.94-1.42) | 0.17 |
| | Scotland Advantage | 0.79 (0.61-1.02) | 0.07 | 0.77 (0.59-1.00) | 0.05 | 0.78 (0.60-1.01) | 0.06 |
| | Scotland Disadvantage | 1.09 (0.85-1.40) | 0.49 | 1.03 (0.80-1.33) | 0.78 | 1.04 (0.80-1.33) | 0.78 |
| | Northern Ireland – Advantage | 1.03 (0.76-1.38) | 0.84 | 1.05 (0.79-1.42) | 0.72 | 1.04 (0.77-1.40) | 0.80 |
| | Northern Ireland - Disadvantage | 1.36 (1.07-1.71) | 0.01 | 1.29 (1.01-1.63) | 0.04 | 1.26 (0.99-1.59) | 0.06 |
| **IMD** | Highest decile | | | 1 (ref) | | 1 (ref) | - |
| | 80 - < 90% | | | 1.23 (0.97-1.57) | 0.09 | 1.21 (0.95-1.54) | 0.13 |
| | 70 - < 80% | | | 1.16 (0.91-1.49) | 0.23 | 1.13 (0.88-1.45) | 0.34 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 60 - < 70% | | | 1.20 (0.93-1.53) | 0.16 | 1.16 (0.90-1.48) | 0.25 |
| | 50 - < 60% | | | 1.22 (0.94-1.54) | 0.13 | 1.16 (0.91-1.49) | 0.23 |
| | 40 - < 50% | | | 1.39 (1.08-1.76) | 0.009 | 1.31 (1.02-1.68) | 0.03 |
| | 30 - < 40% | | | 1.41 (1.10-1.78) | 0.007 | 1.32 (1.03-1.69) | 0.03 |
| | 20 - < 30% | | | 1.54 (1.18-1.91) | 0.001 | 1.40(1.10-1.79) | 0.006 |
| | 10 - < 20% | | | 1.46 (1.12-1.81) | 0.004 | 1.31(1.02-1.68) | 0.03 |
| | Bottom decile | | | 1.33 (1.03-1.71) | 0.03 | 1.21 (0.93-1.57) | 0.14 |

Model 3 = Household income + occupation class + educational level + ethnicity + lone parent + Ever had breastfed + low birth weight + obesity/overweight + Gender + maternal smoking + ward type

Model 4 = IMD + ethnicity + lone parent + Ever had breastfed + low birth weight + obesity/overweight + gender + maternal smoking + ward type

Model 5 = Household income + occupation class + educational level + IMD + ethnicity + lone parent + Ever had breastfed + low birth weight + obesity/overweight + gender + maternal smoking + ward type

In Model 3, after controlling for all individual level predictors, only household income has significant effect on asthma occurrence. Specifically, the odds ratio for lowest and second quintiles household income was over 1.2 which indicated that the risk of having asthma of children in low income families was over 20% higher than children in households in the highest income quintile. Children with birth weight under 2,500gr had 1.39 higher risk of asthma than children with normal birth weight. Overweight and obesity children at 7 years old have risk of asthma are 1.19 and 1.66 times higher than normal weight children significantly. Risk of having asthma among children who had never breastfed was approximately 13% higher than children who had breastfed. Girls had 35% lower risk of asthma than boys. Main carer's education, occupation, lone parental status and maternal smoking were no more significant predictors of asthma. (Compared to unadjusted model in Table 5.2)

Model 4 examines the relationship between neighborhood deprivation and asthma in children. Results showed that IMD had an independent effect on asthma so including neighborhood level variables in studies of asthma was necessary to have better explanatory model for asthma. In this model, lone parental status and ward type still had significant effect on asthma while maternal smoking turned into non-significant factor.

The final model (Model 5) evaluates the independent effect of individual SES and area deprivation after controlling for individual risk factors on childhood asthma onset. The results indicate that the neighborhood and individual SES have independent effect on asthma. After controlling for all individual confounders and IMD at ward level, household income still had a significant effect on asthma while occupation and education of main carers were no longer significant. Children who live in a household in the lowest or second quintiles income have over 20% higher risk of asthma than those in highest income quintile family. Model 5 also shows that children who live in deprived area at 20-50% decile have higher risk of having asthma compared with those live in less deprived area with OR is about 1.3.

Significant individual factors in the final model for asthma were low birth weight, breastfed, obesity or overweight and gender. Obesity was the factor with highest effect on asthma with the odds ratio was 1.66 (95%CI: 1.39-1.98). After adjustment, education, occupation, ethnicity, lone parental status, maternal smoking and ward type were not related to asthma significantly.

***Different effect by gender***

There was no interaction found in this study, however the results were different between boy and girl. (Detail in Annex 3) Among boys, income had a large effect on the onset of asthma with the OR is 1.64 among children at lowest income household, larger than overall effect on model 5; but IMD was no longer significant predictors. Children with low birth weight and obesity have increased risk of asthma 42% and 57%, respectively. Breastfeeding and overweight had no effect on the onset of asthma among boy.

Among girls, individual level SES had no effect on asthma except children whose main carer was not working had 33% higher risk of asthma, compared to those have main carer was higher managerial and professional. Results showed that children lived in areas in the 20-30% decile have 1.51 times risk of having asthma than children living in less deprived ones. Children living in areas in the 80-90% decile also have significant increased risk of asthma with OR was 1.57 (95% CI: 1.09-2.26). Lone parental status had effect on asthma risk only among girls with quite large magnitude, OR is 1.36 (95% CI: 1.12-1.66). Overweight was still significant factor and the effect of obesity among girl was seem bigger than boy, with the increased risk among girl obesity children is 77%.

***Income and employment deprivation at ward level***

At the area level, IMD which includes seven domains, was used as an indicator of SES. The domains used to contrast the four IMD scores vary between countries (Detail in Appendix 1) but two main domains which are income and employment are common to all four IMD with around half the weight of IMD. To evaluate the role of income deprivation and employment deprivation in predicting asthma, model 6 was conducted with individual SES, these two domains and potential risk factors (Appendix 4). Household income, low birth weight, breastfeeding, overweight/obesity were still predictors of asthma. However, both income deprivation and employment deprivation were not associated with elevated risk of asthma.

# CHAPTER 6. DICUSSION

This section provides the summary of the results and methodology issues will be discussed. These results will be also compared with previous research. Research implication and policy recommendations will be presented in the following parts.

## 6.1 Summary of results

This study used data from MCS study and linked census 2004 data to evaluate the impact of individual risk factors and neighborhood characteristics on children's asthma in the UK. It was hypothesized that children living in low SES family and/or in more deprived area would have higher risk of asthma.

The descriptive analyses showed that there were linear gradients of asthma prevalence by household income, education level, occupation and IMD. Higher prevalence of asthma was found in low SES households. Children lived in deprived neighborhood also had an increased risk of asthma. In order to quantify the independent effect of household SES and IMD, a multilevel model included household SES, IMD and all potential confounders, was established. The final model confirms the independent effect of household income and IMD. Household income has significant effect on the risk of asthma, with over 20% increased risk of asthma among children live in low income household in comparison with those in high income household. According to this study, the odds ratio of having asthma among children living in more deprived was about 1.3 times compared to those lived in less deprived wards. Other variables had significant effect on asthma including low birth weight, obesity/overweight, breast feeding and gender.

Although no interaction of gender was found, there were different effects of risk factors on asthma. This study found that household income had no effect on girls, only on boys. If the main carer was not working and living in most deprived area, there was an increased risk of asthma among girls. Obesity and low birth weight still have quite big effects on onset of asthma in both genders.

### 6.2 Methodological issues

There are many strengths and limitations in this study which may affect the study findings.

This study includes all children in the UK born in 2000-2001, which enables the inclusion of a population sample and thus increases the validity and generalizability of the study. A large study sample also increases the study power. Another advantage of this study is using cohort data and multilevel modelling. Using cohort data with a wide range of variables allows us to evaluate the effect of three measurements of household SES and IMD - is linked with census and also several potential confounders. Also using multilevel modelling helps to analysis data on both individual and neighbourhood levels. The combination of individual and neighbourhood variables in one models helps to evaluate the compositional and contextual effect and increase the validity of the analytical results. The correlation between household SES and IDM was only moderate thus it's better to include both individual and area based measures of SES. Ben-Schlomo et al. also recommend that it is better to include both SES at household and area level when they are available (Ben-Shlomo and Smith, 1999).

Nevertheless, the study has several limitations. First, non-response is an important issue. The overall response rate for sweep 1, 2, 3 and 4 is 68%, 78%, 79% and 72%, respectively. Non-response participants are more likely to be from disadvantage areas, non-white group (Brown and Schoon, 2010). Thus, the findings may be affected by bias as the sample is unlikely to be representative of whole sample.

Another issue that poses a concern in this study is missing data because not all household responded to the questionnaire completely. The missing values could influence the validity of the data. In order to correct for the missing data, a case deletion was used by deleting all cases with at least one missing value. As a result, 7.7% children were dropped out of the sample.

Sensitivity analyses showed that there were no substantive differences in the asthma between missing and non-missing children. With less than 10% of missing data, exclusion of children with missing value would not affect the results sustainably. For future work, missing imputation method to fill in missing data might be used to have more complete data.

Thirdly, there were some problems related to misclassification in this study. Asthma was based on the main carer's report. Asthma is difficult to diagnose among very young children with fully understand thus parent reports of asthma is a possible source of bias. Miller et al approved this issue in a study which found the poor agreement between maternal and medical reports, even severe cases (Miller, 2001). If the misclassification of asthma is non-differential misclassification, the strength of the association would be under-estimate. Besides, a possible misclassification bias is IMD. Information about the census ward and IMD was defined at the time of first sweep when children are 9 months old, not at the time of asthma onset. Children might have moved to other areas therefore children in same ward become less independent of the risk of asthma onset.

Fourth, some previous research suggested that adverse effect of low SES on asthma would be poor air quality due to traffic density, pollution from industrial sites; social network and community stressors. However, in this study, these factors were not taken into account due to unavailability in the datasets.

### 6.3 Comparison with previous research

In MCS sweep 2 and 3, Panico found the prevalence of asthma among children at the age of 3 and 5 was around 12% (Panico, 2012, Panico et al., 2007). In this study, the prevalence of asthma among children at 7 years old was higher (16.12%).

#### 8.1.5 6.3.1 Household SES and asthma

There are several indicators to measure social deprivation at the individual level. Each measurement has different advantage and limitation. SES is usually measured by 'big 3 –

income, education and occupation' or a composite of these dimensions (Cowan and Hauser, 2003). Previous studies found relative importance of different SES dimensions for health. An study in the US suggested that education was the strongest factors to predict health (Winkleby et al., 1992). Smith et al found occupational class was the best indicator for mortality risk (Smith et al., 1998) while a study showed income as the best predictor for self-reported health in Canada (Hay, 1988). A study in Oslo found occupation, education are all important factors of mortality risk (Naess et al., 2005). In this study, three measurements of household SES which are household income, main carer's education level and occupation were used. The correlations between education level with income and occupation are weak, with correlation coefficient are - 0.32 and 0.30 respectively; and the correlation between household income and main occupation is moderate (r= -0.52). It proposed that each dimensions reflect some different effects on asthma.

This study found income was only significant predictor of asthma at 7 years old. The effect of household income on asthma remained after controlling for low birth weight, obesity, ethnicity, lone parental status, breast feeding, and maternal smoking suggesting that these factors do not fully explain effect of income. The effect of household income is consistent with previous studies (Ruijsbroek et al., 2011, Nikiema et al., 2010). The study of using MCS 1, MCS2 and MCS3 data showed that household income had significant but weak impact on respiratory health (Violato et al., 2009). Violato el al generated a continuous household income and equivalised as suggestion of Gravelle and Sutton (Gravelle and Sutton, 2003) while OECD equivalence scale was used in this study. OECD with more detail weighted for adults and children in household seems more accurate. Although a different income scale was used and at different ages of children, two studies' findings are similar. Moreover, similar results found from MCS sweep 1 to 4 in two these studies might support that there was no significant income health gradient as children age. Income gradient in child health increase with child age was suggested in previous research (Mark Harris, 2008, Currie and Stabile, 2003), which is contrast with MCS study (Violato et al., 2009).

There are several possible reasons why low income might lead to higher risk of asthma. Exposure to asthma triggers such as air pollution, cigarette smoking, chemical fumes are probably greater in poor households. In this study, maternal smoking turned into non-significant factor of asthma after individual SES taken into account, suggesting that SES may partly explain the influence of smoking on asthma. Unfortunately, chemical fumes and air pollution were not examined in this study. Another possible reason is the lack of understanding on asthma and its relation with educational attainment and occupation. However, after controlling for household income, there was no more significant association between main carer's educational level, occupation class and asthma. Thus, the effect of occupation and education attainment may be explained or medicated by household income.

The results from this study showed that main carer's education level and occupation class have no convincing evidence of increased risk of asthma after controlling for income, IMD and other risk factors. This result was contrasted with previous studies which showed that lower parental education was associated with increased risk of asthma (Cesaroni et al., 2003). In study of 4,027 children aged 6-7 years in Rome, Cesaroni found an association between parental education and asthma occurrence. However, important predictors such as household income and obesity were not included in study in Rome. Similarly, previous studies showed that asthma was more common in lower SES which is defined by parental occupation but without controlling for income (Almqvist et al., 2005).

### 8.1.6 6.3.2 IMD and asthma

Area-level SES was evaluated by IMD, which was linked from the Census 2004. IMD is more updated and has advantage by using a range of information from local government and agencies to create a measure of deprivation comprising seven domains compared to other multiple deprived indexes such as the Townsend, Jarman Index, Oxford Index and others. The IMD is a ward-based index which should be more appropriate than postcode because of large number of household in each unit (Danesh et al., 1999). Besides, the correlation between household SES and IDM was only moderate thus it's better to include both individual and area based measures of SES. This study hypothesized that area-level SES influences childhood asthma onset, even after controlling for individual-level SES and taking into account potential confounding variables. This finding supported the hypothesis and was consistent with previous research (Claudio et al., 2006, Li et al., 2013b).

There are several explanations for the effect of neighborhood deprivation on developing risk of asthma. One explanation is the compositional effect as aggregation of individual factors. Thus children live in more deprived communities have lower income and less access to material resources. However, in this study, the effect of IMD is still significantly after controlling for family income and individual risk factors. Therefore, this association cannot be totally explained by the compositional effect of individual socio-economic characteristics. Moreover, a possible explanation is that the disadvantaged neighborhood has an impact on health related behaviors such as maternal smoking, breast feeding (Kawachi and Berkman, 2003). However, results in model 4 showed that smoking and breast feeding were not explained by area deprivation. Previous findings also suggested that chronic stress would be a possible explanation (Shankardass et al., 2011, Rietveld et al., 2000). In this study, the impact of these behaviors was not significant after taken into account household SES and IMD. Present analytical results suggested that IMD includes income, employment, health and disability, education, barriers to housing and services, living environment deprivation and crime, which have significant effect on asthma onset among children. Thus, combination effect of high concentration of low income family, unemployment, high rate of crime and barriers to service could be reason for the association between neighborhood SES and asthma.

In a model included only income and employment deprivation, these two domains were not found as the contributing factor for the association with asthma. Thus, other domains are also important and needed to evaluate for future research. Several previous work found the role of other aggregated level predictors such as education (Basagana et al., 2004), community violence (Sternthal et al., 2010, Wright et al., 2004, Wright and Steinbach, 2001, Shankardass et al., 2011) on asthma trigger.

### 8.1.7 6.3.3 Other risk factors

In the 1958 birth cohort (Anderson et al., 1986) and Canada birth cohort (Chen et al., 2013), boy is more likely to diagnosis/reported to have asthma. This study presented a consistent result with the risk of having asthma among girl was around 35% lower significantly. One explanation should be the difference in asthma is diagnosed by gender. Wright et al found that are there are many girl with symptoms of nocturnal cough without frequent wheeze are less likely to be labeled as having asthma. In addition, girls were also less likely to see the physician when have symptoms than boy (Wright et al., 2006). In this study, we also noticed that stronger adverse effect of household income in boy than girl although the interaction was not significant. Further investigation is needed in order to explain for the interaction of the adverse SES and gender.

Obesity and low birth weight were found as important predictors of asthma. The effect of obesity contributing to the developing of asthma was consistent with many publish work especial in prospective studies (Scholtens et al., 2009, Menezes et al., 2007, Zhang et al., 2010). However, the results in this study showed that the effect of obesity is higher among girls, which is contrast with previous studies (Bibi et al., 2004, Menezes et al., 2007, Suglia et al., 2011, Priftis et al., 2007, Chen et al., 2013). Earlier studies also showed that children with low birth weight have increased risk of asthma (Brooks et al., 2001, Davidson et al., 2010, Nepomnyaschy and Reichman, 2006). The elevated risk of asthma among low birth weight children was independent effect of gestational age.

Regarding to smoking exposure, our data included only mother smoking status because many studies shows that maternal smoking have stronger effect on asthma onset than parental smoking (Burke et al., 2012, Mitchell et al., 2012). In this study, maternal smoking was not significant associated with asthma after controlling for household SES. Some studies found that smoking was related to asthma among children (Neuman et al., 2012, Mitchell et al., 2012) while CDC did not suggest a causal relationship between parental smoking and asthma (CDC, 2006).

### 6.4 Research implication

This is one of the first studies to examine the association of several predictors of SES at individual level as well as SES at wards level with asthma onset among children in the UK. Education and occupation of main carer did not have impact on asthma but income. This is a new result which was not found in most of previous research. Results of the study suggested that future research should include many predictors of SES.

With a large sample size and rich information from birth up to 7 years old, this study has strong power and gives precise results after controlling for many predictors. Association between changing in family SES and asthma would also examined in the future research to advantage the strength of this prospective birth cohort. For example, Kozyrskyj found that there was no significant association between asthma and single time low income but increasing income (Kozyrskyj et al., 2010). Running a separate analysis data by income and gender would be suggested for future research. Previous studies found that effect of ethnicity on asthma existed only at low income children (Smith et al., 2005). This study failed to show significant interactions with gender despite the different results of the associations between SES in individual and neighborhood level. The exact nature of the effect of SES on asthma needs to be further explored in future studies.

In addition, in the UK, each country measures deprivation with their distinct index of multiple deprivations, therefore these four IMD scores are not directly comparable. To compare between countries, and develop UK-wide policies taking account each areas' specific context and need, we can use adjusted IMD or use employment and income domains of the IMD score (Rupert A Payne, 2012). Evaluating the role of each domain in predicting asthma among children is also suggested for future research.

### 6.5 Policy implication

This study confirms the presence of systematic inequalities in asthma among children according to their household income and neighborhood deprivation. This research's results also provide valuable evidence to advocate for reducing social deprivation's by implementing interventions or programs in the UK aimed at the domains of deprivation described in this study. Given these findings, programs targeting vulnerable children in family with low income and more deprived neighborhood with obesity and low birth weight may reduce the risk of asthma in children. Up until now, health inequalities among children have been confirmed in a wide body of research. However, in the WHO strategy and Global Initiative for Asthma mention, there were no interventions and prevention programs proposed to dealing with inequalities issues. In England, *Tackling Health Inequalities: A Programme for Action* in established in 2003 which aimed at tackling health inequalities. The national, however, estimates spending only 4% on early intervention (Science, 2013).

It is potential to deliver universal programs using effective resources focusing on those who are mostly effect in needed, taking the social gradient into account. Generating policy to reduce inequalities would help not only dealing with asthma but also improve child health and development in general. Therefore, policies and interventions delivered should be aimed not only at the biological or health determinants of asthma, but focus as well at the social determinants of deprivation and inequalities. Moreover, The Marmot Review identify the influence the whole life course approach (Marmot and Bell, 2012) so a variety of intervention across different sectors and pregnancy care, social support and health care services for whole family should be required.

# CHAPTER 7. CONCLUSIONS

In conclusion, this study explored the relationship between deprivation at individual and neighborhood level and childhood asthma onset. Results showed clear gradients in asthma prevalence by SES household and IMD. The multilevel methods allowed us to evaluate the independent effect of two levels deprivation and asthma. Inequalities in asthma by household income and deprived neighborhood area were explored. Continuing research to improve the evidence, as well as prevention program to reduce health equity is needed for increasing efforts of asthma prevention in the UK.

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APPENDIX 1 **Index of Multiple Deprivations**

| **Domain** | **England** | **Wales** | **Scotland** | **Northern Ireland** |
|---|---|---|---|---|
| Income | x | x | x | x |
| Employment | x | x | x | x |
| Health and disability | x | x | x | x |
| Education | x | x | x | x |
| Barriers to housing and service | x | x | | |
| Proximity to service | | | | x |
| Geographic access | | | x | |
| Housing | | x | x | |
| Living environment | x | | | x |
| Physical environment | | x | | |
| Crime | x | | x | x |

The domains in The English Indices of Deprivation 2004 are describes below.

## 1. Income Deprivation Domain

The purpose of this Domain is to capture the proportion of the population experiencing income deprivation in an area.

- Adults and children in Income Support households (2001).
- Adults and children in Income Based Job Seekers Allowance households (2001)
- Adults and children in Working Families Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
- Adults and children in Disabled Person's Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
- National Asylum Support Service supported asylum seekers in England in receipt of subsistence only and accommodation support (2002).

## 2. Employment Deprivation Domain

This domain measures employment deprivation conceptualised as involuntary exclusion of the working age population from the world of work.

- Unemployment claimant count (JUVOS) of women aged 18-59 and men aged 18-64 averaged over 4 quarters (2001).
- Incapacity Benefit claimants women aged 18-59 and men aged 18-64 (2001)
- Severe Disablement Allowance claimant women aged 18-59 and men aged 18-64 (2001).
- Participants in New Deal for the 18-24s who are not included in the claimant count (2001).
- Participants in New Deal for 25+ who are not included in the claimant count (2001).
- Participants in New Deal for Lone Parents aged 18 and over (2001).

**3. Health Deprivation and Disability Domain**

This domain identifies areas with relatively high rates of people who die prematurely or whose quality of life is impaired by poor health or who are disabled, across the whole population.

- Years of Potential Life Lost (1997-2001).
- Comparative Illness and Disability Ratio (2001).
- Measures of emergency admissions to hospital (1999-2002).
- Adults under 60 suffering from mood or anxiety disorders (1997-2002).

**4. Education, Skills and Training Deprivation Domain**

This Domain captures the extent of deprivation in terms of education, skills and training in a local area. The indicators fall into two sub domains: one relating to education deprivation for children/young people in the area and one relating to lack of skills and qualifications among the working age adult population.

The sub domain Children/young people comprises of the following;

- Average points score of children at Key Stage 2 (2002).
- Average points score of children at Key Stage 3 (2002).
- Average points score of children at Key Stage 4 (2002).
- Proportion of young people not staying on in school or school level education above 16 (2001).
- Proportion of those aged under 21 not entering Higher Education (1999-2002).
- Secondary school absence rate (2001-2002).
- The sub domain Skills comprises of the following:
- Proportions of working age adults (aged 25-54) in the area with no or low qualifications (2001).

**5. Barriers to Housing and Services Domain**

This domain is to measure barriers to housing and key local services. The indicators fall into two sub-domains: 'geographical barriers' and 'wider barriers' which also includes issues relating to access to housing, such as affordability.

The sub domain wider barriers comprises of the following;

- Household overcrowding (2001).
- LA level percentage of households for whom a decision on their application for assistance under
- The homeless provision of housing legislation has been made, assigned to SOAs (2002).
- Difficulty of Access to owner-occupation (2002).
- The sub domain geographical barriers comprises the following;
- Road distance to GP premises (2003).

- Road distance to a supermarket or convenience store (2002).
- Road distance to a primary school (2001-2002).
- Road distance to a Post Office (2003).

## 6. The Living Environment Deprivation Domain

This domain focuses on deprivation with respect to the characteristics of the living environment. It comprises two sub-domains: the 'indoors' living environment which measures the quality of housing and the 'outdoors' living environment which contains two measures about air quality and road traffic accidents.

The sub-domain 'indoors' living environment comprises of the following

- Social and private housing in poor condition (2001).
- Houses without central heating (2001).

The sub-domain 'outdoors' living environment comprises the following;

- Air quality (2001).
- Road traffic accidents involving injury to pedestrians and cyclists (2000-2002).

## 7. Crime Domain

This domain measures the incidence of recorded crime for four major crime themes, representing the occurrence of personal and material victimisation at a small area level.

- Burglary (4 recorded crime offence types, April 2002-March 2003).
- Theft (5 recorded crime offence types, April 2002-March 2003, constrained to CDRP level).
- Criminal damage (10 recorded crime offence types, April 2002-March 2003).
- Violence (14 recorded crime offence types, April 2002-March 2003).

**APPENDIX 2**

**Model 2 - Multilevel regression for the impact of individual SES on onset of asthma, controlling for all individual risk factors**

| Variable | Category | OR (95% CI) | p-value |
|---|---|---|---|
| **OECD Income Weighted Quintiles** | Highest quintile | 1 (ref) | - |
| | Fourth quintile | 0.95 (0.80-1.12) | 0.12 |
| | Third quintile | 1.15 (0.96-1.36) | 0.12 |
| | Second quintile | 1.28 (1.07-1.54) | 0.008 |
| | Lowest quintile | 1.30 (1.06-1.60) | 0.01 |
| **Main carer occupational class** | Higher managerial and professional | 1 (ref) | - |
| | Intermediate | 0.88 (0.73-1.05) | 0.16 |
| | Small employers and own account workers | 1.11 (0.88-1.40) | 0.37 |
| | Low supervisory and technical | 1.03 (0.75-1.42) | 0.84 |
| | Semi-routine and routine | 1.09 (0.92-1.29) | 0.34 |
| | No work | 1.07 (0.92-1.26) | 0.39 |
| **Main carer educational level** | NVQ5 | 1(ref) | - |
| | NVQ 4 | 1.08 (0.87-1.35) | 0.48 |
| | NVQ 3 | 0.97 (0.76-1.25) | 0.83 |
| | NVQ 2 | 1.04 (0.82-1.32) | 0.75 |
| | NVQ 1 | 0.99 (0.74-1.33) | 0.96 |
| | Oversea qualification only | 1.16 (0.81-1.66) | 0.40 |
| | No qualification | 0.93 (0.71-1.23) | 0.61 |
| **Ethnicity** | White | 1 (ref) | - |
| | Mixed | 1.23 (0.92-1.65) | 0.16 |
| | Indian | 1.03 (0.71-1.48) | 0.89 |
| | Pakistani and Bangladeshi | 0.96 (0.71-1.28) | 0.75 |
| | Black or Black British | 0.84 (0.61-1.17) | 0.32 |
| | Others | 1.18 (0.75-1.84) | 0.48 |
| **Ever had breastfed** | Yes | 1 (ref) | - |
| | No | 1.13 (1.01-1.26) | 0.03 |
| **Low birth weight** | No | 1 (ref) | - |
| | Yes | 1.30 (1.07-1.60) | 0.01 |
| **High birth** | No | 1 (ref) | - |

| | | | |
|---|---|---|---|
| **weight** | Yes | 0.88 (0.76-1.03) | 0.11 |
| **Short gestational age** | No | 1 (ref) | - |
| | Yes | 1.08 (0.90-1.31) | 0.41 |
| **Obesity/ Overweight** | Normal | 1 (ref) | - |
| | Overweight | 1.20 (1.05-1.37) | 0.008 |
| | Obesity | 1.68 (1.40-2.00) | <0.001 |
| **Maternal smoking** | No | 1 (ref) | |
| | Yes | 1.08 (0.96-1.21) | 0.19 |
| **Ward type** | England Advantage | 1 (ref) | - |
| | England Disadvantage | 1.09 (0.93-1.29) | 0.29 |
| | England ethnic | 0.91 (0.69-1.21) | 0.53 |
| | Wales Advantage | 1.09 (0.82-1.44) | 0.57 |
| | Wales Disadvantage | 1.22 (0.99-1.50) | 0.05 |
| | Scotland Advantage | 0.79 (0.61-1.02) | 0.08 |
| | Scotland Disadvantage | 1.09 (0.85-1.40) | 0.49 |
| | Northern Ireland – Advantage | 1.04 (0.77-1.39) | 0.82 |
| | Northern Ireland - Disadvantage | 1.36 (1.08-1.72) | 0.01 |

**APPENDIX 3 Multilevel regressions for the impact of individual and contextual SES on asthma by gender**

| Variable | Category | Male | | Female | |
|---|---|---|---|---|---|
| | | OR (95% CI) | p-value | OR (95% CI) | p-value |
| **OECD Income Weighted Quintiles** | Highest quintile | 1 (ref) | - | 1 (ref) | - |
| | Fourth quintile | 1.08 (0.86-1.36) | 0.49 | 0.78 (0.60-1.00) | 0.06 |
| | Third quintile | 1.30 (1.03-1.63) | 0.03 | 0.92 (0.70-1.20) | 0.54 |
| | Second quintile | 1.58 (1.24-2.03) | <0.001 | 0.88 (0.66-1.18) | 0.40 |
| | Lowest quintile | 1.64 (1.24-2.17) | 0.001 | 0.86 (0.62-1.18) | 0.35 |
| **Main carer occupational class** | Higher managerial and professional | 1 (ref) | - | 1 (ref) | - |
| | Intermediate | 0.79 (0.62-1.01) | 0.06 | 1.01 (0.76-1.35) | 0.92 |
| | Small employers and own account workers | 1.09 (0.80-1.48) | 0.58 | 1.17 (0.80-1.68) | 0.42 |
| | Low supervisory and technical | 1.08 (0.72-1.63) | 0.70 | 0.94 (0.56-1.59) | 0.82 |
| | Semi-routine and routine | 0.95 (0.76-1.19) | 0.67 | 1.28 (0.98-1.67) | 0.06 |
| | No work | 0.92 (0.74-1.13) | 0.41 | 1.33 (1.04-1.71) | 0.02 |
| **Main carer educational level** | NVQ5 | 1(ref) | - | 1(ref) | - |
| | NVQ 4 | 1.19 (0.88-1.62) | 0.26 | 0.98 (0.71-1.36) | 0.90 |
| | NVQ 3 | 1.05 (0.75-1.47) | 0.79 | 0.87 (0.60-1.26) | 0.46 |
| | NVQ 2 | 1.08 (0.78-1.51) | 0.63 | 0.99 (0.69-1.41) | 0.95 |
| | NVQ 1 | 1.20 (0.81-1.76) | 0.37 | 0.77 (0.49-1.19) | 0.24 |
| | Oversea qualification only | 1.13 (0.69-1.86) | 0.61 | 1.18 (0.71-1.99) | 0.52 |

| | | | | | |
|---|---|---|---|---|---|
| | No qualification | 1.02 (0.70-1.49) | 0.90 | 0.85 (0.56-1.27) | 0.42 |
| **Ethnicity** | White | 1 (ref) | - | 1 (ref) | - |
| | Mixed | 1.41 (0.96-2.10) | 0.09 | 1.04 (0.67-1.61) | 0.86 |
| | Indian | 0.96 (0.59-1.58) | 0.90 | 1.08 (0.63-1.84) | 0.78 |
| | Pakistani and Bangladeshi | 0.92 (0.62-1.56) | 0.71 | 0.98 (0.65-1.49) | 0.94 |
| | Black or Black British | 1.06 (0.70-1.61) | 0.80 | 0.59 (0.34-1.01) | 0.06 |
| | Others | 1.17 (0.65-2.12) | 0.59 | 1.14 (0.58-2.23) | 0.71 |
| **Lone parent** | No | 1 (ref) | - | 1 (ref) | - |
| | Yes | 0.95 (0.80-1.13) | 0.58 | 1.36 (1.12-1.66) | 0.002 |
| **Ever had breastfed** | Yes | 1 (ref) | - | 1 (ref) | - |
| | No | 1.11 (0.96-1.29) | 0.17 | 1.16 (0.98-1.37) | 0.09 |
| **Low birth weight** | No | 1 (ref) | - | 1 (ref) | - |
| | Yes | 1.42 (1.12-1.80) | 0.004 | 1.36 (1.06-1.74) | 0.02 |
| **Obesity/ Overweight** | Normal | 1 (ref) | - | 1 (ref) | - |
| | Overweight | 1.16 (0.96-1.40) | 0.13 | 1.23 (1.02-1.50) | 0.03 |
| | Obesity | 1.57 (1.22-2.03) | <0.001 | 1.78 (1.37-2.30) | <0.001 |
| **Maternal smoking** | No | 1 (ref) | | 1 (ref) | |
| | Yes | 1.16 (1.00-1.36) | 0.05 | 0.99 (0.83-1.18) | 0.90 |
| **Ward type** | England Advantage | 1 (ref) | - | 1 (ref) | - |
| | England Disadvantage | 0.95 (0.76-1.20) | 0.68 | 1.12 (0.88-1.44) | 0.36 |

| | | | | | |
|---|---|---|---|---|---|
| | England ethnic | 0.72 (0.50-1.04) | 0.08 | 1.10 (0.74-1.63) | 0.63 |
| | Wales Advantage | 1.01 (0.70-1.44) | 0.97 | 1.18 (0.80-1.76) | 0.39 |
| | Wales Disadvantage | 1.17 (0.90-1.52) | 0.26 | 1.13 (0.83-1.52) | 0.44 |
| | Scotland Advantage | 0.83 (0.60-1.15) | 0.26 | 0.73 (0.49-1.08) | 0.12 |
| | Scotland Disadvantage | 1.15 (0.84-1.59) | 0.40 | 0.88 (0.60-1.30) | 0.54 |
| | Northern Ireland – Advantage | 1.32 (0.92-1.91) | 0.13 | 0.71 (0.44-1.15) | 0.16 |
| | Northern Ireland - Disadvantage | 1.08 (0.79-1.48) | 0.65 | 1.48 (1.05-2.07) | 0.02 |
| **IMD** | Highest decile | 1 (ref) | - | 1 (ref) | - |
| | 80 - < 90% | 0.97 (0.71-1.34) | 0.87 | 1.57 (1.09-2.26) | 0.02 |
| | 70 - < 80% | 1.22 (0.89-1.69) | 0.21 | 1.00 (0.67-1.50) | 0.99 |
| | 60 - < 70% | 1.16 (0.84-1.60) | 0.36 | 1.16 (0.78-1.71) | 0.46 |
| | 50 - < 60% | 1.15 (0.83-1.59) | 0.41 | 1.19 (0.81-1.75) | 0.37 |
| | 40 - < 50% | 1.24 (0.90-1.71) | 0.19 | 1.46 (0.99-2.13) | 0.05 |
| | 30 - < 40% | 1.29 (0.94-1.78) | 0.12 | 1.43 (0.97-2.10) | 0.07 |
| | 20 - < 30% | 1.34 (0.98-1.85) | 0.07 | 1.51 (1.04-2.20) | 0.03 |
| | 10 - < 20% | 1.29 (0.94-1.79) | 0.12 | 1.36 (0.93-2.01) | 0.12 |
| | Bottom decile | 1.30 (0.93-1.82) | 0.13 | 1.12 (0.75-1.70) | 0.58 |

**APPENDIX 4**

**Multilevel regression for the impact of individual SES, income and employment deprivation on asthma onset, controlling for individual risk factors**

| Variable | Category | OR (95% CI) | p-value |
|---|---|---|---|
| **OECD Income Weighted Quintile** | Highest quintile | 1 (ref) | - |
| | Fourth quintile | 0.93 (0.78-1.10) | 0.38 |
| | Third quintile | 1.11 (0.93-1.32) | 0.25 |
| | Second quintile | 1.24 (1.03-1.49) | 0.03 |
| | Lowest quintile | 1.25 (1.02-1.55) | 0.04 |
| **Main carer occupational class** | Higher managerial and professional | 1 (ref) | - |
| | Intermediate | 0.88 (0.73-1.06) | 0.16 |
| | Small employers and own account workers | 1.12 (0.89-1.41) | 0.34 |
| | Low supervisory and technical | 1.03 (0.75-1.41) | 0.87 |
| | Semi-routine and routine | 1.08 (0.91-1.27) | 0.39 |
| | No work | 1.07 (0.91-1.25) | 0.40 |
| **Main carer educational level** | NVQ5 | 1(ref) | - |
| | NVQ 4 | 1.09 (0.87-1.36) | 0.47 |
| | NVQ 3 | 0.95 (0.74-1.22) | 0.71 |
| | NVQ 2 | 1.03 (0.81-1.31) | 0.81 |
| | NVQ 1 | 0.98 (0.74-1.31) | 0.91 |
| | Oversea qualification only | 1.14 (0.80-1.63) | 0.47 |
| | No qualification | 0.92 (0.70-1.21) | 0.55 |
| **Ethnicity** | White | 1 (ref) | - |
| | Mixed | 1.22 (0.91-1.63) | 0.18 |
| | Indian | 1.02 (0.70-1.46) | 0.93 |

| | | | |
|---|---|---|---|
| | Pakistani and Bangladeshi | 0.97 (0.73-1.30) | 0.86 |
| | Black or Black British | 0.85 (0.61-1.18) | 0.33 |
| | Others | 1.17 (0.75-1.82) | 0.50 |
| **Lone parent** | No | 1 (ref) | - |
| | Yes | 1.10 (0.96-1.25) | 0.16 |
| **Ever had breastfed** | Yes | 1 (ref) | - |
| | No | 1.12 (1.01-1.26) | 0.04 |
| **Low birth weight** | No | 1 (ref) | - |
| | Yes | 1.38 (1.16-1.63) | <0.001 |
| **Obesity/ Overweight** | Normal | 1 (ref) | - |
| | Overweight | 1.19 (1.04-1.36) | 0.01 |
| | Obesity | 1.66 (1.39-1.99) | <0.001 |
| **Maternal smoking** | No | 1 (ref) | |
| | Yes | 1.08 (0.96-1.21) | 0.19 |
| **Gender** | Male | 1 (ref) | - |
| | Female | 0.65 (0.59-0.71) | <0.001 |
| **Ward type** | England Advantage | 1 (ref) | - |
| | England Disadvantage | 1.02 (0.86-1.21) | 0.83 |
| | England ethnic | 0.87 (0.66-1.16) | 0.34 |
| | Wales Advantage | 1.10 (0.83-1.46) | 0.50 |
| | Wales Disadvantage | 1.15 (0.93-1.41) | 0.20 |
| | Scotland Advantage | 0.79 (0.60-1.02) | 0.07 |
| | Scotland Disadvantage | 1.05 (0.81-1.35) | 0.74 |
| | Northern Ireland – Advantage | 1.05 (0.78-1.41) | 0.78 |
| | Northern Ireland - Disadvantage | 1.27 (0.99-1.61) | 0.05 |

| | | | |
|---|---|---|---|
| **Income deprivation** | Highest decile | 1 (ref) | - |
| | 80 - < 90% | 1.01 (0.78-1.30) | 0.94 |
| | 70 - < 80% | 0.91 (0.68-1.21) | 0.51 |
| | 60 - < 70% | 1.02 (0.76-1.37) | 0.89 |
| | 50 - < 60% | 0.94 (0.69-1.28) | 0.68 |
| | 40 - < 50% | 1.09 (0.78-1.51) | 0.62 |
| | 30 - < 40% | 1.16 (0.82-1.64) | 0.39 |
| | 20 - < 30% | 1.24 (0.86-1.78) | 0.25 |
| | 10 - < 20% | 1.21 (0.82-1.77) | 0.34 |
| | Bottom decile | 0.97 (0.64-1.49) | 0.90 |
| **Employment Deprivation** | Highest decile | 1 (ref) | - |
| | 80 - < 90% | 1.07 (0.83-1.39) | 0.60 |
| | 70 - < 80% | 0.98 (0.73-1.31) | 0.87 |
| | 60 - < 70% | 1.23 (0.91-1.68) | 0.17 |
| | 50 - < 60% | 1.10 (0.80-1.52) | 0.55 |
| | 40 - < 50% | 1.12 (0.80-1.57) | 0.52 |
| | 30 - < 40% | 1.00 (0.69-1.43) | 0.99 |
| | 20 - < 30% | 1.13 (0.77-1.64) | 0.54 |
| | 10 - < 20% | 1.02 (0.68-1.53) | 0.92 |
| | Bottom decile | 1.20 (0.78-1.86) | 0.40 |

## Appendix 5. Maternal Psychological Distress and Total Mental Health Difficulties among Children aged 5 and 7: Evidence from the UK Millennium Cohort Study

(MSc dissertation for UCL degree in Health and society: Social Epidemiology submitted by A.Karamanos and supervised by Milagros Ruiz and Hynek Pikhart)

**Abstract**

**Background:** In the UK, little is known about the effect of maternal psychological distress (MPD) or maternal socio-economic position (SEP) on total mental health difficulties (TMHD) among children across the period of early childhood. The absence of prevalence rates of TMHD in early childhood by MPD in the UK and other aspects of MPD, such as the effect of its chronicity on TMHD in early childhood, make this study highly informative.

**Aim**: The aim of this study is to investigate the association between maternal psychological distress (MPD) and maternal socio-economic position (SEP) upon total mental health difficulties (TMHD) among children aged 5 and 7 years old in a nationally representative sample of the UK.

**Methods:** Prospective longitudinal data from the UK Millennium Cohort Study were used. Children (N=7898) were studied according to maternal psychological distress and maternal SEP. MPD was assessed when their children were 9 months, 5 and 7 years using the Rutter malaise inventory and Kessler scale (K6). The Strengths and Difficulties Questionnaire (SDQ) was administered during home interviews in order to identify TMHD in children aged 5 and 7. In addition, the study used *survey logistic regression* and *non-response weights* for sweeps 3 and 4 for the whole UK.

**Results:** There are clear associations between MPD at infancy, MPD at 5 and 7 and the risk of TMHD among children aged 5 and 7. Children of mothers suffering from MPD were nearly 3 times (OR 2.97, 95% CI 1.80-4.88) more likely to develop TMHD at 5 and approximately 2.2 times (OR 2.20, 95%CI 1.32-3.69) more likely to face TMHD at 7, after taking into account MPD at infancy and other covariates. Similarly, children whose mothers had MPD at infancy were 1.9 (OR 1.90, 95% CI 1.41-2.54) and 1.7 (OR 1.71, 95%CI 1.29-2.28) times more likely of TMHD at ages 5 and 7 respectively, after accounting for MPD at ages 5 and 7 and covariates. For maternal SEP, there was evidence of a strong cross-sectional association between maternal education and increased risk of TMHD at age 5, and similarly between maternal social class and increased risk of TMHD at age 7. Lastly, chronic MPD was found to be strongly associated with TMHD in children at age 7, as children of mothers suffering MPD at 2 sweeps were 4.1 times (OR 4.09, 95%CI 2.21-7.60) more likely to develop TMHD compared to children of mothers with no MPD at any of the sweeps.

**Conclusion:** Maternal psychological distress and socioeconomic disadvantage during the early years were found to impact children’s mental health and well-being. This study suggests the need for further investigation of factors related to MPD and maternal SEP during early childhood, which may inform policy interventions for mothers and families needed to improve mental health outcomes in children.

**Abbreviations**

**UK:** United Kingdom
**USA:** United States of America
**MCS:** Millennium Cohort Study
**ALSPAC:** Avon Longitudinal Study of Parents and Children
**HSE:** Health Survey for England
**OECD:** Organisation for Economic Co-operation and Development
**MPD**: maternal psychological distress
**TMHD:** total mental health difficulties
**HPA:** hypothalamic-pituitary-adrenal *axis*
*SDQ: Strengths and Difficulties Questionnaire*
**SEP: s**ocio-economic position
**SES**: socio-economic status
**OR:** Odds Ratio
**CI**: confidence interval
**Chi2**: Chi-square test

## Chapter 1: Introduction

TMHD comprise an important public health issue in modern Western societies (Wittchen et al., 2011, Levav and Rutz, 2002). They are prevalent in adulthood and may manifest during childhood (Marmot et al., 2008, Allen et al., 2014). **TMHD** in children are characterized by *internalizing (anxiety, depression)* and *externalizing (aggression, oppositional defiance)* difficulties. Early childhood is a very sensitive period, where the early environment plays a major role on individual vulnerability to later development of psychopathology. Particularly, the early environment of a child is crucial to programming aspects of neurobiological development and, in turn, behavioral, emotional, cognitive, and physiological development (Lanius et al., 2010). Thus, studying the environmental conditions that children experience in early life is very important, because TMHD experienced among children emerge may continue throughout childhood, adolescence and well onto adulthood (Bosquet and Egeland, 2006).

To date, the prevalence of TMHD is estimated up to 20% of children globally, including children in later childhood (Belfer, 2008). In the UK, 1 in 10 children from age one to fifteen face TMHD. The current costs are high and are anticipated to rise. Specifically, the total cost for the care of children with TMHD in the UK was estimated at 147 million pounds, and expected to reach 237 million pounds by 2026 (McCrone et al., 2008). Among other characteristics, previous studies showed that various maternal psychological markers of mental health influence the mental health of children (Goodman et al., 2011). Therefore, this study examines maternal psychological distress (MPD) in order to consider the wide range of psychological disorders which may be experienced by mothers. **MPD** include constructs such as *anxiety, depression, cognitive problems, irritability, anger, obsessive compulsive disorder, post-traumatic stress disorder (PTSD) , sleep disorders, eating disorders* and *loss of energy* (Links, 1983, Masse et al., 1998). There is also evidence that maternal socio-economic position (SEP) could have a detrimental impact on both MPD and TMHD.

An auspicious start in life is critical for an individual to develop his/her full potentials throughout the life course and lead healthy lives (Marmot, 2010). An adverse start in life for children could result in peer and learning difficulties, poor school attainment and school dropouts, poor vocational outcomes, family violence and suicide. Societal costs are extremely high, as children with poor mental health are more likely to require clinical and remedial education services, take up unemployment and sick-leave, and to be disciplined in the criminal justice system (Bor et al., 2004, Bor, 2004). In order for future research and policy on TMHD in early childhood to be effective and targeted, a clear understanding of underlying mechanisms based on population studies is needed. The paucity of life course studies upon TMHD in early childhood makes the UK Millennium Cohort Study (MCS) an ideal study population for detecting social and environmental risk factors of TMHD in early childhood.

In the following chapter, I will summarize and critically evaluate the existing evidence of the association between MPD and maternal SEP upon TMHD in children. I will also discuss other covariates that potentially influence these associations. Following to Background, the Aim and objectives for this thesis will be stated in Chapter 3. Further, the study population, study data, and statistical methods will be described in Chapter 4. The subsequent chapters will feature the results, discussions and conclusions of this thesis.

## Chapter 2. Background

The significance of the first years of life in determining mental health in later life has been stressed in the pioneering work of Freud (Freud, 1937) and Bowlby (Bowlby, 1951). Primarily, these works on child development were hermeneutic interpretations and stressed the ramifications of early life adversities and maternal care (Rutter, 1979).

Since then, there has been a shift of interest in child mental health beyond hermeneutic paradigms. The innovative Isle of White Study critically diverged the interest towards a bio-psychosocial understanding of the etiology of psychiatric disorders in childhood and helped to effectively apply the concept of psychopathology in an attempt to better understand the interaction between nature and nurture and how mental health evolves at different developmental stages (Rutter, 1989). Social and behavioral factors, such as adverse economic circumstances, good parenting and good parental relationships seem to play a crucial role in child development and in the onset of TMHD in children.

The following review includes primarily UK studies, with additional studies from Europe, North America and Oceania. The purpose of the review is to provide information regarding the association between MPD, maternal SEP, child TMHD and other key variables of interest.

**2.1 Total mental health difficulties in early childhood**

Mental health is a major component of health, with scientists claiming that there is no health without mental health (Prince et al., 2007). Although TMHD could begin from birth, there are few epidemiological studies investigating TMHD in early childhood, with even fewer focusing on below the third year of age (Carter et al., 2004, Egger and Angold, 2006).

TMHD consist of internalizing and externalizing difficulties as mentioned in the Introduction. Internal mental health is characterized by emotional and peer relationship difficulties. Common characteristics of internal mental health difficulties in children comprise of *psychosomatic symptoms, such as worrying, being unhappy, clingy, or fearful, having good friends, being bullied*, and *having good relationships with adults*. External mental health difficulties include having *conduct and hyperactivity difficulties, such as having a bad temper, not being obedient, engaging in fights, lies, stealing, and being fidgety, restless, persistence* and *distraction* (Muris et al., 2003).

In the studies reviewed, case definition was based on parental self-reports, using validated instruments, such as the Behavior Screening Questionnaire and the Child Behavior Checklist (Achenbach et al., 1987). These studies showed TMHD in early childhood are pervasive. A study conducted in a London Borough among 3 year-old children (Richman et al., 1975), found a prevalence of TMHD at 7.3%. According to a UK survey report published in 2003, the prevalence of TMHD was 10% for boys and 6% for girls aged 5-9, and then increased to 13% and 10% respectively for boys and girls aged 10-15 years (Jenkins et al., 2003) .

In another study conducted in the USA among 3.860 children aged 2 to 5, Lavigne and colleagues (Lavigne et al., 1996) found that the prevalence of having TMHD in children was 4.7% at 2 years, 7.3% at 3 years and 13.2% at 4 years. However, there was a significant decline at age 5 as the prevalence fell to 10%. A cross-sectional study of 1.280 children aged 1 and 2 years old respectively, in New Haven, Connecticut, found that of TMHD prevalence ranged from 12-16% (Briggs-Gowan et al., 2001). Two epidemiological studies of children aged 2-5 were apocalyptic in terms of TMHD in early childhood. Egger and Angold (Egger and Angold, 2006) conducted a study in 1073 children in the USA, found that the overall prevalence of TMHD in children was 16.2%. These studies report a significant burden of internalizing and externalizing difficulties in early childhood, which seems to increase as children age as shown in the previous studies conducted in the UK and USA.

**2.2 Maternal psychological distress**

A great number of epidemiological studies focus onto mothers to investigate the prevalence of TMHD in children, since mothers in most cases are the responsible caregiver of the child and devote the majority of their time to childrearing (Magill-Evans and Harrison, 1999). This is the reason why their mental health is of interest to the study of TMHD.

In fact, maternal depression and maternal anxiety seem to gain much of the scientific interest (Matthey et al., 2003, Goodman et al., 2011) since depression is considered to be the leading cause of disability for both men and women in developed and developing world, with women having 50% higher probability of developing depression than men (Ribeiro et al., 2008). Also SEP could have a deleterious impact on MPD. Goodman (Goodman, 1999) found that SEP was associated with maternal depression.

**2.3 Maternal psychological distress and total mental health difficulties in early childhood**

Parental psychopathology has been thought to affect the psychological well-being of a child in many ways. Particularly, observational studies have shown that parental psychological symptoms are associated with TMHD in children (Decaluwe et al., 2006) (Stein and Newcomb, 1994, Compas et al., 1989). A study conducted by Canino and colleagues, showed that parental psychopathology explained 20.3% of children's TMHD; after controlling for child's demographic characteristics, child's health and family SEP. Whereas after accounting for the above factors, in addition to harmonious relationships between parents and children and child stress, parental psychopathology explained 28.9 % of the variance in children's TMHD (Canino et al., 1990). As mentioned above, most studies have focused on studying child's mental health through the effect of maternal psychopathology (Tronick and Reck, 2009, Murray et al., 2009). A cohort study conducted by Bayer and colleagues is characteristic (Bayer et al., 2008). A follow-up of 585 children from 7 month to 36$^{th}$ month of life, showed that MPD, family characteristics, socio-demographic characteristics of mother and child, household income, maternal education and maternal substance use could explain 25.4% of externalizing difficulties in children and 17.1% of internalizing difficulties.

Furthermore, studies conducted in the UK provide information about the crucial role that maternal psychopathology plays on child's TMHD. Vostanis and Colleagues

(Vostanis et al., 2006) investigated the mental health of 10,438 children aged 5-15, a study population derived from the UK National Survey. This study found that children of parents with poor mental health were almost 4 times (OR 3.99, 95%CI:3.13-5.08) more likely to have TMHD of their own, after adjusting for parenting practices, child gender, child age, family type, family functioning and weekly household income. McMunn and colleagues (McMunn et al., 2001) found that among 5075 child participants aged 4-15 from the Health Survey for England (HSE), children whose mothers had poor mental health were 2 times more likely to face TMHD, after accounting age and gender, family structure, maternal working status, maternal educational qualifications, the use of benefits, social class of the head of the household, and housing tenure. Evidence supports that the detection of maternal mood disorders is crucial because increased MPD could in fact result in elevated cortisol levels and to dysfunctional behaviors in offspring (Ashman et al., 2002, Smider et al., 2002, Schmidt et al., 1997).

Exposure to MPD (especially maternal depression and anxiety) during infancy may increase the vulnerability of the developing child's HPA system to later stressful exposures (Anisman et al., 1998, Essex et al., 2002). Evidence highlights that maternal depression during infancy is the most potent predictor for later elevated cortisol levels among children, which subsequently leads to TMHD. Characteristic is that children who faced stress without being exposed to MPD, did not have elevated levels of cortisol (Essex et al., 2002, Gunnar and Donzella, 2002). It is worth noting that one panel study found that postpartum depression in infancy was associated with higher cortisol levels at age 3 (Dawson et al., 1997) but another study found no evidence to this relationship at age 7 (Ashman et al., 2002). Consequently, this could be an indication that MPD at infancy and its chronicity over the years could further influence the mental health of children in early childhood. A similar study of the UK MCS by Mensah and Kiernan (Mensah and Kiernan, 2011) stressed a significant relationship between sporadic and chronic general health problems, after adjusting for MPD, and TMHD at age 3. Children of mothers who were continuously under poor general health from 9 months to 3 years of age, had a 112% higher risk of TMHD compared to children mothers with fair to good general health in the two time points.

**2.4 Socio-economic position, maternal psychological distress and total mental health difficulties**

Over the years, studies have detected a relationship between SEP and health developmental psychopathology in early childhood (Pellegrini, 1990, Velez et al., 1989) (Epstein et al., 1996). Children from low SEP backgrounds are at a greater risk of psychiatric comorbidities and maladaptive social functioning compared to more advantaged children (Sameroff et al., 1987, Starfield, 1989, Zaslow et al., 2006) (Lahey et al., 1995). McMunn and colleagues (McMunn et al., 2001) showed explicitly that children whose mothers had low to no educational qualifications had a greater chance of TMHD, by almost 5 fold compared to children whose mothers had degrees or higher qualifications, after accounting for maternal mental health and socio-economic characteristics, child's socio-demographic characteristics, and other family factors. A subsequent study by Vostanis and colleagues (Vostanis et al., 2006) found that weekly household income was strongly associated with a greater risk of developing a psychiatric disorder. Children living in a household earning more than £600/week were found having a lower risk of psychiatric disorders (OR 0.55;

95%CI:0.42-0.71), compared to those living in a household with earnings less than £200/week.

Low SEP could lead to children's TMHD, as being of low SEP precludes families from being able to provide their children a variety of goods, services, parental activities and social connections which probably reap many benefits to children (Brooks-Gunn and Duncan, 1997). Findings by Shaw and colleagues (Shaw et al., 1998) show that school-aged children from low-income families are exposed to a greater number of chronic family stressors, including negative parental relationships and maternal depression, which result in increased behavioral problems and lower self-worth in children. It has been proposed that parental SEP could also have detrimental impact on both children and their parents (Bradley and Corwyn, 2002). A review by the MacArthur Network on SES and health identified two possible mechanisms that could affect both child's and mother's health, namely through environmental and/or material resources and also through psychological influences (Adler and Ostrove, 1999).

Housing conditions could also have detrimental effects on TMHD in early childhood. Poor housing conditions have been suggested to be, at least partly, responsible for the SES gradient seen in child's mental health (Marmot, 1999). It is well documented that usually children coming from lower SEP live in homes that are characterized by inadequate heat, are overcrowded, have damp and have leaky ceilings (Bradley et al., 2001, Evans and Kantrowitz, 2002, Wright and Subramanian, 2007). Also Bradley and colleagues (Bradley et al., 1988) in their study found that the housing quality is associated with children's intellectual and social well-being, whereas Evans and colleagues (Evans et al., 1999) found that a crowded house has deleterious impact on child’s emotional and cognitive functioning.

**2.5:Mother-child relationships**

The development of the child is affected by an interplay between the child, the family and other social factors (Bronfenbrenner and Ceci, 1994). The establishment of an affectionate relationship between mothers and their infants is very important. It has been shown that MPD may not only impose psychological constraints among mothers, but may also have deleterious effects on children’s social and emotional development (Tronick and Reck, 2009). Mother-child relationships generate an emotional communication system between mothers and their children, which functions to regulate infants’ state of arousal and emotions. Ineffective regulation generates extreme states of arousal and affect that disrupt infants’ engagement with people and with inanimate objects. Scientific evidence shows that altered mother-infant-interactions triggered by high levels of maternal stress and depression mediates the effects on children’s later cortisol levels and behaviour (Essex et al., 2002, Spangler and Grossmann, 1993).

Besides, the lack of stability in child’s early life could have prominent effects on the development of TMHD. Insecure parent-child relationships can lead to a variety of mental health and physical difficulties in childhood and in later life, through chemical imbalances in the brain and hormonal dysregulation, constituting a form of allostatic load that alters interpretations of stimuli and influences, behavioural, and hormonal responses to potentially stressful situations (McEwen, 2003). Research findings seem to suggest that children whose mothers suffered from depression showed higher rates of insecure attachments and more TMHD than offspring of non-depressed mothers (Cicchetti et al., 1998).

There is agreement that an harmonious relationship between the mother and the child is an important predictor for the effective response and communication of child with his/her social environment (Fonagy and Target, 1997). Particularly, secure attachment between mothers and children could determine the development of the child in the domains of the formation of self-identity, memory, comprehension, communication, empathy and understanding of others feelings and intentions.

Last but not least, there is evidence that children who experience secure attachment in their relationships with their mothers are more likely to ask them and others for help in order to master tasks, elaborate their play, seek comfort from their mothers, joke or involve them in a shared play (Ginsburg et al., 2007, Tamis-LeMonda and Bornstein, 1993, Tamis-LeMonda et al., 2004). Secure attachment may then engender patterns of verbal interaction between the child and the primary caregiver that help them to work through feelings and intentions (Cassidy, 1994, Sroufe, 2005).

**2.6 Parental relationship and child TMHD**

Findings show that MPD, especially maternal depression is associated with an increased risk of inter-parental conflict and relationship insecurity, family functioning and family-level conflict. In family environments with existing maternal depression in particular, marital conflicts are distinguished by negative verbal behavior, sad affect, elevated risk and use of destructive conflict tactics and a decreased possibility of conflict resolution. Therefore, disruptions in family processes represent crucial links to TMHD in early childhood (Cummings et al., 2003, El-Sheikh et al., 2008, Du Rocher Schudlich et al., 2008, Shelton and Harold, 2008). There is ample documentation in the epidemiological and psychological literature suggesting that conflict and aggression in the family setting are either cross-sectionally or longitudinally associated with an increased risk of TMHD in children, including aggression, conduct disorders, delinquency, antisocial behavior, anxiety, depression and even suicide (Emery, 1982, Emery and Laumann-Billings, 1998, Reid and Crisafulli, 1990) . Findings show that high levels of conflict at home may sensitize children to react with anger, anxiety and fear. The study conducted by Vostanis and colleagues (Vostanis et al., 2006) showed that children who lived and experienced unhealthy family functioning had a 71% higher chance of developing any psychiatric disorder, compared to children who experienced healthy family functioning, after adjusting for parental mental health, non-physical punishment, child age and gender, family type and weekly household income.

It is established that children living in risky family environments are exposed to chronic or repeated stressors, such as high levels of family conflict, which may not allow children to recover from aroused emotional states, an essential process for the proper functioning of the homeostatic regulation in the body (*allostatic model theory*) (McEwen, 2003). In other words, the continuity of stress in children could have deleterious effects on their neurobiological development, such as a sensitized stress-responsive system that impacts upon arousal, emotion regulation and behavioral reactivity. Besides, low income has been tied to unhealthy family environments, with poor children being more likely to be exposed to family violence or belong to families in which relationships lack warmth and support (Bradley et al., 2001, McLeod and Shanahan, 1996).

**2.7 Parenting practices**

Parenting behavior consists of a strong psychosocial influence on child functioning. Specifically, studies focusing on depression have found that depressed mothers tend to be lax, inconsistent and ineffective in disciplining their children (Clark et al., 1988, Lovejoy et al., 2000). A study conducted in 276 dyads in a relatively deprived area of London (Bifulco et al., 2002) detected that children of mothers with a history of a range of psychiatric disorders, low self-esteem, negative close relationships and support were at high risk of multiple adverse outcomes. In particular, children of vulnerable mothers were 5 times and almost 4 times at greater risk, respectively, to exhibit TMHD. This association was almost entirely mediated by child-rated neglect and abuse. It was found that children of vulnerable mothers were almost 4 times (OR 3.82; $p<0.001$) more likely to undergo physical abuse and almost 5 times more likely to experience neglect from their mothers (OR 5.27; $<0.001$).

Economic deprivation and related economic stress placed on parents may increase MHD in children due to a tendency on the part of parents' to discipline their children in a punitive and inconsistent manner. Poor parents may over-rely on negative parenting practices, exhibit low warmth and responsiveness, and inadequately monitor their children (McLoyd and Wilson, 1990, McLoyd, 1998). In one of the few longitudinal studies of how economic hardships influence parental practices, McLeod and Shanahan (McLeod and Shanahan, 1996) found that low levels of maternal involvement with their children and frequent physical abuse, accounted for the effect of poverty to children's both internalizing and externalizing behavioral difficulties (MHD). Furthermore, other studies have pointed out that maternal depression and dysphoria mediated the association between material deprivation and harsh parenting practices by mothers (Duncan et al., 1994, McLoyd et al., 1994)

### 2.8 Neighborhood conditions

Research findings show that neighborhood conditions are a strong risk factor for children's internalizing difficulties (Xue et al., 2005). Children are aware of their community environment characteristics and as with adults (Leslie and Cerin, 2008, Sheppard et al., 2012) they evaluate the quality of the neighborhoods they reside with their own subjective neighborhood standards (Bradley and Corwyn, 2002). Children from low SEP that live in deprived neighborhoods experience more everyday stressors than children living in more affluent neighborhoods (Tolan and Henry, 1996). Particularly, exposure to community violence is prevalent in poor neighborhoods contributing to internalizing difficulties in children such as, aggression and posttraumatic stress (fear, anxiety, depression and hostility) (Richters and Martinez, 1993).

### 2.9 Conclusion

As the mental health of children is strongly correlated to their mother's mental health and that the elevation of risk for TMHD in children is closely confined to mothers (Epstein et al., 1996), this thesis will focus on risk factors for the development of child TMHD that stem from MPD and maternal SEP. Studies in the UK has yet to explore the influence of MPD and its chronicity on THMD, nor the influence of maternal SEP on MHD from infancy to school-age.

To my knowledge this would be the first longitudinal study in the United Kingdom, that will try to uncover the burden of TMHD in childhood (combining internalizing and externalizing behavior problems). Therefore, it is crucial in the current study to investigate the association between MPD and TMHD in early childhood in the MCS at 5 and 7 years old and define the prevalence rate of TMHD in these ages. In the current study, also, it is important to investigate the mental health of children at ages 5 and 7 in conjunction with the chronicity of MPD from infancy and onwards, as it may be a fruitful area of public health information and intervention.

For this scope, epidemiological studies are of great importance, as diagnoses of psychiatric disorders, happening, in clinical settings, frequently fail to fully investigate the burden of psychiatric disorders in community populations. Then, the prospective design of MCS and availability of highly validated instruments used of in it, offer a great opportunity to explore the association between MPD or maternal SEP and TMHD in children at 5 and 7 years in the UK.

## Chapter 3. Aims and objectives

The aim of this study is to investigate the association between maternal psychological distress (MPD) and maternal socio-economic position (SEP) upon total mental health difficulties (TMHD) among children aged 5 and 7 years old in the representative sample of the UK population. Thus, this study will focus on following research questions:

1. Does maternal psychological distress (MPD) predict total mental health difficulties (TMHD) among children aged 5 and 7?
2. Do maternal socio-economic position (SEP) predict total mental health difficulties (TMHD) among children aged 5 and 7?

Specific objectives of the study are:

**Objective 1:** To investigate the cross-sectional associations between MPD and the risk of TMHD among children aged 5 and 7. We form the following hypothesis:

- **Hypothesis 1a:** Children of mothers with cross-sectional MPD have a higher risk of TMHD at ages 5 and 7.
- **Hypothesis 1b:** MPD at infancy predicts TMHD among children aged 5 and 7, independent of temporal MPD.

**Objective 2:** To examine the association between low maternal SEP (occupational class, educational attainment and household income) and TMHD in children. The following hypothesis is being formed:

- **Hypothesis 2**: Low SEP household predicts a heightened risk of TMHD at ages 5 and 7, independent of MPD.

**Objective 3:** To investigate the effect of chronicity of MPD on TMHD in early childhood.

- **Hypothesis 3:** Children of mothers experiencing chronic MPD over the years have the highest risk of TMHD at 7.

## Chapter 4. Methodology

This chapter will describe methods and data sources used in this thesis. Initially, a discussion of study population will be given. The description of the outcome variable, explanatory variables, and potential confounders and data sources will follow. A discussion of software used and specific statistical technique(s) for the current study will also be presented.

### 4.1: Study population

The UK Millennium Cohort Study is a representative prospective longitudinal study which follows the life and health of infants who were born in the UK during the period 2000 to 2001 in England and Wales, and between the November of 2000 and the January of 2002 in Scotland and Northern Ireland (Dex et al., 2005).

The sample was clustered by electoral wards and is disproportionally stratified to over represent areas with high percentage of ethnic groups and child poverty in England. Overall 9 strata represent the sample's wards. Child poverty was measured using the Child Poverty Index (CPI), which was defined as the percentage of children aged below 16 in an electoral ward whose families were receiving in 1998 at least on benefit from the following: job seekers allowance, income support, family credit and disability working allowance.

Furthermore, the sample population was recruited separately in each stratum in each county. In England and Scotland, the sample was selected by regions and ward size. Consequently, the study population differed in size and the number of births varied. It was preferable then to combine the very small wards with bigger wards, and create ''super wards'' with at least 24 expected births in years. The total number of wards, therefore, consisted of 398 wards.

Cohort members were identified by UK government Department of Work and Pensions Child Benefit records. The exclusion criteria for the Millennium Cohort Study include: children who died before the age of 9 months, children who emigrated from the UK or were not considered as residents of the UK at 9 months of age. Baseline data were collected when cohort children were 9 months year of age in total 18,552 families were interviewed. Data were also collected when children were 3 (wave 2) and 5 years old (wave 3). In wave 4, when children were 7 years old, the number of families reached 13,857. The overall wave to wave response rate for sweeps 1,2,3, and 4 was 68%, 78%, 79% and 72% respectively.

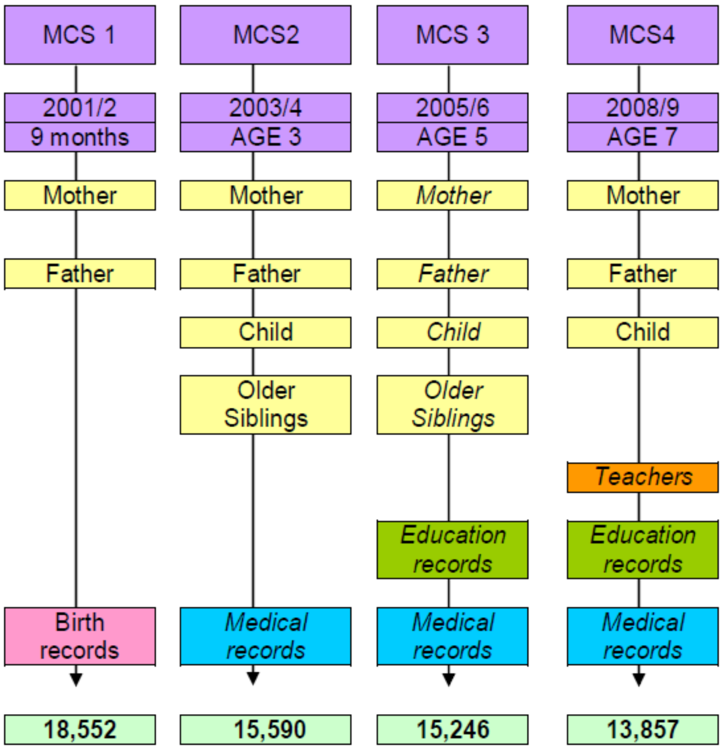


**Figure 1.** MCS survey sample size (Centre for Longitudinal Studies, 2012)

**4.2 Analytic Sample**

Data management was conducted prior to data analysis. Issues like missing data, outliers and wrong values were checked and assessed. Overall, complete information for all the variables included in the analysis were available for 8010 dyads. In order to address the missing data (11.234 missing values), complete case-analysis was decided to be used by deleting all cases with at least one missing value. Further, a number of 112 fathers who identified as the main carer of the child were excluded from the analysis. Finally, the analysis included **7898 children** whose mothers had been reviewed at 9 months, age 5 and 7.

### 4.3 Sensitivity Analysis

Comparing children with at least one missing and non-missing values at all variables used in the current study, there were statistically significant differences between them (**chi2=725.17, =<0.001**). Moreover, further analysis showed that the prevalence of TMHD in children with at least one missing value in this study were more likely to belong in lower SEP (**Appendix 2**). Specifically, at age 5 TMHD in children with at least one missing value were more likely to have mothers with lower education and belong in low income households. Maternal social class proved to be statistically insignificant in terms of TMHD in children with missing values at age 5. Furthermore, at age 7, again a social gradient in terms of TMHD in children with at least one missing value was apparent. TMHD at age 7 (in children with at least one missing value) were statistically significant for those whose mothers had low education, belonged in low social class, and came from low-income households.

### 4.4 Data sources and Variables

#### 4.4.1 Outcome Variables

The main outcome of interest in this study is TMHD of children in ages 5 and 7 and it can be identified by using the Strengths and Difficulties Questionnaire (SDQ). The SDQ is a brief questionnaire that can be self-administered by parents, teachers and children. For the scope of the current thesis, the SDQ completed by mothers has been used. The SDQ total difficulties score was used as a derived variable from sweeps 3 and 4. SDQ total difficulties score represents a combination of 4 SDQ subscales including emotional difficulties, peer relationship difficulties and hyperactivity and inattention (Goodman and Goodman, 2009). Each of these scales of the SDQ are scored from 0-10, to create a total difficulty score (0-40) A score of 14 and above represents a substantial risk of TMHD in children, according to a previous study (Mensah and Kiernan, 2011). SDQ total difficulties score was dichotomized and it was used as a binary variable.

#### 4.4.2 Main explanatory variables

Maternal Psychological Distress (MPD): Two measurements were used, that have been proved to manifest well, maternal psychological distress. Both of them were self-administered. The nine-item Rutter inventory is a modified version of the original Malaise inventory, used in the 1st sweep of MCS, which reflects a total score from 0 to 24 in a total number of 24 items (Rutter et al., 1970). The nine-item Rutter malaise inventory has a scale of 0-9, derived from dichotomous values assigned (No=0, Yes=1), and where a score of 4 and above indicates MPD. The instrument has a quite adequate reliability for survey analysis purposes, with a Cronbach's alpha coefficient estimated at 0.70, and thus Rutter malaise inventory is used in this study as it yields well-documented results about the maternal psychological states during the first year of the child.

Besides, MPD at ages 5 and 7 was assessed with the Kessler scale (K6). This measure is considered as a highly sensitive and reliable measure of defining mental illness, and thus psychological distress in women. A derived Kessler (K6) variable was used in this study, which includes 6 questions , with a scale from 0-4 and a total score from 0-24. A cut-off point of 13 and above was used to classify high levels of maternal psychosocial distress (Kessler et al., 2003).

Finally, the mothers were grouped into those who did not report high levels of psychological distress at all waves, those who reported high levels of MPD at nine months of child's age, those who reported high levels of MPD in at least two waves, and finally those who reported MPD in all waves.

Socio-economic position: There are a number of different methods used to measure SES at individual level. Parental SEP is considered as a proxy measurement that includes parental occupation or household income or education attainment. According to past studies , it is preferable to use income, education and occupation in multiple regression modelling, since each of these measures explain some variance of the outcome (Cowan and Hauser, 2003). Therefore, socio-economic measures, such as household income, maternal education and maternal occupation , will be used in sweeps 3 and 4:

*Equivalized household income quintiles*: At sweeps 3 and 4, income data were collected in a single banded question and several detailed questions on different income measures such as gross earnings, net earnings, child benefit, earning from a second job, state pension and so on. Missing income data was inputted using interval regression. In this study, modified OECD scales and income quintiles were used.

Table 4.1 **OECD household equivalence scales**(Centre for Longitudinal Studies, 2012)

| Equivalence scales before housing cost | OECD weight |
|---|---|
| First adult (Main respondent) | 0.67 |
| Spouse | 0.33 |
| Dependent child age between 14 <=18 years old | 0.33 |
| Child aged under 14 years | 0.20 |

The measure for social class within the MCS is derived from the UK's National Statistics' Socioeconomic Classification (NS-SEC 2000). Classifications are based on current maternal occupation, in combination with maternal employment status. In the current study, 5 category occupations were used, classified as: managerial and professional, intermediate occupations, small & self-employers, lower supervisory & technical occupations, semi routine and routine occupations. A *new category* was also created, including those mothers that were in work or in maternal leave and those mothers that were not in work or in maternal leave.

*Maternal education* will be included as a categorical variable in seven groups according to the UK National Vocational Qualification classification (NVQ). Categories for analysis were NVQ1, NVQ2, NVQ3, NVQ4, NVQ5, overseas qualifications only and no qualifications. NVQ5 is equivalent to a graduate degree; NVQ3 is equivalent to 1-5 A levels at A*-C. Despite the absence of detailed information on overseas qualifications only, this category was included in the analysis as a separate category.

#### 4.4.3 Further covariates

## Demographic parameters

*Gender of Child*: Gender was categorized as male and female.

*Maternal age:* Maternal age was included as an already categorized variable in 3 age groups (20-29,30-39,40+).

## Maternal psychosocial factors

*Parenting Practices:* In order to measure the use of discipline practices from mothers to their children, the Murray Straus's Conflict Scale has been used (Straus et al., 1998) by asking the question the following question to mothers: How often do you do the following when cohort member is naughty?. According to a recent study, 2 new variables were generated (Barnes et al., 2013). The first one refers to *withdrawal of maternal attention (neglect),* and consisted of *sending* the cohort member *to bedroom/chair or taking away treats*. The second variable refers to *overt punishment* with mothers *shouting, smacking or telling of*, when the cohort member was *naughty*. The first variable regarding neglect was categorized in 3 groups (high-medium-low), and the second in quartiles.

*Parental Relationship*: In sweep 3 the Golombok Rust Inventory of Marital State, which consists of 7 items has been used in order to evaluate the overall quality of a couple's relationship. A new composite variable was generated and was recoded in quartiles. It is important to mention that this set of questions has been asked to all mothers who have a full-time partner. Also, an additional question was asked regarding the use of *force onto mother by partner*. Owing to the absence of the seven items consisted of the Golombok Rust Inventory, in sweep 4; two variables were selected to reflect the quality of the relationship of mothers with their partners. Particularly, mothers asked if they were *happy or unhappy* in the current relationship with the partner and if the partner had ever used force to them.

*Relationship with the Child:* The assessment of maternal relationship with the child at age 5 and 7, was identified by asking mother's perceived opinion about the *closeness of relationship* with her child.

## Housing and Area parameters

*Area Conditions:* Area conditions questions were asked in sweeps 3 and 4. Particularly, in sweep 3, the following questions asked: *Is the area where you live good for raising children? How safe they feel in the area?* Whereas in sweep 4, one question asked, *if there were any parks or playgrounds in the area where children could play* , due to the lack of the same questions used in sweep 3.

*Housing Conditions*: 3 questions were asked to mothers: if there are problems with the *damp in the home* and if the *home was really disorganised*.

## Household income-related poverty parameter

Income-related poverty was defined as household income below 60% of the median.

### 4.5 Statistical power of the study

Since the present study is based on the already existing data from the MCS, the size of the population samples could not be influenced. However, the power of the study can be calculated under some assumptions.

Assuming that the *confidence level is 95% or 99%*, exposed (mothers with MPD)/unexposed ratio, with a conservative estimation, is 1.50 and prevalence of the outcome (TMHD) is approximately 5%, it is possible to calculate statistical power for multiple odds of developing TMHD in early childhood.

**Table 4.2 :**Power calculation for population of 7898 children.

| **OR** | **Power** | |
|---|---|---|
| | **95% CI** | **99% CI** |
| **1.4** | >99% | >99% |
| **1.5** | >99% | >99% |
| **1.6** | >99% | >99% |

Despite some loss of power in multiple regression analyses (adjusting for MPD and other covariates), all analyses have sufficient sample size to demonstrate even moderate associations. For ORs larger than 1.6, *statistical power is over 99%* in all analyses.

### 4.6: Data Management

## Data Linkage

In this study, one identifier was used to link data. *Parent interview data* and *derived variables* by sweeps 1, 3 and 4 were linked by *''mcsid''*, which is a unique household identifier.

#### 4.7 Analytic Strategy

In order to analyse the dataset, STATA 12 was used. A p-value of less than 0.05 was considered as statistically significant.

## Descriptive analysis

Tabular technique was used to describe the main characteristics of the study population at age 5 and 7, according to maternal and child demographic characteristics maternal and child psychosocial factors and maternal SEP.

## Univariate analysis

Univariate associations between each factors and TMHD at age 5 and 7 respectively, were evaluated before running survey logistic regression models.

## Survey logistic regression analysis

Since the sample of births in the beginning of the study was clustered disproportionately across the geographic area in order to over-present residents of areas of high child poverty and residents from smaller countries of the UK respectively, the distribution of participants for each country was different. In addition, the current dataset contained 11234 observations with missing values across 397 wards in the UK, which resulted in 8010 observations with no missing values. In order to correct for the disproportionate clustered sample design and the attrition of the waves used for this study, it was decided to use *survey logistic regression* and *non-response weights* for sweeps 3 and 4.for the whole UK.

It should be noted that analysis strategy was applied based on the study's objectives. The first model (null model) was used to determine whether there was a significant association between MPD and TMHD in children at age 5 and 7.

To evaluate study's objectives, the following models will be tested:

*Objectives 1 and 2:*

To evaluate the cross-sectional and temporal associations between MPD and the risk of TMHD among children aged 5 and 7, 8 models were formed in a step-wise fashion to test for demographic characteristics, MPD in infancy, psychosocial factors, poverty level, and maternal SEP.

**Table 4.3**: Summary of models 1-8

| Model | Explanatory variable(s) |
|---|---|
| Model 1 | Null model = no explanatory variables |
| Model 2 | Model 1+MPD in infancy |
| Model 3 | Model 2+maternal age+ child sex |
| Model 4 | Model 3+ Parenting practices + closeness to child +parental relationship* + use of force from partner |
| Model 5 | Model 4 +disorganised home +damp or condensation in home + good area to raise children** + safe area** |
| Model 6 | Model 5 + Poverty level |
| Model7 (Full model) | Model 6+ Household income +maternal education + maternal occupational class |
| Model 8 Final Model | Significant variables in the full model |

* In wave 4 the variable asking mothers whether they are happy or unhappy in current relationship was used.

** In wave 4: the variable regarding the availability of playgrounds for the child to play was used.

*Objective 3*

In order to explore the effect of MPD chronicity on TMHD at age 7, seven models were structured, adjusting for demographic characteristics, psychosocial factors, and poverty level and SEP factors.

**Table 4.4**: presents a summary of models 9 to 15

| **Model** | **Explanatory variable(s)** |
|---|---|
| Model 9 | Null model = no explanatory variables |
| Model 10 | Model 1+maternal age+ child sex |
| Model 11 | Model 2+ Parenting practices + closeness to child + happy/unhappy in current relationship + use of force from partner |
| Model 12 | Model 3 +disorganised home +damp or condensation in home + parks, playgrounds that child can play |
| Model 13 | Model 4 + Poverty level |
| Model 14 (Full model) | Model 5+ Household income +maternal education + maternal occupational class |
| Model 15 (Final Model) | Significant variables in the full model |

## Interactions

Interactions with the main explanatory variables of this study were tested by *Wald tests* comparing the models including and excluding the interaction term. Nevertheless, none of the interaction terms were found statistically significant.

### 4.8: Ethical Issues

The Multi-Center Research Ethics Committee in the UK obtained ethical approval for the MCS. Informed consent was obtained from all carers of participating children. Data for the analysis were publicly available for academic scholars and were obtained from the UK Data Archive and Economic and Social Data Service.

### 4.9: Summary

This chapter described the MCS dataset which was used for the analysis of the current research project, and the methodological instruments were used, were also introduced. In this methods section, a description of the missing data and their handling is given and the analytical strategy used is presented. The next chapter will present the main findings of this study.

# Chapter 5: Results

## 5.1: Descriptive analysis

### Sample characteristics and prevalence of MPD/TMHD

Descriptive statistics of 7898 children whose mothers participated in the study up to 7 years old are shown (**tables 5.1 & 5.2**). A high *prevalence* rate of **10.8%** women with MPD during *infancy* period was detected in this study. Accordingly, at ages 5 and 7, temporal MPD represented a lower prevalence (**1.8%** & **1.9%**). In terms of TMHD at **5 years** of age, **7.8%** of the study sample faced MHD, with an increase at **7 years** of age (**9.9%).** Also, the highest number of women participated in this study belonged in the age group of 30 to 39 years old.

### Sample psychosocial characteristics of mothers and children

At both 5 and 7 years, high rates of *poor quality parenting* are being observed (**tables 5.1 & 5.2**). High withdrawal of attention or child neglect surged from 12.3% at 5 to 20.3% at 7. Similarly, the percentage of children being verbally or physically abused at 5, almost doubled by age 7 (from 13% to 24.4%). Besides, a deterioration of the bonds between mothers and children was prominent during the study period, with 4.4% of the relationships between mothers and their children, characterized as low at 7, compared to 2.8% at age 5. The same pattern is shown for the *quality of parental relationship* on the fifth year of age, with 23.1% of couples facing serious marital problems **(table 5.1).**

**Sample socio-economic characteristics**

In each socioeconomic parameter analysed (maternal education, maternal social class and household income), the absolute number of respondents from higher SEP is higher than lower SEP. This fact gives further support to sensitivity analysis results, in which it was shown that children from lower SEP were less likely to have complete information for the parameters used in the analysis **(Appendix 2).** Moreover, substantially high rates of children living in poverty, in disorganised homes and in homes with damp or condensation were observed. Surprisingly, unemployment rate between women was striking, with 1/3 of mothers being unemployed at age 5 (sweep 3) and 28.7% of them not working at age 7**.**

**Table 5.1:** Sample characteristics at age 5

| Variable | Category | N | % |
|---|---|---|---|
| **Mothers** | | 7.898 | 98.60% |
| **Fathers** | | 112 | 1,40% |
| **Total mental health difficulties at 5** | No | 7,281 | 92,2% |
| | Yes | 617 | 7,8% |
| **MPD at 5** | No | 7,757 | 98,2% |
| | Yes | 141 | 1,8% |
| **Maternal Psychological Distress at infancy** | No | 7,045 | 89.2% |
| | Yes | 853 | 10.8% |
| **Maternal age at sweep 3** | 40+ | 1,625 | 20,6% |
| | 30-39 | 5,011 | 63,4% |
| | 20-29 | 1,262 | 16% |
| **Child's sex** | Male | 3,991 | 50,5% |
| | Female | 3,907 | 49,5% |
| **Withdrawal of attention** | Low | 2,126 | 26,9% |
| | Medium | 4,799 | 60,7% |
| | High | 973 | 12,3% |
| **Overt punishment** | Lowest quartile | 2,445 | 31% |
| | Second quartile | 1,585 | 20% |
| | Third quartile | 2,846 | 36% |
| | Highest quartile | 1,022 | 13% |
| **Maternal closeness to child** | Extremely close | 5,629 | 71,2% |
| | Fairly close | 2,049 | 26% |
| | Not very close | 220 | 2.8% |
| **Quality of parental relationship** | Highest | 638 | 8,1% |
| | Second quartile | 2,064 | 26,1% |
| | Third quartile | 3,375 | 42,7% |
| | Lowest | 1,821 | 23,1% |
| **Has partner ever used force to mother?** | No | 7,764 | 97% |
| | Yes | 234 | 3% |
| **Damp or condensation in home** | No | 7,076 | 89.6% |
| | Yes | 822 | 10.4% |
| **Disorganised home** | No | 6,846 | 86,7% |
| | Yes | 1,052 | 13,3% |
| **Whether good area for raising children** | Excellent | 2,911 | 36,8% |
| | Very good | 3,305 | 41,8% |
| | Average | 1,410 | 17,8% |
| | Poor | 204 | 2,6% |
| | Very poor | 68 | 0,9% |
| **Feeling of safety in the area** | Yes | 7,636 | 96.7% |
| | No | 262 | 3.3% |

| | | | |
|---|---|---|---|
| **Poverty level** | Over median 60% | 6,582 | 83,4% |
| | Below median 60% | 1,311 | 16,6% |
| **OECD equivalized household income at 5** | Highest quintile | 2,338 | 29,5% |
| | Second quintile | 2,087 | 26,4% |
| | Third quintile | 1,767 | 22,5% |
| | Fourth quintile | 1,164 | 14,8% |
| | Lowest quintile | 542 | 6,9% |
| **Maternal Education at 5** | NVQ5 | 536 | 6,8% |
| | NVQ4 | 2,939 | 37,2% |
| | NVQ3 | 1,264 | 16% |
| | NVQ2 | 2,092 | 26,4% |
| | NVQ1 | 485 | 6,2% |
| | Overseas | 126 | 1,6% |
| | No qualifications | 456 | 5,8% |
| **Maternal social class at 5** | Higher managerial and professional | 2,189 | 27.7% |
| | Intermediate | 1,207 | 15,3% |
| | Small employers and own account workers | 455 | 5,8% |
| | Low supervisory and technical | 201 | 2,5% |
| | Semi-routine and routine | 1,235 | 15.6% |
| | Not working | 2,611 | 33.1% |

**Table 5.2:** Sample characteristics at age 7

| Variable | Category | N | % |
|---|---|---|---|
| **Mothers** | | 7.898 | 98,6% |
| **Fathers** | | 112 | 1,4% |
| **Total mental health difficulties at 7** | **No** | 7,118 | 90,1% |
| | **Yes** | 780 | 9,9% |
| **MPD at 7** | No | 7,748 | 98,1% |
| | Yes | 150 | 1,9% |
| **MPD in infancy** | No | 7,045 | 89.2% |
| | Yes | 853 | 10.8% |
| **Maternal age at sweep 4** | 40+ | 2,607 | 33% |
| | 30-39 | 4,469 | 56,6% |
| | 20-29 | 882 | 10,4% |
| **Child's sex** | Male | 3,992 | 50.5% |
| | Female | 3,906 | 49.5% |
| **Withdrawal of attention** | Low | 2,458 | 31,1% |
| | Medium | 3,837 | 48,6% |
| | High | 1,603 | 20,3% |
| **Overt Puvishment** | Lowest quartile | 2,961 | 37,5% |
| | Second quartile | 1,571 | 19.9% |
| | Third quartile | 1,477 | 18,3% |
| | Highest quartile | 1,919 | 24,3% |
| **Maternal closeness to child** | Extremely close | 5,268 | 66,7% |
| | Fairly close | 2,281 | 28,9% |
| | Not very close | 349 | 4,4% |
| **Happy in current relationship** | Yes | 7,267 | 92% |
| | No | 631 | 8% |
| **Has partner ever used force to mother?** | No | 7,651 | 96.9% |
| | Yes | 247 | 3.1% |
| **Damp or condensation in home** | No | 6,944 | 87,9% |
| | Yes | 954 | 12,1% |
| **Disorganised home** | No | 6,846 | 86.7% |
| | Yes | 1,052 | 13.3% |
| **Are there any places for child to play** | Yes | 7,087 | 89.7% |
| | No | 811 | 10.3% |
| **Poverty level** | Over median 60% | 6,768 | 85,7% |
| | Below median 60% | 1,130 | 14,3% |
| **OECD equivalized household income at 7** | Highest quintile | 2,227 | 28,2% |
| | Second quintile | 2,095 | 26,5% |
| | Third quintile | 1,716 | 21.7% |
| | Fourth quintile | 1,155 | 14,6% |
| | Lowest quintile | 705 | 9% |
| **Maternal Education at 7** | NVQ5 | 652 | 8,3% |
| | NVQ4 | 2,955 | 37,4% |

| | | | |
|---|---|---|---|
| | NVQ3 | 1,271 | 16% |
| | NVQ2 | 2,029 | 25,7% |
| | NVQ1 | 455 | 5,8% |
| | Overseas | 119 | 1,5% |
| | No qualifications | 417 | 5,3% |
| **Maternal social class at 7** | Higher managerial and professional | 2,317 | 29.4% |
| | Intermediate | 1,252 | 15,7% |
| | Small employers and own account workers | 519 | 6.6% |
| | Low supervisory and technical | 208 | 2,6% |
| | Semi-routine and routine | 1,339 | 17% |
| | Not working | 2,269 | 28.7% |

## 5.2 Univariate analysis

In the univariate analysis performed, after testing for total mental health difficulties at ages 5 and 7, most variables were associated the outcome of the study, except the *use of force from partner* variable (p=0.24) at age 5 (**Appendix 1**).

**Univariate analysis for total mental health difficulties at 5**

At age 5, sub-categories of the categorical variables used in the analysis were statistically insignificant. However, it was decided for those variables not to be omitted since the p-value of *Wald tests* conducted were highly significant (p <0.001).

**Univariate analysis for total mental health difficulties at 7**

At age 7, *Wald tests* were conducted in order to decide whether to include in the analysis the categorical variables with insignificant subcategories. All of them were significant and it was decided to keep them in the analysis

## 5.2 Logistic regression analysis

In this section results from multivariable statistical analysis are being reported for all models, whereas models **3,5,6,10,12,13** are being shown in the **appendix 4**.

### 5.2.1 Total mental health difficulties at age 5

First, the null model (**model 1**) showed a very strong association between MPD at 5 and TMHD at 5, respectively (**table 5.3**). In particular, the null or unadjusted model showed that children whose mothers suffered from MPD when they were 5 years-old were 8.5 times more likely to develop TMHD at that age, compared to children whose mothers did not suffer from MPD at that age.

**A**fter controlling for *MPD at 9 months***(model 2)** an attenuation of the odds was observed, with children of mothers with MPD being 5.8 times more likely to face TMHD at age 5 and 2.5 times more likely to face TMHD if their mothers suffered from MPD at 9 months, after controlling for MPD at 5. *Demographic factors* (**model 3**), such as maternal age and child sex seemed to play a small but an important role in explaining the association studied.

*Psychosocial factors* (**model 4**) were found very important in explaining the association between MPD and TMHD at 5. After adjusting for them, the odds of TMHD at 5 dropped substantially, with children living with MPD sufferers being 3.5 times more likely to develop TMHD and almost 2 times more likely if their mothers had MPD during their infancy. Furthermore, when adjusting for *housing, area conditions and poverty* (**models 5 and 6**) a further attenuation in the odds of TMHD at 5 is being monitored regarding current MPD and MPD in infancy. Adjustment for *maternal SEP* **(model 7)** provided further but small attenuation in the odds of TMHD at 5. Contrary to the other models, poverty ceased to explain the association between MPD and TMHD, suggesting a greater important role of *social inequalities* on TMHD risk in early childhood, compared to poverty.

Particularly, children whose mothers belonged in the lowest household income quintile were 2 times more likely of TMHD at 5. Children of mothers with no educational qualifications were almost 2.3 times more likely to develop TMHD at 5 and social class was insignificant at all. *Adjusted Wald tests* conducted showed that only maternal education was strongly significant (**table 5.3 and model 7**) and was included in the final model.

In the *final model* **(model 8)**, results indicated that children whose mothers suffered from temporal MPD were almost 3 times and strikingly almost 2 times more likely to face TMHD at 5 if their mothers had MPD at 9 months, after adjusting for covariates. Independently of MPD, children of mothers **without *education*** were almost 4 times more likely to suffer from TMHD, 2.36 and 2.6 times respectively when their mother had **lower** or **overseas** vocational qualifications.

Other significant factors in the final model for TMHD at 5 were *young motherhood, child sex, poor maternal parenting practices, mother-child relationship, low quality of parental relationship, and disorganised home condition*.

## Table 5.3: ORs (95%) of TMHD at age 5

| | | MODEL 1 | | MODEL 2 | | MODEL 4 | | MODEL 7 | | MODEL 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **Category** | OR | P-value | OR | P-value | OR | P-value | OR | P-value | OR | P-value |
| **MPD at 5** | **No** | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Yes** | 8.48 (5.91-12.2) | <0.001 | 5.80 (3.90-8.63) | <0.001 | 3.55(2.17-5.87) | <0.001 | 2.64 (1.57-4.42) | <0.001 | 2.97 (1.80-4.88) | <0.001 |
| **Maternal Psychological Distress at infancy** | **No** | | | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Yes** | | | 2.53 (1.97-3.25) | <0.001 | 1.97 (1.48-2.61) | <0.001 | 1.79 (1.34-2.39) | <0.001 | 1.90 (1.41-2.54) | <0.001 |
| **Maternal age at sweep 3** | | | | | | | | | | | |
| | **40+** | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **30-39** | | | | | 0.97 (0.76-1.30) | 0.98 | 0.93 (0.70-1.23) | 0.61 | 0.96 (0.73-1.25) | p=0.75 |
| | **20-29** | | | | | 2.33(1.68-3.23) | <0.001 | 1.50 (1.06-2.11) | <0.02 | 1.78 (1.27-2.50) | <0.001 |
| **Child's sex** | **Male** | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Female** | | | | | 0.65 (0.53-0.81) | 0.001 | 0.64 (0.51-0.80) | <0.001 | 0.63 (0.51-0.78) | <0.001 |
| **Parent-Child relationship** | | | | | | | | | | | |
| **Withdrawal of attention** | **Low** | | | | | 1 (ref) | | 1 (ref) | | | |
| | **Medium** | | | | | 0.94 (0.71-1.25) | 0.69 | 1.02 (0.76-1.37) | 0.90 | 1.00 (0.74-1.33) | p=0.98 |
| | **High** | | | | | 1.80 (1.31-2.46) | <0.001 | 1.94 (1.39-2.69) | <0.001 | 1.90 (1.37-2.63) | <0.001 |
| **Wald test** | | | | | | | | | <0.001 (F=10.64) | | |
| **Overt punishment** | **Lowest quartile** | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Second quartile** | | | | | 1.47 (1.01-2.14) | 0.04 | 1.56 (1.06-2.29) | 0.03 | 1.51 (1.05-2.25) | <0.03 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Third quartile** | | | | | 2.36 (1.76-3.17) | <0.001 | 2.56 (1.91-3.44) | <0.001 | 2.43 (1.81-3.25) | <0.001 |
| | **Highest quartile** | | | | | 4.36 (3.22-6.66) | <0.001 | 4.68 (3.26-3.73) | <0.001 | 4.52 (3.14-6.51) | <0.001 |
| **Maternal closeness to child** | **Extremely close** | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Fairly close** | | | | | 1.52 (1.24-1.87) | <0.001 | 1.49 (1.20-1.85) | <0.001 | 1.50 (1.21-1.85) | <0.001 |
| | **Not very close** | | | | | 2.66 (1.72-4.11) | <0.001 | 2.50 (1.60-3.90) | <0.001 | 2.64 (1.70-4.10) | <0.001 |
| **Quality of parental relationship** | **Highest** | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | **Second quartile** | | | | | 1.04 (0.62-1.74) | 0.87 | 1.14 (0.68-1.94) | 0.61 | 1.11 (0.65-1.9) | 0.69 |
| | **Third quartile** | | | | | 1.46 (0.91-2.32) | 0.11 | 1.49 (0.92-2.38) | 0.11 | 1.48 (0.92-2.38) | 0.11 |
| | **Lowest** | | | | | 2.31 (1.42-3.76) | <0.001 | 2.01 (1.22-3.34) | 0.01 | 2.05 (1.24-3.37) | 0.01 |
| | | | | | | | | | 0.01 (F=4.97) | | |
| **Housing conditions** | | | | | | | | | | | |
| **Damp or condensation in home** | **No** | | | | | | | 1 (ref) | | 1 (ref) | |
| | **Yes** | | | | | | | 1.70 (1.34-2.16) | <0.001 | 1.80 (1.42-2.29) | <0.001 |
| **Disorganised home** | **No** | | | | | | | 1 (ref) | | | |
| | **Yes** | | | | | | | 1.06 (0.77-1.45) | 0.74 | | |
| **Whether good area for raising children** | **Excellent** | | | | | | | 1 (ref)* | | | |
| | **Very good** | | | | | | | 0.90 (0.69-1.19) | 0.47 | | |
| | **Average** | | | | | | | 1.01 (0.74-1.38) | 0.96 | | |
| | **Poor** | | | | | | | 1.90 (1.07-3.36) | 0.01 | | |
| | **Very poor** | | | | | | | 0.95 (0.36-2.51) | 0.92 | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wald test** | | | | | | | | | 0.15 (F=1.67) | | |
| **Safe area** | **Yes** | | | | | | | 1 (ref) | | | |
| | **No** | | | | | | | 1.08 (0.93-1.26) | 0.33 | | |
| **In poverty** | **Yes** | | | | | | | 1 (ref) | | | |
| | **No** | | | | | | | 1.05 (0.75-1.48) | 0.78 | | |
| **OECD equivalized household income at 5** | **Highest quintile** | | | | | | | 1 (ref)* | | | |
| | **Second quintile** | | | | | | | 1.17 (0.83-1.66) | 0.37 | | |
| | **Third quintile** | | | | | | | 1.25 (0.87-1.79) | 0.22 | | |
| | **Fourth quintile** | | | | | | | 1.28 (0.88-1.95) | 0.19 | | |
| | **Lowest quintile** | | | | | | | 2.00 (1.26-3.17) | <0.001 | | |
| **Wald test** | | | | | | | | | p=0.20 (F=1.50) | | |
| **Maternal Education at 5** | **NVQ5** | | | | | | | 1 (ref) | | 1 (ref) | |
| | **NVQ4** | | | | | | | 0.87 (0.51-1.47) | 0.59 | 1.04 (0.60-1.79) | 0.89 |
| | **NVQ3** | | | | | | | 1.29 (0.73-2.25) | 0.38 | 1.66 (0.95-2.88) | 0.07 |
| | **NVQ2** | | | | | | | 1.20 (0.70-2.07) | 0.51 | 1.68 (0.98-2.90) | 0.06 |
| | **NVQ1** | | | | | | | 1.59 (0.85-2.98) | 0.15 | 2.36 (1.27-4.40) | 0.01 |
| | **Overseas** | | | | | | | 1.64 (0.77-3.59) | 0.20 | 2.60 (1.22-5.55) | 0.02 |
| **Wald test** | | | | | | | | | p=0.01 (F=3.89) | | |
| | **No qualifications** | | | | | | | 2.26 (1.26-4.07) | 0.01 | 3.97 (2.27-6.95) | <0.001 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| **Maternal social class at 5** | **Higher managerial and professional** | | | | | | | 1 (ref)* | | | |
| | **Intermediate** | | | | | | | 1.03 (0.73-1.46) | 0.86 | | |
| | **Small employers and own account workers** | | | | | | | 1.22 (0.69-2.13) | 0.49 | | |
| | **Low supervisory and technical** | | | | | | | 1.40 (074-2.62) | 0.30 | | |
| | **Semi-routine and routine** | | | | | | | 1.11 (0.72-1.71) | 0.62 | | |
| | **Not working** | | | | | | | 1.36 (0.98-1.89) | 0.06 | | |
| **Wald test** | | | | | | | | | 0.26 (F=1.30) | | |

### 5.2.2 Total mental health difficulties at 7

At age 7 (**table 5.4**), a strong but attenuated association between MPD (at 7) and TMHD at 7 was observed in the null model (**model 1**). After controlling for *MPD at 9 months* (**model 2**), there was further decrease in the odds of MHD associated with temporal MPD. In **model 4**, when *psychosocial factors* were being adjusted to the previous models, the chances of TMHD when the child had a mother with MPD dropped from an OR of 3.75 to an OR of 2.74, and from OR 2.15 to OR 1.88 when child's mother suffered from MPD in infancy, after controlling for confounders. Housing and area conditions (**model 5**) seemed to play an important on the association between temporal MPD and the odds of TMHD. In **model 6**, poverty was a significant predictor of TMHD at 7, after adjusting for covariates. In the full model (**model 7**), after adjusting for *maternal SEP*, poverty ceased to be significant predictor of TMHD at 7, as it happened at age 5. Particularly, lower household income and lower social class at 7 predicted increased chances of TMHD at 7. Nevertheless, when adjusted Wald tests conducted for those categorical variables with insignificant sub-categories, only maternal social class found to be significant and therefore should be included in the final model.

In the final model (**model 8**), the association between current MPD and TMHD remained strong, with children at age 7 living with psychologically distressed mothers being 2.2 times more likely to develop TMHD at 7, whereas children whose mothers experienced MPD at nine months were 71% more likely to develop TMHD, after controlling for all covariates. In addition, independently of TMPD, demographic characteristics, psychosocial characteristics, housing and area conditions, children belonged in *lower* ***social class*** were at a substantial higher risk of TMHD.

To conclude, in the final model, significant risk factors of TMHD at 7 were *maternal age, child sex, maternal parenting practices, maternal child relationship, housing conditions*, such as *damp or condensation-disorganised home*.

## Table 5.4: ORs (95%) of TMHD at age 7

| Variable | Category | OR | P-value | OR | P-value | OR | P-value | OR | P-value | OR | P-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MPD at 7** | No | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | 5.36 (3.56-9.09) | <0.001 | 4.05 (2.60-6.29) | <0.001 | 2.74 (1.63-4.61) | <0.001 | 1.98 (1.16-3.37) | 0.02 | 2.20 (1.32-3.69) | 0.01 |
| **Maternal Psychological Distress at infancy** | No | | | 1 (ref) | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | | | 2.19 (1.70-2.81) | <0.001 | 1.88 (1.42-2.49) | <0.001 | 1.61 (1.22-2.13) | <0.001 | 1.71 (1.29-2.28) | <0.001 |
| **Maternal age at sweep 4** | | | | | | | | | | | |
| | (40+)* | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | (30-39)* | | | | | 1.37 (1.11-1.69) | <0.001 | 1.24 (1.01-1.54) | 0.05 | 1.30 (1.05-1.61) | 0.02 |
| | (20-29)* | | | | | 3.19 (2.36-4.31) | <0.001 | 2.10 (1.52-2.91) | <0.001 | 2.48 (1.82-3.39) | <0.001 |
| **Child's sex** | Male | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Female | | | | | 0.68 (0.56-0.83) | <0.001 | 0.67 (0.55-0.82) | <0.001 | 0.69 (0.56-0.84) | <0.001 |
| **Parent-Child relationship** | | | | | | | | | | | |
| **Withdrawal of attention** | Low | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Medium | | | | | 1.27 (0.96-1.69) | 0.09 | 1.31 (0.99-1.72) | 0.06 | 1.28 (0.97-1.68) | 0.08 |
| | High | | | | | 2.68 (2.06-3.48) | <0.001 | 2.63 (2.03-2.40) | <0.001 | 2.57 (1.98-3.34) | <0.001 |
| **Wald test** | | | | | | | | | <0.001 (F=42.1) | | |
| **Overt punishment** | Lowest quartile | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Second quartile | | | | | 1.00 (0.75-1.33) | 1.00 | 1.05 (0.79-1.41) | 0.73 | 1.01 (0.75-1.34) | 0.95 |
| | Third quartile | | | | | 1.35 (1.03-1.78) | 0.04 | 1.40 (1.07-1.83) | 0.02 | 1.37 (1.05-1.77) | 0.03 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest quartile | | | | | 2.06 (1.59-2.67) | <0.001 | 2.16 (1.68-2.78) | 0.001 | 2.07 (1.61-2.67) | <0.001 |
| **Wald test** | | | | | | | | | <0.001 (F=17) | | |
| **Maternal closeness to child** | Extremely close | | | | | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Fairly close | | | | | 1.28 (1.07-1.54) | 0.01 | 1.30 (1.07-1.58) | 0.01 | 1.28 (1.05-1.54) | 0.02 |
| | Not very close | | | | | 2.50 (1.80-3.48) | <0.001 | 2.40 (1.69-3.39) | <0.001 | 2.37 (1.68-3.34) | <0.001 |
| **Happy in current relationship** | Yes | | | | | 1 (ref) | | 1 (ref) | | | |
| | No | | | | | 0.73 (0.54-0.98) | 0.04 | 0.76 (0.56-1.03) | 0.07 | | |
| **Use of force from partner** | No | | | | | 1 (ref) | | 1 (ref) | | | |
| | Yes | | | | | 1.16 (0.71-1.90) | p=0.55 | 1.14 (0.72-1.80) | 0.58 | | |
| **Housing conditions** | | | | | | | | | | | |
| **Damp or condensation in home** | No | | | | | | | 1 (ref) | | 1 (ref) | |
| | Yes | | | | | | | 1.47 (1.15-1.88) | 0.01 | 1.54 (1.20-1.97) | <0.001 |
| **Disorganised home** | No | | | | | | | 1 (ref) | | 1 (ref) | |
| | Yes | | | | | | | 1.88 (1.54-2.31) | <0.001 | 2.04 (1.68-2.48) | <0.001 |
| **Any places for child to play** | Yes | | | | | | | 1 (ref) | | | |
| | No | | | | | | | 1.35 (0.99-1.81) | 0.052 | | |
| **In poverty** | Yes | | | | | | | 1 (ref) | | | |
| | No | | | | | | | 1.09 (0.77-1.53) | 0.63 | | |
| **OECD equivalized household income at 7** | Highest quintile | | | | | | | 1 (ref)* | | | |
| | Second quintile | | | | | | | 1.20 (0.93-1.57) | 0.17 | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Third quintile | | | | | | | 1.38 (1.03-1.85) | 0.04 | | |
| | Fourth quintile | | | | | | | 1.52 (1.09-2.12) | 0.02 | | |
| | Lowest quintile | | | | | | | 1.46 (0.95-2.24) | 0.052 | | |
| **Wald test** | | | | | | | | | 0.10 (F=1.95) | | |
| **Maternal Education at 7** | NVQ5 | | | | | | | 1 (ref)* | | | |
| | NVQ4 | | | | | | | 0.80 (0.53-1.22) | 0.30 | | |
| | NVQ3 | | | | | | | 0.87 (0.55-1.37) | 0.56 | | |
| | NVQ2 | | | | | | | 0.96 (0.65-1.42) | 0.85 | | |
| | NVQ1 | | | | | | | 0.97 (0.59-1.57) | 0.86 | | |
| | Overseas | | | | | | | 1.31 (0.57-3.00) | 0.52 | | |
| | No qualifications | | | | | | | 1.49 (0.93-2.38) | 0.09 | | |
| **Wald test** | | | | | | | | | 0.08 (F=1.88) | | |
| **Maternal social class at 7** | Higher managerial and professional | | | | | | | 1 (ref) | | 1 (ref) | |
| | Intermediate | | | | | | | 1.29 (0.92-1.81) | 0.14 | 1.42 (1.03-1.95) | 0.04 |
| | Small employers and own account workers | | | | | | | 1.00 (0.64-1.56) | 0.98 | 1.21 (0.79-1.86) | 0.34 |
| | Low supervisory and technical | | | | | | | 2.29 (1.37-3.82) | 0.01 | 2.60 (1.58-4.27) | <0.001 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Semi-routine and routine | | | | | | | 1.43 (1.00-2.03) | 0.05 | 1.75 (1.27-2.42) | <0.001 |
| | Not working | | | | | | | 1.48 (1.08-2.02) | 0.02 | 1.92 (1.46-2.52) | <0.001 |
| **Wald test** | | | | | | | | | 0.02 (F=2.68) | | |

### 5.2.3 The effect of chronic maternal psychological distress chronicity on total mental health difficulties at 7

Chronic MPD was strongly associated with TMHD at 7 (**table 5.5**). In the null model (**model 9**), it was found that children whose mothers suffered from MPD in at least 2 sweeps were 645% more likely to face TMHD at 7, whereas children of mothers with MPD in all 3 sweeps were 640% more likely to develop TMHD at 7. A small attenuation of odds for TMHD was observed when demographic factors were taken into consideration (**model 10**), but when psychosocial factors were adjusted (**model 11**), a considerable decrease in the odds of TMHD at 7, took place. The largest decrease happened in the odds of children whose mothers suffered from MPD in all 3 sweeps (from an OR 7.28 to an OR of 4.50). Considerable also was the decrease in the category including the OR of children having mothers with MPD at 2 sweeps. This time a smaller attenuation was recorded, from an OR of 7.11 to an OR 5.22.Housing and area conditions (**model 12**) were responsible for a further decline in all categories of MPD chronicity, which was the second biggest after adjustment of psychosocial factors. In **model 13**, poverty was a significant predictor of TMHD at 7, but stopped being when controlling for SEP (**model 14**) was done. In the full model only *social cla*ss was found statistically significant after conducting *adjusted Wald tests*. It worth noting that MPD in all sweeps was not significant in this model, but turned to be significant in the final model. In the final model (**model 15**), it was found that MPD ,I n all categories of chronic MPD formed, was a considerable predictor of TMHD at 7, with the strongest effect being monitored on children whose mothers suffered from MPD in at least 2 sweeps .

**Table 5.5:** The effect of chronic MPD on TMHD at 7

| Chronicity of MPD | N | Model 9 | Model 11 | Model 14 (Full model) | Model 15*/** (Final model) |
|---|---|---|---|---|---|
| **MPD in none of the sweeps** | 6912 (87,5%) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) |
| **MPD at least in one sweep** | 862 (11%) | 2.48 (1.97-3.12) | 1.87 (1.44-2.44) | 1.73 (1.34-2.25) | 1.84 (1.41-2.41) |
| **MPD in two sweeps** | 90 (1.1%) | 7.45 (4.39-12.7) | 4.51 (2.50-8.15) | 3.50 (1.90-6.45) | 4.09 (2.21-7.60) |
| **MPD in three sweeps** | 34 (0,4%) | 7.40 (3.17-17.3) | 3.28 (1.33-8.11) | 2.25 (0.90-5.61) | 2.98 (1.27-6.99) |

*Chi trend of odds=251.74, p<0.001 (OR for MPD in 3 sweeps insignificant)

**maternal age, child sex, withdrawal of attention, overt punishment, mother-child closeness, disorganised home conditions, damp or condensation and maternal social class

# Chapter 6: Discussion

This section provides the summary of the results and methodological issues will be discussed. These results will be also compared with previous research findings. Research and policy implications will be presented below.

## 6.1: Summary of results

This study used data from MCS study to evaluate the impact of MPD or that of maternal SEP on TMHD of children aged 5 and 7 in the UK. The prevalence rate of mental health difficulties at age 5 was 7.8% and increased to 9.9% at age 7. Respectively, a reverse pattern was observe for MPD. MPD at 9 months was 10.4% and fell to 1.8%-1.9% at $5^{th}$ and $7^{th}$ year of children. Mothers were more than three times more likely to belong in low-income strata, were also more likely to be unemployed and have lower education at both age 5 and 7 (results not shown).

With respect to the first hypothesis, this study showed that cross-sectional MPD at 5 and 7 was strongly associated with higher chances of TMHD in children of 5 and 7 years of age respectively, even after adjusting for demographic characteristics of mothers and children, mother-child relationship, quality of parental relationship, poverty level, maternal SEP, housing and area characteristics. Furthermore, this strong relationship remained even after accounting for maternal psychological distress in infancy. Particularly, the findings showed that MPD at the first months of life of a child could have a significantly and substantially detrimental effect on developing TMHD in early childhood, after considering individual, psychosocial and socioeconomic characteristics.

Second, maternal SEP was partly associated with TMHD at ages 5 and 7. Lower or no maternal education at 5 played an important role in the development of TMHD at age 5, whereas maternal social class at 7 was an important predictor of TMHD at age 7.

Third, it was found that the chronicity of MPD at 9 months, 5 and 7 years old predicted substantial high chances of MHD in the 7$^{th}$ year of age after adjusting for covariates.

In the next parts of this chapter, the strengths and the limitations of this study will be addressed, whereas the conceptual, methodological and clinical implications of the findings are being considered.

**6.2 Methodological issues**

The present study has both methodological strengths and limitations, which should be considered while interpreting its results. The most important methodological issues, including sample representativeness, prospective study design, random and systematic error, and confounding will be discussed in the following sections.

**Sample representativeness**

The current study includes all children in the UK born in 2000-2001, which increases the ***validity*** and the ***generalizability*** of the results since the current study includes a wide study population from the whole UK. The large study sample increases the power of the study, and thus decreases the possibility of bias and error.

**Prospective design of the sample**

The prospective design of this study can provide insights into the association between MPD/ maternal SEP and TMHD in early childhood. Particularly, since children were free of TMHD at the time MPD was identified (9 months), the ***cross-sectional association*** between MPD and MHD at both age 5 and 7 can be clearly elucidated. In addition, it should be mentioned that the study's nature is essentially observational and thus the associations found and reported do not indicate causality._However, if any causal relationship exists, is largely towards the direction of mother-to-child.

**Random error**

In order to investigate the role of ***chance*** as a potential explanation to study's results, 95% CIs have been calculated and reported for all the ORs, to represent the most possible population effect size. Since a relatively great number of statistical tests conducted, the role of chance should not be excluded and it should be considered that some statistically significant results (5%) might be attributable to chance. However, chance is not a likely explanation for the results obtained in this study, as they were firmly consistent across sweeps 3 and 4. The research hypotheses were formulated before the initiation of statistical analysis. Therefore, the results of this study seem *plausible* and *consistent* to similar studies conducted in the past.

**Response rate**

Theoretically, ***non-response selection bias*** could not be excluded**,** non-response is more likely to come from disadvantaged areas and people with low SEP (Brown and Schoon, 2010). This would potentially decrease the strength of the association of interest and consequently underestimate the risk of TMHD in early childhood. Relatively Further, a comparison of the children remained in the analysis and children whose mothers failed to give information for at least one of the variables included in the study, showed that children with at least one missing value were more likely to come from lower SEP. Therefore, relatively low levels of general response, as well as selection of mothers with high or higher SEP, could restrict the generalizability of the results obtained upon TMHD of children coming from low SEP. Thus, future research should apply *imputation method* to deal with missing data, and enrich future analyses with more complete and valid data.

**Misclassification**

In current study, both the exposure and outcome of interest *were self-reported* rather than been identified by *clinical assessment*. This constitutes of a methodological concern to the extent to that, mothers may exaggerate when answering questions about their mental health **(*differential misclassification*)** and it may also be that mothers with MPD, may misreport or not recognize the signs of mental health difficulties in their children. Particularly, if mothers with MPD had misreported on their children's total mental health difficulties, there could be a high risk of a deflation onto the chances of developing TMHD in early childhood (Mensah and Kiernan, 2011).

**Attrition**

Attrition or loss to follow-up, could certainly raise doubts about the validity of study's results. Despite the rate of loss to follow-up in MCS is not extreme the probability of loss may be related to the exposure of interest in the current study. Particularly, mothers with MPD may be more likely to move to another geographic location. Relative to this, evidence on MCS states that movers-out are more prevalent in socio-economic disadvantaged areas, and that the current address of people moved, could not be ascertained in 33.2% of the cases (Joshi et al., 2010) .

**Confounding**

***Residual confounding*** or otherwise unmeasured confounding is an unavoidable element of observational studies. In terms of SEP, even the use of a variety of socioeconomic parameters (maternal education, social class, current unemployment status, household income, housing conditions, household-income related poverty) may not accurately reflect the influence of all those socioeconomic conditions related to a higher risk of MHD in early childhood. For instance, the lack of information in the final sample of this study, regarding children of lone mothers and children living in overcrowded houses could demonstrate substantial confounding on the association of interest, as the results of the study revealed that socioeconomically disadvantaged women and their children are the most vulnerable.

The *lack of biomarkers* and *genetic* information for both mothers and children is another limitation, since there is evidence of an interaction between environment, dysregulation of brain biochemical processes and vulnerability to disease in genetically predisposed individuals (De Kloet et al., 1998, de Kloet et al., 2005). Nevertheless, findings of studies addressing maternal postnatal depression have indicated a clear pattern of environmentally mediated effects (Murray L, 2003).

In addition, some lifestyle behaviours, such as *smoking status*, could also act as a confounder, being linked to both lower SEP and increased TMHD in early childhood. Nonetheless, existing scientific literature provides evidence about the effect of smoking onto TMHD in early childhood (DiFranza et al., 2004, Williams and Ross, 2007). Therefore, the inclusion of smoking during pregnancy was considered as inconsistent with the study's hypotheses. Future research should then include data relevant to mother's pregnancy, in order to make it possible to explore the *programming theory* that takes place in utero and has long lasting effects in child's life. Such information could possibly lead to evidence useful to support the existence of the biological programming in psychological sciences proposed by O'Connor and colleagues (O'Connor et al., 2003).

Besides , the use of *two different measures* to reflect MPD, the reduced Malaise inventory at nine months and the Kessler (K6) at 5 and 7 years, as none of them had been included in all 3 ages (sweeps 1,3 and 4), could not have an impact on the magnitude of the exposure of interest (MPD). Each of those two measures has been shown to reflect the magnitude of components of MPD, such as anxiety and depression in community populations (Rodgers et al., 1999, Kessler et al., 2003, Kessler et al., 2002). Nevertheless, the use of different variables for the quality of parental relationship at age 7 and maternal perception about area conditions may not reflect the true contribution of parental relationship quality and area conditions on MHD at 7.

Lastly, restricted time rendered difficult the rating of MPD and TMHD from different people, and thus an increased risk of *rater bias* as a potential confounder should be taken into account.

Finally, it should be noted that, due to the *UK context specific analysis* of this study, the findings may not be generalizable to other cultures, developed or developing countries.

To sum up, despite the limitations of the current research project findings seem to be of great importance in the attempt to explain child development, and mainly MHD in early childhood. Thus, the limitations of this study should be viewed under the pretext of study's strengths, including a large-scale prospective longitudinal study, which follows the condition of health of thousand children from their birth.

### 6.3 Comparison with previous research

In MCS sweep 3, McMunn and colleagues found that the prevalence of TMHD at the age of 5 was 9.3% for boys and 5.8% for girls (McMunn et al., 2012). In this study, the prevalence of TMHD among children at 5 years old was 7.8% and 9.9% at 7 years old.

#### 6.3.1: Maternal psychological distress and total mental health difficulties in early childhood

According to our knowledge, this is the first study using MCS data, looking at the effect of MPD on TMHD in early childhood. Particularly, the current study found a strong relationship between **cross-sectional MPD** and TMHD at ages 5 and 7, after taking into account demographic characteristics, psychosocial, housing/area conditions, poverty level and socioeconomic characteristics. It could be said that similar to this study's findings are the cross-sectional findings from the Health Survey of England (McMunn et al., 2001) , in which was indicated a two-fold increased risk of developing TMHD between the period 4-15, in children and adolescents having parents with MPD, after controlling for various individual demographic, psychosocial and socioeconomic characteristics. Compared to the cross-sectional study conducted by Vostanis and colleagues (Vostanis et al., 2006), the magnitude of the association between MPD in this study is smaller, however it should be mentioned that the cross-sectional character of Vostanis and colleagues, could be a source of *reporting bias* able to overestimate the magnitude of association.

Another finding that consists of a highly clinical and public health importance is the relatively strong effect that **MPD at nine months** could have on TMHD at ages 5 and 7 respectively. This finding is consistent with a study using data from the ALSPAC study, a birth cohort study recruited babies from the Avon County in England. According to this study, maternal antenatal anxiety predicted an increased likelihood of TMHD in early childhood. A strong relationship between maternal postnatal depression and hyperactivity/inattention difficulties at age 4 (OR:1.85, 95%CI: 1.22-2.81), and also a strong association between postnatal maternal anxiety and TMHD at age 4 found (OR:1.68, 95%CI: 1.12-2.54)(O'Connor et al., 2002). Also at age 8, stratified results by sex , after controlling for obstetric risks, psychosocial disadvantage, postnatal anxiety and depression at 4 months of age, boys exhibited a 116% (OR:2.16, 95%CI 1.41-3.30) higher chance of developing TMHD, whereas girls had a 91% (OR 1.91, 95%CI 1.26-2.89) increased probability of developing TMHD (O'Connor et al., 2003).

A novel and of high clinical importance finding, is that **chronic MPD** had a large effect on the chances of developing TMHD in early childhood. Therefore, this particular finding lays the foundations for future studies to address more systematically the impact of chronic MPD on TMHD. This would enable greater understanding of the role of the chronicity of MPD, with subsequent clinical and public health benefits in the identification, prevention and management of risk.

To sum up, chronic MPD, temporal MPD and MPD in infancy seem to have a highly deleterious effect on TMHD.

### 6.3.2: Socioeconomic position and total mental health difficulties in early childhood

In an attempt to answer to the question of how possible is for socioeconomic characteristics to predict TMHD at ages 5 and 7, the current study discovered that **maternal education at age 5** and maternal **social class at 7** are predictors of TMHD, independently of MPD. The significant results of this study support the results presented in the study by McMunn and colleagues (McMunn et al., 2001), in which they stated that children whose mothers had lower or no educational qualifications were almost 5 times more likely to have TMHD during a period from 4 to 15 years old. Contrary to that finding, this study's findings represent a more robust measurement of the effect size of the association. The narrowly derived confidence interval and the longitudinal design of the current study contribute to that.

Also, ***employment*** was a highly significant predictor of TMHD at age 5 and 7. Similarly, in a previous study conducted using MCS data, it was shown that maternal unemployment was an important source of TMHD at age 5 (McMunn et al., 2012).

Two possible explanations could be speculated on the negative or protective effect of lower or no maternal education and maternal social class on TMHD in early childhood. Firstly, it is assumed that children who belong in lower SEP face various socio-environmental inequities that are also depicted in this study. Particularly, economically disadvantaged children, as a consequence of low income and low maternal education, are exposed to a poorer home environment which involves meagre or no intellectual stimulation, less parental involvement and less financial resources devoted for child's entertainment and acquisition of skills, with detrimental consequences on child's TMHD (Evans and English, 2002, Evans, 2004). Another possible explanation could be given through the *illness behavior theory*. According to which, mothers who belong in low SEP do not recognize in time the mental health difficulties that possibly their children face. As literature suggests (Blane et al., 1996), it is more difficult for people with lower socioeconomic background to identify the symptoms of chronic disease since they may normalize these symptoms, and their children are often more likely to have a delayed psychiatric diagnosis and less adequate treatment.

### 6.3.3 Other predictors of total mental health difficulties at 5 and 7

In this study, a significant proportion of children TMHD at ages 5 and 7 had younger mothers. This coincides with studies that showed that child TMHD were associated with **young parenthood** (Bornstein, 2002) and also young motherhood with increased MPD (Mensah and Kiernan, 2010, Mensah and Kiernan, 2011). Generally, it could be said that increased maternal age was a protective factor in this study against TMHD in early childhood. This finding supports the evidence found in studies using MCS data (Sutcliffe et al., 2012, Barnes et al., 2014).

**Child sex** proved to have a protective effect for girls in this study. This finding is consistent to other studies conducted in the UK. In the ALSPAC longitudinal study boys were 61% more likely to face TMHD at age 4 (O'Connor et al., 2002), whereas McMunn and colleagues (McMunn et al., 2001) found that girls were 38% less likely to face TMHD.

Besides, **mother-child relationship** and interaction, proved to be significant predictors of TMHD in early childhood. This finding is consistent with previous studies suggesting that closeness to child consists of an important factor of healthy child development (Sroufe, 2005, Cassidy, 1994). Consistently, children whose mothers suffer from a mental health illness are more prone to be subjected to physical abuse and neglect (Casady and Lee, 2002, Kinard, 1996). Generally, many hypotheses have been formed in order to explain the mechanisms through which mother-child relationship could lead to the development of MHD in early childhood. Mechanisms posited include: a) chemical imbalances in the brain and hormonal dysregulation, constituting allostatic load that alters interpretations of stimuli and influences, behavioural, and hormonal responses, as a reaction, to potentially stressful situations (McEwen, 2003), b) inadequate and highly insufficient parenting practices interfere to a great extent with parent-child relationship driving to attachment problems and disruption of the normal child development (Lovejoy et al., 2000),and c) the experience of a stressful life when living with a mother with MPD and an aggregate number of risk factors generated by early life adversity such as marital disharmony and parental illness (Goodman and Gotlib, 1999).

This study provides evidence about the importance of maternal perception of **housing conditions**. Damp or condensation proved to be a significant risk factor only at 7 and not at 5 years of age in accordance with past evidence (Marmot, 1999). Also, an interesting finding is the strong and *cumulative effec*t of a disorganised home or alternatively home chaos on child's TMHD in this study. A cross-sectional study conducted in South England consistently found that home chaos was predictive of behavioural difficulties at age 4 and 8 (Coldwell et al., 2006). Also in another longitudinal study conducted, using MCS data, found that home chaos expressed by inconsistent bed-times was strongly associated with TMHD at age 7 (Kelly et al., 2013).

### 6.4. Research implications

The finding that MPD during infancy and cross-sectional MPD at 5 and 7 years old had a negative effect on TMHD, provides valuable evidence for the contribution of MPD in early child development in the UK.

However, evidence of deleterious effects of both prenatal and postnatal anxiety and depression on child mental health, support a systematic development and careful planning of future longitudinal studies, able to follow mothers from the conception. This in fact, could help public health scientists to provide enough evidence for supporting a fetal programming hypothesis in psychological sciences. Such evidence will set a firm basis for a wide range of actions, ranging from postnatal and early life interventions to preventive measures starting early enough (beginning of pregnancy), rather than late (postpartum period-early childhood).

To the best of my knowledge, no study conducted in exploring the possible mechanisms of MPD on TMHD in early childhood in the UK. Thus, it is suggested that future studies use *structural equation modelling* to explore direct/indirect pathways between MPD and TMHD in early childhood. Valuable evidence will be generated in informing feasible interventions and their correct timing.

One of the challenges encountered in the present research project and should be taken into consideration for future research on child development, is the absence of detail regarding the *severity of MPD*. In other words, future studies should be planned in a way in which validated instruments included, in order to provide information about the range of severity of MPD ,and not only instruments providing solely clinical cut-off points able to distinguish between presence and absence of MPD.

### 6.5 Policy implications

One of the most striking evidence of this research project is that MPD at 9 months had a greater impact on 5-year-old children and modestly decreased but highly significant effect on the TMHD of 7-year-old children.. This finding can be highly informative of the timing of future public health policies and interventions. Besides, in the current research project, psychosocial factors played an important role in TMHD in early childhood. Particularly, it is believed that inequalities in early development of TMHD can be prevented through policies that provide family and parenting support, maternal care, child care and education (Allen et al., 2014). The *Triple-P-Positive Parenting Program* is a population-oriented policy that was first implemented in Australia and was successfully implemented in other countries in Asia and Europe, including China, Japan and Switzerland (Leung et al., 2003, Matsumoto et al., 2010, Bodenmann et al., 2008). In its core, the program is a behavioral intervention in the family level that tries to contribute to the optimal emotional and behavioral development of the child (the components of MHD). A transformation of the family environment is being attempted, to one that helps the child to realize and develop its potential, and reduce as possible the risks associated with poor mental health and threaten future life chances (Sanders et al., 2008).

Although family environment should receive most of the attention, it is necessary to assure as well that those that take care of children (during toddlerhood, preschool and age-school years) have the appropriate education regarding the effects of MPD on the development of MHD in children. They should also be able to effectively identify MPD and unhealthy developmental patterns in children, and advocate for local services for the child and the family (Clinton, 2009).

Despite this study's recommendations of reducing the health inequalities observed in TMHD of children, there are serious obstacles to overcome. On the one hand, in the UK, prevention through early intervention is a comparatively neglected area, since financial resources devoted for such kind of interventions are scarce (Beecham, 2014). On the other hand, the budget cuts in child and adolescent mental health taking place in the UK to date are concerning. Therefore, a systematic effort should be attempted, in order to provide proportionately *universal programs*, according to the social gradient and the effective use of the scarce financial resources. Tackling mental health inequalities in early childhood could be not only beneficial for both individuals and their families, but also to the whole society, since with a healthier population a society is more likely to thrive. It should also been mentioned that policy interventions should not only focus on the biological or physical determinants of TMHD, but focus as well at the social determinants in an upstream level, in order to tackle health inequity in TMHD in early childhood. Finally, *a life course* approach according to the could then signal a variety of policy interventions across different health sectors, such as prenatal and postnatal care, social support and health care services for the whole family (Marmot, 2010).

## Chapter 7: Conclusions

In conclusion, this study explored the association between MPD/ maternal SEP and the risk of TMHD in early childhood. Results showed that temporal MPD, MPD in infancy, and chronic MPD were strongly associated with TMHD at ages 5 and 7, whereas statistically significant inequalities in TMHD at 5 years were seen by maternal education, and by maternal social class in TMHD at 7 years. Continuing research to improve the existing evidence is crucial, as well as preventive actions to reduce health inequity are necessary, through systematic efforts aiming at modifiable risk factors of TMHD in early childhood in the UK.

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## Appendix 1

## 1.1 Univariable regression for TMHD at age 5

| | | | | | |
|---|---|---|---|---|---|
| **Variable** | OR | Std.E | P-value | 95% | CI |
| **MPD at age 5/no** | 8.48 | 1.56 | <0.001 | 5.91 | 12.2 |
| **Maternal Psychological Distress at infancy** | 3.09 | 0.37 | <0.001 | 2.44 | 3.92 |
| **Maternal age at sweep 3** | | | | | |
| **30-39/40+** | 1.07 | 0.14 | 0.59 | 0.83 | 1.39 |
| **20-29/40+** | 2.96 | 0.46 | <0.001 | 2.18 | 4.01 |
| **Wald Test** | | | <0.001 | | |
| **Females/Boys** | 0.59 | 0.06 | <0.001 | 0.49 | 0.72 |
| **Withdrawal of attention** | | | | | |
| **Medium/High** | 1.42 | 0.19 | <0.01 | 1.1 | 1.85 |
| **Low/high** | 4.58 | 0.68 | <0.001 | 3.42 | 6.13 |
| **Overt Punishment** | | | | | |
| **2nd quartile/highest** | 1.55 | 0.28 | <0.02 | 1.08 | 2.22 |
| **3rd quartile/highest** | 2.77 | 0.39 | <0.001 | 2.1 | 3.66 |
| **4th quartile/highest** | 7.21 | 1.14 | <0.001 | 5.28 | 9.85 |
| **Maternal closeness to child** | | | | | |
| **Fairly close/very close** | 1.83 | 0.19 | <0.001 | 1.5 | 2.24 |
| **Not very close/very close** | 5.31 | 0.95 | <0.001 | 3.73 | 7.55 |
| **Quality of parental relationship** | | | | | |
| **2nd quartile/highest** | 0.89 | 0.22 | 0.65 | 0.55 | 1.45 |
| **3rd quartile/highest** | 1.53 | 0.34 | 0.06 | 0.99 | 2.37 |
| **Lowest/highest** | 3.19 | 0.71 | <0.001 | 2.06 | 4.94 |
| **Wald test** | | | <0.001 | | |
| **Has partner ever used force?** | | | | | |
| **Yes/no** | 0.75 | 0.18 | 0.24 | 0.46 | 1.21 |
| **Damp or condensation in home/no** | 1.59 | 0.22 | 0.01 | 1.21 | 2.09 |
| **Disorganised home/no** | 2.66 | 0.29 | 0.001 | 2.14 | 3.29 |
| **Whether good area for raising children** | | | | | |
| **Good/excellent** | 1.18 | 0.15 | 0.19 | 0.92 | 1.51 |
| **Average/excellent** | 2.06 | 0.27 | <0.001 | 1.59 | 2.66 |
| **Poor/excellent** | 4.68 | 1.02 | <0.001 | 3.05 | 7.17 |
| **Very poor/excellent** | 4.95 | 1.73 | <0.001 | 2.49 | 9.85 |
| **Feeling of safety in the area** | | | | | |
| **No/yes** | 1.53 | 0.09 | <0.001 | 1.36 | 1.72 |
| **In poverty/no** | 2.75 | 0.3 | <0.001 | 2.21 | 3.41 |
| **OECD equivalized household income** | | | | | |
| **2nd quintile/highest** | 1.68 | 0.3 | 0.01 | 1.19 | 2.38 |
| **3rd quintile/highest** | 2.48 | 0.41 | <0.001 | 1.79 | 3.43 |
| **4th quintile/highest** | 3.58 | 0.6 | <0.001 | 2.58 | 5,00 |
| **5th quintile/highest** | 3.48 | 0.71 | <0.001 | 2.33 | 5.21 |
| **Maternal Education** | | | | | |
| **NVQ4/NVQ5** | 1.15 | 0.29 | 0.58 | 0,70 | 1.91 |

| | | | | | |
|---|---|---|---|---|---|
| **NVQ3/NVQ5** | 2.38 | 0.62 | <0.001 | 1.43 | 3.97 |
| **NVQ2/NVQ5** | 2.33 | 0.58 | <0.001 | 1.42 | 3.8 |
| **NVQ1/NVQ5** | 3.75 | 1.1 | <0.001 | 2.11 | 6.67 |
| **Overseas qualifications** | 4.03 | 1.48 | <0.001 | 1.96 | 8.3 |
| **No qualifications** | 5.35 | 1.36 | <0.001 | 3.25 | 8.84 |
| **Wald test** | | | <0.001 | | |
| **Maternal social class** | | | | | |
| **Intermediate/Managerial-Prof.** | 1.46 | 0.24 | 0.03 | 1.06 | 2.02 |
| **Small employers and own account workers/ Managerial-Prof** | 1.69 | 0.43 | 0.04 | 1.03 | 2.77 |
| **Low supervisory and technical/ Managerial-Prof** | 2.55 | 0.8 | 0.01 | 1.38 | 4.72 |
| **Semi-routine and routine/Managerial-Prof** | 1.98 | 0.37 | <0.001 | 1.37 | 2.86 |
| **Not working/ Managerial-Prof** | 2.99 | 0.4 | <0.001 | 2.3 | 3.88 |

### 1.2: Univariate regression for TMHD at 7

| Variable | OR | Std.E | P-value | 95% | CI |
|---|---|---|---|---|---|
| MPD at 7/no | 5.36 | 1.12 | <0.001 | 3.56 | 8.09 |
| Maternal Psychological Distress at infancy/no | 2.48 | 0.3 | <0.001 | 1.95 | 3.16 |
| Maternal age at sweep 4 | | | | | |
| 30-39/40+ | 1.59 | 0.17 | <0.001 | 1.29 | 1.96 |
| 20-29/40+ | 3.98 | 0.57 | <0.001 | 3,00 | 5.29 |
| Females/Boys | 0.6 | 0.05 | <0.001 | 0.5 | 0.71 |
| Withdrawal of attention | | | | | |
| Medium/High | 1.61 | 0.21 | <0.001 | 1.26 | 2.08 |
| Low/high | 4.83 | 0.57 | <0.001 | 3.84 | 6.09 |
| Overt Puvishment | | | | | |
| 2nd quartile/highest | 1.22 | 0.17 | 0.15 | 0.93 | 1.63 |
| 3rd quartile/highest | 1.9 | 0.25 | <0.001 | 1.47 | 2.46 |
| 4th quartile/highest | 3.7 | 0.42 | <0.001 | 2.96 | 4.64 |
| Maternal closeness to child | | | | | |
| Fairly close/very close | 1.46 | 0.13 | <0.001 | 1.23 | 1.73 |
| Not very close/very close | 4.18 | 0.62 | <0.001 | 3.13 | 5.59 |
| Quality of parental relationship | | | | | |
| Happy in current relationship/no | 0.59 | 0.08 | <0.001 | 0.45 | 0.77 |
| Has partner ever used force? | | | | | |
| Yes/no | 1.77 | 0.38 | 0.01 | 1.16 | 2.69 |
| Damp or condensation in home/no | 2.13 | 0.24 | <0.001 | 1.71 | 2.65 |
| Disorganised home/no | 2.74 | 0.27 | <0.001 | 2.26 | 3.32 |
| No places for child to play/yes | 1.59 | 0.24 | <0.001 | 1.19 | 2.12 |
| OECD equivalized household income | | | | | |
| 2nd quintile/highest | 1.47 | 0.19 | 0.01 | 1.14 | 1.89 |
| 3rd quintile/highest | 2.45 | 0.33 | <0.001 | 1.88 | 3.18 |
| 4th quintile/highest | 3.33 | 0.44 | <0.001 | 2.58 | 4.31 |
| 5th quintile/highest | 3.13 | 0.5 | <0.001 | 2.28 | 4.29 |
| Maternal Education | | | | | |
| NVQ4/NVQ5 | 1.03 | 0.2 | 0.88 | 0.7 | 1.51 |
| NVQ3/NVQ5 | 1.63 | 0.34 | 0.02 | 1.09 | 2.44 |
| NVQ2/NVQ5 | 1.81 | 0.31 | <0.001 | 1.29 | 2.54 |
| NVQ1/NVQ5 | 2.48 | 0.53 | <0.001 | 1.63 | 3.76 |
| Overseas qualifications | 3.01 | 1.1 | 0.01 | 1.47 | 6.18 |
| No qualifications | 3.34 | 0.69 | <0.001 | 2.23 | 5.03 |
| Wald test | | | <0.001 | | |
| Maternal social class | | | | | |
| Intermediate/Managerial-Prof. | 1.57 | 0.25 | 0.01 | 1.15 | 2.13 |
| Small employers and own account workers/ Managerial-Prof | 1.25 | 0.27 | 0.30 | 0.82 | 1.9 |
| Low supervisory and technical/ Managerial-Prof | 3.21 | 0.76 | <0.001 | 2.02 | 5.11 |
| Semi-routine and routine/Managerial-Prof | 2.19 | 0.33 | <0.001 | 1.63 | 2.94 |
| Not working/ Managerial-Prof | 2.72 | 0.35 | <0.001 | 2.11 | 3.51 |

## Appendix 2

### 2.1 Prevalence of TMHD at 5 between children with no missing/at least one missing value by SEP-parameters' subcategories.

| Variable | Category | % | Total | p-value | % | Total | p-value |
|---|---|---|---|---|---|---|---|
| | | Complete Cases | | | At least one missing | | |
| **OECD equivalized household income at 5** | Highest quintile | 1.3 | 7,2% | <0.001 | 1.3 | 14,6% | p=0.001 |
| | Second quintile | 1.5 | | | 2.1 | | |
| | Third quintile | 1.8 | | | 3.8 | | |
| | Fourth quintile | 1.6 | | | 3.4 | | |
| | Lowest quintile | 1 | | | 4 | | |
| **Maternal Education at 5** | NVQ5 | 0.2 | 7,1% | <0.001 | 0.8 | 14,5% | <0.001 |
| | NVQ4 | 1.6 | | | 2.3 | | |
| | NVQ3 | 1.3 | | | 1.4 | | |
| | NVQ2 | 2.2 | | | 4.5 | | |
| | NVQ1 | 0.7 | | | 2.1 | | |
| | Overseas | 0.2 | | | 0.3 | | |
| | No qualifications | 0.9 | | | 3.1 | | |
| **Maternal social class at 5** | Higher managerial and professional | 1.7 | 8% | <0.001 | 1.5 | 14,7% | p=0.058 |
| | Intermediate | 1.4 | | | 1.1 | | |
| | Small employers and own account workers | 0.5 | | | 0.5 | | |
| | Low supervisory and technical | 0.4 | | | 0 | | |
| | Semi-routine and routine | 0.2 | | | 1.8 | | |
| | Not working | 3.8 | | | 9.8 | | |

### 2.2 Comparison of prevalence of TMHD at 7 between children with no missing/at least one missing value by SEP-parameters' subcategories

| Variable | Category | % | Total | p-value | % | Total | p-value |
|---|---|---|---|---|---|---|---|
| | | Complete cases | | | At least one missing | | |
| **OECD equivalized household income at 7** | Highest quintile | 1.8 | 10.6 % | <0.001 | 1.8 | 15.7 % | 0.001 |
| | Second quintile | 2.3 | | | 2.4 | | |
| | Third quintile | 2.8 | | | 3.1 | | |
| | Fourth quintile | 2.3 | | | 4 | | |
| | Lowest quintile | 1.4 | | | 4.4 | | |
| **Maternal Education at 7** | NVQ5 | 0.5 | 3.6% | <0.001 | 0.5 | 9.8% | <0.001 |
| | NVQ4 | 0.3 | | | 0.3 | | |
| | NVQ3 | 0.2 | | | 0.2 | | |
| | NVQ2 | 0.3 | | | 0.4 | | |
| | NVQ1 | 0.9 | | | 2.3 | | |
| | Overseas | 0.3 | | | 0.8 | | |
| | No qualifications | 1.1 | | | 3.5 | | |
| **Maternal social class at 7** | Higher managerial and professional | 1.6 | 10.3 % | <0.001 | 1.4 | 15.5 % | <0.001 |
| | Intermediate | 1.4 | | | 1 | | |
| | Small employers and own account workers | 0.5 | | | 0.4 | | |
| | Low supervisory and technical | 0.4 | | | 0 | | |
| | Semi-routine and routine | 2.1 | | | 1.9 | | |
| | Not working | 4.3 | | | 10.8 | | |

Appendix 3

## 3.1: Multivariable models 3, 5, 6 of TMHD at age 5

| | | MODEL 3 | | MODEL 5 | | MODEL 6 | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Category** | **OR** | | **OR** | **P-value** | **OR** | **P-value** |
| **MPD at 5** | No | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | 5.30 (3.55-7.90) | <0.001 | 3.05 (1.83-5.08) | <0.001 | 2.87 (1.70-2.85) | <0.001 |
| **Maternal Psychological Distress at infancy** | No | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | 2.48 (1.91-3.20) | <0.001 | 1.91 (1.44-2.54) | <0.001 | 1.89 (1.42-2.52) | <0.001 |
| **Maternal age at sweep 3** | | | | | | | |
| | 40+ | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | 30-39 | 1.17 (0.68-1.99) | 0.57 | 0.99 (0.76-1.29) | 0.95 | 0.98 (0.75-1.27) | 0.86 |
| | 20-29 | 2.78 (2.03-3.80) | 0.01 | 2.10 (1.51-2.91) | <0.001 | 1.94 (1.39-2.70) | <0.001 |
| **Child's sex** | Male | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Female | 0.58 (0.47-0.71) | <0.001 | 0.64 (0.52-0.80) | <0.001 | 0.64 (0.52-0.80) | <0.001 |
| **Parent-Child relationship** | | | | | | | |
| **Withdrawal of attention** | Low | | | 1 (ref) | | 1 (ref) | |
| | Medium | | | 0.99 (0.74-1.32) | 0.94 | 0.99 (0.75-1.33) | 0.99 |
| | High | | | 1.83 (1.33-2.52) | <0.001 | 1.86 (1.35-2.56) | <0.001 |
| **Overt Punishment** | Lowest quartile | | | 1 (ref) | | 1 (ref) | |
| | Second quartile | | | 1.44 (0.89-2.30) | 0.13 | 1.47 (1.00-2.16) | 0.05 |
| | Third quartile | | | 2.33 (1.73-3.13) | <0.001 | 2.42 (1.80-3.26) | <0.001 |
| | Highest quartile | | | 4.42 (3.07-3.36) | <0.001 | 4.52 (3.14-6.50) | <0.001 |
| **Maternal closeness to child** | Extremely close | | | 1 (ref) | | 1 (ref) | |
| | Fairly close | | | 1.48 (1.20-1.83) | <0.001 | 1.47 (1.19-1.81) | <0.001 |
| | Not very close | | | 2.51 (1.60-3.92) | <0.001 | 2.43 (1.54-3.83) | <0.001 |
| **Quality of parental relationship** | Highest | | | 1 (ref) | | 1 (ref) | |
| | Second quartile | | | 1.07 (0.64-1.80) | 0.79 | 1.08 (0.65-1.82) | 0.76 |
| | Third quartile | | | 1.43 (0.90-2.30) | 0.13 | 1.45 (0.92-2.32) | 0.12 |
| | Lowest | | | 2.05 (1.25-3.37) | <0.001 | 2.03 (1.24-3.33) | 0.01 |
| **Housing conditions** | | | | | | | |
| **Damp or condensation in home** | No | | | 1 (ref) | | 1 (ref) | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Yes | | | 1.81 (1.43-2.29) | <0.001 | 1.78 (1.40-2.25) | <0.001 |
| **Disorganised home** | No | | | 1 (ref) | | 1 (ref) | |
| | Yes | | | 1.16 (0.85-1.59) | 0.36 | 1.10 (0.80-1.51) | 0.54 |
| **Whether good area for raising children** | Excellent | | | 1 (ref) | | 1 (ref) | |
| | Very good | | | 0.93 (0.71-1.23) | 0.63 | 0.92 (0.70-1.21) | 0.55 |
| | Average | | | 1.20 (0.88-1.62) | 0.24 | 1.14 (0.84-1.54) | 0.39 |
| | Poor | | | 2.25 (1.29-3.92) | 0.01 | 2.15 (1.24-3.73) | 0.01 |
| | Very poor | | | 1.27 (0.48-3.34) | 0.63 | 1.13 (0.42-2.99) | 0.81 |
| **Safe area** | Yes | | | 1 (ref) | | 1 (ref) | |
| | No | | | 1.10 (0.94-1.24) | 0.21 | 1.09 (0.94-1.28) | 0.23 |
| **In poverty** | Yes | | | | | 1 (ref) | |
| | No | | | | | 1.64 (1.23-2.20) | <0.001 |

## 3.2: Multivariable models 3, 5, 6 of TMHD at age 7

| | | MODEL 3 | | MODEL 5 | | MODEL 6 | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Category** | OR | | OR | P-value | OR | P-value |
| **MPD at 7** | No | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | 3.75 (2.40-5.87) | <0.001 | 2.27 (1.33-3.87) | <0.001 | 2.11 (1.23-3.63) | 0.01 |
| **Maternal Psychological Distress at infancy** | No | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Yes | 2.15 (1.65-2.79) | <0.001 | 1.77 (1.33-2.34) | <0.001 | 1.73 (1.31-2.29) | <0.001 |
| **Maternal age at sweep 4** | | | | | | | |
| | (40+)* | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | (30-39)* | 1.56 (1.26-1.92) | <0.001 | 1.38 (1.11-1.70) | 0.01 | 1.34 (1.09-1.67) | 0.01 |
| | (20-29)* | 3.81 (2.84-5.11) | <0.001 | 2.98 (2.19-4.05) | <0.001 | 2.68 (1.94-3.68) | <0.001 |
| **Child's sex** | Male | 1 (ref) | | 1 (ref) | | 1 (ref) | |
| | Female | 0.58 (0.48-0.70) | <0.001 | 0.68 (0.56-0.83) | <0.001 | 0.67 (0.55-0.82) | <0.001 |
| **Parent-Child relationship** | | | | | | | |
| **Withdrawal of attention** | Low | | | 1 (ref) | | 1 (ref) | |
| | Medium | | | 1.28 (0.97-1.68) | 0.08 | 1.28 (0.97-1.68) | 0.08 |
| | High | | | 2.63 (2.03-2.40) | <0.001 | 2.63 (2.03-2.40) | <0.001 |
| | | | | | | | |
| **Overt Puvishment** | Lowest quartile | | | 1 (ref) | | 1 (ref) | |
| | Second quartile | | | 1.00 (0.75-1.33) | 1.00 | 1.03 (0.77-1.36) | 0.86 |
| | Third quartile | | | 1.29 (0.99-1.70) | 0.06 | 1.32 (1.01-1.73) | 0.05 |
| | Highest quartile | | | 2.02 (1.57-2.61) | <0.001 | 2.07 (1.61-2.67) | <0.001 |
| **Maternal closeness to child** | Extremely close | | | 1 (ref) | | 1 (ref) | |
| | Fairly close | | | 1.26 (1.04-1.53) | 0.02 | 1.26 (1.04-1.53) | 0.02 |
| | Not very close | | | 2.42 (1.72-3.40) | <0.001 | 2.42 (1.72-3.40) | <0.001 |
| **Happy in current relationship** | Yes | | | 1 (ref) | | 1 (ref) | |
| | No | | | 0.76 (0.56-1.02) | 0.06 | 0.77 (0.57-1.04) | 0.08 |
| **Use of force from partner** | No | | | | | 1 (ref) | |
| | Yes | | | 1.16 (0.71-1.90) | 0.55 | 1.16 (0.71-1.90) | 0.55 |
| **Housing conditions** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Damp or condensation in home** | No | | | 1 (ref) | | 1 (ref) | |
| | Yes | | | 1.60 (1.26-2.04) | <0.001 | 1.51 (1.19-1.92) | 0.01 |
| **Disorganised home** | No | | | 1 (ref) | | 1 (ref) | |
| | Yes | | | 2.02 (1.66-2.47) | <0.001 | 1.99 (1.63-2.44) | <0.001 |
| **Any places for child to play** | Yes | | | 1 (ref) | | 1 (ref) | |
| | No | | | 1.45 (1.07-1.95) | 0.02 | 1.38 (1.03-1.86) | 0.03 |
| **In poverty** | Yes | | | | | 1 (ref) | |
| | No | | | | | 1.58 (1.24-1.98) | <0.001 |

### 3.3 Multivariable models 10, 12, 13 for the effect of chronic MPD on TMHD at age 7

| Chronicity of MPD | N | Model 10 | Model 12 | Model 13 |
|---|---|---|---|---|
| **MPD in none of the sweeps** | 6912 (87,5%) | 1 (ref) | 1 (ref) | 1 (ref) |
| **MPD at least in one sweep** | 862 (11%) | 2.36 (1.34-3.02) | 1.87 (1.44-2.44) | 1.84 (1.41-2.39) |
| **MPD in two sweeps** | 90 (1.1%) | 7.11 (4.04-12.53) | 4.51 (2.50-8.15) | 4.04 ( 2.22-7.36) |
| **MPD in three sweeps** | 34 (0,4%) | 7.28 (3.13-16.92) | 3.28 (1.33-8.11) | 3.00 (1.21-7.48) |