The hidden ill-health of mothers of young disabled children

The health and primary healthcare use of mothers of preschool children with developmental disabilities

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Abstract

Mothers of disabled children (caregivers) have worse health than mothers of typically developing children. Ill-health increases perception of the difficulties of caregiving, and adversely affects mother-child attachment, child development and behaviour. Caregivers may also experience barriers to accessing healthcare (time-consuming caregiving tasks, unsuitable transportation), increasing the risk of undetected and untreated symptoms. Most research is non-UK based and focuses on stress and depression in mother-caregivers of children over five, despite disability diagnosis often occurring earlier. In my thesis, I explore differences in the psychological and physical ill-health and healthcare use of caregivers of children with disabilities compared with other mothers of preschool (0-5 years) children in the UK, and the influence of child disability diagnosis.

I conducted a systematic review of the association between caregiving and ill-health. This informed analyses of the Born in Bradford cohort with linked primary care data for caregivers of children with developmental disabilities and delay and other mothers, including: prevalence of symptoms of ill-health; frequency of visits for symptoms; and healthcare use by mothers of children with Autism Spectrum Disorders (ASD).

In the review, there was evidence of a large adverse association between caregiving and health. The high heterogeneity in the data was not explained by disability diagnosis. In the cohort analysis, compared with other mothers: caregivers had worse health; visited the doctor for psychological distress slightly more often but were less likely to visit when actually distressed; visited as often for exhaustion and head/musculoskeletal pain. Differences in patterns of healthcare use were not associated with caregiving for children with ASD.

I show that disparities in the health of caregivers and other mothers emerge in the preschool period, and caregiver ill-health may be under-detected in primary care. Unlike older child groups, caregiving rather than specific child diagnoses is associated with ill-health during the preschool period.

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Author's declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

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Section A: Background

Chapter 1 Introduction

This chapter presents the thesis background of the UK context for families with disabled children and outlines the rationale and aim of the thesis.

1.1 Introduction

Parents of disabled children report feeling that they experience greater practical, physical and emotional challenges than families with non-disabled children (Bennett, 2009). They identify as parents before caregivers but stress the distinctiveness of their situation (Paterson, 2003), which they believe to be more demanding (e.g. greater demands on time and finances) and difficult than parenting a child of the same age without disabilities (Stiell, 2006; Leonard, 1993). Parents report especially high emotional stress during the process of seeking and receiving a disability diagnosis for their child, which usually begins during the preschool period (between birth and age five) (Graungaard, 2006).

In this chapter, I will define the research population (Section 1.2), introduce the central concept of caregiver burden (Section 1.3), as the chief cause of caregiver ill-health and barrier to primary healthcare use. I summarise the evidence for a relationship between caregiving, ill-health (Section 1.4) and healthcare use (Section 1.5), and evidence that these relationships vary by the key child and maternal characteristics of different child disability diagnoses and maternal socioeconomic status (Sections 1.4.3 and 1.5.1). I then state the research gap (Section 1.6), aims and objectives (Section 1.7) that this thesis seeks to address, and outline the thesis structure (Section 1.8).

This thesis focuses on the UK context. However, due to the paucity of UK research on the health and healthcare use of caregivers of disabled children (which is especially scarce for the preschool period), I draw on published research from other high income countries conducted for samples of children with specific and mixed developmental disabilities and developmental delay.

1.2 Definitions

As some terms within the field of disability can be contentious or misunderstood, I will first describe the definitions and terminology that inform and are used throughout the thesis.

1.2.1 Child disability

Disability describes how a physiological impairment affects human function (the presence of skills which enable the performance of activities of daily living e.g. feeding, dressing, ambulating

independently) (World Health Organization, 2018). Under the UK Equality Act, someone is considered disabled if they report a long-standing illness, disability or impairment which causes substantial difficulty with day-to-day activities (GOV.UK, 2010). Using this definition, 8% of children in the UK are classified as disabled (1 in 13) - approximately 1.1 million children (8% of the 13.86 million UK population aged 0-18 in 2018) (Department of Work and Pensions, 2018; Office for National Statistics, 2018). About 17,000 families in the UK have more than one disabled child, and around 6,500 have two or more severely disabled children (Lawton, 1998).

The most common types of impairment of childhood in the UK are social/behavioural (41%), learning disabilities (37%), stamina/breathing/fatigue (26%), mobility (22%) and mental health (22%) (Department of Work and Pensions, 2018). Learning and mobility impairments are often classified as developmental disabilities, which is the umbrella term for impairments associated with a persistent failure to meet developmental milestones (e.g. cognitive development, mobility, speech) with a significant impact on the performance of activities of daily living (World Health Organization, 2012; Mithyantha, 2017). A developmental disability is also implicated if a child has a medical condition which is known to significantly affect function, such as ASD, cerebral palsy, and Down syndrome (Mithyantha, 2017). Social/behavioural problems and stamina/breathing/fatigue impairments may be associated with delayed development (a failure to meet developmental milestone which may be temporary) but are not causally related and therefore not classified as developmental disabilities (Mithyantha, 2017).

The UK prevalence of developmental disabilities in preschool children is 4,683 per 100,000 (4.7%) (Global Research on Developmental Disabilities Collaborators, 2018); although estimates vary depending on the disabilities included and age range used (e.g. whether cerebral palsy or epilepsy are included or not) (discussed in Section 4.7.5.1) (Emerson, 2012).

1.2.2 Caregivers

Almost all disabled children (99.1%) are cared for at home by a parent or guardian (Department for Work and Pensions, 2017). As a result, the majority of the caregiving responsibility is borne by them (Buckner and Yeandle, 2006). Caring is a normal part of being the parent of a young child. The term ‘caregiver’ is used to differentiate the role of caring for a disabled child. The child’s biological mother is typically the primary caregiver. Mothers report feeling their lives are more changed by assuming the caregiver role than other family members (Paterson, 2003), as they feel they have little daily help and are more likely than fathers to reduce or give up employment due to the child’s care needs (Hope, 2017; Cidav, 2012; Olchawski, 2016).

In this thesis, the terms 'mother-' and 'parent-caregiver' (mothers and fathers) are also used when necessary to clarify the reference population. 'Other parents/mothers' is used to identify those with typically developing children. The phrase 'family-caregiver' is used to indicate people who have a caregiving role for a family member of any age, including spouses, parents, or children.

1.2.3 Typical development

The term typically developing is used as the antonym of development disability to identify children who meet the expected developmental milestones, and have no emotional, behavioural, learning or developmental disabilities or delay (Quintero, 2010). For preschool children, this means the ability to perform age-appropriate tasks e.g. sitting without support by eight months (NHS, 2016). Children with minor health issues not affecting development (e.g. cold symptoms or diarrhoea) are considered typically developing.

1.2.4 Disabled children or children with disabilities

It is the convention to use 'person-first language' to reference people with disabilities, because it is appropriate to place the person before the impairment, i.e. to describe people 'with' or who 'have' an impairment (Dunn, 2015). However, for consistency with the above definition of disability as functional impairment (Section 1.2.1) and the terminology of the International Classification of Functioning, Disability and Health, the term 'disabled people' is appropriate (World Health Organization, 2018). This indicates the understanding that disability is a consequence of the interaction between the person and their environment, and not only a result of their impairment (Horridge, 2016a).

In my thesis, the term 'children with developmental disabilities' will be used when it is necessary to reinforce the definition that I am using to guide my research. Elsewhere, the term 'disabled children' will be used as it is the simpler term and will help shorten sentences, thus aiding communication. I stress that this decision is pragmatic whilst respecting the rationale for the use of each term.

1.2.5 Ill-health

Ill-health is the umbrella term for medical signs, symptoms and conditions (e.g. depression) (Fuchs, 2011). This includes signs identified by others, e.g. observed by a doctor or health researcher (NHS Digital, 2018); symptoms reported by the mother, e.g. via a survey or recorded in the mother's medical record; and conditions indicated by an outcome measure or diagnosed by a healthcare professional.

1.2.6 Summary

Now that I have defined my research population and some of the key terms/phrases used in this thesis, I will introduce the concept of caregiver burden which is central to the understanding of the relationship between caregiving, ill-health and healthcare use.

1.3 Caregiver burden

Caregiver burden is a consequence of caregiving stressors "the problematic conditions and difficult circumstances experienced by caregivers (i.e. demands and obstacles that exceed or push to the limit one's capacity to adapt)" (Aneshensel, 1995, p. 34). For caregivers of disabled children this is commonly understood as the additional practical and ongoing tasks that must be performed by the caregiver due to the care needs of the child and the emotional and cognitive reaction of the caregiver to the situation (Oyebode, 2003). This includes the additional time required for caregiving tasks (including dispensing medication and use of medical technology); medical and other appointments; disability-related expenditure (e.g. washing clothes more frequently, specialised equipment and toys) (Caicedo, 2014; Kassa, 2019). The strain of these demands on the caregivers' time and resources is expected to cause stress (Raina, 2004).

In addition to the essential burden of these caregiving tasks, I outline some of the systemic, social, and economic circumstances which increase caregiver burden.

1.3.1 Seeking, receiving and adjusting to a disability diagnosis

Seeking and receiving a child disability diagnosis and the process of adjusting to this diagnosis is a period of high emotional stress (Voigt, 2009; Mayberry, 2013; Graungaard, 2006; Estes, 2013; Reed, 2013). In a blog about her experience of running an Applied Behavioural Analysis support group, Razwana Mushtaq describes the experience of receiving her daughter's diagnosis of ASD at age three:

> "To have the diagnosis of autism confirmed was upsetting indeed, even though I was very much expecting it. But to know your child has disability for life was painful and I felt helpless. I was left not just to deal with her difficulties and behaviours but also without a clue on how to manage all of this. Not one professional mentioned early intervention or anything else to support us. At this point I was losing all hope; I was mentally and physically tired from running after her all day, trying to stop her from eating inedible items and hardly sleeping at night. My other children were all affected and us as a family" (Mushtaq, 2017).

Kandel and Merrick (2003) and Patersen (2003) have summarised the literature on parent-caregivers' experiences of their disabled child being born/receiving a diagnosis and the process of adjustment. Emotions frequently experienced were shock, grief, guilt and anger, similar to those experienced by people dealing with bereavement. The parents required time to adjust to the diagnosis and, during this time, parenting and caregiving is likely to be adversely affected.

The process of adjusting to parenting and caregiving for a disabled child involves both acceptance of the child's disability and its implications for the child, caregiver and family's life, including incorporating the hours and intensity of caregiving due to the specific requirements of the child's medical and disability needs into the daily routine (Carlson, 2017). This includes home care and visits from health and social care professionals, medication and therapy regimes, and absorbing large amounts of information about the child's condition and management (Rahi, 2004).

Parents' first-hand accounts of the adjustment phase describe the difficulties of accepting that their child has a lifelong disability, and sometimes life-limiting medical condition, their sense of isolation, despair and often depression (Beaumont, 2016; Wright, 2015; Melville-Ross, 2016). UK and international online support groups and charities (such as Contact a Family, Kids Health, and LD Online) provide information and advice to help support families during this challenging period (Contact a Family, 2018; KidsHealth, 2011; Healey, 2017). In the research literature, the failure to adjust to the caregiver role is frequently measured in terms of stress, depression and anxiety (Carlson, 2017; Sanders, 1997).

Caregivers describe struggling to navigate the health and social care services efficiently and to access supportive services to overcome their daily challenges and lead independent lives (Bennett, 2009). For example, in a focus group held by the Care Quality Commission to examine healthcare for disabled children, parent-caregivers were recorded as saying:

> "At every stage we have had to fight for services – at one time even threatening legal action until we got our way. The whole process has been physically, emotionally and financially draining" (Care Quality Commission, 2012, p. 24).

When services are available, caregivers report frustration with the lack of integration between them. They report stress at having to attend appointments (for their child's medical impairment and functional disabilities) with a range of paediatric specialists in inpatient, outpatient and community settings, sometimes requiring travel to a different town or region to attend the most appropriate clinic (Beresford, 2007; Rahi, 2004). Children are receiving multidisciplinary support without a joined up approach - caregivers want the different services and healthcare professionals

to communicate with each other to make the process as streamlined as possible to reduce the burden on the caregiver and child of attending numerous appointments.

1.3.2 Formal support

Caregivers report a lack of support from health and social care professionals (Bennett, 2009). The burden experienced by caregivers is affected by the availability, adequacy and their knowledge about local authority (social service) and National Health Service (NHS) supportive services (home, child and respite care). Local authorities have a duty to assess the needs of disabled children and provide services to minimise the effects of the disability and improve child welfare (Broach, 2016). Since 2014, they have also had a statutory duty to maintain a 'Local Offer' which:

- provides clear, comprehensive, accessible and current information about support and services for families with disabled children and how to access them; and
- makes provision more responsive to local needs by directly involving disabled children and their parents in its development and review (Butler, 2017).

However, many caregivers do not realise they are eligible for a Carer's Assessment of their wellbeing and need for support so do not apply for an assessment (Carers UK, 2014; Council for disabled children, 2014). When a child and their family's needs are assessed (via Carer's Assessment of their wellbeing and need for support and a child's Needs Assessment) (NHS, 2019), local authorities are not required to meet every need identified, and can provide minimal services to meet the need (Broach, 2016). For example, they may identify the need for the child and caregivers to have a short break away (respite) from each other, but this could be fulfilled by offering a home sitting service, offering the child an activity away from the home or attending a day service.

Children with disabilities with a statement of special education needs (SEN), an education, health and care (EHC) plan or receiving Disability Living Allowance are eligible from the age of two for free education and childcare hours (GOV.UK, 2019a). However, if they do not meet these eligibility criteria the mother might not receive free childcare support until the child starts school in their fifth year. There is also the issue of caregivers struggling to find suitable childcare and, where it is available, prices can be high and availability limited (Working Families, 2018). The cost of childcare for disabled children is often higher than for typically developing children and in settings with restricted opening hours (Harding, 2017). These limitations prohibit low income families from accessing them and prevent caregivers (usually the mother) from returning to work (Harding, 2017). Thus, mothers can find themselves with very little respite, especially during the child's early years.

In 2017, local authorities reported only 18% sufficiency of childcare for disabled children (Harding, 2017). In a nationwide survey, almost 50% of families reported not having access to support services such as short breaks, a key worker and childcare (Bennett, 2009); whilst 56% felt that the cause of their isolation was due to a lack of support from statutory services such as social care and education services (Contact a Family, 2011a). Services have been affected by central Government-imposed reductions in local authority budgets. Research in 2018 identified a £1.5 billion investment shortfall for services needed by disabled families with £434 million extra needed for social care (Disabled Children's Partnership, 2018).

There are additional barriers to minority ethnic caregivers receiving formal support for which they may be eligible, including:

- language and literacy combined with a lack of knowledge about available financial and other support for family-caregivers;
- cultural barriers to asking for support;
- uncertainty over eligibility due to immigration status; and
- others' assumption that there is a large extended family and that they will offer support (Carers UK, 2010; Bennett, 2009).

Health and social care staff are aware of failing to reach some caregivers due to language or cultural barriers but frequently do not have the resources to provide separate services for ethnic minority family-caregivers or talking therapies in languages other than English. Furthermore, the community services that black and minority ethnic caregivers engage with do not always have the health or social care expertise or knowledge to signpost them to the relevant services (Carers UK, 2010).

1.3.3 Isolation and social support

Caregivers of disabled children report feeling isolated, a lack of support from friends and family and difficulties in their relationship with their partner or co-parent and the wider family (Acton Shapiro, 2003; Bennett, 2009; Contact a Family, 2011a). There is evidence that most families of disabled children experience greater resilience against the adverse effects of caregiver burden when they have high levels of social support (McConnell, 2014). A lack of social support, including positive intimate relationships, has an adverse influence on caregiver positive attitude, stress and depression (Fonseca, 2014; Gallagher, 2015; Dunst, 1986; Warfield, 1999; Kersh, 2006).

In a survey of 1,148 families, 65% felt isolated frequently or all the time and 72% had experienced mental ill-health such as anxiety, depression or breakdown due to isolation (Contact a Family,

2011a). Caregiver burden causes isolation, for example giving up work due to their caregiving role or experiencing disability stigma, including from their own friends and family (Spindler, 2017). As a result of un/underemployment, caregivers can experience a loss of identity and the psychosocial support that they received from colleagues (Stiell, 2006). Half of the 1,148 survey respondents attributed their isolation to discrimination or stigma that they have experienced (Contact a Family, 2011a).

Caregivers report reduced social support in their family environment as they spend too much time on caregiving tasks and not enough 'quality' time with their disabled and/or other children and partner (Beresford, 2007; Smith, 2001). Caregivers also identify the burden of caregiving (stress and time spent) as the major cause of intimate relationship difficulties/breakdown (Acton Shapiro, 2003; Bennett, 2009). Relationship breakdown is more common in families of children with complex health problems (including disability) and ASD (Brehaut, 2011; Hartley, 2010). Greater care needs also increase the likelihood of family social exclusion due to challenges to social participation. For example, if access to specific equipment is required for toileting (e.g. a hoist), the family can only travel to places with these facilities (Davey, 2015).

1.3.4 The financial cost of caregiving

The annual cost of bringing up a disabled child can be three times greater than that of bringing up a non-disabled child (Contact a Family, 2014). Caregiving has an adverse effect on socioeconomic status as caregiving for a disabled child has additional expenditure and caregivers are frequently un/under-employed. Families with disabled children are more likely to experience material deprivation, where they have to prioritise the family's biological needs (such as food and heating) above social participation (such as leisure activities and holidays), thus creating a deficit in the family's psychological and social well-being (Bartley, 2004; Tehee, 2009).

The Disability Alliance and Barnardo's attributed the additional expenses of caring for a child with a disability to the need for: extra heating, laundry, clothing, transport (especially for hospital appointments or childcare), and equipment or adaptations (House of Commons Work and Pensions Committee, 2004). Low income and lone parent families are likely to experience socioeconomic deprivation as a result (52% of children in lone parent households live in income poverty compared with 21% of children in couple households) (House of Commons Work and Pensions Committee, 2004). Further, the financial inequality between caregiving and other families is likely to increase over time as caregivers necessarily look ahead to longer periods of caring for and supporting their child than a child without disabilities (Stiell, 2006; Murphy, 2006).

Compared with 61% of mothers of typically developing children, as few as 16% of mother-caregivers are in paid employment (Langerman, 2005). Of caregivers, 72% have cut back on work or given up a career because of their caring responsibilities and childcare issues (Contact a Family, 2004). The average caregiver income in 2014 was £15,270, 23.5% below the average UK salary of £19,968, and 21.8% earned less than half the UK average (Contact a Family, 2014). In 2011, 40% of disabled children in the UK were living in poverty (n=320,000), with a third classified as living in 'severe poverty' (The Children's Society, 2011). Despite these income challenges, eligible families do not always claim the Disabled Living Allowance for Children (Contact a Family, 2014). Benefit application rates among parents of disabled children are especially low in minority ethnic families (for the reasons listed in Section 1.3.2) (Bennett, 2009).

1.4 Caregiver ill-health

There has long been the assumption that mothers of disabled children will have poorer health than other mothers due to caregiver burden (Green, 2007). Risk factors for psychological health conditions that disproportionately affect women (and are associated with high rates of comorbidity in women) include negative life experiences and events, socioeconomic disadvantage, low income and income inequality, low or subordinate social status and high burden of caring for others, such as disabled children (World Health Organization, 2017b). These risk factors have been shown to be both directly and indirectly associated with caregiving (see Section 1.3). Additionally, the greater the number of hours spent caregiving for disabled children (associated with disability severity and health problems), the higher the stress and ill-health (Leonard, 1993; Roach, 1999; Saddler, 1993; Brehaut, 2011; Bramlett, 2009).

There is a substantial body of published and unpublished research linking caring for a disabled child and maternal ill-health. The majority focuses on stress and psychological ill-health (Raina, 2004). For example, in two surveys, almost 80% of parent-caregivers reported experiencing mental ill-health including stress and depression as a result of caring (Carers UK, 2017; Acton Shapiro, 2003). Repeatedly, a greater proportion of mothers with disabled children have been found to have symptoms of stress and depression and more acute symptoms than other mothers (Marquis, 2019; Singer, 2006).

A greater prevalence of a range of physical symptoms and conditions has also been identified in caregivers of disabled children, although comparatively few studies have been conducted. These include asthma, arthritis, migraine/headaches, joint symptoms, migraine/headaches, common colds, sinusitis, pain (especially neck and back), heart conditions, chronic bronchitis and stomach/intestinal ulcers and cancer (Brehaut, 2004; Lach, 2009; Lee, 2017; Miodrag, 2015;

Fairthorne, 2014; Tong, 2003). For example, 59.3% of Canadian mothers of children with neurodevelopmental and behavioural problems (aged 4-11) had at least one chronic condition compared with 41.6% of parents of typically developing children (Lach, 2009).

Caregiver ill-health adversely affects the whole family (Weinfield, 2009). Caregivers with ill-health perceive the magnitude of their caregiving burden and its impact on the family to be greater than caregivers without ill-health (Roach, 1999; Hedov, 2002). Ill-health also adversely affects caregivers' perception of their ability to provide effective care (Donenberg, 1993; Hedov, 2002). Psychological ill-health adversely impacts mothers' ability to respond to their child's needs (Weinfield, 2009); and increases mothers' concerns about their child's development (Eapen, 2017). These concerns may be warranted as positive caregiver-child interactions are important for child development, as stated in a World Health Organization report: "the child's growth, in all aspects of health and personhood, depends on the capacity of adults, in whose care the child rests, to understand, perceive and respond to the child's bids for assistance and support" (p1 (Richter, 2004)).

Parents of disabled children experience additional challenges to developing secure parent-child interaction and attachment which can reinforce poor caregiver psychological health (Howe, 2006; Shonkoff, 1992; Sarimski, 2013). Insecure parent-child attachment and maternal psychological distress, especially during the preschool period, hinder child development and are associated with the development of child behavioural problems, and psychosocial maladjustment in children with disabilities (Howe, 2006; Murray, 1992; Witt, 2003). High parenting stress has also been found to reduce the effectiveness of early interventions to improve intellectual, educational, behavioural and social outcomes in disabled children (Osborne, 2008).

1.4.1 The stress-health relationship

The relationship between caregiving and health has largely been described and explained in terms of caregiver burden and stress, although there are other (often related) causes too (e.g. isolation, financial issues, lack of assistance, inability to address their own health needs due to their caring responsibilities, and physical injuries sustained whilst performing caregiving tasks (Carers UK, 2012)). In this thesis, stress is conceptualised as a product of the burden of caregiving, with a causal relationship to physical and psychological ill-health, and is therefore classified as a symptom of ill-health as well as the mechanism by which other symptoms can develop (Dykens, 2013; McEwen, 2010).

Stress both directly and indirectly affects health. Stress arises from social and psychological circumstances where people feel worried, anxious and unable to cope. Ongoing or additive

stressful circumstances can result in chronic stress, with the common characteristics of anxiety, insecurity, low self-esteem, social isolation and lack of control over work and home life (World Health Organization, 2003). Chronic stress is known to adversely affect health, due to the process of allostatic load, when the brain becomes maladaptive at regulating the body's physiological and behavioural stress processes (McEwen, 2010). Stress is also associated with increased detrimental health behaviours, such as smoking and alcohol consumption (Umberson, 2008).

Providing ongoing caregiving for a disabled child is a cause of chronic stress (Biswas, 2015). Higher levels of the stress biomarker, diurnal cortisol, have been found in mothers of children with ASD and other developmental disabilities, and associated with lower health ratings, and higher anxiety and depression (Dykens, 2013). An association has been found between increased alcohol consumption and parenting stress, depressive and anxiety symptoms and child behavioural problems (which are common in children with developmental disabilities (Bailey, 2019)) in caregivers of children with attention-deficit hyperactivity disorder and during the preschool period (Pelham, 1999; Cunningham, 1988; Martin-Merino, 2010). In addition to higher stress and depression, maladaptive coping strategies may be more likely in mothers of children with both learning disabilities and behavioural problems than in mothers of typically developing children (Knudsen, 2015).

It is important to acknowledge that not all caregivers experience elevated stress levels and ill-health related to caregiving (Glenn, 2009; McConnell, 2014; McConnell, 2015). The assumption of caregiver burden has been rebuffed by disability campaigners and their families. They argue that although there may be challenges in parenting disabled children, there are also rewards, which often bring positive outcomes, rather than adverse health outcomes (Swain, 2010; Stainton, 1998; Nurullah, 2013). In studies on caregiver health, the extent of ill-health in caregivers is variable, with a minority of studies finding no evidence of an association between caregiving and adverse health (e.g. Olsson, 2008). In addition to differences in the population and data collection methods, variation has been attributed to factors such as social support, mother-child attachment, parenting approaches, and socioeconomic status (Shonkoff, 1992; Woolfson, 2005).

1.4.2 Bio-psycho-social model of disability

It is widely accepted that many challenges faced by people with disabilities and their families are as a result of, or exacerbated by, living in a society which disables them (Llewellyn, 2010). For example, a wheelchair user is disabled if they cannot enter a building because it does not have level access or a wheelchair lift. The theory that attributes disability entirely to the person's environment is called the social model of disability (Oliver, 2013).

In this thesis, I acknowledge the importance of the disabling effect of society on these families' lives, whilst also recognising that parents of children with disabilities will inevitably experience additional challenges due to their child's particular disability. This is a bio-psycho-social perspective of disability. For example, if a child aged four requires a wheelchair for mobility, their parent will experience transport challenges (e.g. requiring a car/taxi that can take wheelchairs, space on buses etc.) and they will be helping them to transfer in/out of the wheelchair and elsewhere. Lower back pain has been reported by 80% of caregivers who provide physical assistance with transfers to disabled children compared with 40% in caregivers who do not (Tong, 2003). As children age, the caregiver burden may increase, especially if they need ongoing physical assistance or develop behavioural problems (Brehaut, 2004).

Caregivers experience complex relationships between additional stress, physical burden and sleep deprivation leading to a greater risk of physical and psychological symptoms of ill-health than mothers of typically developing children (Tehee, 2009; Gerstein, 2009). The primary mechanism of caregiver ill-health is stress but there are also physical, social and environmental stressors and complex interrelationships between them (Green, 2007). For example, caregivers report poor sleep quality and high sleep deprivation. In a survey of over 2,000 parents of disabled children, 93% said they were up in the night with their child, and 49% reported health issues as a result of lack of sleep (Family Fund, 2013). The relationship between caregiver sleep quality and depression is bidirectional: poor sleep increases depressive symptoms and these symptoms adversely affect sleep quality (Lee, 2013).

1.4.3 Potential sources of variation in caregiver ill-health

Other factors are also known to affect health, the health of mothers and caregivers of disabled children specifically. Four important factors are presented.

1.4.3.1 Child age

There is substantial evidence that mothers of mixed age, school age and older (≥6 years) disabled children have worse health than other mothers of children in the same age group. Less research has investigated whether this relationship is present during the preschool period, despite the likelihood of key stressors occurring during this period: noticing disability and seeking a diagnosis; adjusting to its implications for the family's life; navigating the health and social care system to access support and information (outlined in Section 1.3) (Woodman, 2014a; Woodman, 2014b; Contact a Family, 2018). Therefore, symptoms of ill-health associated with stress can reasonably be expected during the preschool period (Baker, 2002; Baker, 2003; Woodman, 2014b).

This relative lack of focus on the preschool period may be due to challenges obtaining a sample of adequate size given the difficulties identifying young disabled children (discussed in Section 4.7) (Bailey, 2007). However, advances in medical knowledge and technology have resulted in the earlier diagnosis of developmental delay and disabilities (Committee on Children With Disabilities, 2001; Council on Children With Disabilities, 2006), and in children with complex needs (profound disability) living longer with higher care demands (Yang, 2002; Patja, 2000). For example, since 2003, all pregnant women in England are offered an ultrasound scan to detect foetal abnormalities (Ward, 2011), and ASD can now be diagnosed in children as soon as 12 months after birth (De Giacomo, 1998; Chawarska, 2007).

A few studies have compared caregiver ill-health between child age groups, but they provide contradictory evidence. Greater stress and psychological distress has been shown in caregivers of young (0-5 years) disabled children compared with school age children (Orr, 1993; Giovagnoli, 2015; Schieve, 2007; Woolfson, 2005); whilst the inverse relationship or no difference between age groups has also been found (Tehee, 2009; Laxman, 2015). Caregiver ill-health may vary by child age due to the changing demands of parenting, in general, and specific requirements of ageing disabled children. For example, the high stress of noticing atypical developmental and seeking a diagnosis during the preschool period compared with the increasing physical demands of caregiving for growing children above the age of five with behavioural or mobility impairments (Fairthorne, 2015b; Graungaard, 2006; Voigt, 2009; Schieve, 2007; Kaya, 2010).

1.4.3.2 Disability-related factors

There is evidence that the relationship of caregiving to ill-health varies by disability diagnosis and other disability characteristics e.g. behavioural problems and disability severity (due to greater caregiving demands, as outlined in Section 1.4). Mothers of children with ASD are frequently found to have poorer (largely psychological) health than mothers of children with other disabilities (Laxman, 2015; Xu, 2014; Demir, 2008; Fairthorne, 2015a). However, largely these studies have made comparisons between a specific disability group (e.g. ASD) and a mixed 'other' disabilities group or a typically developing group (Bailey, 2007). Fewer studies have compared caregiver health across a number of specific diagnoses or compared specific diagnoses with children with potential disability e.g. developmental delay.

The common explanation for the greater ill-health observed in caregivers of children with ASD is comorbid behavioural problems (Stacey, 2009) - 53% of children with ASD were found to have 4 or more types of behavioural problems (in the areas of e.g. sleep, toileting, eating, hyperactivity, self-injury, aggression) (Maskey, 2013). Child behaviour is defined as problematic (or as a

disability) when it persists over time and "is of such an intensity, frequency or duration as to threaten the quality of life and/or the physical safety of the individual or others and is likely to lead to responses that are restrictive, aversive or result in exclusion" (British Psychological Society, 2016, p. 8). Behavioural problems can be internalising (depression, anxiety) and externalising (aggression, defiance) (Ogundele, 2018).

Woodman et al. (2014b) identified child behavioural problems as a contributing factor in the increased risk of stress experienced by parents of children with any developmental disability compared with typically developing children; whilst Dumas et al. (1991) found that mother-caregivers of children with ASD or behavioural problems had clinically and statistically greater parenting stress than parents of children with Down syndrome or typical development. Behavioural problems have also been associated with increased caregiver fatigue (Seymour, 2013). However, it is important to note that behavioural problems are not only common in children with ASD. In general, behavioural problems are more common in disabled than typically developing children - preschool disabled children in England have a greater total number of behavioural problems, more serious and clinically significant problems that persist over time (Fauth, 2017). Children with developmental/intellectual disabilities may be up to four times more likely to have behavioural problems (Crnic, 2004).

Conversely, mothers of children with Down syndrome have the same or better health than caregivers of children with other disabilities and none (Griffith, 2010; Fairthorne, 2015a; Dumas, 1991). Initially an aetiological explanation was proposed, e.g. children with Down syndrome are more socially able and have fewer externalising behavioural problems than children with other learning disability aetiologies (Hodapp, 2001). However, it is more likely that socioeconomic status provides the explanation as parents of children with Down syndrome tend to be older and more affluent than parents of children with other learning disabilities (Section 1.4.3.2). Stoneman (2007) found that the so called 'Down syndrome advantage' disappeared when socioeconomic status was controlled for. She cautions that socioeconomic status must be considered in studies of the relationship between maternal health and child disability because it can be a predictor or a confounder.

1.4.3.3 Socioeconomic status

Caregivers are not a homogenous group, but are differentiated by sociodemographic contexts (Graham, 2009). It has been established that "health reflects the patterns of social, psychological and biological advantages and disadvantages experienced by the individual over time" (Bartley, 2004). Socioeconomic status is the single greatest predictor of individual health and well-being

(World Health Organization, 2003). It is a multidimensional concept of economic resources (indicated by income, material deprivation, means-tested benefits) and social status (education, employment, ethnicity). These social determinants of health are responsible for health inequalities (as modelled in Dahlgren and Whitehead's rainbow model (Dahlgren, 1991)) - the differences in health status or in factors that determine health between different population groups (World Health Organization, 2017a). Thus, socioeconomically disadvantaged caregivers will be, on average, more likely to have ill-health than more advantaged caregivers.

1.4.3.4 Previous episodes of ill-health

An episode of ill-health increases the risk of a repeat episode. For example, a previous episode of depression greatly increases the risk of perinatal depression in women (Lancaster, 2010; Gjerdingen, 1994), with recurrent episodes of depression usually occurring within five years of the first episode (Burcusa, 2007). A history of lower back pain is a predictor of lower back pain in caregivers of children with physical disabilities (Tong, 2003). Due to caregiver burden, caregivers may be at greater risk of repeat episodes than other mothers as stress and high stress life events (which could include adjusting to caregiving) are risk factors for recurrent depression and can increase the severity of other symptoms e.g. headaches (Demir, 2008; Wittrock, 1998; Cronkite, 2019).

There is also some evidence that caregivers of disabled children may have poorer health before (pre-natal) as well as after (post-natal) the child's birth, including evidence for pre-existing psychological ill-health in mothers of children with ASD (Fairthorne, 2013; Vasa, 2012). Explanations include the possibility of causal relationships between child ASD and maternal pre-natal medication use and lifestyle factors associated with psychological distress, or some shared genetic traits (Fairthorne, 2015b; Fairthorne, 2013; Brehaut, 2019a).

1.5 Caregiver healthcare use

Healthcare use can include primary, secondary and emergency healthcare services. It is preceded by health-seeking behaviour (also called help-seeking behaviour), whereby the individual recognises a health problem and decides to do something to alleviate the clinical symptom (Cornally, 2011). In this thesis, I use the phrase 'healthcare-seeking' to indicate health-seeking behaviour via formal healthcare services.

In the UK, primary care services are the first point of clinical contact for healthcare. Primary healthcare use is associated with a clinical need, but the underuse of healthcare services is common. Worldwide, the underuse of effective and affordable health services is responsible for substantial suffering due to ill-health, disability and loss of life (Glasziou, 2017). Frequent

explanations for not visiting the doctor (applicable in the UK) include low perceived need (expectation that the symptoms will resolve with time or are not severe enough), unsatisfactory healthcare received previously, and barriers to access (e.g. time constraints) (Cromme, 2016; Taber, 2015). Some people will access support outside the National Health System (NHS), such as complementary or alternative medicine (e.g. acupuncture), which is largely not available on the NHS, or psychological (talking) therapies via private or voluntary sector providers (NHS, 2018a).

Caregiving for disabled children is commonly associated with a rise in symptoms of ill-health, but there are also additional obstacles to visiting primary care services (i.e. their General Practitioner (GP)), especially for mental ill-health. These include greater time constraints due to caregiving tasks and diminished support networks to assist with childcare (Cantwell, 2015; Carlson, 2017). A survey of family-caregivers found that they were more likely than non-caregivers to suffer with chronic back and mobility problems as a result of the physical stress of moving and handling without the right equipment or training. However, despite delaying treatment often exacerbating the condition, they reported being unable to find the time for medical check-ups or treatment, and postponing seeking treatment because of their caregiving responsibilities, (Carers UK, 2017).

Willet et al. (2018) found that of 100 caregivers of children with ASD in Australia, 64% had visited their doctor about their physical, psychological or support needs; but the caregivers also identified personal barriers to healthcare-seeking behaviour. These included potential differences in the health beliefs of caregivers and other mothers (e.g. opinion of the health system) and that healthcare use may be affected by temporal factors, such as receiving the child's disability diagnosis. Mothers may also not exhibit healthcare-seeking behaviour if they do not perceive their symptoms to be indicative of adverse health status. For example, if the mother perceives symptoms of psychological distress as an expected response to adjusting to the caregiving role and not a clinical need, as suggested in the first-hand accounts of caregivers (Beaumont, 2016).

All other research (from high income countries) on caregiver healthcare use has found increased use in caregivers of disabled children compared with other mothers (Brehaut, 2019b; Fairthorne, 2016a; Thurston, 2011). For example, in Canada, mothers of disabled children (aged 0-19 with complex needs (multiple diagnoses) with high levels of maternal anxiety and depressive symptoms visited primary care services significantly more often than mothers with fewer symptoms (Thurston, 2011).

To my knowledge the only insight into caregiver healthcare use in the UK comes from Arksey and Hirst's (2005) who used longitudinal data to research the access and use of primary care services by unpaid family-caregivers (24% of the sample of 5,000 households contained parents of

disabled children). They expected increased caregiver primary care consultation rates due to increased rates of ill-health in caregivers and use of primary care as a one-stop shop for practical help with caregiving demands e.g. use of equipment, first aid, and advice about benefits, such as Carer's Allowance. Instead they found evidence that female caregivers who provided at least 20 hours care a week to someone in the same household (e.g. spouse or child) were less likely to visit the GP between one and five times a year (but were as likely to visit more than 5 times) than other women. This led them to conclude that caregiving is a barrier to the frequency of healthcare use but did not give any insight into whether fewer caregivers had healthcare-seeking behaviour (i.e. more caregivers than other mothers did not visit the GP when experiencing symptoms of ill-health). The authors called for more research on healthcare use by caregivers, but as far as I am aware, no research on healthcare use by caregivers in general or parent-caregivers specifically has been conducted since 2005.

The symptoms of people who do not health-seek (via primary care or other routes) may not resolve and can increase in severity over time. Reduced healthcare-seeking behaviour and healthcare use can increase caregiver burden and associated ill-health due to the risk of symptoms not being detected and treated, or inconsistent symptom management via irregular healthcare appointments (Carers UK, 2019; Dixon, 2016; Waitzfelder, 2018).

1.5.1 Potential sources of variation in healthcare use

There is some evidence that child disability diagnosis (including behavioural problems) and socioeconomic status may influence caregiver healthcare use as well as health. Healthcare use is informed by clinical need but also by socioeconomic factors. For example, in Australia, maternal depressive symptoms were associated with increased healthcare use by mothers of infants with behavioural problems (Le, 2016); whilst the cost of accessing support was a key barrier to healthcare use for caregivers of children with ASD (Willet, 2018). One study found that caregivers of children with ASD experienced greater financial, employment and time burden than caregivers of children with other developmental disabilities and none, which were barriers to healthcare use for the child's health (Vohra, 2014). It is possible that these same barriers impact healthcare-seeking by mothers for their own health.

Studies on healthcare use in the USA also identified the cost of health insurance and/or healthcare as significant determinants of healthcare use (D'Angelo, 2012; Taylor, 2006; Altman, 2001). In the UK, healthcare is free at the point of access with no requirement for health insurance or supplementary costs (although prescriptions have a nominal cost). Instead, the financial impediment to healthcare use is the cost of access via travel (and possible childcare)

rather than via direct healthcare charges (Mangalore, 2006; Willet, 2018). Thus, socioeconomically disadvantaged caregivers may be more likely to have ill-health (see Section 1.4.3.3), but less likely to visit the doctor than more advantaged mothers.

Additionally, healthcare use is influenced by previous healthcare-seeking behaviour - if a caregiver initiates healthcare-seeking by visiting a primary care service, it is likely that they will visit again if the same or another symptom of ill-health arises. This produces a series of consultations per episode of ill-health rather than a single GP visit (Herrmann, 2017). Thus, mothers' pre-natal healthcare-seeking behaviour and frequency of healthcare use is correlated with whether and how often they visit the doctor after the child's birth. There is also some evidence that mothers of disabled children visit the doctor more often before as well as after the child's birth (Brehaut, 2019a; Arim, 2019).

1.6 Research focus

This thesis focuses on the population of mothers of preschool children (aged 0-5 years) with developmental disabilities.

I focus on the preschool period as less is known about caregiver health in this period than for older age groups, and nothing is known about UK caregiver healthcare use exclusively during this period. A few studies have found high levels of stress and psychological distress in caregivers of young disabled children (which may be greater than in older disabled children) (Orr, 1993; Giovagnoli, 2015; Schieve, 2007; Woolfson, 2005), but very few have looked at a wider range of symptoms associated with stress (e.g. caregiver sleep problems) and exclusively in the preschool age group (Lee, 2013). Furthermore, few studies have looked at the relationship between caregiving and healthcare use in the preschool period and none in UK. As the first point of contact for healthcare in the UK, I focus on primary healthcare use and not health-seeking behaviour via other formal and informal routes. I focus on the category of developmental disabilities as they are identifiable during the preschool period and share the common feature of atypical development compared with other children.

I focus on the health and healthcare use of mothers because they are typically the primary caregiver and are more likely to be lone parents to a disabled child, due to marital breakdown (91% of 500,000 lone parents in 2006 were mothers) (Office for National Statistics, 2014; Gordon, 2008; Gordon, 2007). Perception of the difficulties of caregiving and ill-health have been identified as greater in mothers than fathers in two parent households, particularly in families with disabled children (Neely-Barnes, 2008; Roper, 2014; Romans-Clarkson, 1986; Beckman, 1991; Bristol, 1988; Scott, 1997; Dabrowska, 2010; Olsson, 2008; Roach, 1999; Hedov, 2002). Higher

rates of psychological ill-health have also been found in lone parents than in cohabiting parents (Office of Population and Censuses and Surveys, 1996).

In this thesis, I seek to investigate whether the additional challenges of caregiving for disabled children during the preschool period are associated with: 1) adverse maternal physical and psychological health outcomes; and 2) lower maternal healthcare-seeking behaviour via primary care in the UK.

Research on caregiver health has been criticised for not considering, in the measurement of health outcomes, the complex interrelationship between sociodemographic and other factors which influence stress and health, and often using self-selecting caregiver samples without appropriate comparison groups (Bailey, 2007). Quantitative research on the health of caregivers of disabled children has frequently excluded socioeconomic status from the statistical analysis because of the assumption of a causal relationship between low status and child disability (with the exception of Down syndrome which is associated with high socioeconomic status) (Woolfson, 2005). A rigorous quantitative approach which includes investigation of potential explanations for variation in caregiver health and healthcare use outcomes is needed. Little research has explored the influence of different disability diagnoses on health outcomes in the preschool age group.

In this thesis, I will consider the extent to which child disability diagnosis, socioeconomic status and maternal pre-natal ill-health and healthcare can be understood as potential causes of variation in post-natal ill-health and healthcare use (reflected in the following aim and objectives – Section 1.7). From my knowledge of the literature, I expected there to be limitations to the inclusion of all three factors in every analysis (which influenced the objectives specified below). For example, there is very limited literature on the relationship between caregiver health outcomes and pre-natal symptoms, which is why pre-natal ill-health was excluded was a potential source of variation in the investigation outlined in objective one below. There is extensive literature on the relationships between socioeconomic status and caregiving and between socioeconomic status and health, but not on the relationship between caregiving, socioeconomic status and health (Olsson, 2008; Hatton, 2009a; Hatton, 2009b; Emerson, 2010; Emerson, 2007; Emerson, 2006a; Emerson, 2006b).

Accordingly, I will primarily investigate disability diagnosis as the cause of variation in the maternal outcomes of interest (where possible). I will include socioeconomic status and pre-natal outcomes in the analyses (where possible) as secondary causes of variation but give less weight in the discussion to their association with the outcomes.

I note that the socioeconomic status of caregivers may change over time as a result of caregiving (as outlined in Section 1.3.4), but it is outside the scope of this thesis to look at variation in caregiver health and healthcare use due to change in socioeconomic status.

1.7 Aim and objectives

The aim of the thesis is to investigate differences in the health and healthcare use of mothers of preschool children with and without developmental disabilities and the potential influence of different disability diagnoses, pre-natal symptoms and socioeconomic factors.

The aim will be achieved by meeting the objectives:

1. To review the literature on the health of mothers of preschool children with developmental disabilities compared with mothers of typically developing preschool children, exploring whether the association between caregiving and health varies by disability diagnosis and socioeconomic status.
2. To conduct a secondary analysis of a cohort study:
    a. To compare the prevalence of symptoms of ill-health in mothers of preschool children with and without developmental disabilities, exploring the effects of pre-natal symptoms and socioeconomic status.
    b. To compare the rate of primary care consultation for symptoms of ill-health in mothers of preschool children with and without developmental disabilities, exploring the effects of pre-natal consultation frequency and socioeconomic status.
    c. To compare how subgroups of mothers of preschool children with different pre- and post-natal frequencies of healthcare use vary by disability diagnosis and socioeconomic status.

1.8 Structure of the thesis

This thesis consists of three sections: A) Background (Chapters 1-3); B) Comparative cohort analysis (Chapters 4-9); and C) Discussion and recommendations (Chapter 10).

Section A (Background) is comprised of the overview of the area of research, aims and objectives (Chapter 1) then the theoretical context is described (Chapter 2). This leads into a systematic review with meta-analysis of the literature which has quantitatively assessed ill-health in caregivers of preschool children with developmental disabilities compared with mothers of typically developing children (Chapter 3). Together, these three chapters provide the context and justification for the cohort study and identify the theory and evidence on which the study builds.

Section B (Comparative cohort analyses) describes the dataset used and two approaches for identifying disabled preschool children and symptoms of maternal ill-health via primary care records. The conceptual model, rationale and methods used to perform three linked analyses are outlined in a single chapter (Chapter 4): 1) a study of the prevalence of maternal ill-health; 2) a study of rates of a. healthcare-seeking behaviour and b. healthcare use via primary care consultation for maternal ill-health; and 3) a study of subgroups of mothers with different frequencies of healthcare use. Descriptive summaries of the cohort are then provided with reference to the approaches for identifying the exposure group (Chapter 5). The results of the three studies are presented in separate chapters, each with a section that discusses those results within the context of the relevant published literature (Chapters 6-8). The strengths and limitations of the comparative cohort study are discussed in Chapter 9.

Section C (Discussion and recommendations; Chapter 10) concludes the thesis by bringing together the findings from my research with the theoretical context (Chapter 2) to discuss whether the thesis aims have been met, what conclusions can be drawn, and recommendations for practice and research.

Chapter 2 Theoretical models of caregiver health and healthcare use

This chapter introduces the theoretical models of caregiver-health and healthcare use and the hypotheses which inform the thesis.

2. 1 Introduction

The role of theory in research is to inform our understanding of the phenomena under investigation (Sutton and Staw, 1995). In my thesis, the phenomena are caregiver health and healthcare use. A recent literature review examined 162 papers on caregiver health and identified 23 different factors that may have an effect on the health of parent-caregivers of children with developmental disabilities (Marquis, 2019). The authors highlighted the interrelationships between the variables (categorised into: social determinants of health; individual characteristics of the parent; characteristics of the disabled child; family variables; support factors) and the need to reflect this complexity in caregiver-health research. Theoretical models provide a framework for this complexity - a theory provides the logic of how factors relate to each other and why the outcome occurs (Sutton and Staw, 1995), such as explaining the causal mechanism by which caregivers are at greater risk of ill-health than other mothers (Weed, 2001).

Theory provides the heuristic process for the construction of hypotheses which can then be examined and modified via research (Raina, 2004). For example, providing the underpinning causal rationale for the hypothesis that caregivers may visit the doctor less often than other mothers about their health. A theoretical model is the diagrammatic presentation of the theory.

To understand and theorise about the relationship of caregiving for preschool children with developmental disabilities to maternal health, I will use Raina et al.'s (2004) multidimensional model of caregiving process and caregiver burden. Then to understand and theorise about the relationship of caregiving for preschool children with developmental disabilities to maternal primary healthcare use I will use Andersen's health service utilization model (Andersen, 1995).

2.2 Models of caregiver health

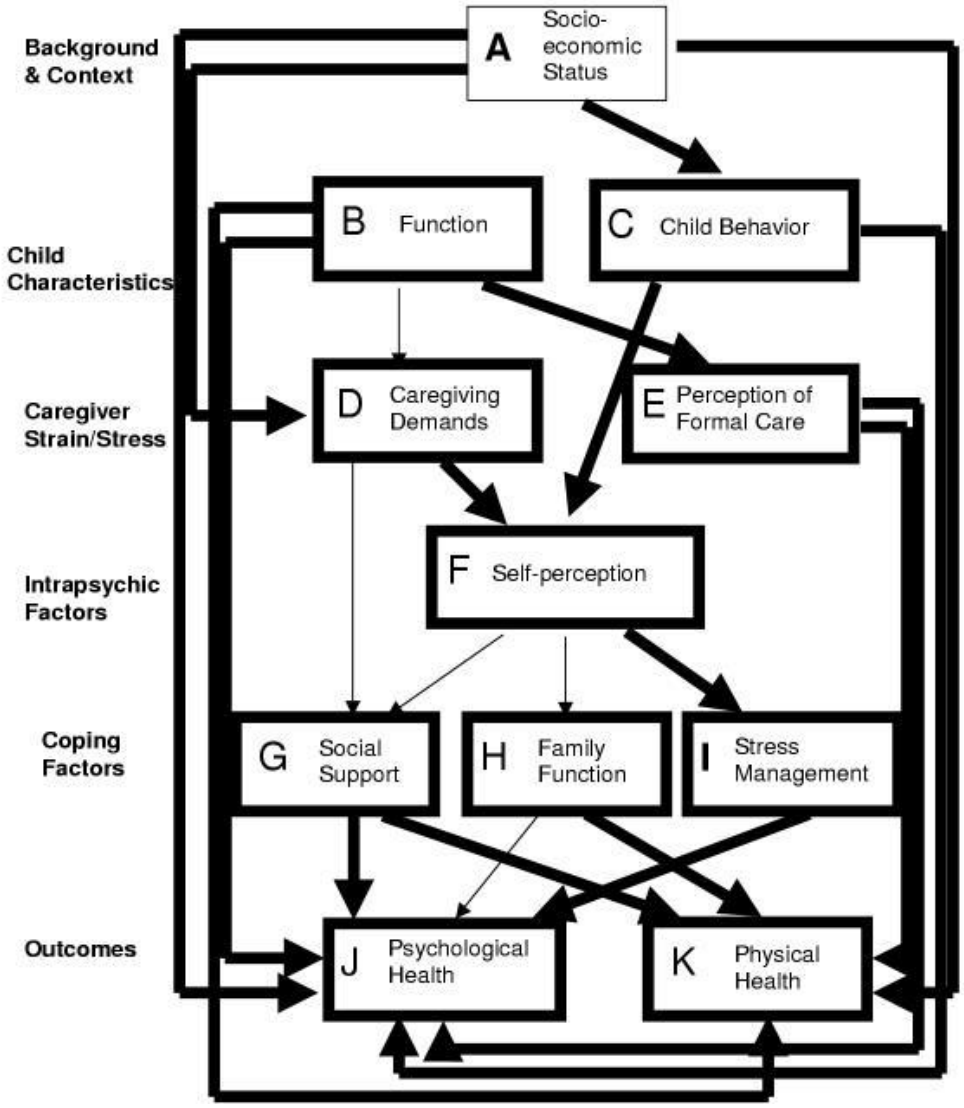
From the 1980s, a number of models have been developed to understand the complex associations between an individual's environment, the informal caregiving role, stress and ill-health: risk-resilience model (Wallander, 1989b; Wallander, 1989a); the caregiving process model (Pearlin, 1990); risk-resilience model process model (King, 1999); family caregiving model (Mcdonald, 1997; Mcdonald, 1992); caregiving process and caregiver burden model (Raina, 2004).

Each of these models builds on the conceptualisation that stress occurs at the intersection between the individual's internal state and their external environment (the stress process) (Pearlin, 1981). People will therefore be protected against the outcome of ill-health when they have greater resilience due to factors that support a positive internal state and/or they experience low demands or conflict from the external environment. This mechanism explains why some caregivers experience worse health outcomes than other caregivers and/or people without caregiving responsibilities: all caregivers experience additional demands in their external environment but the burden of these demands and the internal state which informs the individual's resilience will vary by person (and over time) (Raina, 2004).

2.2.1 Description of the model of caregiving process and caregiver burden

Raina et al. (2004) helpfully pointed out limitations with all previous models in explaining why some caregivers experience ill-health whilst others do not. They argued that a comprehensive multidimensional model, which separated out the differing components so that specific causal pathways could be examined, was needed to guide research in the field of parent-caregiver health. In developing the model of caregiving process and caregiver burden (Figure 1), their concern was that traditional approaches overlooked the complex matrix of direct (bold arrows) and indirect (faint arrows) relationships that influence caregiver health (such as social support and caregiver self-perception) because possible interactions between contingent variables were not being explored. The direction of the arrows indicates the strongest defensible causal direction, although a reverse causal relationship may also be present between some components.

Figure 1. The model of caregiving process and caregiver burden



Permission to reproduce the model received from Dr P. Raina and Dr M, O'Donnell June 2018 (Open Access licensee copyright on the paper (Raina, 2004)).

The model locates caregiving within the caregiver's previous and current sociodemographic context, emphasising the social and economic characteristics of the family that can contribute to the caregiver burden. Unlike the other models, there is a distinction between child characteristics of function and behaviour. The child's functional ability (the extent of their disability) is directly related to both the degree of physical and psychological caregiver burden and thus ill-health. Whereas, for Raina et al., child behaviour increases the risk of caregiver psychological ill-health but does not directly add to the physical burden and risk of ill-health.

Caregiver strain is the daily demands on the caregiver and the conflicts between caregiving and other roles such as employment and other family tasks (e.g. domestic or relating to other

children). Caregivers with fewer demands are theorised to have higher self-perception (e.g. sense of mastery and self-esteem) which is a measure of the caregiver's internal state; and (indirectly) to have increased levels of social support (as fewer demands make maintaining social networks easier). Unlike alternative models, this one includes formal care examined through caregiver perception (as opposed to actual hours of formal care or multidisciplinary support received). The perception of formal support as being family-centred (related to the child's functional ability and sufficiency of support) is theorised to reduce caregiver burden and, consequently, limit ill-health.

Compared with other models, family function is distinguished from social support, and stress management is included as a coping factor. The direct and indirect causal pathways to and from these components to the health outcomes are theorised to differ. Family function describes the extent to which the family works as an effective unit e.g. if the caregiving demands are shared between two cohabiting parents the physical burden of the caregiving tasks is reduced. Social support is the informal practical assistance and emotional support received from family, friends and neighbours which can reduce the real and perceived caregiver burden, thus arbitrating the risk of both psychological and physical ill-health. Lastly, by employing strategies to reduce and manage stress, psychological stress is theorised to be less likely.

2.2.2 Limitations of the model of caregiving process and caregiver burden

Raina et al. selected components for the model for which there was some evidence in the caregiver-health literature at the time of its development, focusing more on internal (to the caregiver e.g. perception) than external factors. As such they acknowledge that there may be components missing from their model which affect the caregiver-health relationship, such as the availability of access to formal care (the importance of which has been shown in research since (Vohra, 2014; Marquis, 2019)). They state that as the theoretical support and evidence for these relationships develops, components can be added.

Despite the strength of evidence for the importance of child behaviour to caregiver stress and ill-health (included in the model), Raina et al. did not draw on McDonald et al.'s (1997; 1992) family caregiving model for children with emotional (or behavioural) disorders during its development. McDonald et al. (1997) recommended conceptualising models on caregiver health into three stages: antecedent components, mediators, and outcomes. The incidence of a previous episode of a symptom of ill-health almost always increases the risk of a repeat episode, therefore it is highly relevant to account for medical history when examining the relationship between an exposure and disease (discussed in Section 1.4.3.3). For example, an antenatal episode of depression increases the risk of perinatal depression (Leigh and Milgrom, 2008). The relationship between

previous episodes of ill-health and the risk of developing symptoms appears to be an under-researched aspect of this field (described in Section 1.4.3.4). However, based on the wider evidence, it should theoretically be important and therefore included in models of caregiver-health.

2.3 Models of healthcare utilisation

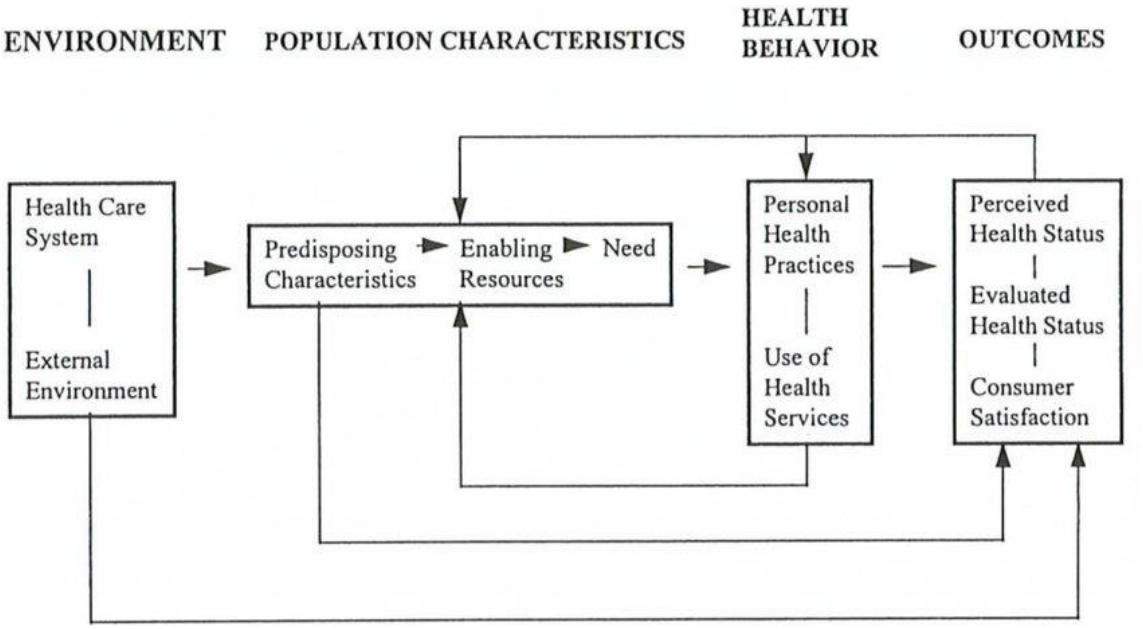
Models of healthcare use provide guidance for defining the variables included in analyses of the factors informing: who uses healthcare services; for what; how frequently; and for assessing whether available services are meeting the needs of the study population and population subgroups, such as caregivers (Aday, 2005). To my knowledge, no models of caregiver healthcare use or primary (only) healthcare use exist.

Since the emergence of healthcare use (also known as healthcare or health services utilisation) as a field of research in the 1960s, four major theoretical models have guided research: models of patient decision-making, such as the stages of illness and medical care model (Suchman, 1965); the behavioural model of health services utilization (Andersen, 1968); economic models of healthcare, such as the demand for health model (Grossman, 1972); and the health belief model (Becker, 1975). The latest (fourth) version of the behavioural model of health services utilization, published in 1995, is the most commonly used for understanding the complex influences on access to and use of healthcare services, including in the field of caregiver healthcare use (Babitsch, 2012; Willet, 2018).

2.3.1 Description of the behavioural model of health services utilization

The latest iteration of the behavioural model of health services utilization reflects the complex interaction between a multitude of factors in predicting healthcare use, including both healthcare-seeking behaviour and the frequency of consultation (by those who exhibit health-seeking behaviour) (Figure 2).

Figure 2. The behavioural model of health services utilization



Permission to re-print the model in the published thesis received in September 2019 [**Appendix(A)1.1**] (Andersen, 1995).

The model evolved from the 1960s to 1990s in response to emerging understanding of factors that influence access to and use of healthcare services, including the components identified in the other models. For example, in the 1970s the role of the healthcare system was added in recognition of the importance of organisational and funding factors in the distribution and delivery of services. The subjective element of service user satisfaction as a factor in healthcare use for an ongoing or new health problem was also added. In the 1980s and 1990s the influence of the external environment and personal health practices (e.g. the economic climate, diet and exercise) were acknowledged.

The central process indicates the linear pathway from the availability of healthcare services and emergence of ill-health to the outcome of receiving healthcare and patient satisfaction. This mechanism requires the identification of ill-health and the opportunity for healthcare-seeking behaviour. For successful healthcare use in an equitable healthcare system, the individual will have a predisposition to using healthcare services (health-seeking behaviour) combined with factors that enable use and the actual need for healthcare (the population characteristics in the model). Demographic and social support factors and health beliefs predispose the individual to health-seek via healthcare services. These behaviours are enabled (or disabled) by resources at the individual (income, insurance) and community (supply of doctors and waiting lists) levels. Need is assessed by the individual and/or the doctor. The model therefore distinguishes between characteristics that relate to the healthcare system (described as mutable) and the

sociodemographic factors (described as immutable) (Aday, 2005). This process is driven by the population characteristics combined with the individual health behaviours: personal health practices (e.g. smoking, alcohol consumption, diet, self-care) and use of healthcare services; which directly informs the outcomes of perceived (patient-assessed) and evaluated (doctor assessed) health status, and patient satisfaction.

The indication of additional direct pathways and co-called "feedback loops" reflect the dynamic and complex theorised relationship between the components (Aday, 2005). The physical, political and economic environment, and organisational and funding elements of the healthcare system influence both the predisposing characteristics and the outcomes. There is also a direct theoretical pathway between the predisposing characteristics and the outcomes. The feedback loops indicate recursive relationships, where the outcome in turn affects the subsequent predisposing factors and health behaviour, and health behaviour also affects the subsequent predisposing factors.

2.3.2 Limitations of the behavioural model of health services utilization

More recently, Aday and Andersen (2005) have acknowledged that the model does not distinguish between the type of health services the individual accesses (e.g. primary or emergency healthcare) or reflect the interaction between specific factors in determining healthcare use. In recent research on caregiver healthcare use, it was suggested that e-health platforms and social media should be added as they are remote modes of accessing education, information and emotional support, which all influence healthcare use (Willet, 2018).

The model does not consider caregiving as a direct barrier to healthcare use. However, as described in Chapter 1 (Section 1.5), caregiving has a physical, psychological and material impact which may impede healthcare-seeking behaviour via primary care services. For example, the external environment of a reduction in income, lack of childcare due to diminished social support, and the possibility of previous unsatisfactory experiences due to disability stigma, may inhibit healthcare-seeking or reduce maternal healthcare use. Caregiving may also have an indirect influence on healthcare use if mothers do not identify their symptoms as a healthcare need because they assume that e.g. a prolonged period of low mood (indicative of depression) is an expected response to adjusting to the caregiving role.

2.4 Summary

The model of caregiving process and caregiving burden offers the most comprehensive theoretical model for understanding the mechanism of caregiving to ill-health and is used to guide my research. However, it is largely constructed around the (internal) responses of the caregiver to the

caregiving environment. In the context of caregiver healthcare use, it would specify the importance of pre-caregiving socioeconomic factors and identifies the need for indirect relationships to be examined but does not include the known relationship between previous and subsequent episodes of ill-health, which may represent an important latent relationship in the process of caregiving to ill-health. The model of health services utilization offers a dynamic theoretical approach to the myriad environmental, population and behavioural factors that influence health perception as well as healthcare use. This model recognises the importance of antecedent to subsequent healthcare use.

The description and use of both models as the theoretical foundations of my research illustrates the synergies between the development of ill-health and healthcare use, highlighting the caregiver-specific factors which are likely to influence both outcomes. This approach also highlights potential gaps in using these models to understand caregiver health and healthcare use, whereby previous ill-health may increase caregiver susceptibility to subsequent ill-health, whilst the importance of caregiving as an environmental or enabling characteristic of healthcare use is unknown.

2.5 Thesis hypotheses

The thesis hypotheses are presented as alternative (rather than null) hypotheses to provide a clear record of the direction of the expected relationships between caregiving and ill-health/healthcare use and how the outcomes are expected to vary by disability diagnosis, pre-natal ill-health and healthcare use and socioeconomic status.

In the caregiver-health model, caregiver burden is a direct and indirect cause of caregiver ill-health. This, and the substantive evidence of caregiver burden experienced by mothers of disabled children (including during the preschool period) (outlined in Sections 1.3-1.4) provides the basis for my first hypothesis:

1. Mothers of children with developmental disabilities have greater ill-health than other mothers during the preschool period.

The direct and indirect contributory influence of caregiver burden in the process of ill-health to healthcare use described with reference to the theoretical model of healthcare use, and evidence of potential barriers to caregiver healthcare use (outlined in Section 1.5) provides the basis for my second hypothesis:

2. Mothers of children with developmental disabilities have lower healthcare-seeking behaviour and primary healthcare use for maternal symptoms of ill-health than other mothers during the preschool period.

The following three hypotheses relate to the exploration of variation in the relationship between caregiving and the outcomes of ill-health and healthcare use during the preschool period. The hypotheses with the greatest available evidence and a theoretical basis are stated.

As disability is not homogenous, especially between diagnoses (e.g. ASD compared with cerebral palsy), the child disability characteristics and sociodemographic characteristics of their families will vary. Hypotheses 1 and 2 are expected to be observed in the comparison of mothers of children with and without disabilities with some variation by disability diagnosis. There is evidence of some variation in the health and healthcare use outcomes for caregivers by disability diagnosis was outlined in the sections on potential sources of variation: 1.4.3.3, 1.4.3.4 and 1.5.1. The influence of socioeconomic status and previous episodes of ill-health and healthcare use on (subsequent) health and use were discussed in Chapter 1 and with reference to the models in this chapter. These factors influence all mothers, but the hypotheses are given for the caregivers only as they are the population of interest. This background provides the basis for the third, fourth and fifth hypotheses:

3. Mothers of children with ASD have greater pre- as well as post-natal ill-health and healthcare use than caregivers of children with other developmental disabilities during the preschool period.
4. Caregivers of preschool children with developmental disabilities with socioeconomic disadvantage have greater ill-health and healthcare use than more advantaged caregivers during the preschool period.
5. Caregivers of children with developmental disabilities with pre-natal episodes of ill-health and healthcare use have greater ill-health and healthcare use than those without pre-natal ill-health and healthcare use during the preschool period.

In the next chapter, I describe my systematic review with meta-analysis to understand what is already known about the relationship between caregiving and ill-health during the preschool period.

Chapter 3 A systematic review of the association between caregiving and ill-health

This chapter reviews studies that have quantified and compared symptoms of ill-health in mothers of preschool children with and without developmental disabilities and examines possible causes of variation in the relationship between caregiving and ill-health.

3.1 Introduction

In Chapter 1, I outlined the rationale for investigating the relationship between caregiving for children with developmental disabilities and ill-health during the preschool period, extending the investigation to more symptoms than stress and depression and using quantitative research methods. The limitations identified in the field of caregiver-health research are also found in the (very few) literature reviews conducted. Here, I summarise the limitations of existing reviews of the relationship between caregiving and ill-health briefly and reference key limitations when discussing the review eligibility criteria (Section 3.3).

Many studies have examined the relationship of caregiving for disabled children to mother-caregiver health, but few have summarised this literature. Most literature reviews (like most studies) have been limited to the outcomes of stress and depression (McCann, 2015; Biswas, 2015; Singer, 2006; Raina, 2004; Singer, 2007). Every literature review that I have identified includes wide age ranges, with no subgroup analysis by age; and many examine health in the mothers of children with specific disability diagnoses e.g. ASD (Biswas, 2015; Fairthorne, 2017; Hayes, 2013; Bekhet, 2012; Honey, 2005). Very few meta-analyses have been performed. This may be due to a limited number of studies including comparison groups of mothers without disabled children (Dyson, 1991; Scott, 1997; Roth, 2015). Instead, groups of children with differing disability from the exposed group have been used or no comparison group, and comparison groups in the field of caregiver health are often poorly characterised. These study design limitations also affect the generalisability of the results to other mother-caregiver groups, and the ability to make between study comparisons (Dyson, 1991; Singer, 2006).

Definitions of the key terms used are provided in Chapter 1: typical development, developmental disabilities, and symptoms of ill-health. Mother-caregiver and caregiver are used most frequently, but exposed mothers or the exposed group (versus unexposed mothers or the comparison group) are also used where it aids clarity and simplifies sentence structure.

3.1.1 Review purpose

This systematic review acknowledges the limitations in the research in this field and brings together the available evidence to guide the development of research questions (presented in Chapter 4) to fill any existing gaps. The aim of the review is to summarise the literature on differences in the health of mothers of preschool children with developmental disabilities compared with mothers of typically developing preschool children; and whether disability diagnosis and socioeconomic status explain any differences.

3.1.2 Objective

To conduct a systematic review with meta-analysis to summarise the findings from studies that have quantified differences in the symptoms of ill-health detected in mothers of preschool children with and without developmental disabilities and identify what child disability and socioeconomic factors might explain any differences.

3.1.3 Research questions

1. Is there evidence that mothers of preschool children with developmental disabilities have poorer health than mothers of typically developing preschool children?
2. Is variation in the differences in maternal health between studies explained by different child disability diagnoses or socioeconomic status?

3.2 Protocol

The review protocol was conducted in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses for Protocols 2015 (PRISMA-P) to ensure systematic and transparent reporting in sufficient detail for repeatability [**A2.1**] (Moher, 2009; Shamseer, 2015).

PROSPERO was checked on 2nd March 2018 for ongoing reviews on similar topics (Centre for Reviews and Dissemination, 2013). None were identified. The review protocol was not registered.

3.3 Eligibility criteria

The PICOS mnemonic (Participants, Intervention, Comparison, Outcome, Study design) was used to identify the characteristics of the studies for the review (Welch, 2018).

3.3.1 Participants (exposed group)

Mother-caregivers of preschool aged children with developmental disabilities (research population defined in Section 1.2).

3.3.2 Intervention

In intervention studies, the comparison group is drawn from the same study population (mothers of disabled children) to assess the effectiveness of an intervention to improve caregiver health. It would not be appropriate to use typically developing comparison groups. For this reason, intervention studies were not included in my review and were screened out using a study design filter for observational studies (cohort and case-control studies were included and case series and case reports excluded) (Dekkers, 2012).

3.3.3 Comparison

A comparison group of mothers of typically developing (defined in Section 1.2.3) preschool children needed to be included in the study. Studies with typically developing normative groups were included.

3.3.4 Outcome

Studies were included if at least one physical or psychological symptom of ill-health was measured for the study and comparison group. Stress was included as an outcome (decision explained in Section 1.4.1).

Obesity, smoking and alcohol consumption are risk factors for ill-health and increased risk behaviours are associated with higher stress (Bauld, 2017). However, they are not included in the model of caregiving process and burden (see Section 2.2.1) so were not examined in this review.

3.3.5 Study design

Given the relative lack of quantitative summaries of the relationship between caregiving and symptoms of ill-health and none for the preschool period (see Section 3.1.1), I only included studies with designs that produced quantitative findings (measured the symptom of ill-health) so that a meta-analysis could be performed.

The inclusion of qualitative studies could have aided the interpretation of the results of the meta-analysis (Higgins, 2011, Section 20). However, qualitative studies often also focus on specific disability groups (e.g. cerebral palsy) and do not include a comparison group (Reed, 2012; Griffith, 2014; Whittingham, 2011). Thus, synthesising this data would not have helped in understanding the effect of caregiving on health for a mixed disability group compared with other mothers or the variation by diagnosis between different disability diagnosis groups. Furthermore, very few qualitative studies of the experience of caregiving focus solely on the relationship between caregiving and health. They more typically explore coping, adjustment, and parenting challenges (Watermeyer, 2014; Maul, 2009; Kuhaneck, 2010). To identify relevant content in these papers

would have required abstract or full text review, greatly adding to the literature screening task. This was considered disproportionate to the benefit that their inclusion could have brought, so qualitative studies were excluded from the review and qualitative content in any mixed methods studies included in the review not extracted.

3.4 Information sources

3.4.1 Databases

I searched Medline(OVID), EMBASE(OVID), PsycINFO(OVID) and CINAHL(EBSCO) (Elsevier, 2018; U.S. National Library of Medicine, 2018; American Psychological Association, 2018b; EBSCO, 2018). I attempted searches in ASSIA and Web of Science, but the search strategy could not be converted using the proximity operators in these databases. As these operators were vital to restricting the amount of irrelevant references retrieved, these databases were excluded.

3.4.2 Grey literature

Sources of grey literature, defined as "literature that is not formally published in sources such as books or journal articles" were not searched (e.g. The Healthcare Management Information Consortium (HMIC) database or PsycEXTRA) (Higgins, 2011, Section 6.2.1.8). This was due to:

- the large amount of literature identified through the academic databases and time constraints;
- it was not possible to apply the observational study design filter to sources of grey literature;
- not knowing whether they had received peer-review for quality assurance; and
- the requirement for quantitative data in enough detail for a meta-analysis to be performed.

3.4.3 Reference list searching

Reference lists for a sample of five studies included in the review were searched but no additional relevant studies were identified. No further reference lists were searched.

3.5 Search strategy

The University of York Health Sciences Liaison Librarian was consulted during the development of the search strategy. The search strategy (Table 1) was developed in Medline(OVID) with a combination of key terms and subject headings. The database function 'map term to subject heading' was used to ensure that all relevant subject headings were included. The subject

headings were not exploded as this broadened the search and returned a very high number of irrelevant papers. This was investigated by comparing the first 150 returns for searches with exploded and unexploded subject headings, and for searches with key terms alone. No additional relevant papers were identified by exploding.

Table 1. The literature search strategy used in Medline, EMBASE and PsycINFO

1.(((mother-carer* or mother carer* or mother caregiver* or mother care-giver* or parent-carer* or parent carer or parent care giver* or parent care-giver* or carer* or care-giver* or caregiver* or care giver* or family caregivers or mother* or parent* or parenting or caring) adj2 (asthma or arthritis or allergies or food allergies or rheumatism or joint pain or joint symptom* or neck pain or neck problem* or back pain or back problem* or migraine* or headache* or diabetes or hypertension or high blood pressure or sinusitis or heart condition* or heart disease or chronic bronchitis or bronchitis or emphysema or sleep problem* or sleep disturbance or sleep deprivation or poor quality of sleep or fatigue or exhaustion or stomach ulcer* or intestinal ulcer* or gastrointestinal problem* or gastrointestinal condition* or pain or stress or low mood or depression or back or neck or stomach or mobility or vision or hearing or sleep or joint or anxiety or depressive symptom* or cold or common cold or cold symptom* or flu or flu symptom* or symptom* or physical health or physical problem* or psychological health or psychosocial problem* or general health or ill-health or ill health or poor health or chronic conditions or mental health or mental health problems or psychological distress or emotional problem*)) or (burden of care or burden of caring or care* burden or caregiver burden or care-giver burden or caregiver strain or care-giver strain or strain" or burden)).mp.
2. (((behaviour* or emotion* or conduct or development* or communication or social* or mental health or anti-social or learning or cognition or intellectual or psychomotor or growth or congenital or chronic or speech or mental* or language development or language or motor skills or neurodevelopmental or sensory or rare or complex or childhood-onset or intellectual development or anti-social behaviour or attention deficit hyperactivity or autis* spectrum) adj1 (disorder or problem or need* or behaviour or behavior or disabil* or disabl* or handicap* or impair* or condition or anomal* or abnormalit or retard*) adj2 (child* or infant or newborn or new born or pre-school or preschool or primary school or neonat*)) or (disabled child* or child* with disabilities or child* with disability or handicapped child* or child* with handicap* or impaired child or child with impairment or disabl* infant* or disabl* newborn*)).mp.
3. ((cerebral palsy or autis* or Down* syndrome or deaf* or blind* or epilepsy or attention-deficit-hyperactivity-disorder) adj2 (child* or infant or newborn or new born or pre-school or preschool or primary school or neonat*)).mp.
4. 2 or 3
5. 1 and 4
6. 5 not (adults with disabilities or disabled adults or disabled parent* or disabled mother or mother with disabilities).mp

The asterisk indicates truncation.

Subject headings for generic terms for ill-health and disability were included in the strategy as well as generic and specific key terms for disabilities (e.g. ASD) and symptoms of ill-health (e.g. fatigue) that had been associated with caregiver burden and ill-health during scoping reviews and reading on the subject. This approach was approved by the Health Sciences Librarian without concerns about the introduction of bias towards studies on the specified disabilities and symptoms. Further strategy development details are provided as an appendix [**A2.2**].

The same search strategy was used in EMBASE(OVID) and PsychINFO (OVID). The strategy did not need adapting because the key terms were relevant and PsychINFO uses the Medline Medical subject headings (MeSH) system and EMBASE includes all the MeSH in their subject heading system (Emtree) (Elsevier, 2015; American Psychological Association, 2018a). For use in CINAHL, the proximity operators were converted, and inverted commas inserted around key terms of more than one word [**A2.3**].

3.5.1 Study design filter

A cohort and case-control strategy search filter was applied to remove non-observational study designs (Table 2) (BMJ Clinical Evidence, 2018).

Table 2. Medline (Ovid) cohort and case-control strategy study design search filter

1. exp cohort studies/
2. cohort$.tw.
3. controlled clinical trial.pt.
4. epidemiologic methods/
5. limit 4 to yr=1966-1989
6. exp case-control studies/
7. (case$ and control$).tw.
8. or/1-3,5-7

See A2.4 for the adapted version of the filter for EMBASE (OVID).

It was appended to the specific search strategy (Table 1) using the 'AND' operator (Higgins, 2011, Sections 6.4.2-6.4.8). The filter, available for OVID databases, was designed and tested by the British Medical Journal Evidence Centre information specialists performing systematic review and randomised control trial searches. The development and testing process is documented, but the sensitivity and specificity of the filter were not reported (Glanville, 2008). No filter was applied to the searches in CINAHL as there was no equivalent filter verified by use in a systematic review.

3.6 Study selection

The study selection and screening process were performed between 10 March and 7 May 2018. My supervisors were consulted in the development of the selection criteria. When commencing the review there were no potential collaborators (e.g. other PhD students looking for a secondary reviewer) so I performed the screening alone.

Full citations were retrieved from the searches and exported into Endnote (desktop). Duplicates were removed. The remaining studies were screened for the inclusion/exclusion criteria (Table 3). An abstract screening form was used to provide clarity and consistency [**A2.5**] (Higgins, 2011, Section 5).

Table 3. Summarised inclusion and exclusion criteria

Inclusion	Exclusion
Study measures and reports at least one symptom of ill-health	No quantification or measurement of maternal ill-health
Mothers	>50% of the exposed group consists of fathers, parents, or grandparents; or has not disaggregated the analysis and reported the outcomes separately for mothers and fathers
Mothers of children diagnosed with at least one developmental disability	>50% of the exposed group is at risk of a developmental disability, has developmental delay, unspecified disabilities, or no details of the diagnoses are provided
Comparison group of typically developing children	No comparison group of typically developing children
Children aged between 0 and 5 years	Child mean age or range >5
Quantitative studies	The maternal health outcome is not reported numerically
Publication in English	Full text not published in English
Study conducted in an OECD country	Study conducted in a non-OECD country

3.6.1 Language

Only studies in English were included.

3.6.2 Country

Only research conducted in the 35 countries in the Organisation for Economic Co-operation and Development (OECD) was included. They all have developed health, social care and education infrastructures with a commitment to improving population well-being, and health as a key spending priority (Groce, 2011; Dewan, 2009). Studies from non-OECD (low and middle income) countries were excluded because differing and additional challenges are experienced by mother-caregivers in countries without developed health, social care and education infrastructures (Maulik, 2007).

3.6.3 Mother-caregivers

To ensure that the findings reflected the experience of mother-caregivers, most of the study population (>50%) had to be mothers.

3.6.4 Child age range

Children in most OECD countries start primary school by the age of six, therefore most of the children in the study had to be age five or under (mean age or range ≤5) (OECD, 2018).

3.6.5 Child disability diagnosis

To fit my definition of developmental disabilities (in Section 1.2.1), studies with populations of children with the following groups of impairments were excluded:

- conditions not causally associated with long-term developmental delay e.g. asthma, diabetes, cancers, heart disease, behavioural or emotional problems unless comorbid with a developmental disability;

- developmental delay of unknown causes, as I could not ascertain whether the delay might be temporary or a consequence of another condition e.g. hearing impairment;
- risk of developmental disabilities e.g. preterm babies who are at risk of developmental delay but have not been assessed and/or received a diagnosis; and
- mixed developmental disability groups where the specific disabilities comprising the sample were not stated so the proportion from the excluded groups could not be ascertained.

The exposed group were required to have a diagnosed disability, but the method of ascertainment was not an inclusion criterion. Disability ascertainment by diagnostic tools, medical record or parent-report were accepted.

3.6.6 Outcome

Symptoms of ill-health had to meet the definition (see Section 1.2.5). No restrictions were placed on the outcome measures used to detect or assess the severity or duration of the outcome.

3.6.7 Publication type

Only published articles where the full text could be accessed via the open access publishing, University of York Library subscription or interlibrary loan were included. Conference and dissertation abstracts were excluded as they were expected to provide insufficient detail to screen the abstracts for inclusion and/or were not reliably known to have received peer-review for quality assurance (McAuley, 2000). Time and resource constraints prevented writing to the authors of potentially relevant abstracts to request the full study.

3.6.8 Sample size

No minimum or maximum sample size was specified.

3.6.9 Publication date

No date criterion was specified. Beyond the possibility of increasing sample sizes (due to developments that have improved survival rates and enabled earlier diagnosis (Hertz-Picciotto, 2009; Yang, 2002; Patja, 2000), there have been no major changes in the field of disability that would affect caregiver-health research. Thus, there was no reason to specify a lower or upper date range for the review.

3.7 Data collection process

The data extraction form [**A2.6**] was developed using guidance from the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 (Higgins, 2011, Section 7.5). The form was piloted in five studies and reviewed by my supervisors to ensure it provided sufficient information on study design, child disability (including indicators of disability severity and behavioural problems) and study population/sample.

3.8 Quality assessment

The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses was used (Wells, 2017). For reviews of studies which include studies with different observational study designs (longitudinal cohort and case-control), it is recommended that the quality of the study methodologies is assessed and quality assessments are incorporated into the interpretation of the results of the review (Higgins, 2011, Section 13.5.2.3). For cross-sectional studies I used a modified version of the NOS (Herzog, 2013), which has been used in a number of peer-reviewed systematic reviews (Prins, 2009; Modesti, 2016) [**A2.7**].

Using a star rating, each study is assessed in three domains: selection of the exposed group, comparability, and outcome. Guidelines on the use of the NOS indicate that the tool can be adapted for the specific purposes of the review (Wells, 2017). Minor adaptations and clarifications were made to suit the context of my review (Table 4).

Table 4. Adaptations made to the Newcastle-Ottawa Scale

Version of the NOS	Domain: item	Amendment/decision and rationale
Both	All	A criterion was assumed not to be met if details were not provided in the paper. For example, no stars were awarded if no details were provided on efforts to increase representativeness of the sample to the general adult female population.
Both	Selection: Ascertainment of the exposure	Parent-reported diagnosis of the child's disability replaced self-reporting.
Both	Comparability	Two factors that are controlled for by the study design can be specified and stars awarded. Study participant age is recommended as a comparability factor. My inclusion criteria ensured that the appropriate comparability factors were controlled for by the study design (e.g. preschool age group and mothers). No additional factors were specified. A study received a score of one for this domain if both criteria were met and reported for the exposed and unexposed groups.
Longitudinal study	Outcome: Was follow-up long enough for outcomes to occur	≥3 months was specified as a long enough time period for the outcomes to occur. As most studies on caregiver health examine psychological health, it was anticipated that the studies included in the review would follow this trend. Three months is long enough for changes in psychological symptoms to be observed and has been specified in studies in psychological health using the NOS (Anglin, 2013; NICE, 2016).
Longitudinal study	Outcome: Adequacy of follow up of cohorts	The follow up of cohorts was specified as adequate and unlikely to introduce bias if <20% of the subjects were lost to follow up and a description provided of those lost, thus proving a non-selective loss to follow up. This cut point has been specified in other studies using the NOS (Eijkemans, 2012; Gierisch, 2014).

The total star score was converted into a rating of good (≥7), fair (2-6), or poor (0-1) using threshold guidance issued by the Agency for Healthcare Research and Quality (AHRQ) (McPheeters, 2012). The same conversion applied to the longitudinal and cross-sectional study design versions despite the total score differing (x/8 for longitudinal; x/7 for cross-sectional studies). I have provided both the star score and ratings for each study as the ratings provide a descriptive interpretation of the quality of the studies, whilst the scores provide more detail on the differences between the individual studies. No studies were excluded due to their quality rating. Differences in the scores and the implications for the review are discussed.

3.8.1 Bias in the measurement of caregiver ill-health in measures of parenting stress

Some parenting stress outcome measures include child cognitive and behavioural problems as measures of stress as well as parent experience. The use of these measures in the assessment of parent-caregiver stress introduces measurement bias as caregivers of children with learning disabilities or behavioural problems will, by design, receive higher scores than parents of typically developing children without behavioural problems (Baker, 2003). For these measures, the

relationship between caregiving and ill-health is confounded by the assumption that cognitive problems (child disability) and behavioural problems (strongly associated with child disability) always increase caregiver stress. Thus, the scores of the caregivers and other mothers are not directly comparable because the caregivers' scores include the measurement of their caregiver status rather than measuring the extent to which they feel stressed due to their child's cognitive or behavioural problems.

The measures with this bias used in studies in this review were the Questionnaire on Resources and Stress, and the Parenting Stress Index (n=5) (Friedrich, 1983). The Family Impact Questionnaire was developed to try and resolve this issue by asking questions about parents' experiences without reference to the child's behaviour or cognitive abilities (Donenberg, 1993; Abidin, 1990). The measurement bias should be observable in the review results, with greater standardised mean differences for the studies with the biased measures compared with those using the Family Impact Questionnaire (n=4). In recognition of this issue, reference groups for children with cognitive and physical impairment and behavioural problems were included in later versions of the Parenting Stress Index (Abidin, 1995b). However, this will not mitigate the measurement bias for the studies in my review using the 1995 version.

3.9 Synthesis of results

I described the studies, then synthesised the results using meta-analysis. Following the guidance provided in the Cochrane Handbook, meta-analysis was appropriate if sufficient data were provided for a between-group difference to be estimated (or imputed from the other studies) and the studies were similar enough to justify pooling the data (Higgins, 2011, Section 13.6.2.4).

The adequacy of the data for meta-analysis and heterogeneity of the data and study designs were assessed and are described in the description of the studies (Section 3.11) and the quality appraisal (Section 3.12). Meta-analysis was considered the best method to answer the research questions, and techniques were employed to examine and limit the impact of the heterogeneity (using a random-effects model, subgroup analysis and the addition of predictive intervals (Section 3.9.5)).

3.9.1 Purpose

Meta-analysis is a statistical technique used to synthesise the results of several studies into a single estimate. It adds precision to the estimate of the true effect of the exposure and the opportunity to investigate consistency and variation between the studies (Bradburn, 2009). Studies with samples of disabled children are generally small (Bailey, 2007; Borenstein, 2009), which affects the precision and representativeness of the results because there is usually high

variation and quality of the studies preventing generalisability (Scott, 1997). Meta-analysis increases the power to answer the research question by pooling the data. Although the term 'effect' is used, it is more accurately a measure of association (because causation cannot be inferred) (Weed, 2000).

Another function of meta-analysis is to resolve controversies arising from conflicting study findings (Sanderson, 2007; Singer, 2006). Whether caregiving for a child with developmental disabilities has a direct adverse influence on mothers' health or whether specific disability-related factors or socioeconomic status can explain the association, is an outstanding controversy (Green, 2007; Stoneman, 2007).

I will perform a meta-analysis to:

1. compare the direction, magnitude and precision of the relationship between caregiving and ill-health between studies; and
2. provide evidence of whether there is support for the assumption of a direct adverse relationship between caregiving and ill-health.

3.9.2 Summary statistic

From my knowledge of the field of caregiver-health research, I expected (and found) the studies to use continuous data for the outcome measurements. This enabled the calculation of the standardised mean difference as the summary statistic (also called the effect size) - the size of the effect relative to the variability observed in that study:

$$\text{Standardised mean difference} = \frac{\text{Difference in mean outcome between groups}}{\text{standardised deviation of outcome among participants}}$$

It converted the results of the studies which measured the outcome in differing ways onto the same scale with the same units, so that they could be compared and pooled to produce an overall effect estimate and 95% confidence interval (Higgins, 2011, Section 9.2.3.2). For example, the outcome of depression measured using the Beck Depression Inventory could be compared with the Centre for Epidemiological Studies Depression scale. As a general rule, an effect estimate of 0.2 was considered small but not trivial, 0.5 moderate and 0.8 and above was a large effect (Cohen, 1988; Durlak, 2009). As is conventional, I used forest plots to display the results of the meta-analysis graphically (Bland, 2015). The pooled estimate was illustrated by a horizontal dotted line which intersects the diamond shape that illustrates the confidence intervals for the pooled estimate.

Meta-regression would have been performed if more than ten analyses were available in the studies. Few studies were expected (especially for the subgroup analyses), therefore standardised mean difference was used by default (Higgins, 2011, Section 9.6.4). If, instead of continuous data, dichotomous data were provided for all or some of the outcomes, odds ratios would have been calculated (Higgins, 2011, Section 9.2.2).

3.9.3 Software

The analysis was performed in the software package Stata 15 using the 'metan' command (Harris, 2008) available from the Boston College Statistical Software Components (SSC) archive (Stata, 2018).

3.9.4 Subgroup analysis

A pooled estimate for the studies provided an indication of whether there was an adverse relationship between caregiving for preschool disabled children and maternal health in general, as measured by the symptoms represented in the review. Subgroup analysis was performed to examine whether the effect of caregiving on ill-health differed by symptom (e.g. depression), by disability diagnosis (e.g. ASD) or socioeconomic status. Subgroup analysis was performed when there were clearly defined subgroups with at least three studies in the group, the minimum number recommended for meta-analysis in Stata (Bradburn, 2009).

3.9.5 Statistical heterogeneity

Heterogeneity is the extent to which variation in the standardised mean difference is attributable to the statistical variability in the data. This can be caused by methodological and clinical diversity in the studies e.g. differing study populations and outcome measures, as well as by the statistical diversity of the synthesised data (Higgins, 2011, Section 9.5). I expected considerable heterogeneity between the studies due to: small sample sizes, diversity of outcomes and measures, specific and mixed disability diagnosis groups. The methods described in this section were used to examine and mitigate heterogeneity in the meta-analysis.

3.9.5.1 Standardised mean difference

To manage the bias associated with differing sample sizes, the contributions of each mean difference to the overall estimate of SMD were weighted using the Stata default for the model (described in Section 3.9.5.3), which is a function of the estimated variance for each estimate. Samples with smaller sample sizes receive a lower weighting as there is less precision of the mean scores than for larger samples (Higgins, 2011, Section 9.1.3). Accordingly, less heterogeneity was expected in the data for larger sample sizes so weighting the studies in this way mitigated the influence of the greater heterogeneity in the smaller samples on the pooled estimate.

3.9.5.2 Subgroups

The consistency of the difference in the outcome within and between studies could be explained by including differing outcomes, diagnosis groups or studies with differences in socioeconomic status in the pooled estimate. Subgroup analysis was used to explore whether the heterogeneity was less when these parameters were restricted so that groups with similar characteristics were compared e.g. studies with the outcome of depression, or studies with children with ASD. If the score for the test of heterogeneity was lower for the subgroup analyses than for the overall pooled estimate (described in Section 3.9.5.4), some of the heterogeneity was explained by the parameter used to define the subgroups (Higgins, 2011, Section 9.6.2).

3.9.5.3 Random effects model

A random effects model was used because it assumes that the different studies are estimating different but related effects. Each study estimated the effect of caregiving in groups with differing disability and sociodemographic characteristics, which could be used to estimate the common effect of caregiving on maternal health (Higgins, 2011, Section 9.4.4.3). The random effects model estimates the average effect over all the studies using the variability between participants within and between the studies. Both random and fixed effects models award less weight to studies with smaller sample sizes (see Section 3.9.5.1), but a smaller distinction in the weighting of small and large samples is made in random than in fixed effects models. This is because small studies provide more information about the distribution of the effects across studies (greater standard errors) than the larger studies, therefore incorporating the heterogeneity of the data into the pooled estimate (Borenstein, 2009).

The random effects model particularly incorporates unexplained inconsistency (Higgins, 2011, Section 9.5.3). Other factors which affect the pathway from caregiving to ill-health are identified in the model of caregiving process and burden, but their investigation was outside the scope of this review (Raina, 2004). For example, some of the inconsistency in the data may have been explained by social support or child behavioural problems which vary between the study samples but were unmeasured or the data was not extracted for this review.

3.9.5.4 Test of heterogeneity

The generalisability of the findings of the meta-analysis could not be determined without knowing how consistent the results of the studies were and, therefore, how consistent the influence could be in future studies in other samples (Higgins, 2003). Traditionally, high heterogeneity in meta-analyses was interpreted as an indication of the inappropriateness of the meta-analytic method

for the data, but it is now widely recognised that meta-analyses can be used to examine the inconsistency in the data (Higgins, 2011, Section 9.5.3).

Cochran's Q test is the standard test of heterogeneity, where a p value less than 0.05 indicates significant between study variability. However, the test is recognised as overpowered in the estimation of clinical heterogeneity and is poor at detecting significant true heterogeneity among studies (Higgins, 2002). The results of the test are less reliable in meta-analyses of a small number of studies (Hardy, 1998). In this review, the planned subgroup analyses used the information from as few as three studies (described in Section 3.9.4) and significant heterogeneity was expected due to the clinical diversity of the outcomes and study samples.

Accordingly, as well as providing the results of the test of heterogeneity (referred to the chi squared distribution), I also used a measure of the extent of the heterogeneity. The I^2 statistic is used to indicate the proportion of the observed variance that reflects real differences in the effect size; and is not inherently dependent on the number of studies in the analysis. It gives an indication of the amount of observed dispersion within and between studies, thus providing a measure of consistency of effect across the studies in the review (part 4, (Borenstein, 2009). As a standard, 25%, 50% and 75% are considered the thresholds for low, moderate and high heterogeneity, respectively (Higgins, 2003). It is recommended as a summary measure of the impact of heterogeneity on the findings and possible recommendations (Higgins, 2002). Heterogeneity attributable to clinical or methodological diversity was expected to decrease in subgroup analyses as the subgroups were homogenised on a common characteristic (e.g. the same outcome or same disability diagnosis). If high heterogeneity was observed in the overall and subgroup analyses, the heterogeneity was unexplained, which limited the generalisability of the findings.

3.9.5.5 Predictive intervals

To produce an estimation of the average true effect, random effects models assume that there is variation in the average effect between studies, but do not accommodate the width of the distribution of the effect across the individual studies (IntHout, 2016). The summary confidence intervals for the pooled estimate can be misleading as they do not account for the within-study variation in the outcome. Particularly where there is high heterogeneity, a statistically significant pooled estimate should be treated with extreme caution as the confidence intervals do not give a realistic indication of the estimated true range of effect (IntHout, 2016). This can lead to the findings being overgeneralised.

Predictive (also known as credible) intervals can be calculated to present the expected range of true effects in subsequent similar studies. The predictive interval effectively converts the heterogeneity into the same metric as the effect size to give the range within which the effect would be situated in a new study with 95% certainty. Given the heterogeneity, this interval facilitated a more realistic interpretation of the effect and its clinical implications. Originally used to summarise the effects of clinical trials, the use of predictive intervals has grown in the field of epidemiology as a means of presenting more accurate results from data with high heterogeneity (Cole, 2003; Kane, 2011; Tham, 2014).

I calculated predictive intervals for the overall and subgroup pooled estimates (Riley, 2011). In Stata, the interval was generated using the rfdist command which is part of the metan package. The interval incorporated uncertainty in the location and spread of the effect using the formula: t(df) x sqrt(se^2 + tau^2). This is the t-distribution with k-2 degrees of freedom, where k is the number of studies, se^2 is the squared standard error and the heterogeneity statistic is tau^2 (StataCorp, 2017).

The predictive intervals were shown on the forest plots. Stata required a minimum of three standardised mean differences to estimate a predictive interval, as fewer data points (effectively) results in an infinite distribution. Inestimable intervals were illustrated with dotted lines from the diamond (forest plot interpretation described in Section 3.9.2) (Sterne, 2009a).

3.9.6 Outliers

Given the expected high heterogeneity of the data, no data points were excluded as outliers. Any suspected outliers may have been accurate data points illustrating diversity rather than e.g. measurement error (Higgins, 2011, Section 10.4.1).

3.9.7 Data management

I describe the method of data management and key decisions made for specific studies/analyses included in the review.

3.9.7.1 Transformation

Some outcome measures use high scores to indicate greater ill-health, whilst others use low scores. Most of the outcome scales in the studies in this review used higher mean values to indicate greater ill-health. In two studies, where lower scores indicated poorer health, the means were multiplied by -1 to change the direction of the effect (Oelofsen, 2006; Eker, 2004).

3.9.7.2 Imputation

Where standard deviations were available for a study using the same outcome measure and version, the largest standard deviation was imputed for the missing values for the study and comparison groups (Higgins, 2011, Section 9.2.3.2). Values were imputed for Glenn et al.'s (2009) study from another study using the same version of the Parenting Stress Index (Roach, 1999; Abidin, 1995a).

For Scott et al. (1997), the average of the standard deviations for the mean scores of the same symptom were imputed (Higgins, 2011, Section 9.2.3.2). As no other study had used the same version of the depression outcome measure and there were substantial differences between versions, the missing values could not be imputed from a single other study using the Beck Depression Inventory. Scott et al. also did not provide standard deviations of the mean scores for the outcome of psychological distress. As this outcome was not assessed in any other study, the standard deviations could not be imputed, so the outcome was dropped from the meta-analysis.

3.9.7.3 Over-representation

Due to multiple analyses being included in some of the studies included in the review, there were issues of the over-representation of data from some studies in the meta-analyses.

For the longitudinal studies, the standardised mean difference was calculated for the latest data collection point only (Higgins, 2011, Section 9.3.4). In meta-analyses of studies with differing study designs, the inclusion of one standardised mean difference for one time point per study is recommended to prevent the overrepresentation of multiple results from longitudinal studies with multiple data collection points in the pooled estimates (Higgins, 2011, Section 17.1). Results could not be combined across time-points without introducing a unit of analysis error. In this review, three studies had multiple data collection points within the preschool period: four data points for three studies were excluded from the meta-analysis (Gowen, 1989; Laxman, 2015; Norlin, 2013).

Standardised mean differences were calculated for every disability group included in the study which met the study inclusion criteria. One study had multiple specific diagnosis groups (Eisenhower, 2005). The inclusion of all three groups increased the precision of the pooled estimate by increasing the amount of data, but also introduced bias as the study was overrepresented in the meta-analysis.

The overall and disability diagnosis subgroup pooled estimates were biased towards studies which have measured more than one outcome. Although this over-weighting of these studies in the

estimates introduced bias, the inclusion of these studies was valuable because of the contribution of additional data with which to answer the research questions.

3.9.8 Test of Significance

The test of significance (a z test called the test of standardised mean difference in Stata) provided a p value which is the probability of obtaining the observed pooled estimate by chance. If the p value was smaller than 0.05 (indicating statistical significance), the null hypothesis of no effect (on average) was rejected as there was evidence in the pooled data of a significant relationship between caregiving and ill-health. As the 0.05 threshold is largely arbitrary, the Cochrane Handbook (Section 12.4.2) recommends reporting the p value for the test of significance (z test) together with the confidence interval (Higgins, 2011, Section 12.4.2). I reported the p value for the overall and subgroup pooled estimates z tests alongside the corresponding confidence interval; but the test was not performed for the predictive intervals (by Stata). Instead, my interpretation of the results focused on comparisons between the confidence and predictive intervals.

3.9.9 Publication bias

In a meta-analysis, it is standard practice to include the assessment of publication bias as a potential source of heterogeneity in the data. This is the well-documented greater probability of (often small) studies which have statistically significant results being published than studies evidencing little or no significant effect of the exposure to the outcome of interest (Sterne, 2004; Sterne, 2009b). This was assessed by examining the extent to which studies providing evidence of an effect had smaller sample sizes than those with smaller or no effect, thus biasing the results of the pooled estimate.

It was necessary to assess publication bias in the investigation of the effect of caregiving on ill-health because of the general acceptance of the assumption of ill-health associated with caregiving (discussed in Section 1.4.1) and proliferation of smaller studies in caregiver-health research (Plant, 2007; Miodrag, 2015). Alternatively, evidence of the inconsistency of high stress in parent-caregivers and the publication of studies rebuffing the expectation of caregiver ill-health due to caregiver burden may have reduced the effect of publication bias (Plant, 2007; Swain, 2010).

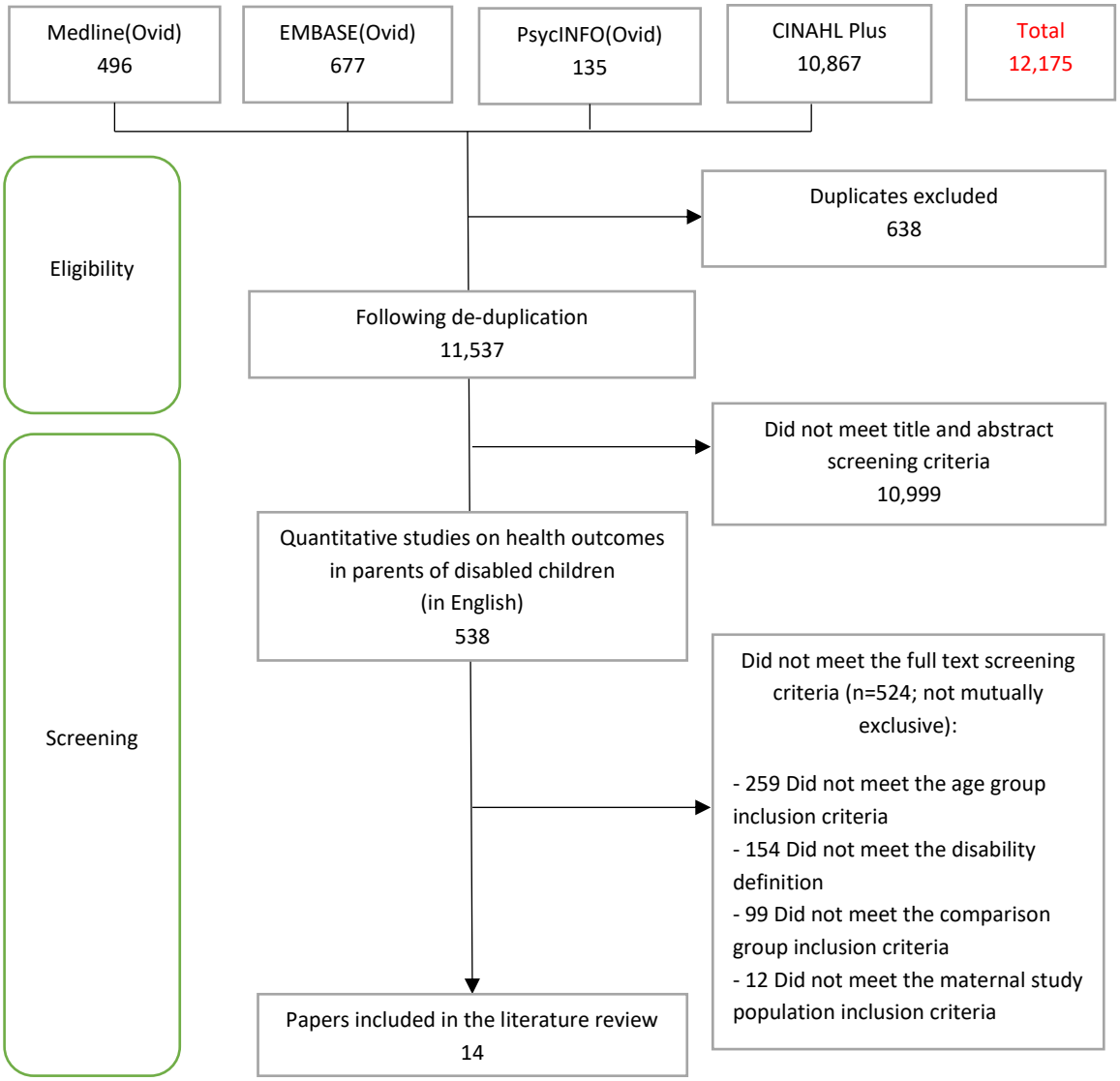
Publication bias is evaluated visually using a funnel plot - a scatterplot of the effect sizes estimated from individual studies against the standard error of the effect size, which is a measure of precision of the effect estimate relative to the study size. If there was a low possibility of publication bias the plot would be symmetrical, resembling an inverted funnel. An Egger test

assesses the asymmetry of the funnel plot in meta-analyses of standardised mean difference. The test assesses how far the intercept for the line of best fit for the studies deviates from zero (the linear relationship between intervention effect and its standard error). The line of the null hypothesis of no bias would be vertical on the forest plot. There was significant publication bias if the p value for the bias coefficient was $p<0.05$. (Sterne, 2004). These procedures were executed using the 'metafunnel' and 'metabias' commands in Stata (Sterne, 2004; Harbord, 2009).

3.10 Study selection results

The search produced 12,175 results, which were imported into Endnote Desktop (X8.2) for screening (Clarivate Analytics, 2018). Fourteen articles met the inclusion criteria (Figure 3).

Figure 3. Flow diagram of the eligibility and screening process



3.11 Description of the studies

3.11.1 Study characteristics

The publication dates of the papers ranged from 1989-2015. Almost half of the studies were conducted in study samples in the USA (n=7/15; 46.7%); two in the UK (14.3%). One study was conducted at locations in both the USA and Canada. The study sizes ranged from 20-188 for the exposed and 20-8,500 for the comparison groups (Table 5). In all 14 studies, the exposed mothers were selected solely on exposure (being the mother of a disabled child or not) and the outcome(s) measured after the exposure (Webb, 2016).

Table 5. Design characteristics of included studies

			N		Recruitment method			
Study	**Country and study design**	**Disability diagnosis**	**Exposed**	**Comparison**	**Exposed**	**Comparison**	**Indication of socioeconomic status (SES) bias[1]**	**Quality assessment (n/total;rating)**
Eisenhower, 2005	USA, longitudinal	ASD Down syndrome Cerebral palsy	14 12 10 (36 total)	136	Disability services	Preschools/day care centres	High SES for exposed and comparison groups	3/8 Fair
Gowen, 1989	USA, longitudinal	Mixed disabilities	21	20	Intervention programmes	Birth records	High SES in exposed group	4/8 Fair
Jeans, 2013	USA, longitudinal	ASD	100	8,500	Selected from pre-existing cohort	Same cohort	High SES in exposed group	5/8 Fair
Laxman, 2015	USA, longitudinal	ASD	50	2,900	Selected from pre-existing cohort	Same cohort	N/S	6/8 Fair
Norlin, 2013	Sweden, longitudinal	Mixed disabilities	58	182	Disability services	Birth records	High SES in exposed and comparison groups	3/8 Fair
Dyson, 1991	Canada and USA, cross-sectional	Mixed disabilities	55	55	Disability services	Preschools, day-care centres, and primary grades	High SES in exposed and comparison groups	3/6 Fair
Eker, 2004	Turkey, cross-sectional	Cerebral palsy	40	44	Health centre (inpatient)	Health centre (out-patient services)	N/S	3/6 Fair
Giallo, 2013	Australia, cross-sectional	ASD	50	1,122	Parent support groups and disability services	A community sample	N/S	1/6 Poor
Glenn, 2009	UK, cross-sectional	Cerebral palsy	80	460	Disability services	N/S (Recruited in the USA)	Low SES in exposed group	2/6 Fair
Hedov, 2002	Sweden, cross-sectional	Down syndrome	86	87	N/S	Birth records	N/S	3/6 Fair
Oelofsen, 2006	UK, cross-sectional	Mixed disabilities	59	45	Disability services	Local preschools and matched by postcode	High SES in exposed and comparison	3/6 Fair

			N		Recruitment method			
Study	**Country and study design**	**Disability diagnosis**	**Exposed**	**Comparison**	**Exposed**	**Comparison**	**Indication of socioeconomic status (SES) bias[1]**	**Quality assessment (n/total;rating)**
							groups (higher in comparison)	
Quintero, 2010	USA, cross-sectional	ASD	20	23	Intervention programmes	Recruitment via the exposed mothers	High SES in exposed and comparison groups (higher in comparison)	2/6 Fair
Roach, 1999	USA, cross-sectional	Down syndrome	41	58	Regional research database	Birth announcements in local newspapers	High SES in exposed and comparison groups	2/6 Fair
Scott, 1997	Canada, cross-sectional	Down syndrome	188	128	Intervention programmes	Recruitment via the exposed mothers	N/S	2/6 Fair

ASD; Autism Spectrum Disorders
N/S; Not specified
[1] High socioeconomic status (SES) was indicated by the author of the study stating that there were more mothers in the sample with high than low SES or more than 50% of the mothers had higher than compulsory education (>12 years) (details of how SES was assessed are in Section 3.11.5 and SES characteristics by study are provided in **A2.8**).
Quality characteristics are provided in **A2.9**.

The mean age of the disabled children in the exposed group ranged from 9 months to 4.7 years, mean 2.9 years. The range was the same for the comparison group, but the mean was a little lower (2.7 years). There were significant differences reported between the age of the children in the exposed and comparison groups in two studies: the disabled group were older in one study and younger in the other (Roach, 1999; Quintero, 2010).

The mean age of the mothers in the comparison group was a little lower than the exposed group: 33.3 years (range 26.4-36.4), comparison 32.7 years (28.2-36.6). The mothers in the study sample were significantly older than the comparison in one study (Laxman, 2015).

The mean percentage of male children was higher in the exposed than unexposed mothers: 64% (range 40-100%) versus 55% (50-63.6%). A table of the full sociodemographic characteristics for each study is included as an appendix [**A2.8**].

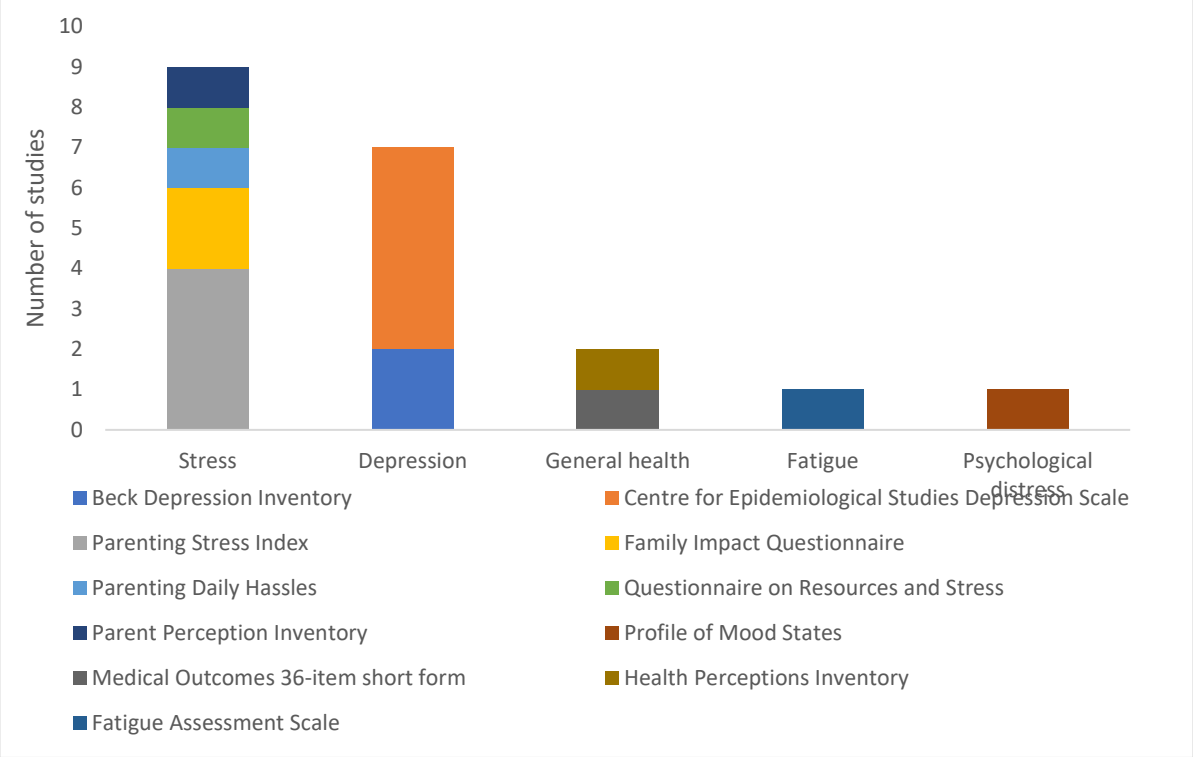
3.11.2 Ascertainment

Exposed mothers were targeted for recruitment via disability support and healthcare services (n=10), parent-report (n=2) or disability databases (n=1). The recruitment method was not specified for one study (Hedov, 2002). In every study, the disability diagnosis reported at recruitment (by a parent or disability service/database record) was accepted without independent verification e.g. additional diagnostic assessment. None of the studies reported how the typical development of the children in the comparison groups was ascertained. Except for one study, there was no reported assessment of health conditions in the typically developing children which might increase parent burden, such as asthma or diabetes (Eker, 2004).

3.11.3 Outcomes

The health outcomes were stress (n=9), depression (n=7), fatigue (n=1), psychological distress (n=1) and general health (n=2). Six (42.9%) measured two health outcomes. Eleven different outcome measures were used (Figure 4).

Figure 4. The number of outcomes examined

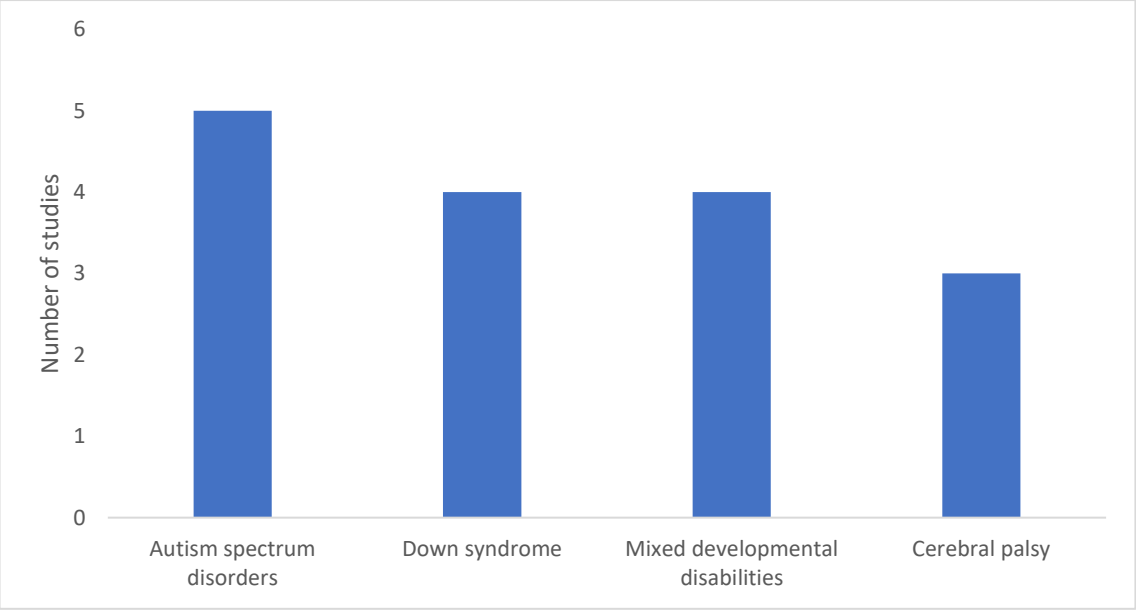


n=20

3.11.4 Disability characteristics

The exposed group comprised of mothers of children with specific or mixed diagnosis groups (Figure 5).

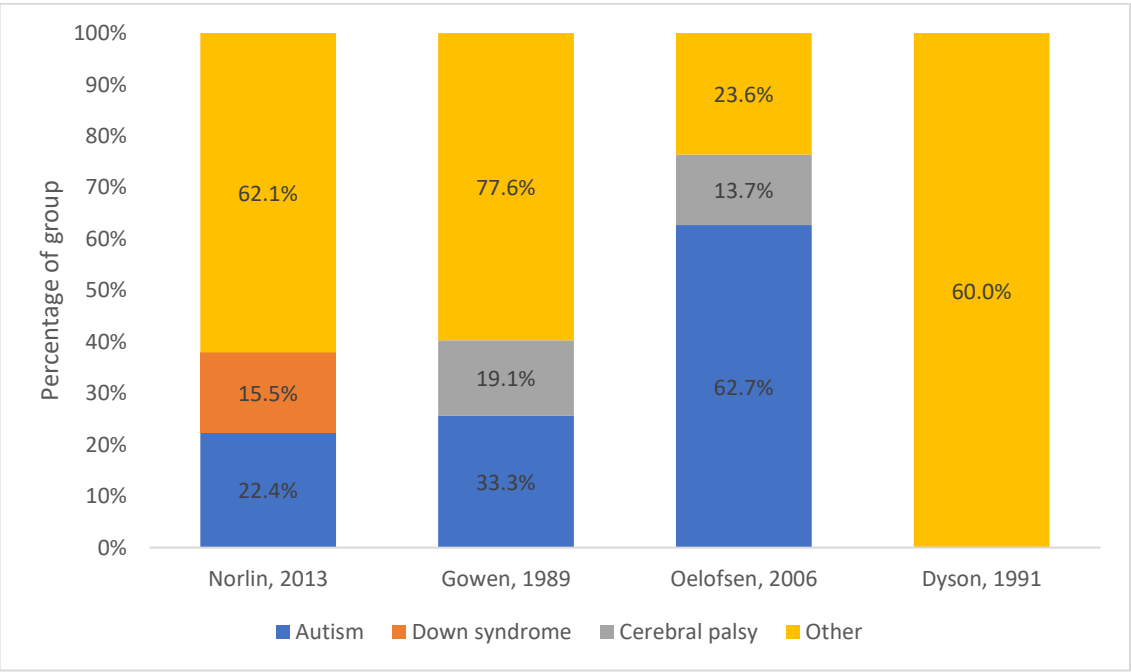
Figure 5. The disability composition of the exposed group



n=16 disability groups

Children with Down syndrome, cerebral palsy and ASD were also present in the mixed disability groups (Figure 6).

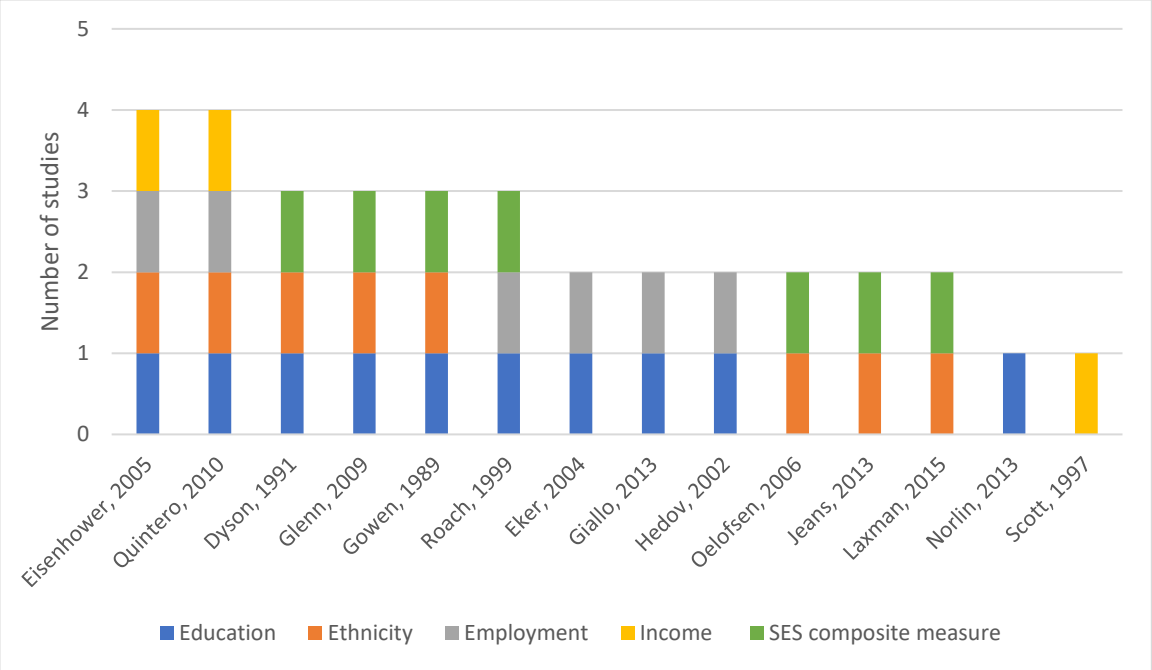
Figure 6. The major disability diagnoses in each mixed disability group (if specified)



3.11.5 Socioeconomic status

Indicators of socioeconomic status were not consistently reported across the studies (Figure 7). Differences in educational attainment between exposed and comparison groups were reported for 10 (71.4%) studies but differing scales were used so between-study comparison was difficult. Employment was reported for six (42.9%) studies and ethnicity for nine (64.3%).

Figure 7. Indicators of socioeconomic status included in each study



n=14

From the socioeconomic status information provided and interpretable, a bias of socioeconomic advantage (a high status skew) was observed in 8 studies (n=9). In most of these studies the socioeconomic information was provided for both the exposed and unexposed groups (n=7/10) (details by study included as an appendix [**A2.8**]). This assessment was based on whether the author of the study reported that there was a bias or whether more than 50% of the sample had more than compulsory education, as education was the most consistently reported (and relatively reliable) indictor of socioeconomic status (Galobardes, 2006b). For example, Jeans et al. (2013) reported a bias because 57% of the sample were in the two highest SES quintiles. In two other studies conducted in the USA (Quintero, 2010; Gowen, 1989), 59% or more of the exposed and comparison group had tertiary education, which is above the US average of 45.7% of adults aged 25-64 (OECD.Stat, 2018).

Of the studies that examined between group differences for the indicators of socioeconomic status (n=8), the comparison group had higher status than the exposed group (n=6 (75%)), with

significantly greater employment (n=4) and education (n=2). A very high proportion of the study samples (exposed and comparison) were married/cohabiting (n=14): median 96.25, range 81-100%. The proportion of the samples that were White (n=8) ranged from 40-94%.

3.12 Quality assessment summary

Most of the studies had a quality rating of fair (13 (92.9%)). One was poor, none were good (Table 5 above). The five longitudinal studies were awarded 3-6 stars (maximum 8; mean 4.2, median 4) and the nine cross-sectional studies received 1-3 stars (maximum 6; mean 2.3, median 2) (details by study included as an appendix [**A2.9**]).

3.12.1 Representativeness of the exposed group

A sample is considered representative if there is no potential for bias in the recruitment method and no differences between the mothers that participate in the study and those that chose not to (Wells, 2017). Poor representativeness affects the generalisability of the results to the study population (mothers of preschool children with developmental disabilities).

3.12.2 Recruitment bias

A purposive recruitment strategy was used in 12 (85.7%) of the studies, where families of disabled children were targeted for recruitment via disability services, intervention programmes, health centres or disability registers. This presents a potential selection bias because only mothers known to these services had the opportunity of recruitment. It is unknown whether mothers not known to the services differed significantly on sociodemographic or child disability-related factors (e.g. socioeconomic status, the severity of child disability).

Two studies used existing data from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B). They used the same study design and the exposed group was comprised of the same disability diagnosis (ASD and other developmental disabilities). It is highly likely that the children in the smaller study (Laxman, 2015) had also been included in the larger (earlier) study (Jeans, 2013); therefore the results of these studies cannot be considered entirely independent in this review.

3.12.2.1 Self-selection bias – healthier exposed mothers?

Nine studies (64.3%) recruited the exposed mothers via disability services and intervention programmes. These are families who are engaged with services that are designed to support the child's medical and developmental needs and to reduce the related challenges and stress experienced by the mothers. In two of the studies, it was theorised that these engaged caregivers (who are receiving support) were likely to have fewer and less severe symptoms of ill-health than mothers who were unknown to the services or who chose not to participate in the study (Scott,

1997; Gowen, 1989). If correct and extrapolated to the wider mother-caregiver population, this might have resulted in an underestimate of caregiver ill-health.

Alternatively, the mothers engaged with services might have more severely disabled children and be expected to have greater symptoms of ill-health due to very high caregiver burden (Roach, 1999). Then the caregivers unknown to services (excluded from the studies) might have had better health than the sample, thus providing a sample that was biased towards finding an association between caregiving and ill-health.

The direction of selection bias was unknown; thus, the findings can only be generalisable to caregivers who engage with disability services.

3.12.2.2 Self-selection bias – sociodemographic factors

Of the studies using a purposive strategy (n=12), one provided information on differences between the exposed group and nonresponders, although the information was minimal (Hedov, 2002). The children of the nonresponding exposed mothers had a higher mean age (4.8 years compared with exposed responders 4.7). As no sociodemographic differences between the participating and nonresponding mothers or those that left during the study were provided for the other studies, the generalisability of the results was limited.

Sociodemographic biases observed in the study samples (outlined in 3.11.5 and **A2.8**) raise concerns about the representativeness of the exposed group but were likely to reflect known patterns of disability diagnosis (outlined in 3.12.2.3).

3.12.2.3 Diagnosis bias

As highlighted in Chapter 1, mothers of children with Down syndrome, on average, have higher socioeconomic status than other mothers (Section 1.4.3.2). There was evidence of this bias in the one study with an exposed group of mothers with Down syndrome who provided maternal education information (Roach, 1999) (presented in A2.8).

There is also a known sociodemographic bias in the diagnosis of ASD, where advantaged families (via the mechanism of high maternal education) receive ASD diagnoses for their children earlier than disadvantaged families (Mandell, 2005; Brett, 2016). Two studies in this review with a high education bias had an exposed group comprised exclusively/with a high proportion of mothers of children with ASD (Quintero, 2010; Gowen, 1989). There were also indications of a high socioeconomic status bias in other exposed groups with only or a high proportion of children with ASD (assessed via other indicators) (Laxman, 2015; Eisenhower, 2005; Oelofsen, 2006; Quintero,

2010). For example, the ASD group in Laxman et al.'s (2015) study had a higher (but not statistically significant) socioeconomic status (quintile) than the comparison mothers.

There is also a known ethnicity bias in the diagnosis of ASD in Western countries, where White families receive diagnoses for their children earlier than minority ethnic families (Mandell, 2002). A high proportion of the exposed group were White (ranging from 45-92%) in almost all the studies in the review which provided ethnicity information (n=11 (78.6%)). It is possible that this diagnostic ethnicity bias was present in the studies with exposed groups containing ASD children. However, this could not be examined because none of the studies described ethnicity with reference to the ethnic composition of the region from which the sample was drawn.

3.12.3 Comparability of the comparison group

This is the likelihood of risk of bias between exposed groups based on study design or analysis, which necessitates the ability to make comparisons between groups by examining differences and controlling for confounders. The ideal comparison group should be representative of the population from which the exposed mothers come so that (theoretically) the only difference between the groups is the exposure (caregiving for a disabled child) (Kleinbaum, 2006). Eleven (78.6%) of the studies provided the same descriptive information for exposed and comparison mothers.

3.12.3.1 Group description

Three studies (21.4%) did not provide descriptive data for the comparison groups (Jeans, 2013; Giallo, 2013; Glenn, 2009). As such, the sociodemographic differences between the groups were unknown and could have been uncontrolled confounders. In most of the studies (n=11; 78.6%), the exposed and comparison mothers were recruited from the same community/geographic region at the same time point, albeit using differing recruitment methods. This limited the risk of confounding due to regional variation or age-period-cohort differences e.g. the children in the exposed and comparison groups being born in different years. One study measured the impact of the year of birth (1988 or 1991) on the outcome and found that there was no effect, so pooled the data (Scott, 1997).

3.12.3.2 Volunteer bias

Most of the studies (n=11; 78.6%) either targeted families for the comparison group (approached them directly), advertised for families of typically developing children, or used snowball sampling where exposed mothers recruited mothers with typically developing children. In each scenario, the mothers who chose to participate were self-selecting. This is widely expected to affect the

outcome of the studies because self-selecting participants are generally healthy people who are socially active (Roth, 2015).

3.12.3.3 Unknown ill-health

The extent of acute or chronic illness in the children (not classified as disability) was not specified for either the exposed or the comparison group. Only one study stated that children with minor health problems (such as fever, cough and diarrhoea) were included in the typically developing group. This was deliberate as, for convenience, they were recruited from a hospital out-patient unit (Eker, 2004). The presence of ill-health in the typically developing children potentially reduced the size of the difference in the health of caregivers and other mothers. If some of the typically developing children had increased care needs (e.g. due to having severe asthma or epilepsy), then the mothers were likely to be experiencing greater stress and caregiver burden than mothers of children without these care needs.

3.12.4 Outcomes

Key factors that introduced bias to the measurement of the outcome were whether:

- the exposed and comparison mothers could have had the outcome at the point of exposure (i.e. already had ill-health when they became a caregiver);
- the parenting stress outcome tool included a measure of child disability as an indicator of stress (under the assumption that child disability increases stress) (described in Section 3.8.1). Thus, the tool is biased towards finding greater stress in mother-caregivers; and
- the statistical test was appropriate for the examination of the difference in the outcome between the exposed and comparison group.

Every study used self-reported outcome measures without medical record linkage so there was no independent verification of the symptoms. This is common in the assessment of psychological symptoms and was not a major impediment to study quality as validated outcome measures were used (Rosenman, 2011).

3.13 Symptoms of ill-health

3.13.1 Overview

In every study (100%, n=14), poorer health was observed in the exposed than comparison group. The differences in mean scores between the groups were significant in 88.9% of the tests of difference between the outcomes measured (n=8/9). My meta-analysis found significant adverse relationships between caregiving and health in general and stress and depression specifically. The

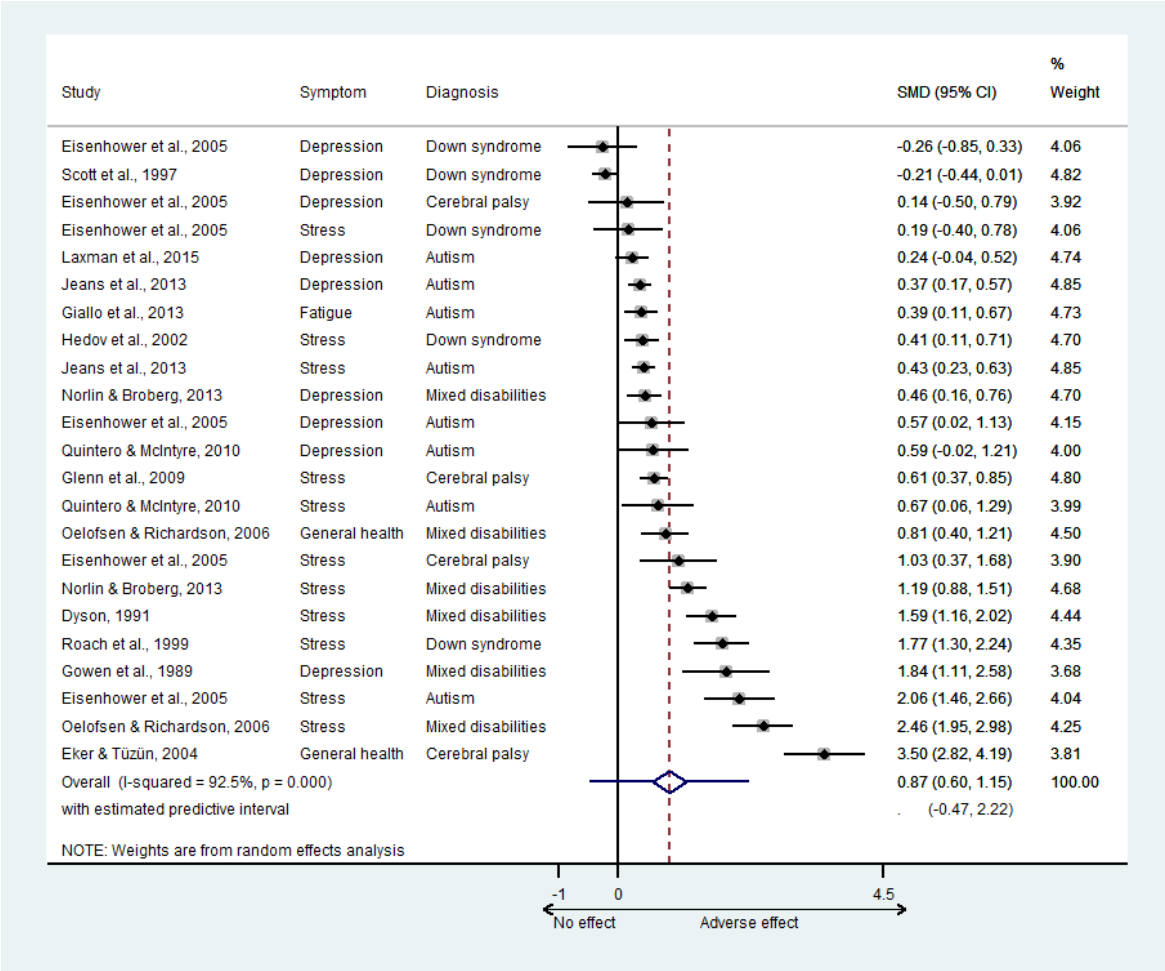
size of the effect of caregiving was less in caregivers of children with Down syndrome than for children with other diagnoses. There was high inconsistency in the data, with significant implications for the interpretation and generalisability of the results.

3.13.2 The association of caregiving to symptoms of ill-health

3.13.2.1 Overall pooled estimate

The pooled estimate for symptoms of ill-health in mother-caregivers compared with mothers of typically developing children was 0.87 (95% confidence interval (CI) 0.60, 1.15) (Figure 8). There was a significant relationship between caregiving and maternal ill-health (z 6.19, p<0.000).

Figure 8. Standardised mean difference (SMD) for caregiving to symptoms of ill-health in mothers of preschool children



Study, symptom and disability diagnosis are displayed to demarcate the SMDs as there are multiple SMDs for some studies.
The analysis for the outcome of psychological distress in Scott et al.'s study was dropped from the meta-analysis as the standard deviations could not be imputed.

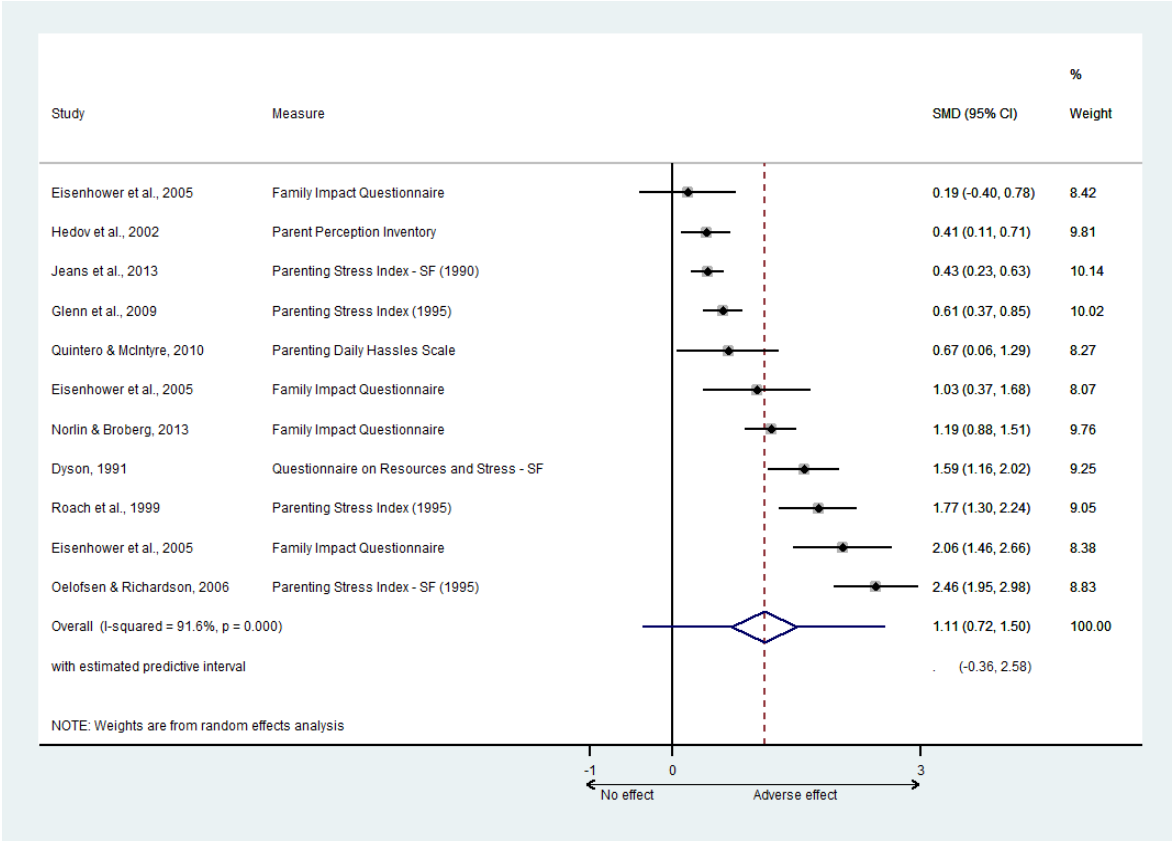
This was a large effect size, but the high level of statistically significant heterogeneity (I^2 92.5%; chi squared 294.11, p<0.000) in the data made the precision of the estimate questionable. The

predictive intervals which account for the inconsistency in the data included zero (95% predictive interval -0.47, 2.22) and there was a higher upper boundary than the pooled estimate confidence interval (95% confidence interval 0.60, 1.15). Therefore, an average effect was highly likely to exist and may be greater than indicated by the estimate of the average effect, but due to the inconsistency of the data the null hypothesis (no relationship of caregiving to ill-health on average) could not be rejected.

3.13.2.2 Stress

The standardised mean difference for the symptom of stress in exposed compared with unexposed mothers was 1.11 (95% CI 0.72, 1.50) with significantly higher stress in the exposed mothers (z5.57, p<0.000). The means ranged from 0.19 to 2.46; a small-very large relationship (Figure 9).

Figure 9. Standardised mean difference for caregiving to stress in mothers of preschool children



Abbreviations: short form (SF). Measure details: Both studies using the Family Impact Questionnaire used only the combined negative impact score. Dates in brackets denote the version of the Parenting stress index.

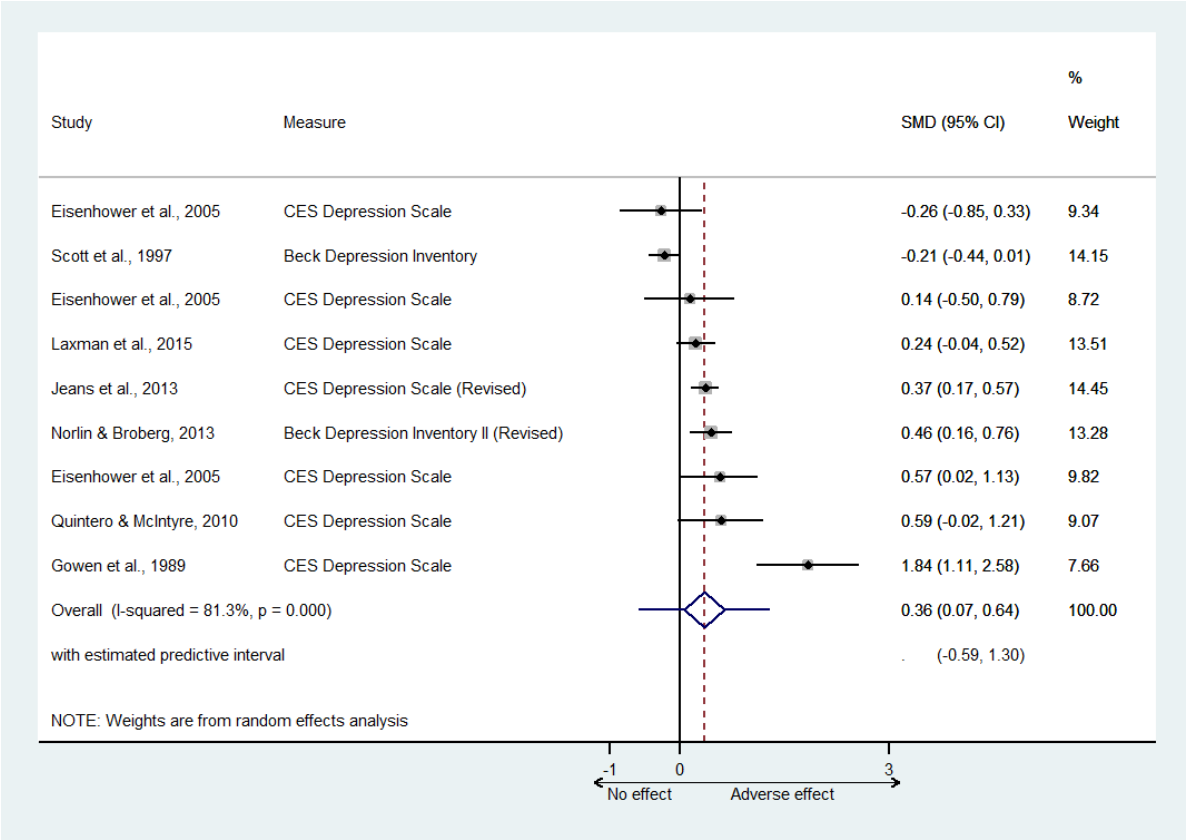
There was high heterogeneity (I^2 91.6%; chi squared 119.11, p<0.000; 95% predictive interval -0.36, 2.58). Only one study provided evidence to support the acceptance of a null hypothesis (no relationship of caregiving to stress on average), but due to the inconsistency of the data across

the studies, a very imprecise estimate of the predicted effect in any subsequent studies was produced.

3.13.2.3 Depression

The standardised mean difference for symptoms of depression in exposed compared with unexposed mothers was 0.36 (95% CI 0.07, 0.64), with significantly greater depression in the exposed mothers (z2.43, p=0.02) (Figure 10).

Figure 10. Standardised mean difference for caregiving to depression in mothers of preschool children



Abbreviations: Centre for Epidemiological Studies (CES)

The difference ranged from -0.21 to 1.84. Seven studies (n=9; 77.8%) found an adverse relationship between caregiving and depression. There was high heterogeneity (I^2 81.3%, chi squared 42.86, p<0.000; 95% predictive interval -0.59, 1.30). As the predictive interval included zero, caution was necessary in interpreting the results. This indicated that in any subsequent studies an association between caregiving may or may not be observed. Evidence to support a null hypothesis of no effect was provided by four studies.

Subgroup analyses were not possible for general health and fatigue as fewer than three analyses were performed for each of these outcomes.

3.13.2.4 Clinical thresholds

The outcome scores were interpreted with reference to clinical thresholds in seven studies (50%). The clinical threshold indicates the score above which the symptom has an impact on the person's daily life (National Institute for Health and Care Excellence, 2011). Three of these indicated the percentage of exposed and unexposed mothers above the threshold for clinical (moderate-severe) depression. This ranged from clinical depression in 5.6-32.1% of exposed and 5.0-29% of unexposed mothers (Scott, 1997; Jeans, 2013). Four studies summarised the results of stress outcome measures with reference to clinical thresholds, ranging from 84% to 'a handful' of clinically stressed exposed mothers (Roach, 1999; Oelofsen, 2006). The studies which provided threshold interpretations for the comparison group found 5% and 15% had clinical (severe) levels of stress (Glenn, 2009; Oelofsen, 2006). Giallo et al. (2013) stated that the clinical threshold for fatigue in the exposed group was in the moderate range.

3.13.3 Variation explained by disability diagnosis and related factors

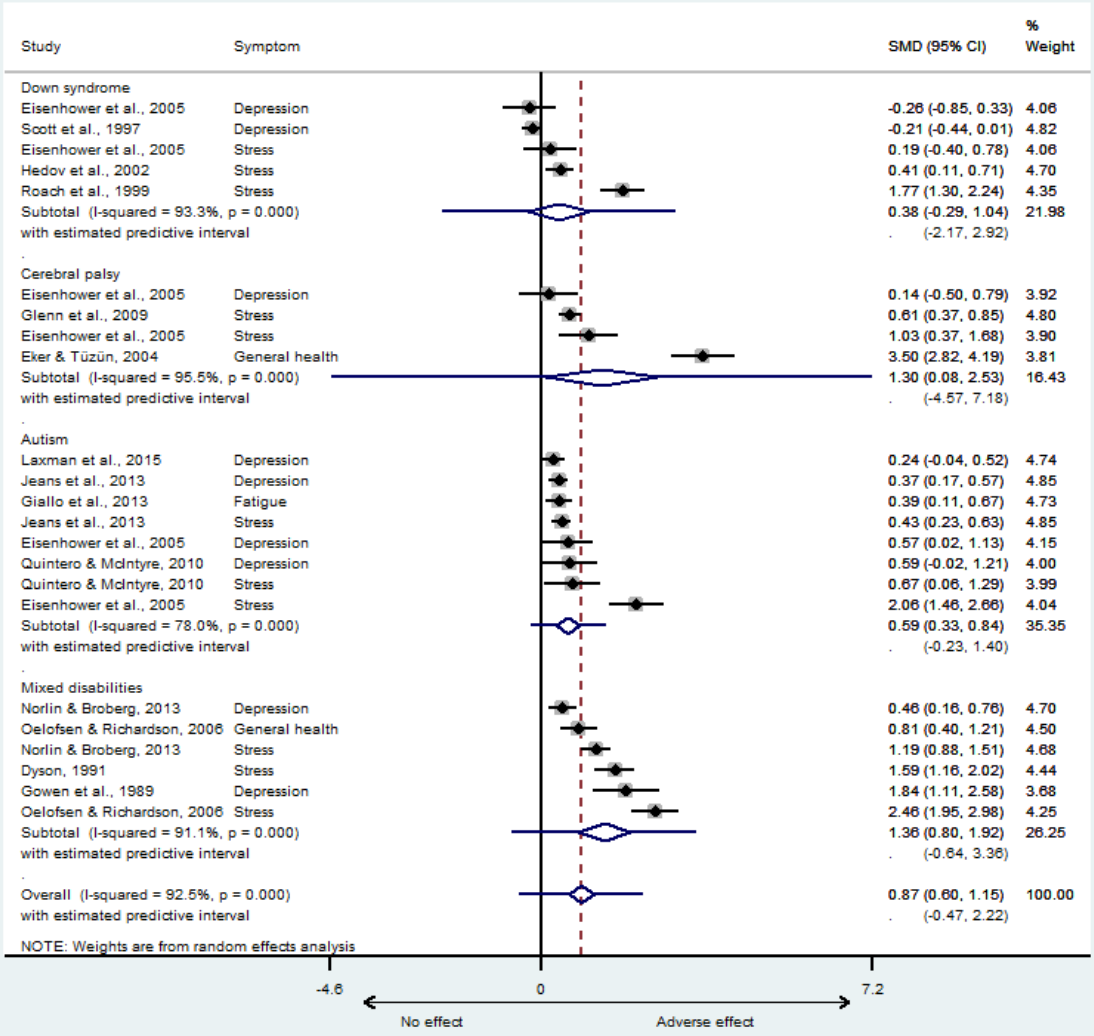
3.13.3.1 Overview

Ten studies compared mothers of children with typical development to mothers of children with specific disability diagnoses. Subgroup meta-analysis was possible (as three or more analyses had been performed) for ASD, Down syndrome, cerebral palsy and mixed disabilities. Other indicators of caregiver burden related to child disability were examined in the studies: behavioural problems (n=2); time spent caregiving (n=1); cognitive level (n=1); caregiving difficulty (n=1); and severity of motor functioning (n=1).

3.13.3.2 Disability diagnosis

There was evidence of greater ill-health in caregivers of children in each of the disability diagnoses groups compared with mothers of typically developing children, but the size, significance and precision of the association varied. The pooled estimates identified a small/moderate-large adverse effect of caregiving to ill-health for each diagnosis subgroup: mixed disabilities 1.36 (95% CI 0.80, 3.36); cerebral palsy 1.30 (95% CI 0.08, 2.53), ASD 0.59 (95% CI 0.33, 0.84) and Down syndrome 0.38 (95% CI -0.29, 1.04) (Figure 11).

Figure 11. Standardised mean difference for caregiving to symptoms of ill-health in mothers of preschool children analysed by disability diagnosis



The largest effect of caregiving on ill-health was for mixed disabilities. There were significant relationships between caregiving and children with mixed disabilities (z4.75, p<0.000), ASD (z4.47, p<0.000) and cerebral palsy (z2.09, p=0.04). There was a trend for greater ill-health in caregivers of children with Down syndrome, but the relationship was the smallest of the diagnosis subgroup analyses and not significant (z1.11, p=0.27).

Two studies had effect estimates in the opposite direction (below zero) from the expected adverse relationship of caregiving to ill-health (above zero). A further four had confidence intervals crossing zero (but the effect estimate was a positive value). Three of these six analyses were in mothers of children with Down syndrome.

There was high heterogeneity for each subgroup analysis, with all four predictive intervals crossing zero:

- mixed disabilities (95% predictive intervals -0.64, 3.36; I^2 91.1%; chi squared 55.97, p<0.00);
- ASD (-0.23, 1.40; 78.0%; 31.87, p<0.00);
- cerebral palsy (-4.57, 7.18; 95.5%; 66.29, p<0.00);
- Down syndrome (-2.17, 2.92; 93.3%; 59.51, p<0.00).

The consequence was considerable imprecision in the estimate of the predicted effect in a subsequent study with any of the diagnosis subgroups, including the possibility of no effect. This was most apparent for the mixed disability subgroup where every study (n=6) had an effect estimate and confidence intervals above zero, yet the predictive interval included zero.

The heterogeneity was affected by the wide range of standardised mean differences available for each subgroup analysis: mixed disabilities (0.46-1.84), ASD (0.24-2.06), cerebral palsy (0.14-3.50), Down syndrome (-0.21-1.77). The greatest inconsistency was in the cerebral palsy subgroup (95.5%) where the 95% predictive interval was over four times the width of the 95% confidence interval. This highly imprecise estimate of the true effect was influenced by the limited number of studies in the analysis (n=4) and the magnitude of the standardised mean difference for Eker and Tunzen's study (2004).

3.13.3.3 Disability-related factors

It was not possible to perform a meta-analysis on any other disability-related factors (e.g. severity or behavioural problems) because none were described in sufficient detail or examined in three or more studies. However, in the studies, variation due to these factors was described. In three, significant relationships were identified between greater maternal ill-health and more severe disability. For mothers of children with Down syndrome, greater caregiving difficulties (greater disability severity) was a significant predictor of higher scores on the depression subscale of the parenting stress index (β .24, p<.05) (Roach, 1999). Also in cases of Down syndrome, mothers who spent more than eight hours a day caregiving had significantly higher stress scores than mothers spending less than one hour a day ((t 1.79, p < 0.05) (Hedov, 2002). In a number of health subscales (physical; emotional and mental health; bodily pain and general health), mothers of children with cerebral palsy with the greatest impairment of motor function had significantly poorer health than mothers of more independent children (Eker, 2004).

There was insufficient description of the exposed groups in the studies to ascertain whether there were between study differences in child disability severity or behavioural problems which might explain variation between studies. Two studies excluded children who were nonambulatory (Quintero, 2010; Eisenhower, 2005) whilst others applied no additional exclusion criteria. Thus the mixed or specific disability groups could have included children who were nonambulatory or had multiple disability diagnoses (e.g. disability diagnoses in addition to ASD in a study with caregiving for a child with ASD as the exposure) (Laxman, 2015; Giallo, 2013; Jeans, 2013; Scott, 1997).

3.13.4 Variation explained by socioeconomic status

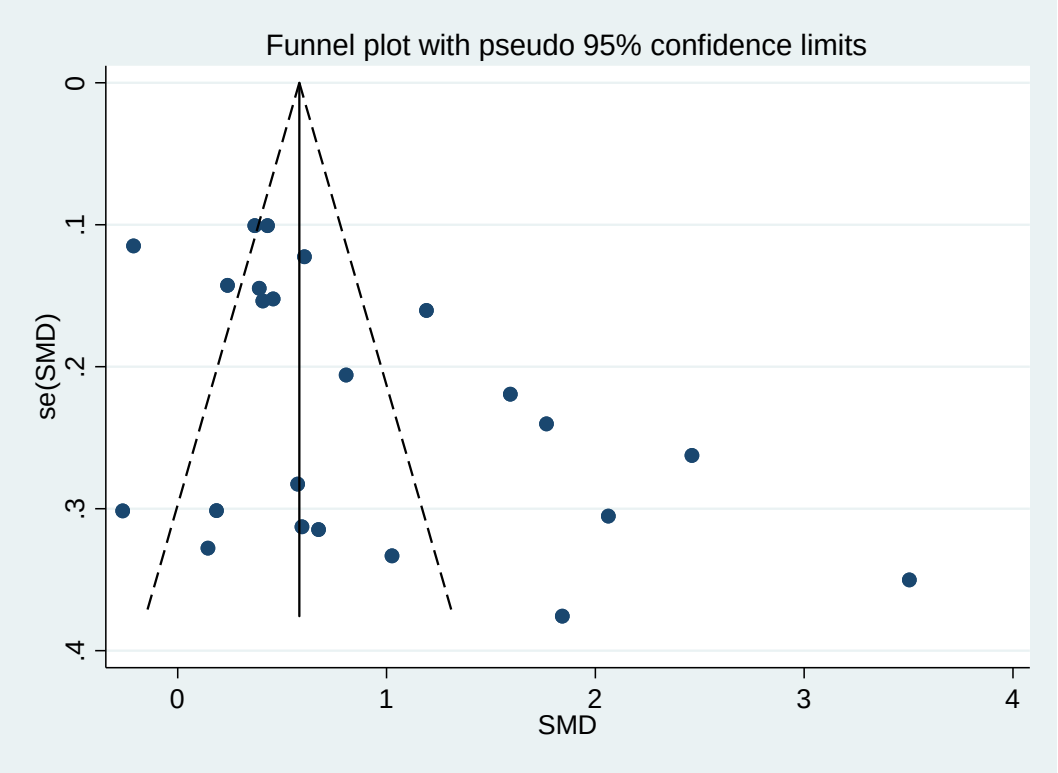
No studies reported that socioeconomic status explained variation in the outcome in addition to caregiver status; although, in two studies, the lack of socioeconomic diversity was suggested as an explanation for limited between-group differences for the outcome (Gowen, 1989; Quintero, 2010). The lack of information and analysis by socioeconomic status, and the different measures used (even for the same variable e.g. education) made it impossible to perform subgroup analysis by socioeconomic status. There was insufficient data to test the hypothesis that variation in the association between caregiving and ill-health was explained by socioeconomic status. Moreover, there was insufficient data to investigate whether health varied differently by different indicators of socioeconomic status (e.g. education versus socioeconomic status quintiles) in exposed and unexposed mothers.

3.13.5 Publication bias

There was evidence of the possibility of substantial publication bias. The bias coefficient for the Egger test of funnel plot asymmetry was positive with wide confidence intervals and a p value indicating significance (β 4.74, 95% CI 1.40-8.07, p=0.008). The null hypothesis of no publication (small-study effects) bias could not be rejected (Sterne, 2009a).

The substantial asymmetry of the graph of the plotted studies illustrated the influence of small study size on the precision of the effect sizes (Figure 12). There was a trend for larger study size (plotted as variability – larger studies have lower variability) to be associated with lower effect sizes (SMD) as, in general, the studies with lower variability were proximal to the pooled estimate (the solid vertical line). As the variability increased, so did the distance from the pooled estimate (an increasing number of plotted studies outside the bounds of the funnel plot 95% confidence limits (Higgins, 2011, Section 10.4.1-10.4.3).

Figure 12. Funnel plot to assess small study bias in the meta-analysis



Se(SMD); standard error of the standardised mean difference

There was also apparent evidence of consistency of effect size across the studies (despite variation in study size) as most of the data points are distributed within the confidence limits. However, the plot does not account for heterogeneity (i.e. the width of the confidence intervals for each effect estimate). The consistency of the effect sizes must be considered within the wider context of the data heterogeneity (Higgins, 2011, Section 10.4.1).

3.13.6 Other sources of variation

As none of the investigations of heterogeneity adequately accounted for the high inconsistency, patterns attributable to other observable factors with the potential to generate bias were considered.

Visual analysis of the forest plots did not identify differences in effect size, direction or data consistency attributable to:

- the country where the research was conducted;
- exposed mothers receiving support via disability services compared with other recruitment strategies;

- outcome measures with a known measurement bias compared with other outcome measures (as described in Section 3.8.1); or
- child age (the mean age in the exposed group).

3.14 Discussion

Most other reviews in this field have focused on symptoms of stress and depression and used narrative rather than meta-analytic methods of synthesis. Both methods have provided evidence of an adverse relationship between caregiving and psychological health (Biswas, 2015; Lee, 2013; Cantwell, 2015; Miodrag, 2015; Singer, 2006; Hayes, 2013). I use this wider literature to contextualise my findings.

3.14.1 Greater ill-health in mother-caregivers

This review identified a strong and significant relationship between caregiving for preschool children with developmental disabilities and greater ill-health compared with mothers of typical developing children (SMD 0.87; 95% CI 0.60, 1.15). The pooled estimate for ill-health based on the effect sizes for the symptoms of general health, depression, stress and fatigue, and the subgroup estimates for stress and depression are consistent with the findings of other reviews. They all identified greater ill-health in more parents of children with developmental disabilities than parents of typically developing children (Fairthorne, 2015a; Lee, 2013; Miodrag, 2015; Miodrag, 2010; Bailey, 2007; Singer, 2006). The meta-analyses in this field, which have included studies in preschool children, have examined outcomes of depression, stress and physical ill-health in caregivers of children with mixed and specific developmental disabilities. The pooled estimates in these studies range from 0.39 in mixed disability groups to 1.58 in ASD groups (Hayes, 2013; Miodrag, 2015; Singer, 2006). Only Singer and Floyd's (2006) review focused exclusively on mothers, akin to the inclusion criteria specified for my review.

3.14.1.1 Depression

From 18 studies, Singer and Floyd (2006) estimated a small-moderate detrimental effect of caregiver status on symptoms of depression in mothers of children of any age with and without developmental disabilities (diagnosed before the age of 21) (weighted effect 0.39; 95% CI 0.31, 0.47). Most of the samples in Singer and Floyd's review had an average child age or range above five years (n=13 (72.2%)). This pooled estimate was slightly greater and with a narrower confidence interval than my pooled estimate for depression (0.36; 0.07, 0.64). My results compared with Singer and Floyd's findings provides evidence that the adverse relationship of caregiving to depression emerges during the child's preschool years, although possibly with greater variation during this period than in older age groups. It could show that the effect is

relatively stable across the lifespan of the disabled child, or that compared with middle childhood and adulthood, there are specific stressors in early childhood, that result in the same magnitude of effect, despite the shorter duration of exposure to caregiving.

3.14.1.2 Stress

Hayes and Watson (2013) conducted a meta-analysis of parenting stress in parents of children of any age with and without ASD. They found a pooled estimate of 1.58 (95% CI 1.16, 2.0) from 15 studies, of which only three had an average child age or range below five years (20%). No meta-analyses have been performed for stress in mothers of children with and without developmental disabilities, despite many studies examining this outcome.

My results show a strong and significant relationship of greater stress in caregivers (1.11; 95% CI 0.72, 1.50) as theorised and based on the evidence from other studies (McKinney, 1987; Hanson, 1990; Dumas, 1991; Krauss, 1993; Honig, 1997; Sanders, 1997). My, and Hayes and Watson's, findings provide evidence of a large adverse association between caregiving and stress. However, as with the outcome of depression, it would be misleading to accept this evidence without recognising the considerable heterogeneity of the data. The greater size of the effect estimate in Hayes and Watson's review and narrower confidence interval could be attributable to the specific disability diagnosis or to the older average age of the children in the analysis (discussed in Section 3.14.3.1).

3.14.1.3 Physical and general ill-health

Compared with stress and depression, fewer studies have examined the association of caregiver status to physical and general health (Lach, 2009; Miodrag, 2010; Lee, 2017). Miodrag et al. (2015) performed a meta-analysis for the relationship between physical ill-health and caregiving for children of any age with intellectual disabilities and chronic conditions using the Parenting Stress Index health sub-domain (Abidin, 2017). They found evidence of poorer physical health (higher health sub-domain scores) in caregivers compared with mothers of typically developing children (0.39; 95% CI 0.23, 0.55).

In my review, some of the stress and depression indices had physical health components, and the general health and fatigue outcomes were reported as being weighted towards physical rather than psychological symptoms (Giallo, 2013; Eker, 2004; Oelofsen, 2006). There was evidence of poorer health outcomes in all these studies (SMD >0). However, a meta-analysis for physical ill-health could not be performed as none of the studies examined specific symptoms of physical ill-health (e.g. pain or cold symptoms) and the outcomes examined (or reported physical health domain totals) were in fewer than 3 studies.

3.14.2 Predictive intervals - The possibility of no effect

Most of the studies found an adverse association between caregiving and health, but there was a lack of precision in the pooled estimates. This inconsistency in the average effect was informed by substantial variation within studies between the health of the exposed and comparison mothers. Significant high heterogeneity (variation above sampling level error alone) indicates difference in effect size due to the presence of moderating factors (Theule, 2010).

When the heterogeneity was accounted for in the meta-analysis by the calculation of predictive intervals, the trend for greater ill-health remained but the precision of the estimate was greatly reduced. As a result, there was insufficient evidence that the relationship of caregiving to ill-health was statistically significant. The inconsistency in the data showed that there is a relationship between caregiving and ill-health during the preschool years but that it is highly variable and may not be found in all caregiver groups.

The heterogeneity of the data in other reviews in this field varied from significant inconsistency of moderate proportions in Miodrag et al.'s (2015) study (I^2 63%) to low non-significant heterogeneity in Hayes and Watson's study (2013) (I^2 16-17%). The heterogeneity was also non-significant in Singer and Floyd's (2006) review. Possible explanations, suggested by meta-analyses and studies in this field, include disability diagnosis, child age group, behavioural problems, sociodemographic factors, the extent of caregiver social support, resilience, and perceptions of disability (Biswas, 2015; Bekhet, 2012; Lee, 2013; Neely-Barnes, 2008).

Miodrag et al. (2015) used meta-regression to assess possible parent and child characteristics associated with variation in effect sizes. Some maternal sociodemographic factors (marital status, mostly college educated parents) and child factors (emotional-behavioural problems, average age, proportion of White children) had an association with study effect size; but with high variability due to study numbers. This affected the ability to detect statistically significant relationships (e.g. too few studies with samples distinguishable as high or low socioeconomic status). The same limitation of study numbers (and under-reporting of study characteristics) affected my ability to adequately examine potential causes of heterogeneity beyond the planned subgroup analyses by outcome and disability diagnosis

3.14.3 Investigation of variability

3.14.3.1 Disability diagnosis

Reviews that have examined the influence of different disability diagnoses and disability-related factors have found greater ill-health associated with caregiving for children with ASD, behavioural problems, and high caregiving demands (disability severity) (Fairthorne, 2015a; Biswas, 2015; Lee, 2013; Neely-Barnes, 2008; Singer, 2006), and differences by child age.

Singer and Floyd (2006) investigated whether disability category moderated the magnitude of the association between caregiving and depression in mothers of children with and without developmental disabilities. They found that studies focusing on children with ASD showed significantly higher effect sizes than those in caregivers of children with intellectual disabilities or spina bifida ($F(2, 15)$, $p=.005$). No differences between the other disability or chronic condition categories were reported (cerebral palsy, developmental disability or delay, multiple disabilities, cystic fibrosis, traumatic brain injury). I found that the greatest association between caregiving and ill-health during the preschool period was for mixed developmental disabilities not ASD. This provides evidence that there is a relationship between caregiving for a child with any developmental disability diagnosis and caregiver ill-health. However, the strength of the association may vary by diagnosis, and diagnosis does not explain the heterogeneity that remained high in the pooled estimates for each different diagnostic subgroup (≥78%).

Studies have identified increasing parental stress as children with ASD age, with significant differences in stress between children in the 3-6 and 11-14 age bands (Tehee, 2009). It is possible that the magnitude of the effect of ASD compared with other diagnoses is not observed in the preschool age group. Other reviews have found that the association between caregiving and physical ill-health was greater in samples of children mostly over the age of five (Miodrag, 2015); whilst the association of caregiving to depression was greater in samples of children in early and middle childhood than adult children (Singer, 2006). They state that this is consistent with research that finds that maternal distress gradually decreases over time. Due to the limited number of studies I could not perform subgroup analysis by age. Visual assessment did not reveal a pattern of growing effect sizes in studies in children with increasing mean ages (over the preschool period), but factors relating to age could still be a cause of heterogeneity (e.g. seeking a diagnosis, not being able to return to work after maternity leave, or the age of other children in the household).

The results of my meta-analysis show that there is substantial evidence of the presence of acute stress and ill-health in mothers of children below the age of five regardless of any later age-

related trends (with divergence by disability diagnosis or otherwise). The finding of the largest effect estimate for mixed developmental disabilities could reflect a common experience of high stress in caregivers during the preschool period as they seek and receive their child's diagnosis and adjust to its implications for their lives (Beresford, 2007). Perhaps ill-health in mothers of children with ASD increases as the difference between their child's development and that of other children becomes more apparent, such as when the child begins school or when an appropriate school is being selected. This is compared with other disabilities where the long-term impact of the impairment is more predictable. This developmental uncertainty has been identified as a caregiver stressor (Bourke-Taylor, 2010).

Alternatively, there could be a high number of children in the exposed groups in my review with behavioural problems (Section 1.4.3.1), thus reducing the difference between the ASD and other groups on the parameter of behavioural problems (to which the 'ASD effect' is often attributed) (Stacey, 2009; Davis, 2008). However, this is unknown as behavioural assessments were not reported for most of the studies.

3.14.3.2 Socioeconomic status

Socioeconomic status has been proposed as the explanation for variation in the relationship of caregiver status to ill-health but has been inconsistently examined in research (Griffith, 2010; Woolfson, 2005). Miodrag et al. (2015) identified college education, ethnicity and marital status as modifiers of effect size, explaining observed differences in the magnitude of the association between caregiving and physical ill-health. In my review, there were only two studies where the effect size was below zero (Scott, 1997; Eisenhower, 2005). These were both exposed groups comprised of Down syndrome children. A socioeconomic bias is expected in mothers of children with Down syndrome, reducing the adverse influence of caregiving on maternal health. From the available information, high socioeconomic status in the exposed group was indicated in two of the four studies with Down syndrome groups (Eisenhower, 2005; Roach, 1999). Therefore, it is only possible to say that the so called 'Down syndrome advantage' (discussed in Section 1.4.3.2) may have been present in Eisenhower et al.'s (2005) study. The lack of information and high socioeconomic status bias observed for the studies in my review (n=8/9; 88.9%) prevented the assessment of the extent to which socioeconomic status explained variation.

3.14.3.3 Clinical thresholds

The relationship of caregiver status to clinical ill-health is unclear (Miodrag, 2010; Bailey, 2007). To be able to make recommendations for systemic changes to improve the support received by mother-caregivers, it is important to ascertain whether the ill-health attributable to caregiving is

of a clinical magnitude. In their review, Singer and Floyd (2006) calculated the percentage of exposed and unexposed mothers in each study with depression above the clinical threshold to produce an average for the review - 29% of caregivers had clinically significant depressive symptoms compared to 19% of other mothers. In my review, it is likely that more exposed mothers had clinical levels of the symptoms than the other mothers as the average outcome measure scores were higher for the exposed mothers, but too few studies provided sufficient information for a similar assessment to be performed.

There may also be variation in the clinical level by symptom. In my review the size of the estimated effect of caregiving was greater for stress than for depression. This may indicate that caregivers are likely to experience higher stress levels than mothers of typically developing children, but for most mothers these symptoms do not reach the clinical threshold that is associated with episodes of clinical depression (Tafet, 2015).

Research in the field of caregiver-health has been criticised for ignoring the threshold between mild and clinical levels of depressive symptoms as it may result in the overestimation of clinical symptoms in caregivers. Bailey et al. (2007) reviewed 42 articles assessing clinical depression in mothers of children with developmental disabilities and only eight measured and reported clinically diagnosed depressive symptoms. They recommended that future research incorporate gold standard diagnostic tools, assess mother's clinical history, symptom severity and type of depression. Of the six studies in my review published after this recommendation was made, only two reported the percentage of mothers with clinical symptoms and one included a measure of clinical history. The lack of consistent clinical reporting continues to prevent the accurate estimation of the extent of clinical need in the caregiver population.

3.14.3.4 Publication and other sources of bias

There was evidence of small study publication bias in the results of the funnel plot and Egger's test. This is consistent with the expectation of greater ill-health in caregivers which could result in a systematic bias towards the publication of studies that find evidence of this effect, and against studies which support a counter narrative of no effect of caregiving on ill-health. However, Egger (1997) cautions against the assumption that asymmetry observed in funnel plots is solely attributable to publication bias. Other mechanisms that can cause asymmetry include: location bias; true heterogeneity (such as differences in the underlying risk in the study cohorts); the choice of effect measure; or poor design of small studies.

My findings suggest that considerable unexplained heterogeneity exists in the relationship between caregiving and ill-health in mothers of preschool children. The variation in the

association between caregiving and ill-health is not adequately explained by any of the factors examined (including symptom and disability diagnosis). Of Egger's above mechanisms, study quality remains unexplored. However, as with socioeconomic status, insufficient diversity in the quality and the limited number of studies prevented the examination of this possibility.

3.14.4 Strengths and limitations

3.14.4.1 Strengths

This is the only review to systematically appraise and quantitatively synthesise what is known about the relationship between caregiving and maternal health during the preschool period. It highlights the adverse influence of caregiving on physical as well as psychological health.

The use of predictive intervals illustrates the impact of heterogeneity of study designs and populations on effect estimates. I have identified gaps in the understanding of factors that contribute to mother-caregiver health outcomes during the preschool period.

3.14.4.2 Limitations

Relevant studies and data may have been missed as in the literature search: only the English language was used; a study design filter was used; and two relevant databases, grey literature and abstracts were excluded. Studies may have been inappropriately excluded during the screening phase as a second screener was not available. The inclusion of only observational study designs risked exaggerated conclusions being drawn from biased studies or misattributed to caregiver burden when potentially influential factors were not measured, such as child behaviour (Bekhet, 2012; Biswas, 2015; Smith, 2001).

The scoping approach to the range of symptoms and inclusion of stress identified heterogeneous outcomes at unknown clinical levels. The expected variation attributable to socioeconomic status and disability-related factors were largely uninvestigable. The generalisability of the results of the meta-analysis was limited by the high heterogeneity of the data. This necessitated the use of predictive intervals which provided a less precise but more reliable estimate. Studies with more than one data point in the analysis were over-represented in the pooled estimates (n=5). However, correcting for this by manually adjusting the weights would not have reduced the heterogeneity of the data and improved the precision of the results.

The generalisability of the results was further limited by the issues of unknown representativeness and evidence of unrepresentative exposed and unexposed mothers due to selection and socioeconomic status biases and lack of descriptive detail. As such the observed trends can only be extrapolated with some reliability to socioeconomically advantaged, White

populations who are engaging with disability support services. The extent to which the relationship between caregiving and health may be misattributed to caregiving in general rather than to child behavioural problems or disability severity is unknown.

This review has not established causality. It is theorised that caregiving has a causal relationship to ill-health due to the additional demands of the role (outlined in Chapters 1 and 2). I found evidence of an adverse relationship of caregiving to health during the preschool period. However, as the studies in this review all identified the exposure at the same time as measuring the outcome, the temporal nature of the associations could not be inferred. From this review, the possibility that other environmental, maternal or child factors have a greater direct or indirect influence on ill-health than caregiving cannot be ruled out (such as socioeconomic status or specific indicators of socioeconomic status, pre-existing ill-health, maternal coping factors (described in Section 2.2.1), or child behavioural problems). There may be interrelationships between symptoms, such as causal or comorbid relationships between stress and depression or depression and fatigue (outlined in Section 1.4.2). However, neither the studies in this review (due to the observational study design) nor the results of the meta-analyses provide evidence of these relationships.

3.15 Conclusions

The results of my meta-analysis showed a strong and significant adverse association between caregiving and maternal health during the preschool period, but with substantial unexplained variation. In general, child disability diagnosis did not substantially explain the variation in the estimates of the effect of caregiving on ill-health. There was evidence of a smaller or no association between caregiving for children with Down syndrome and ill-health, but not of the expected greater impact of caregiving for a child with ASD compared with other developmental disabilities. A lack of information provided in the studies prevented the examination of the influence of socioeconomic status on the relationship between caregiving and ill-health, as well as additional (post hoc) investigations of the variability in the data (e.g. how clinical levels of the symptoms varied).

The findings should be interpreted with caution given the considerable variability in the association of caregiving to ill-health within and between studies. The use of predictive intervals to incorporate the heterogeneity of the data illustrated low generalisability for the pooled estimates. Whether the relationship between caregiving and ill health is causal could not be established.

3.16 Research recommendations

Some important gaps in the understanding of ill-health in mothers of preschool children with developmental disabilities compared with typically developing children highlighted by this review (and informed by Chapters 1 and 2) are:

- whether the relationship between caregiver status and ill-health is causal;
- the relationship of caregiver status to a wider range of symptoms of ill-health;
- the prevalence of clinical levels of symptoms of ill-health;
- the relationship of pre- and post-exposure symptoms of ill-health;
- whether the prevalence of symptoms of ill-health varies by socioeconomic status and how it varies for different indicators; and
- the investigation of factors which might moderate the influence of caregiving to ill-health.

The next chapter of the thesis sets out the methodology of three studies designed to address these gaps. The results of the review are discussed with reference to these studies in the final chapter of the thesis (Chapter 10).

Section B: Comparative cohort analyses

Chapter 4 Methods for the comparative cohort analyses

This chapter describes the methods used to perform three linked secondary analyses of the Born in Bradford cohort study.

4.1 Introduction

To explore the research gaps identified via the literature review (outlined in Section 3.16) and investigate the relationship between caregiving for preschool children with developmental disabilities and healthcare use (research gap discussed in Section 1.6), I designed three comparative studies using secondary analyses of the Born in Bradford (BiB) cohort study with linked primary care records. Visiting a primary care service about a symptom of ill-health is a strong indicator of clinical need (Section 1.5). The use of epidemiological methods within primary care enabled the investigation of ill-health as well as healthcare use, and contributes to the discussion around disability case ascertainment via routinely collected health data (Hannaford, 2006; Lingam, 2012).

4.1.1 Research questions

I compared mothers with and without caregiver status (i.e. being a mother-caregiver of a preschool disabled children or not) to answer the research questions:

- Is caregiver status associated with variation in the prevalence of symptoms of ill-health in mothers of preschool children independent of pre-natal ill-health and socioeconomic status?
- Is caregiver status associated with variation in the rate of consultation for symptoms of ill-health in mothers of preschool children independent of pre-natal healthcare seeking behaviour via healthcare use and socioeconomic status?
- Is variation in caregiver status and caregiving for children with ASD specifically associated with subgroups characterised by different patterns of pre- and post-natal healthcare use and indicators of socioeconomic status?

4.2 Data source - the Born in Bradford study

I applied to use the data of mother-child dyads in the BiB study. This is a large multi-ethnic birth cohort with extensive sociodemographic data for the mothers and linkage to the mother and child primary care records (Wright, 2013). The incidence of child disability in Bradford (northern England) is higher than the UK national average due to the increased risk of congenital anomalies

(including neurodegenerative diseases) in the Pakistani community, partially attributable to consanguineous marriage (Sheridan, 2013; Devereux, 2004). This was expected to produce a sample with more caregivers than other UK birth cohorts, such as the Millennium Cohort (n=19,000 mothers) (Emerson, 2008a).

The cohort was initiated in 2007 in response to concerns about the high infant mortality rate in Bradford (population around 500,000) compared with other UK cities, and high levels of child morbidity (e.g. congenital anomalies and childhood disabilities) (Wright, 2013; Small, 2012). Its aims were:

- To describe health and ill-health in the largely bi-ethnic population with high economic deprivation;
- To identify modifiable causal relationships that contribute to ill-health, and design and evaluate interventions to promote wellbeing;
- To provide an integrated model of epidemiological and evaluative research based on practice in the National Health Service and related health systems; and
- To build and reinforce research capacity in Bradford (Wright, 2013).

Women were recruited to the cohort between March 2007 and December 2010 at the Bradford Royal Infirmary when they attended the clinic for an oral glucose test (offered to all pregnant women at 26-28 weeks gestation). This is the only maternity unit in Bradford. All babies born to these mothers were eligible to participate and more than 80% of women invited agreed to participate (Raynor, 2008). The cohort comprises of 12,453 mothers, 13,776 pregnancies and 3,448 fathers, and has been described extensively elsewhere (Wright, 2013).

Sociodemographic data were collected via the BiB baseline questionnaire when mothers were recruited to the cohort (during pregnancy), including information on the social determinants of health. For women who consented to data linkage, this information was linked to the mother and child's primary and some secondary care data. Secondary analysis of this data has enabled research on topics including child disability incidence, maternal healthcare use and the relationship of socioeconomic status to health outcomes (e.g. Bishop, 2017; Kelly, 2017a; Kelly, 2017b; Prady, 2016b). This provides a rich context for discussion of the findings arising from the analyses outlined here.

4.2.1 Application for access to the data

My application (SP304) to use BiB data was approved on 1st August 2018 and the Collaboration Agreement signed by both parties [**A3.1-2**]. The specification for the data extraction (described below) included:

- the inclusion/exclusion criteria for the mother-child dyads (Section 4.5.1)
- the method of identifying children with disabilities via primary care records (Section 4.5.3)
- the method of identifying mothers with symptoms of ill-health associated with caregiver burden via primary care records (Section 4.7)
- the requested BiB baseline questionnaire variables (Section 4.8)

The mothers and children were linked to each other by BiB using a unique pregnancy identification number.

4.3 Ethical considerations

The BiB data requested are sensitive personal data. BiB received ethical approval for the data collection from the Bradford Research Ethics Committee (Ref 07/H1302/112). Only mothers who consented to the access and linkage of their primary care records to the primary data collected as part of the BiB project were included in my study (Born in Bradford, 2018).

The planned studies received ethical scrutiny as part of the BiB data application. Additional ethical approval was not required because the analyses would use pseudonymised existing data and I complied with all standards and policies of the University of York's Data Management Policy (University of York Information Services, 2018). This decision was confirmed in writing by the Chair of the University of York Health Sciences Department Research Governance Committee.

4.3.1 Data protection

BiB informs its participants that they will not be identified by the results or any reports that they publish, which includes research published by those, like me, with Collaboration Agreements (Born in Bradford, 2018) [**A3.2**]. BiB does not share person identifiable data - the data has been pseudonymised (i.e. using identification numbers instead of names) (specified in Section 3 of the BiB Collaboration Agreement [**A3.2**]). However, individuals become re-identifiable when the description of study participants results in small counts for specific characteristics (Elliot, 2016). In the BiB data there was a high risk of participant re-identification due to small numbers with specific child disabilities or maternal health outcomes combined with the large amount of personal information collected within a specific geographical context (metropolitan Bradford). Best practice guidance on data management and protection were followed to prevent:

- access to the data by unauthorised third parties; and
- identification of the study participants by others with access to the BiB cohort (such as healthcare professionals) or residents of Bradford (approaches described in Section 4.3.1).

Accordingly, I did not include rare child disabilities (prevalence ≤1 in 10,000) in the case ascertainment strategy (outlined in Section 4.7.5); and I used the following data suppression approaches in reporting descriptive statistics to prevent the identification of an individual to within five people (Office for National Statistics, 2006):

- Collapsing categories - categories within a variable were collapsed if this would raise the count above 5 without obscuring the categories in which the groups were theorised to be vary (expected differences outlined in Sections 4.7.7.3 and 4.10.4).
- Dropping variables: variables were not presented in the results of the analyses if collapsing was not possible. This occurred when the variables were: a) continuous; b) collapsing categories did not raise the count above five; or c) it was not logical to collapse the categories given the theorised relationships. For example, if only one mother had the symptom of fatigue recorded, the binary variable of fatigue (yes/no) could not be collapsed so the results of this analysis were not displayed (they were dropped).
- Dropping participants: specific disability groups (included in the case ascertainment strategy) with fewer than five children were dropped from the dataset.

4.4 Data management

The data were extracted by the BiB Data Manager and transferred via the Cisco Registered Envelope Service for the secure transmission of encrypted data. The received data were stored on the University of York drive accessible via a password protected computer in a secure location on the University campus. The requirement of the University of York's Data Management Policy (University of York Information Services, 2018) to evidence ownership and rights in respect to the data and research conducted is satisfied by the BiB Collaboration Agreement.

All changes made to the data, new variables generated and why these actions were performed was recorded in a descriptive meta-data document. This meets the Policy's requirement to evidence understanding and decisions about the creation, curation and ethical treatment of the data. To ensure the access, protection, preservation, use and reuse of the data, the meta-data documentation will be available to BiB when the data is returned at the end of the project or when requested (if sooner), as specified in the Collaboration Agreement.

4.5 Study participant inclusion and exclusion criteria

The participants of the three studies were paired mothers and children from the BiB cohort who met the inclusion and exclusion criteria (Table 6).

Table 6. Study participant inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
An electronic primary care record available for the full study period (from 12 months before and five years after the index child's birth)	Women who: • relocated to Bradford up to one year before the child's birth or relocated from Bradford within 5 years of the index child's birth (identified using NHS tracing files) • withdrew from the BiB cohort or died within the study period
A BiB baseline questionnaire	No BiB baseline questionnaire
Linked primary care records available for the index child from ages 0-5	Children who were withdrawn from the BiB cohort within the study period
Children who survived beyond the age of five	Children who died before the age of five
One child per mother - when a mother has more than one child in the BiB cohort: • the disabled child is selected if one child has a disability code and the others do not • the first born child is selected if more than one disabled child (including if multiple births) • the first born child is selected if no children have disability codes (including if multiple births)	More than one child per mother - subsequent children in the BiB cohort are excluded

4.6 The exposure variable

Caregiver status was the grouping variable for the exposed and unexposed maternal groups (and the main independent variable in the analyses). The exposed group in the studies were mothers with preschool children (aged 0-5 years) diagnosed with a developmental disability. The unexposed group were mothers with preschool children (aged 0-5 years) without a diagnosed developmental disability.

4.7 Identifying children with developmental disabilities

The case ascertainment strategy (to determine exposure status) aimed to identify all children with developmental disabilities. It had to balance being pragmatic in response to the limitations of primary care data (outlined in Section 4.7.1) and the clinical realities of diagnosing disability in children below the age of five (Section 4.7.7.1), whilst limiting the risk of misclassification error (Section 4.7.3).

4.7.1 Primary care data for case ascertainment

Mothers of disabled children were selected to the exposed group by identifying children who had received a diagnosis of disability between birth and the age of 5 via clinical codes recorded in the children's electronic primary care records. All primary care practices in Bradford use the SystmOne electronic record system which uses the hierarchical clinical code language Clinical Terms Version 3 (commonly known as Read codes) (The Phoenix Partnership (TPP), 2019).

Primary care records are a trusted source for disability case ascertainment, if a definitive diagnosis (identification of a disabling condition) has been made (Allgar, 2008; Lingam, 2012). Once a diagnosis is received, usually via a secondary care specialist (e.g. the Bradford Child Development Centre), it will be communicated to the child's primary care provider via a consultant letter and recorded in the child's primary care record (General Medical Council, 2018). Clinical codes recorded in primary care records for diagnoses received in secondary care services are highly reliable (Hammad, 2013).

4.7.2 Dissonance between disability and the classification of disease in primary care data

Disability essentially describes how an impairment affects human function. This is the extent of the deficit in the person's ability to perform activities of daily living (World Health Organization, 2018). However, electronic health records are based on a system of clinical codes designed to classify disease and conditions, not function. The extent of the impact of a condition on function can vary considerably from no impairment to profound. There are a large number of conditions that can cause disability, but the degree of disability is not recorded alongside the diagnosis, unless specified as part of the clinical code e.g. profound learning disability (Lingam, 2012).

To identify children with developmental disabilities solely using clinical codes in primary care data, specific diagnoses that meet the definition of developmental disabilities were specified: medical conditions that cause significant long term variation in the child's capacity to achieve the expected developmental (functional performance) milestones for their age (World Health Organization, 2012).

4.7.3 Misclassification error

The aim of the case ascertainment strategy was to positively identify children with (true positive) and without (true negative) clinical codes which meet the disability definition, and to limit the number of children misclassified as having a disability when they do not (false positive) and vice versa (false negative) (Table 7).

Table 7. 2x2 table of the classification issues balanced in the case ascertainment strategy

Does the child meet the disability criteria for the group (i.e. are the mothers exposed/unexposed to caregiving)?		Exposed to caregiving	
		Yes	No
Unexposed to caregiving	Yes	a (true positive)	b (false positive)[1]
	No	c (false negative) [2]	d (true negative)

[1] A false positive is also known as a type I misclassification error
[2]A false negative is also known as a type II misclassification error

To address these classification issues, there were two options:

1. disabling conditions (condition group) - develop an approach to identify only children diagnosed with developmental disabilities. This reduces the false positive error but risks the exclusion of some children with disabilities from the disabled group; or
2. disability indicators (indicator group) - develop an approach to identify all children who might have developmental disabilities. This reduces the false negative error but risks the inclusion of children without disabilities in the disabled group.

4.7.4 Existing case ascertainment strategies

The simplest approach would have been to use or adapt an existing strategy to identify people with disability via electronic health records. Before developing my own, I assessed the suitability of three available existing strategies to meet my need of identifying preschool aged children with developmental disabilities and the extent of potential false positive misclassification error.

The Disability Complexity Scale includes the 296 clinical terms most widely used in secondary care practice in Sunderland (UK) for the assessment and treatment of children with disabilities (Spencer, 2015a; Horridge, 2016b). It includes diagnoses, symptoms, family-reported issues, and technology dependencies, which can be used to assess the complexity of the child's disability needs. It is not an exhaustive list of all disabling conditions.

I considered converting this strategy into the clinical coding language used in primary care in Bradford. However, the terminology set does not distinguish between disorders that are disabling conditions or complexity indicators, or the extent to which some conditions are typically complex whilst others are only complex if combined with other complexity indicators. For example, the set includes comorbid chronic and acute conditions which are commonly observed in disabled children at secondary care consultations, such as diabetes, anaemia, obesity and constipation. Additionally, much of the information on healthcare needs required for the disability complexity scale is only identifiable via hospital admissions data and consultant letters (Bishop, 2017).

Lingam et al. (2012) and Allgar et al. (2008) both developed strategies for case ascertainment in primary care records but, like Horridge et al., they also required additional information (e.g. the free text content of primary care records and disability verification by the person's GP) to verify the diagnosis and extent of the disability. Lingam et al. (2012) caution that the exclusion of additional information risks over- or under-estimating disability in the population (Lingam, 2012). However, it was outside the scope of my project to examine consultant letters (additional ethics approval and considerable time required to go through them) or admissions data, and to identify every condition which might indicate disability in Bradford, especially given the increased prevalence of (often rare) congenital anomalies (Section 4.2) (Bishop, 2017).

Lingam et al. developed a strategy to identify children with profound impairments as well as those with conditions that may cause functional impairment (potentially disabling). By identifying all potentially disabling conditions, this strategy overestimates disability prevalence. Conversely, Allgar et al. (2008) developed a (specific) strategy to identify only people with learning disabilities in primary care data by identifying the fewest Read codes which would positively identify learning disability in most cases (including the conditions: Down syndrome, Fragile X syndrome and Rett's syndrome). They excluded conditions which do not necessarily cause learning disability and those that do but have a prevalence of less than 1 in 15,000; resulting in an underestimation of learning disability prevalence.

Although informative, my research was not narrowed to only learning disability or extended to potentially disabling conditions and as additional resources (e.g. free text in the children's health records) could not be accessed to mitigate the risk of false positive error, none of the existing strategies were adopted.

4.7.5 Primary ascertainment strategy – disabling conditions

Given the expected small numbers of children with developmental disabilities, a strategy that classified children with mild or no disability to the disability group may have resulted in a conservative estimate of effect (i.e. the difference between the groups on the parameter of caregiver burden would be reduced, masking the effect, if an effect exists). Instead, I developed a strategy (option 1 listed at Section 4.7.3) which:

- identified only children with conditions that typically result in substantial functional impairment (disabling conditions);
- included conditions with a prevalence of at least one in 10,000 children aged 0-18 (discussed in Section 4.7.5.1); and
- included conditions that can be diagnosed below the age of five.

I used the developmental disabilities most frequently associated with paediatric disability complexity by Horridge et al. (2016a) as the disabling conditions in my strategy: ASD, cerebral palsy, chromosomal syndromes and intellectual disability (the disability and related factors of for each condition are included in Table 8 in Section 4.7.5.1). The specific chromosomal syndromes of Down syndrome and Fragile X syndrome were specified as these are the two most common chromosomal syndromes which typically cause disability (Allgar, 2008). Learning disability is one of the few conditions classified by severity (from mild to profound) in the clinical coding hierarchy and was restricted to moderate-profound severity. The severity of cognitive impairment is associated with the extent of functional impairment, and greater cognitive and functional impairment with poorer maternal health outcomes (Shonkoff, 1992; Most, 2006). Each of these disabling conditions has also been associated with caregiver burden and ill-health.

In developing the case ascertainment strategy, I consulted paediatric clinical researchers at the University of York (Dr Bob Phillips and Dr Lorna Fraser) and paediatric clinicians in the Bradford Child Development Centre (Dr Stella Yeung and a Lead Nurse in the Child Development Service). They supported the decision to favour specificity (reducing false positive error) over sensitivity (reducing false negative error) by focusing on a small number of common disabling conditions with typical characteristics. They advised that including more conditions would make the exposed group more heterogeneous on disability characteristics and increase the risk of unmeasured mediators, such as chronic illness. However, they raised concerns about the low number of children that would be identified via the strategy as many would not have received a diagnosis by age five (discussed in Section 4.7.7).

4.7.5.1 Prevalence estimate

It is hard to obtain a prevalence estimate for developmental disabilities as the disabling conditions included in the estimates vary and are often selected for pragmatic reasons (e.g. data on these conditions are available for a number of countries) (Global Research on Developmental Disabilities Collaborators, 2018). For example, the UK prevalence of developmental disabilities for children under the age of five is estimated as 4,683 per 100,000 (Global Research on Developmental Disabilities Collaborators, 2018); but includes vision and hearing loss, epilepsy, and attention deficit hyperactivity disorder, which were excluded from my strategy (Section 4.7.5). This estimate included learning disability and ASD, but excluded motor development disorders, only including cerebral palsy when learning disability was indicated.

An accurate UK prevalence for developmental disabilities (using the conditions included in my strategy) diagnosed by age five was not available. Based on the estimates in Table 8, the UK

prevalence is 419 per 10,000. However, prevalence estimates also vary by country and region, with a higher than the UK prevalence of childhood disability found in Bradford (Wright, 2013). A higher prevalence of ASD and cerebral palsy has been found for Bradford compared with other UK estimates (Table 8); and a higher prevalence of chromosomal syndromes (per 10,000): BiB cohort 25 versus UK prevalence 15 (Bishop, 2017). This estimate includes Down and Fragile X syndromes but is not disaggregated by condition, so the elevated prevalence of these conditions in the BiB cohort is unknown. Adjusting my estimate for the conditions with a known higher prevalence in Bradford, produced a combined condition prevalence of (at least) 505 per 10,000.

Table 8. UK prevalence estimates and disability characteristics for the disabling conditions

Disabling condition	Prevalence estimate[1]	Disability-related factors (typical and common)
Moderate, severe and profound learning disability	• 350 per 10,000 (aged 5-18) (300 moderate, 37 severe, 13 profound) (Public Health England, 2018; Hatton, 2016)	• Learning disability (the inability to understand and perform daily activities) • Behavioural problems (common)
ASD	• 38 per 10,000 boys aged 8 (3 for girls) (Taylor, 2013) • 103 per 10,000 children aged 5-8 in Bradford (Kelly, 2017b)	• Delayed speech and social interaction problems (typical) • Learning disability (if severe ASD) and behavioural problems (common)
Cerebral palsy	• 20 per 10,000 children aged 0-5 (Cans, 2008) • Up to 41 per 10,000 children aged 0-5 in Bradford (Sinha, 1997)	• Motor impairment (typical) • Learning disability and behavioural problems (common)
Down syndrome	• 9 per 10,000 children aged 0-5 (Alexander, 2016)	• Learning disability (typical) • ASD and behavioural problems (common)
Fragile X syndrome	• 2 per 10,000 aged 0-10 (3 for boys, 1 for girls) identified via pre-natal screening (Song, 2003)	• Learning disability (typical) • ASD and behavioural problems (common)
Combined prevalence for the conditions	• 419 per 10,000 • 505 per 10,000 for Bradford	N/A

ASD; Autism Spectrum Disorders

[1] UK prevalence estimates for children aged 0-5 years were not available for every condition (estimates provided as integers). The youngest age range possible is given and estimates for Bradford provided, where available. Where there are differences in prevalence by sex, disaggregated estimates are provided.

The prevalence was also dependent on the children receiving diagnoses for the specific disabling conditions before the age of five (discussed in Section 4.7.7). Lingam et al. (2012) found a prevalence of 1.3% for potentially disabling conditions in children aged 0-4, increasing to 5% for the 5-9 age group. Thus, the prevalence of the diagnosed conditions in children aged 0-5 could be substantially lower than both the UK and Bradford prevalence estimates.

4.7.6 Sample size

Based on the results of my systematic review (Chapter 3), a relationship between caregiving (the exposure) and increased prevalence of symptoms of ill-health associated with stress was expected, but with high variability within the exposed group.

A large sample size is needed:

- if the size of the effect of the exposure on the outcome is expected to be small (and if the outcome is rare);
- if a large amount of variation in the outcome is expected; and
- for a high confidence level in detecting the effect i.e. 95% (Bland, 2015; Hajian-Tilaki, 2011).

A sample size of around 100 exposed and 100 unexposed mothers was estimated as the minimum required to detect a sizeable and significant association between caregiving and higher clinical levels of psychological distress in parents of infants with Down syndrome (using standardised diagnostic outcome measures) (Scott, 1997). The study population was restricted to the size of the BiB cohort (n=12,453 mothers). The size of the exposed group was restricted by both the prevalence of developmental disabilities and the case ascertainment strategy used to identify them. My case ascertainment strategy aimed to identify a disabled sample of at least 100 children with disabling conditions (0.8% of the children in the BiB cohort). For example, if 51 children were diagnosed with cerebral palsy before the age of five (calculated based on the prevalence of 41 per 10,000 (Table 8) and a BiB cohort of 12,453 (only one child was included per mother)), the sample would be too small to perform statistical analyses disaggregated by disabling condition. The regression models would be over-specified (too little data and too many explanatory variables and covariates), biasing the results towards the null hypothesis of no relationship (Austin, 2015; Vittinghoff, 2007).

4.7.6.1 Exposed/unexposed group sizes

As the full BiB cohort was available for sampling, the size of the exposed and unexposed groups was unbalanced. All children not selected to the disabled group by the case ascertainment strategy were included in the comparison group. The size of the disabled sample was limited by the case ascertainment strategy, but a larger unexposed group increased the reliability of any differences observed between the groups because the standard error for the comparison group was reduced (Faresjö, 2010).

The use of unbalanced groups limited the potential influence of misclassification bias in the case ascertainment strategy. If I used size-matched groups and exposed mothers were misclassified to the unexposed group, a conservative difference in the health outcome might be observed between groups. This would occur because, given the hypothesis of greater ill-health in the caregivers, the misclassification error would reduce the heterogeneity between the groups on the parameter of caregiver burden. The greater the size of the unexposed group, the smaller the proportion of the group that may be misclassified, therefore the smaller the influence of misclassification on the measurement of the relationship between the exposure and the outcome.

4.7.7 Secondary case ascertainment strategy – disability indicators

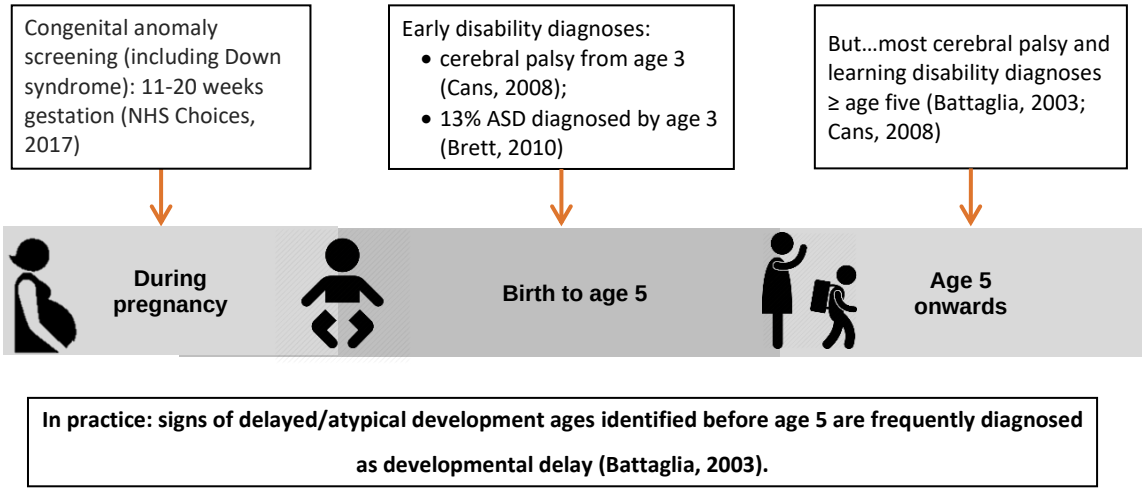
Following the feedback of paediatric clinical researchers and paediatric clinicians (named in Section 4.7.5), I developed a secondary case ascertainment strategy to mitigate for the risk of low numbers of children diagnosed with the disabling conditions by the age of five.

4.7.7.1 Clinical information

The Bradford-based clinicians raised concerns about the number of children that would be identified via the primary case ascertainment strategy. They advised that Down syndrome, Fragile X syndrome, ASD and cerebral palsy can be diagnosed in children under five, but it is common practice for children in Bradford (and elsewhere) to receive these diagnoses later (age 5 and above) (Kelly, 2017b; Bishop, 2017; Christensen, 2016; Provost, 2007). Likewise, learning disability is underdiagnosed in preschool children as an IQ test, the standard assessment used to distinguish mild, moderate or profound learning disability, is not appropriate for use in the preschool age group (NHS Choices, 2018).

Instead, it is standard practice for children aged 0-5 with both specific disabling conditions and indicators of disability (e.g. delayed speech) assessed in the Bradford Child Development Centre to receive initial diagnoses of developmental delay, generalised developmental disorders or disorders relating to specific characteristics, such as speech or social interaction. The only exception (of the conditions in my strategy) is Down syndrome, for which all pregnant women are offered routine pre-natal screening (National Health Service, 2018) (Figure 13).

Figure 13. Pathways to disability diagnosis from gestation to age five



Furthermore, they advised that none of these initial diagnoses (indicators of disability) can be discounted as indicating mild or potentially transient disability. For example, children under five can receive a diagnosis of developmental delay if they fail to meet their developmental milestones but may catch up over time, or have profound learning disability (Sigman, 1999).

4.7.7.2 The decision to include disability indicators in the exposure

To mitigate against the risk of the primary case ascertainment strategy identifying too few mother-child dyads to perform the planned analysis (≤100), a secondary strategy was developed. This strategy aimed to fit the clinical context of Bradford for the preschool age group by identifying children with disability indicators classified as:

- developmental delay;
- generalised developmental disorders;
- disorders relating to specific developmental characteristics;
- mild or unknown severity learning disability; and
- generic disability (e.g. on learning disability register and disability not otherwise specified).

Generic disability was included to maximise the number of mother-child dyads in the exposed group that met the disability definition criterion of child long-term functional impairment (Section 4.5.3.2). However, as disability is under-coded in primary care records, few if any children were expected to be identified via this set of codes.

Given the clinical norm of initially diagnosing developmental delay or a generalised disorder, it was likely that a high proportion of the children identified by the primary strategy would also

have disability indicators. The number of codes and the code description found in the records of the children with disabling conditions for each strategy were compared with those of the children with disability indicator codes only.

The prevalence of developmental delay in high income countries is estimated at 3% of children (Leonard, 2002), and was 3.2% of children aged 3 in the UK Millennium Cohort (Emerson, 2008a). The prevalence of global developmental delay is 1-3%, where children have a delay in more than one area of development e.g. motor and speech (Mithyantha, 2017). The secondary case ascertainment strategy was expected to identify at least 384 children in the BiB cohort (3% of 12,000), and at least 120 with more than one disability indicator (as a measure for global delay).

If the primary strategy identified fewer than 100 exposed mothers, those identified via the secondary strategy would be included in the exposed group.

4.7.7.3 Expected between-group maternal health and sociodemographic differences

The sociodemographic characteristics and maternal outcomes of the mothers and children in the disabling condition and disability indicator groups were compared. Variation was expected between the groups:

1. Mothers of children with disabling conditions were theorised to have greater ill-health than mothers of children with disability indicators. According to the theory underpinning the strategies, compared with the disability indicator group, more of the children with disabling conditions would have disabilities (fewer false positives) and of a greater severity (Howlin, 1999). As a result, the mothers in the condition group would be experiencing greater caregiver burden than those in the indicator group, so more mothers in the condition group would have ill-health.
2. Mothers in the condition group were expected to be older on average (and have higher socioeconomic status) than the indicator group due, in part, to the relationships between higher maternal age and the increased prevalence of Down syndrome and ASD (further discussion in Section 4.10.4.3).
3. The age of the children when they received their condition or indicator diagnosis was expected to be lower in the condition group as (further discussion in Section 4.10.4.5):
    a. Down syndrome and Fragile X syndrome are usually identified during pre-natal screening (NHS Choices, 2017);
    b. greater disability severity (including more visible disability) was expected to be associated with earlier diagnosis; and

4. The condition group was expected to have a higher proportion of boys than the indicator group due to the higher prevalence of ASD and Fragile X syndrome in boys (further discussion in Section 4.10.4.6) (Taylor, 2013; Song, 2003).

4.7.8 Code lists for children with disabling conditions and disability indicators

The case ascertainment strategy consisted of eight code lists: four for the specific disabling conditions and four for the disability indicators [**A3.3,** Tables A12-13]. The lists were developed using the Clinical Terminology Browser Clinical Terms Version 3 - Clinical 2017-10-01 Drugs 2016-04-01 (also known as a Read code browser). Only Read codes which positively identified the condition or indicator were included in the lists. They were identified by searching for the condition key term (e.g. Down syndrome), then using the step-up/step-down functions to identify all relevant Read codes in the 'Clinical findings: Disorders' hierarchy of the classification system.

Drug, treatment and referral Read codes were not included. These codes indicate potential disability complexity, including chronic illness, but do not on their own provide enough information to deduce disability. Codes for assessment were included only when the outcome was a definitive diagnosis of one of the disabling conditions. For example, the paediatric consultants recommended including the Gross Motor Function Classification System (GMFCS) for cerebral palsy. The codes for the Surveillance of Cerebral Palsy Europe (SCPE) classification system for cerebral palsy were excluded as the assessment is not used in preschool children and the GMFCS is the preferred assessment tool in Bradford.

The code lists were checked for duplicates and shared with the BiB data manager. He entered them into the primary care data search algorithm to identify every child who had one or more of the codes recorded (and the date of entry for every code) in their primary care record during the period of birth to their fifth birthday.

4.7.9 Selection bias

The aim of epidemiological research (and the BiB study) is generalisation of research findings for a representative sample to a wider population (i.e. Bradford). Children who did not meet the disability definition but were likely to have additional healthcare needs (e.g. children with epilepsy or asthma) were not identified and remained in the sample. Their exclusion would have made the comparison group unrepresentative of the BiB cohort, artificially increasing the difference in caregiver burden between the exposed and unexposed groups.

4.8 Study period

To encompass the preschool period and facilitate the examination of maternal health prior to the exposure (becoming a caregiver), a six year study time period was used and dichotomised by the child's date of birth into:

- a pre-natal period: from 12 months before to the day before the child's birth (rationale for this timeframe in Section 4.10.4.1); and
- a post-natal period: from the date of the child's birth to their fifth birthday.

The birth of the child was used as the point of exposure. Diagnosis date was not used as the point of exposure as it would vary between children by condition, disability severity and maternal sociodemographic factors (outlined in Section 4.7.7.3). The diagnosis date also does not incorporate the time taken to receive a diagnosis, a period which caregivers frequently describe as high stress (Estes, 2013) (described in Section 1.3.1). By using the child's date of birth and not diagnosis date as the point of exposure, this period was included in my analysis of the influence of caregiver burden on maternal post-natal outcomes (except possibly for Down and Fragile X syndrome as the mothers may have received a pre-natal diagnosis).

4.9 Identification of the symptoms of ill-health via primary care data

To codify outcomes, a strategy was developed to identify reasons for primary care visits using Read code lists.

4.9.1 Strategy to identify maternal ill-health

The strategy to identify the health need for primary care visits required the production of lists of Read codes for health conditions for which the mothers' primary care records could be searched. It was not possible or desirable to develop lists for every condition or symptom for which mothers might visit the doctor. Therefore, clinical code lists for a small number of common psychological and physical symptoms were developed. The conditions met the criteria:

- has been found to have a higher prevalence in mothers of disabled children (aged 0-18) compared with other mothers in more than one study (identified in Section 1.4 and with further evidence from my systematic review);
- could be caused or exacerbated by acute and/or chronic stress (as both could occur in the five year post-natal time frame) as stress was assumed as the causal mechanism in the relationship between caregiver burden and ill-health (stress was included as a condition) (outlined in Section 1.4.1);

- could be positively identified in the primary care data using a single Read code (further discussion in Section 4.9.2); and
- might reasonably be expected to occur in women of child-bearing age and be identified within a 12 month timeframe.

Code lists were developed for six conditions: stress, common mental disorders, fatigue, sleep problems, headaches/migraines, and musculoskeletal (MSK) pain. Other symptoms associated with caregiver burden were excluded from the study for one or more of the following reasons:

- common cold symptoms were excluded because people do not often visit the doctor about them or will seek pharmaceutical advice instead of visiting the doctor (Eccles, 2006);
- common cold and gastrointestinal problems were excluded because they are common umbrella terms used in health but in the caregiver-health studies the range of symptoms included were not defined (Lee, 2017; Lach, 2009);
- asthma was excluded as the condition is not reliably or positively identifiable in primary care data by condition codes or drug prescriptions. No existing code lists were available that had been developed with clinical verification of the drugs to positively identify the symptom; and
- cancer, arthritis, chronic bronchitis and heart problems were excluded as they develop over a longer time period than five years and are rare in women of child-bearing age (Brehaut, 2004).

The conditions are hereafter called the 'symptoms of ill-health' to avoid confusion with the 'disabling conditions', the phrase used to distinguish the children identified via the primary case ascertainment strategy (Section 4.7.5).

4.9.2 Code lists for symptoms of ill-health

The Read codes lists [**A3.3**, Table A14] were used to identify every time a woman in the study population visited a primary care service for any of the six conditions of ill-health in the six year study period. The inclusion of codes which might, but did not definitely, detect the symptoms was limited to prevent false positive misclassification error. The clinical codes were identified by searching the Read code browser for key terms for each symptom (Table 9).

Table 9. Key terms for the six symptoms of ill-health

Symptom	Stress	Common mental disorders	Fatigue	Sleep problems	Head pain	Musculoske letal pain
Key term	stress	depress* anxi*[1] panic obsessive-compulsive	fatigue exhaustion tired	sleep	headache migraine pain of the head	neck pain back pain muscle pain

[1] Truncation was used to widen the search (indicated by the asterisk symbol *). For example, for 'anxi', codes with the clinical descriptors of anxiety and anxious would be returned.

Direct synonyms and key terms for closely linked symptoms were checked. Only synonyms and key terms which retrieved additional relevant codes were used in the final search. For example, the key term 'depress*' also found 'sad', 'lonely' and 'melancholic' so 'sad' was not included in the final search strategy. Using the hierarchical structure, all descendant codes under a key term and related code were included, if they definitively identified the symptom.

Codes which included the key term but related to another symptom or diagnosis were not included, such as 'pars interarticularis stress fracture'. I did not have access to a clinician with a special interest in every symptom, so could not seek guidance about the probability of each code occurring in the study population. Codes which were considered inappropriate for the study population (e.g. combat fatigue and senile exhaustion) were included. However, this did not limit the strategy as these codes could not occur in the mothers' records if truly inappropriate. This approach widened the strategy whilst maintaining the relevance of the codes for each symptom.

Codes for signs, symptoms, and conditions/diagnoses were included for every symptom. Signs are clinical observations made by the healthcare professional e.g. anxious mother. Symptoms are disease characteristics reported by the patient e.g. headache. Conditions are medical condition diagnosed or indicated by the healthcare professional e.g. moderate depression. Codes for the direct monitoring and therapeutic treatment of the symptoms were included e.g. stress monitoring call, stress management, or referral to a headache special interest general practitioner. Means of assessment were excluded as the score is not coded and the assessment could identify an absence of the symptom. Codes for having a medical history of the symptom (not available for every symptom) were not included as the study is looking at the relationship between symptom prevalence in two specific time periods and the 'history' may have pre-dated the limits of the pre-natal period.

Research in the BiB cohort has shown that antidepressant drugs are frequently prescribed without a diagnostic code being recorded. Researchers and clinicians in Bradford developed a list of Read codes (including drug codes) that strongly indicated the presence of common mental disorders (anxiety and depression) and were commonly used in clinical practice (Prady, 2016a). I used this

code list to ensure that most mothers with common metal disorders in my study population were detected. Drugs were not included in the code lists for the other symptoms as a drug (e.g. analgesics) can often be used to treat a range of symptoms (i.e. pain other than head and MSK pain). Thus, these drug codes alone would not positively identify the symptom of interest. It was outside the scope of this project to consult clinicians to ascertain which drugs positively identified each symptom.

The date of entry for every code in the mothers' primary care records was included in the data extraction provided by the BiB data manager.

4.10 Specifying the statistical models

The outcome variables and covariates used in the studies are described, and the rationale for inclusions and exclusions provided.

4.10.1 Pre- and post-natal symptoms of ill-health

I produced three pre-natal covariates and three post-natal outcomes for each of the six symptoms. For example:

- Outcome 1: stress detected in the five years after the child's birth
- Covariate 1: stress detected in the 12 months before the child's birth
- Outcome 2: number of visits (≥1 visit) for stress in the five years after the child's birth
- Covariate 2: number of visits (≥1 visit) for stress in the 12 months before the child's birth
- Outcome 3: number of visits (≥0 visits) for stress in the five years after the child's birth
- Covariate 3: number of visits (≥0 visits) for stress in the 12 months before the child's birth

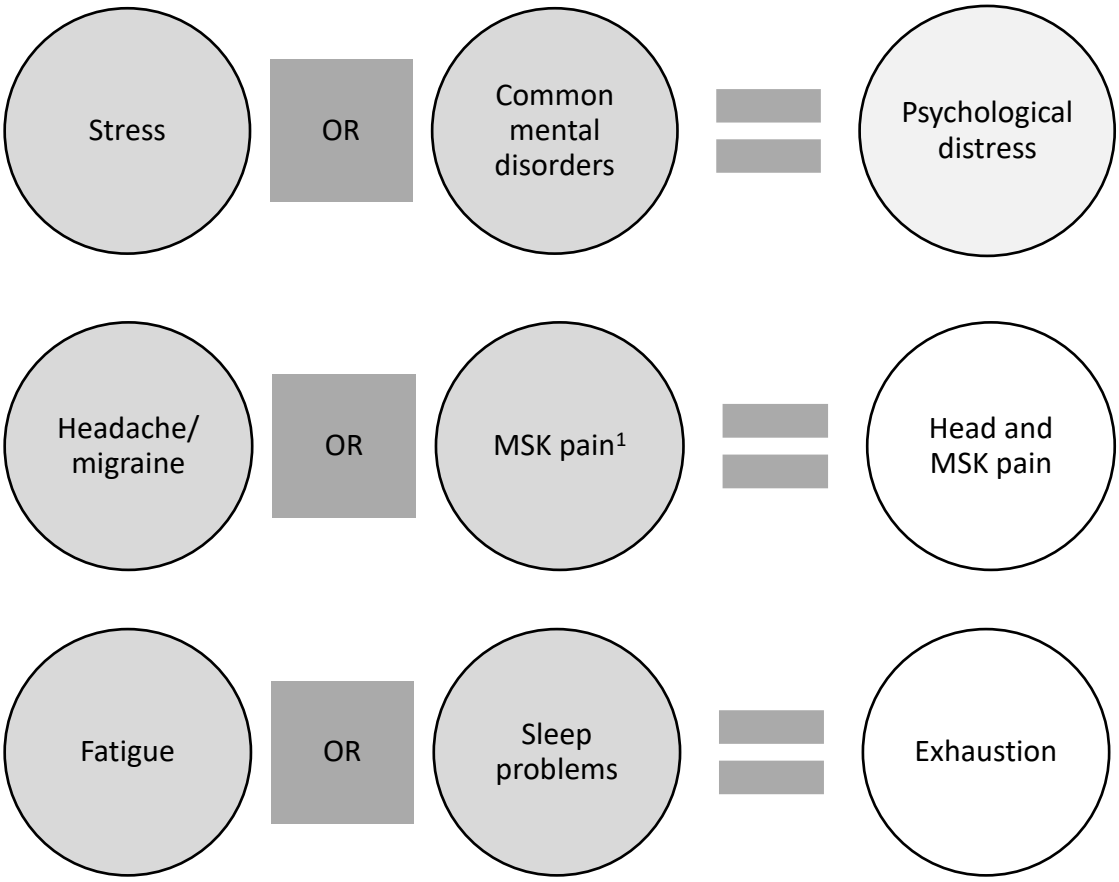
For outcome and covariate 1, a binary variable was produced: 'yes' if a code for the symptom was recorded in the time period; 'no' if the symptom was not detected in the time period. For outcome and covariate 2 and 3, the total number of visits in the time period was calculated from the number of differing dates that codes for that symptom were recorded. If more than one code for a symptom was recorded for the same date (i.e. at the same primary care consultation), it was counted as one visit.

The symptoms were combined to produce three groups with the umbrella names (Figure 14): psychological distress, exhaustion and head and musculoskeletal (MSK) pain because:

- a low number of visits to the doctor was expected for each symptom as mothers of child-bearing age are a generally healthy group; and

- there is overlap between the symptoms, e.g. stress is a symptom of common mental disorders and tiredness is a symptom of sleep problems.

Figure 14. Illustration of how the individual symptoms were combined to produced symptom groups



[1] MSK; musculoskeletal pain

For the grouped symptoms, a mother had psychological distress, for example, if the symptom of stress or CMD was recorded in the time period. If codes for sleep problems and fatigue, for example, were recorded on the same date, one visit was recorded, not two; thus, reflecting the number of unique visits for the grouped symptoms. Hereafter, the phrase 'symptoms of ill-health' refers to the grouped symptom (psychological distress, head and MSK pain, exhaustion); the conditions that comprise them are identified as the 'individual symptoms of ill-health'.

4.10.2 The inclusion of mothers who did not visit the doctor

To fully investigate how frequently caregivers visit the doctor compared with other mothers, I examined between group differences in:

1. healthcare use – the rate of healthcare use (≥1 visit) by mothers who visited the doctor (i.e. demonstrated healthcare-seeking behaviour); and

2. healthcare-seeking behaviour - the risk of healthcare-seeking behaviour (i.e. the likelihood and rate of visiting the doctor when the majority do not visit (≥0 visits)).

There is a known discrepancy between the number of people experiencing symptoms and visiting the doctor about them (Waitzfelder, 2018), resulting in the underestimation of symptom prevalence (known as consultation prevalence). As caregiving is theorised to hamper primary care consultation, caregiver status (the exposure) was expected to both reduce the rate of healthcare use and reduce the likelihood of visiting the doctor compared with other mothers. Analysis of the number and characteristics of mothers who do not visit the doctor in addition to those that did enabled thorough examination of this hypothesis. Although this required the use of an additional and more complex statistical model, removal of the zero counts (mothers who did not visit the doctor) from the data would have been a selection bias and prevented the full examination of the research question.

Additional reasons for why primary care data is zero-inflated (the majority do not visit), which are relevant and expected in this study, include:

- the exclusion of drugs from the code lists for stress, fatigue, sleep problems, headaches and musculoskeletal pain;
- people taking over-the-counter analgesics for pain symptoms;
- women discontinuing antidepressant treatment when trying to conceive or during the first trimester due to the risk these medications pose to foetal development (Petersen, 2011; Ververs, 2006);
- mothers not visiting the doctor about fatigue and sleep problems which they perceive as an expected consequence of having a young child;
- people being more likely to visit the doctor about symptoms of physical than psychological ill-health, and to initially report physical symptoms of psychological ill-health (Farooq, 1995). The extent of somatisation of common mental disorders (psychological distress manifested by physical symptoms) varies by ethnic and cultural groups. Greater somatisation has been observed in the reporting of common mental disorders by Pakistani than white British mothers in the BiB cohort (Bekker, 2009; Prady, 2013a).

4.10.3 Conceptual model

I present the conceptual model that illustrates the theorised relationship of the covariates to the exposure and outcome variables and thus their influence on the causal caregiving-ill health and healthcare use relationship (Suttorp, 2015) (Figure 15). The analytic model that follows illustrates only the relationships which are examined in the bi- and multivariate analyses (outlined in Sections 4.14 and 4.15) (Figure 16).

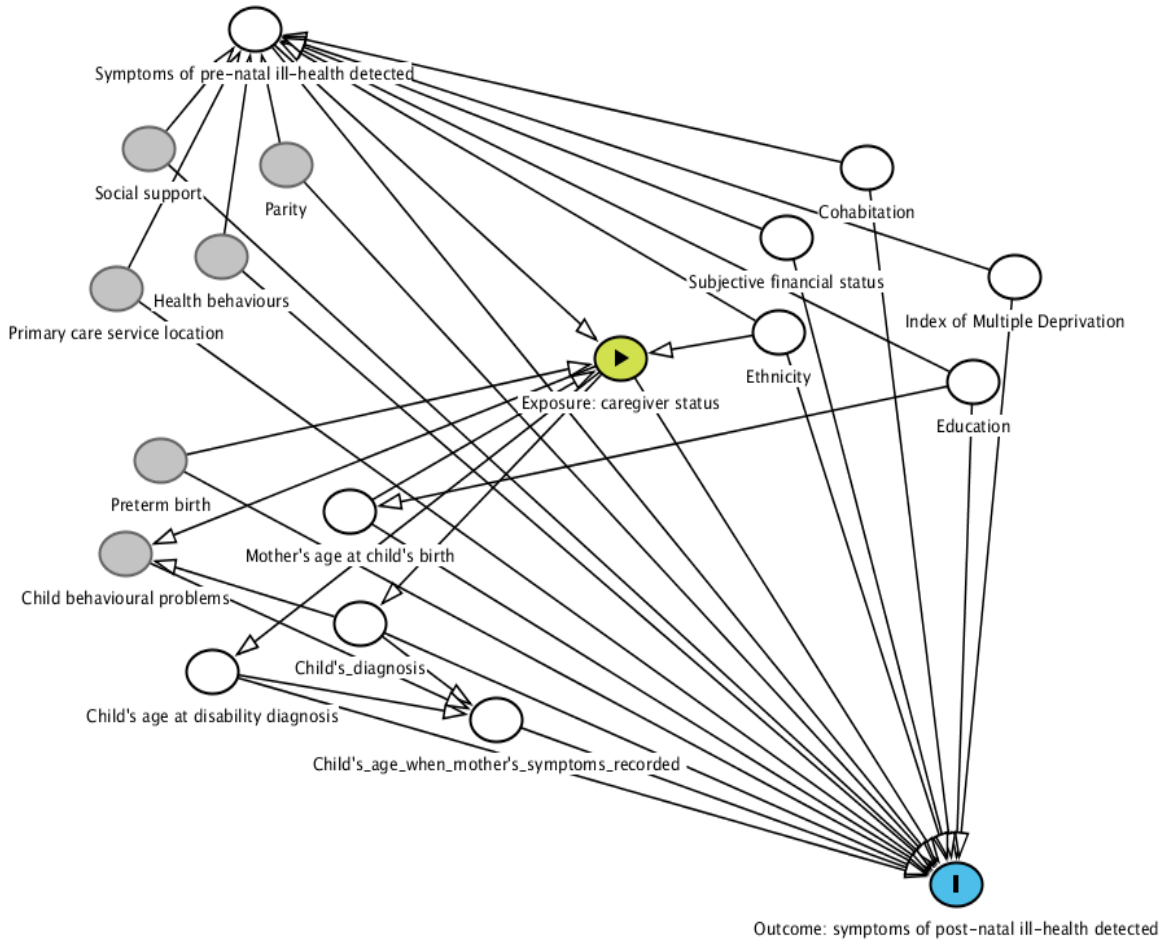
The main independent variable in the analyses was the exposure of caregiver status. The specification of the model aimed to measure the relationship between the exposure and outcome as accurately as possible by:

- including covariates with a known or theorised relationship to the outcomes so that these relationships were shown and did not obscure the measurement of interest; and
- not overfitting the model by including too many covariates, thus reducing the fit of the data and biasing the results towards no relationship (reducing the accuracy of the measurement of interest) (Schisterman, 2009).

Based on the literature on caregiver health, healthcare use, and the BiB cohort, a set of covariates and their most likely relationships to the exposure and outcomes were identified:

- confounder – has an independent causal relationship to both the outcome and the exposure;
- mediator – has an association with the outcome and is a presumed causal consequence of the exposure, so accounts for the relationship between the exposure and the outcome; or
- moderator – has an effect on the direction and/or strength of the relationship between the exposure and the outcome (Shrier, 2008; Babyak, 2009).

Figure 15. Conceptual model of the causal relationship of caregiver status to the symptoms of ill-health and the influence of pre-natal health and child disability-related factors and indicators of socioeconomic status



The green triangle indicates the exposure and the blue I, the outcome. The line between them (with the arrow shows the direction of effect) indicates the causal relationship.
Each arrow indicates the main unidirectional relationship of the variable to the exposure and/or outcome variables, and any major relationships to other variables. For simplicity, the interrelationships between the socioeconomic status indicators are assumed and not shown.
To aid interpretation, the variables are organised into clusters of pre-natal factors, disability-related factors and socioeconomic status indicators. The variables shaded in grey are unmeasured in the research project but theorised/evidenced (from other BiB studies) to have a relationship to caregiver burden and/or the outcome (rationale for included/excluded variables in Section 4.10.4).
The model is the same for each of the outcomes of detected symptoms and number of consultations for the symptoms in the five years after the child's birth. The only change for the model of consultation frequency was replacing whether the symptom of ill-health was detected in the year before the child's birth with the number of consultations for the symptom of ill-health before the child's birth.

The covariates were (mostly) maternal pre-natal ill-health and healthcare use, indicators of socioeconomic status and child disability-related factors:

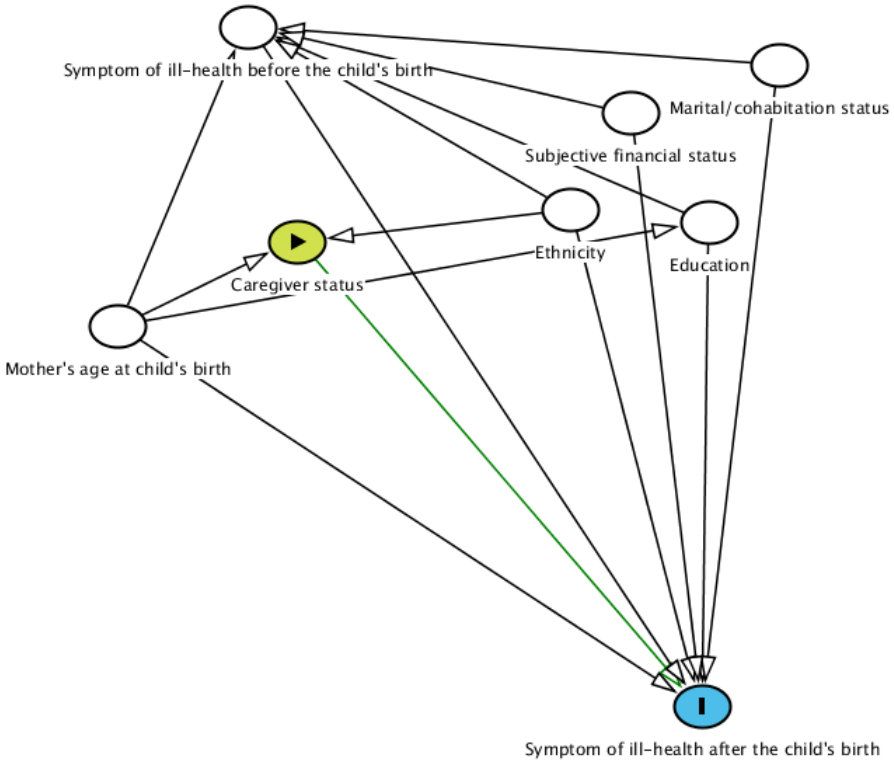
- the covariates of pre-natal health and healthcare use and indicators of socioeconomic status (e.g. education, ethnicity) are moderators as they have an independent relationship to the outcome. If, for example, a mother has low socioeconomic status and

is a caregiver, the moderator will increase the size of the relationship of the exposure to the outcome because both variables are associated with an increased risk of ill-health. By adjusting for socioeconomic status, I measured how much of the variation was associated with the covariate and, therefore, may put caregivers at additional risk of ill-health and/or lower healthcare use.

- the child disability diagnosis and related factors are mediators (except for pre-term birth). They are a causal consequence of the exposure e.g. a child's disability severity is predicated upon the child having a disability and thus the mother being a caregiver. They also have an association to the outcome which can be greater or lesser than that of the exposure. Thus, by adjusting for these covariates, I identified whether specific factors increased the size of the effect of the exposure on the outcome.
- Maternal ethnicity, mother's age at the child's birth, and preterm birth (which is a cause and not the consequence of the exposure) are potential confounders in the relationship of caregiving to maternal ill-health as they have a causal relationship to the exposure and the outcome. The potential influence of confounders was investigated via an initial bivariate regression analysis of the relationship between each of the covariates and the exposure, caregiver status (as an outcome) (described in Sections 4.12 and 4.14).

The relationships that were examined in the multivariate analyses are illustrated in the analytic model (Figure 16) as not every covariate with a theorised relationship to the outcomes and/or exposure could be included in this analytic stage (the rationale for the covariate inclusions and exclusions is in Section 4.10.4).

Figure 16. Schematic of the conceptual causal relationships between the variables included in the analytic model



A simplified (non-causal) version of this model was used in the third of my comparative studies and is presented in Section 4.15.2).

4.10.4 Covariates

Differences between the groups (the exposed/unexposed and disabling conditions/disability indicator groups) were expected for each covariate; but some of the covariates requested or derived from the data could not be included in the bi- and multivariate analyses (the stages are summarised in Figure 17, 4.12). Where possible, these covariates were included in the descriptive analyses (Table 10).

Table 10. Covariates included and excluded from the descriptive, bi- and multivariate analyses

Inclusion in which analytic stages: excluded, descriptive, bi- and multivariate, all analyses	Covariate
All	Symptoms (psychological distress, head and MSK pain, exhaustion) detected before the child's birth
All	Number of consultations (≥0) for the symptoms before the child's birth
All	Number of consultations (≥1) for the symptoms before the child's birth
All	Education (socioeconomic status indicator)
All	Ethnicity (socioeconomic status indicator)
All	Cohabitation status (socioeconomic status indicator)
All	Subjective financial status (socioeconomic status indicator)
All	Mother's age at child's birth (socioeconomic status indicator)
Descriptive	Index of Multiple Deprivation (socioeconomic status indicator)
Descriptive	Parity (first, second, third child etc.)
Descriptive	Child's sex
Descriptive	Child diagnosis (exposed groups only)
Descriptive	Child's age when first disabling condition or disability indicator recorded (exposed groups only)
Descriptive	Child's age when mother's post-natal symptoms detected (mothers with post-natal symptoms detected only)
Excluded	Child behavioural problems
Excluded	Social support
Excluded	Health behaviours
Excluded	Primary care service location

Exposed groups: mother-child dyads for the disabling condition and disability indicator groups.

Some of the covariates were not available, reliable or had to be excluded to prevent overfitting the regression models. To perform the planned regression analyses, there had to be a minimum of 10 observations for each category of the covariates (Austin, 2015). This requirement had to be met for both the exposed and unexposed groups. As a small exposed group was expected, the number of covariates was limited (Austin, 2015; Vittinghoff, 2007). The rationale for the inclusion of each covariate in the conceptual model (including the expected influence of the covariate on the outcomes or other covariates) and specific reasons for exclusions from the analytic model are presented.

4.10.4.1 Pre-natal ill-health and healthcare use

The number of primary care visits in the 12 months before the child's birth provided additional information as it is an indicator of an ongoing health problem and of healthcare use (Mann, 2016). A 12 month pre-natal period was used as it is long enough for symptoms to develop and primary care consultation to be sought (Herrmann, 2017).

An episode of any symptom of ill-health is associated with an increased risk of repeat episodes of that symptom. As ill-health and healthcare use are directly related, previously visiting the doctor about a symptom increases the risk of visiting again (Welch, 1999) (described in Sections 1.4.3.3 and 1.5.1). Therefore, pre-natal symptoms of ill-health and healthcare use were moderators in the measurement of the relationship between caregiving and the outcomes. There is also evidence

that caregivers of disabled children may have poorer health and visit the doctor more frequently before as well as after the child's birth (Ray, 2009; Brehaut, 2019a). Thus, pre-natal health could also be a confounder in the relationship between the exposure and outcome.

As the mothers were typically pregnant for nine months of this period, symptoms directly related to, or exacerbated by, pregnancy would be detected. In the BiB cohort, Pakistani mothers have more frequent pregnancies than the White British mothers (Prady, 2016a), so a longer time period would have introduced a previous pregnancy (parity) bias associated with ethnicity. The BiB cohort were not asked about life events (e.g. deaths of close relatives, relationship breakdown, losing employment). Thus, the 12 month timeframe gave a measure of the number of mothers who were at risk of symptoms after the birth due to previous episodes, whilst limiting the introduction of unmeasured factors to the analysis, such as episodes related to parity or life events. It also ensured complete primary care records, as every mother was living in the Bradford metropolitan area and registered with a primary care centre for 12 months before the birth. However, it is important to note that whilst visiting the doctor is a good indication of health need, not visiting the doctor before (or after) the child's birth did not necessarily mean the symptom was absent.

4.10.4.2 Socioeconomic status

There are complex interrelationships between sociodemographic factors, child disability and caregiver health/healthcare use which necessitate the inclusion of sociodemographic factors in disability and caregiver research (Emerson, 2006b; Hatton, 2009b; Stoneman, 2007; Woolfson, 2005). The relationships between socioeconomic status and ill-health/healthcare use were described in Chapter 1 (Sections 1.4.3.3 and 1.5.1).

Additionally, there is no evidence of a causal association between socioeconomic status and child disability, including in the BiB cohort, but there is a probable causal relationship between low socioeconomic status and developmental delay (Spencer, 2015b; Sheridan, 2013; Brehaut, 2004; Emerson, 2008a). As children with developmental delay were included in my disability indicator group, this relationship could be a potential confounder in the relationship of caregiving to the outcome. The relationships between socioeconomic status and Down syndrome and between socioeconomic status and ASD have been described (in Sections 1.4.3.2 and 3.12.2.3). There is also evidence of ASD underdiagnosis in children with lower educated mothers in the BiB cohort (Kelly, 2017b; Mandell, 2005; Mandell, 2002). Thus, it is appropriate to describe the exposed group (in particular) and adjust in the bi- and multivariate analyses by socioeconomic status to

ensure that these relationships to the exposure and the outcome are accounted for (Brehaut, 2004).

It is recommended in epidemiological research that several indicators are included in the analysis to fully express the variation in socioeconomic status, including income, material deprivation, means-tested benefits, education, and employment (Galobardes, 2006b; Galobardes, 2006a). Ethnicity and marital/cohabitation status are also often used as indicators because of their high correlation: marriage/cohabitation often increases the household income (Kane, 2016); and ethnicity has a relationship to the underlying social structures that inform access to higher education and employment opportunities (Bartley, 2004).

In the largely bi-ethnic and economically deprived BiB cohort, the indicators of education, subjective financial status, ethnicity, mean-tested benefits and marital/cohabitation status are more sensitive to the socioeconomic subgroups than household income, maternal employment and the index of multiple deprivation (IMD) (Fairley, 2014). This is due to:

- high missingness in the household income data, where the household income was unknown or not reported by 35% of the ethnically Asian mothers in the cohort (Prady, 2013b);
- maternal employment being highly related to ethnicity, with 49% of the Pakistani mothers unemployed or never having worked compared with 8% of the White British mothers (Fairley, 2010); and
- 60% of children in Bradford being born into the poorest 20% of the population for England and Wales so the IMD scores are not sensitive to the variation in socioeconomic disadvantage in the geographical context of metropolitan Bradford (Wright, 2013).

The socioeconomic status data were collected for each mother at recruitment to the BiB cohort via the baseline questionnaire. I requested the data for education, ethnicity, marital/cohabitation status, IMD and subjective financial status. The latter was assessed with the question ‘how well are the mother and husband/partner managing financially?’ It is a reflection of the mothers’ perception of their socioeconomic circumstances, which is an indicator of the level of financial stress experienced (Buttler, 2013). Additionally, marital/cohabitation status is an indicator of social support. In general, women who are married have better health than those who live alone, including a lower risk of post-natal depression (Kane, 2016; Beck, 2001). In my studies it was not possible to examine whether relationships observed for marital/cohabitation status were related to socioeconomic status or social support.

Associations between higher primary care consultation frequency and low household income, Asian ethnicity, and divorced/widowed marital status have also been identified (Mann, 2016; Carr-Hill, 1996; Scaife, 2000). These relationships were not present in the BiB cohort, although mothers educated above age 16 with children with congenital anomalies were less likely to consult primary care services for their child's health than lower educated mothers (Kelly, 2017a; Bishop, 2018). Brehaut et al. (2004) observed the same relationship for maternal education, and postulated that the greater ill-health observed for mothers of children with cerebral palsy using primary care data could be associated with greater contact with primary healthcare due to their children's healthcare needs rather than socioeconomic status. The inclusion of the same range of socioeconomic status indicators in the analyses of the prevalence and frequency for symptoms of ill-health allowed investigation of whether the education-consultation relationship extended to healthcare use by caregivers more broadly (not only for cerebral palsy).

IMD scores were used to describe the sample with its differing groups (disabling conditions versus disability indicators, exposed versus unexposed) but, due to the above mentioned limitations, were not included in the subsequent analysis stages. Mothers of children with Down syndrome and ASD were expected to have higher socioeconomic status (observed for the indicators of IMD and education), on average, than mothers of children with the other disabling conditions and disability indicators (Stoneman, 2007; Kelly, 2017b).

No further data were collected after the child's birth so changes in income or subjective financial status over the study period were not known. As in other BiB studies, a binary variable was used for education (beyond age 16; to age 16) instead of UK qualifications due to the number of BiB mothers educated outside of the UK. Age 16 is used as the cut point because, in the UK during the period of data collection, education above this age required continuing beyond compulsory education, which is a key measure of educational attainment and the point of divergence in employment opportunities (Tackey, 2011).

4.10.4.3 Mother's age

The mothers in the BiB cohort range in age from under 20 to over 40 at the child's birth (Wright, 2013). Mothers' age was adjusted for in the analyses as people generally experience poorer health as they age and, in the absence of variables for cumulative life stressors (increasing susceptibility to stress-related ill-health), age can be a marker of unobserved variables (Bartley, 2004). Maternal age at the child's birth is also correlated with education and household income as older, more educated mothers are likely to be earning more (due to progressing in their careers)

than younger, low educated mothers (Stoneman, 2007). Thus, the inclusion of age also increased the precision of the attribution of the outcome to the socioeconomic status indicators.

The mothers of children with Down syndrome and ASD were expected to be older than the mothers of children with the other disabling conditions, disability indicators and the unexposed mothers. There is an increased risk of Down syndrome in children of mothers aged 35 and older at gestation (Wu, 2013). Pregnancy at age 35 and above is correlated with higher maternal education (above age 16). Higher maternal age is also associated with earlier ASD diagnosis. These expected differences by disability diagnosis were examined at the descriptive analysis stage.

4.10.4.4 Disability diagnosis

Child disability diagnosis is associated with variation in the health outcomes of mothers of disabled children, with greater ill-health associated with children with ASD compared with other developmental disabilities and developmental delay (Estes, 2009). Subgroup differences within the exposed group were expected for: 1) the disabling conditions (e.g. the ASD versus cerebral palsy group); and 2) the disabling condition group compared with the disability indicator group. As these grouping distinctions were only applicable to the exposed group and very small numbers were expected, child diagnosis was not included in the regression models. However, the expected differences (stated in Section 4.7.7.3) were investigated at the descriptive stage; and differences between caregiving for a child with ASD compared with other developmental disabilities and none were examined in the third analysis (see Figure 17, stage 3, step 4) (outlined in Section 4.15.2).

4.10.4.5 Child's age

Two child age variables were included in the descriptive analysis:

1. Child's age when first disabling condition or disability indicator diagnosis recorded
2. Child's age when mother's post-natal symptoms recorded

To protect the anonymity of the study participants, they were derived from the month and year of the child's birth, using the first date of the month for the calculation.

There is variation in the age that different disabling conditions are/can be diagnosed (illustrated in Section 4.7.7.1, Figure 13). Children with Down and Fragile X syndrome can be expected to have their diagnosis recorded in their primary care record very soon after birth. ASD was expected to be chronologically last of the disabling conditions to be diagnosed as the characteristics are less visible and developmental delay is commonly diagnosed prior to a more definitive condition diagnosis (Provost, 2007). However, age at diagnosis was also expected to reflect severe disability as children with severe impairment would receive a condition diagnosis earlier than children with

milder impairment (Department of Education, 2015). As such, the children in the disabling condition groups should, on average, have condition and disability indicator codes recorded earlier than the children in the indicator group.

Differences within the disabling condition group and between the condition and indicator groups for the covariate of child's age when mother's post-natal symptoms recorded was also theorised to reflect child disability severity. Over time caregiver health may deteriorate as the chronicity of the stress caused by caregiver burden is prolonged (Raina, 2005), with mothers experiencing high caregiver burden likely to develop symptoms of ill-health sooner than those with less disabled children (Laxman, 2015). Therefore, I expected a positive bias in the child's age when caregivers visited the doctor about maternal symptoms, with caregivers visiting the doctor sooner, on average, than other mothers.

Although within and between group differences were expected, the outlined relationships between age and disability severity could not be independently verified (e.g. via the free text of the child's health records or additional data collection). As these variables were only applicable to some of the mother-child dyads (i.e. 1) children with disabling conditions and disability indicators; 2) children of mothers who visited the doctor), they could not be included in the bi- and multivariate analyses (of the study sample) and were used descriptively only.

*4.*10.4.6 *Child's sex*

Specific disabling conditions, such as Fragile X syndrome and ASD, are more common in males than females (Song, 2003; Taylor, 2013). For ASD, this is attributed to under-diagnosis in females rather than to biological differences (Taylor, 2013). In models of caregiver health where child diagnosis is adjusted for, the relationship of child sex to caregiver health is not significant (Herring, 2006; Jeans, 2013). The groups were described by sex to check for the expected discrepancy in sex by diagnosis.

*4.*10.4.7 *Parity*

Mothers with more than one child are likely to experience greater parental stress due to the additional demands on their time and resources, especially if they have more than one disabled child (Brehaut, 2019a). Caregivers whose first child is disabled are 20% less likely to have subsequent children than mothers without a disabled first-born (MacInnes, 2008). If more mothers in the unexposed group have multiple children (i.e. additional caring demands due to additional children), the relationship of caregiver status to ill-health and healthcare use could be underestimated.

The number of births enrolled in the BiB cohort was available for the mothers but had limitations. Births prior to the mother's recruitment to the study and subsequent births for mothers who left the study were unknown. Unknown parity may also have resulted in the inclusion of exposed mothers in the unexposed group or have biased the results for parity e.g. if the child included in my study was recorded as the mother's first child but was, in fact, a second (third etc.) child. Parity, like all sociodemographic data, is poorly recorded in primary care records (Pringle, 1995). I could have identified parity (for mothers with available health records e.g. who had lived in Bradford for all their pregnancies) via developing a clinical code list (with dates of entry also extracted), but it was outside the scope of my research. Thus, I did not supplement the BiB data on parity to improve its accuracy, and only used the covariate descriptively.

*4.*10.4.8 *Behavioural problems (excluded)*

The relationship between child behavioural problems and maternal ill-health and the increased likelihood of behavioural problems in children with developmental disabilities is presented in Chapter 1 (Section 1.4.3.2). A substantial proportion of the children in the exposed group were expected to have behavioural problems. Compared with other children, there is a higher prevalence of behavioural problems in children with each of the specific disabling conditions (Section 4.7.5.1, Table 8) and with developmental delay (Sipal, 2009; Herring, 2006).

Child behavioural problems are associated with increased caregiver burden, independent of the burden associated with caregiver status (Eisenhower, 2005; Herring, 2006; Hauser-Cram, 2001). In some studies, there is a larger relationship between caregiver ill-health and child behavioural problems than the disabling condition (Herring, 2006; Plant, 2007; Cheng, 2015; Stacey, 2009). Behavioural problems may be a mediator in the relationship between caregiver status and ill-health (Seymour, 2013), but they can also be a confounder (associated with the outcome as well as the exposure). It was outside the scope of this project to develop a Read code list for behavioural problems, therefore the extent to which behavioural problems accounted for the effect, if any, of caregiver status on the outcomes was unmeasured in my analyses.

*4.*10.4.9 *Preterm birth (excluded)*

Babies who are preterm (<37 weeks gestation) have an increased risk of developmental delay and disability, including learning disability and cerebral palsy (McGowan, 2011; Wood, 2005). The risk is greater for extremely and very preterm than late preterm births (Glass, 2015). In a sample of 283 children born very preterm (22-27 weeks gestation), 48.2% had diagnosed developmental disabilities (including delay) at age 2, increasing to 56.2% at age 8 (Roberts, 2010). Women who have preterm births are at increased risk of ill-health (stress, anxiety, fatigue), but not of

depression (Henderson, 2016; Linden, 2015). It is unclear from the literature whether there is an independent relationship between preterm birth and caregiver ill-health for mothers of disabled children (Cacciani, 2013).

Of the BiB cohort, 5.8% (n=771) are preterm births (Wright, 2013). A greater number of extremely and very preterm births would be expected in the exposed than unexposed groups, and for there to be a stronger relationship between caregiver stress and extremely and very preterm births. To investigate these relationships, a distinction between the preterm categories (n=3) would be required; risking overfitting the models. The risk of bias from excluding this variable was considered less than the risk of over-specification by its inclusion in the analyses; although its investigation in future research is warranted. This covariate was not requested so descriptive between group differences could not be investigated.

*4.*10.4.10 *Social support (excluded)*

Social support has a known relationship to health, and to the psychological health of caregivers (Weiss, 2002; MacKian, 2001). Information on family relationships and social networks were collected in the BiB baseline questionnaire but were only available for a subsample (Prady, 2013b). These covariates were not requested as they were not available for all mothers in the cohort, their inclusion would have over-fitted the model and the relationship has been examined extensively elsewhere.

*4.*10.4.11 *Health behaviours (excluded)*

Health behaviour (smoking, alcohol, diet) influences health, but covariates were not requested as the data were unreliable (Pringle, 1995): health behaviours are poorly recorded in primary care data (Pringle, 1995), primary care clinicians inconsistently ask patients about these behaviours and consumption is under-reported by patients when asked (Conner, 2017). In the BiB cohort, consumption is low for the study period as mothers limit adverse health behaviours during pregnancy and whilst breastfeeding, and few Pakistani women report drinking alcohol or smoking (including prior to their pregnancy) (West, 2014; Stacey, 2016). Thus, the impact of any adverse health behaviours on health may not be observable in the study period.

*4.*10.4.12 *Primary care service characteristics (excluded)*

BiB mothers with ill-health living in socioeconomically deprived areas visit their GP less often than those living in advantaged areas of Bradford (Kelly, 2017a). The same trend was observed for Pakistani mothers (fewer visits) compared with White British mothers. Although more mothers in the deprived areas had ill-health, they were disadvantaged by the lack of GP provision. The GP-to-patient ratio was found to have the greatest effect on consultation frequency in the deprived

areas where the ratio was highest. Kelly et al. also identified a trend for patients to preferentially register with larger GP practices, which may not be their closest or easiest to access primary care service, and could affect their consultation frequency (Kelly, 2014).

To protect the anonymity of the participants in my study, I could not link the primary care service location data to my participant data. However, it is important to note the above associations as any differences in consultation frequency attributed to socioeconomic status could, in part, be due to primary care service characteristics.

4.11 Data preparation

I used Stata 15 to prepare the BiB data for the analyses (StataCorp LLC, 2018), following guidance on data management in Stata (Mitchell, 2010; Cox, 2002).

4.11.1 Missing data

No assessment could be made of whether there were missing data in the mothers' and children's primary care records. In the absence of any independent verification of these data it was assumed that the Read codes and administrative data (i.e. consultation dates) were reliable; that there were no missing diagnoses/symptoms and the consultation dates were correct because the Read codes were accurately recorded on the day of the consultation.

Baseline questionnaires were completed by 10,519 mothers (84.5% of the cohort (n=12,453) (Born in Bradford, 2019). As the fullest possible data set was required for the analysis, I excluded mothers without a baseline questionnaire (the exclusion/inclusion criteria were outlined in Section 4.5). This limited the amount of missing data, although missingness remained because women chose not to or did not know the answer to every question and not all foreign education qualifications could not be mapped onto the UK educational system.

If there was missingness of more than 5% for either the exposed or unexposed group, multiple imputation would be used to generate estimates for missing covariate values (Schafer, 1999).

4.12 Analysis overview

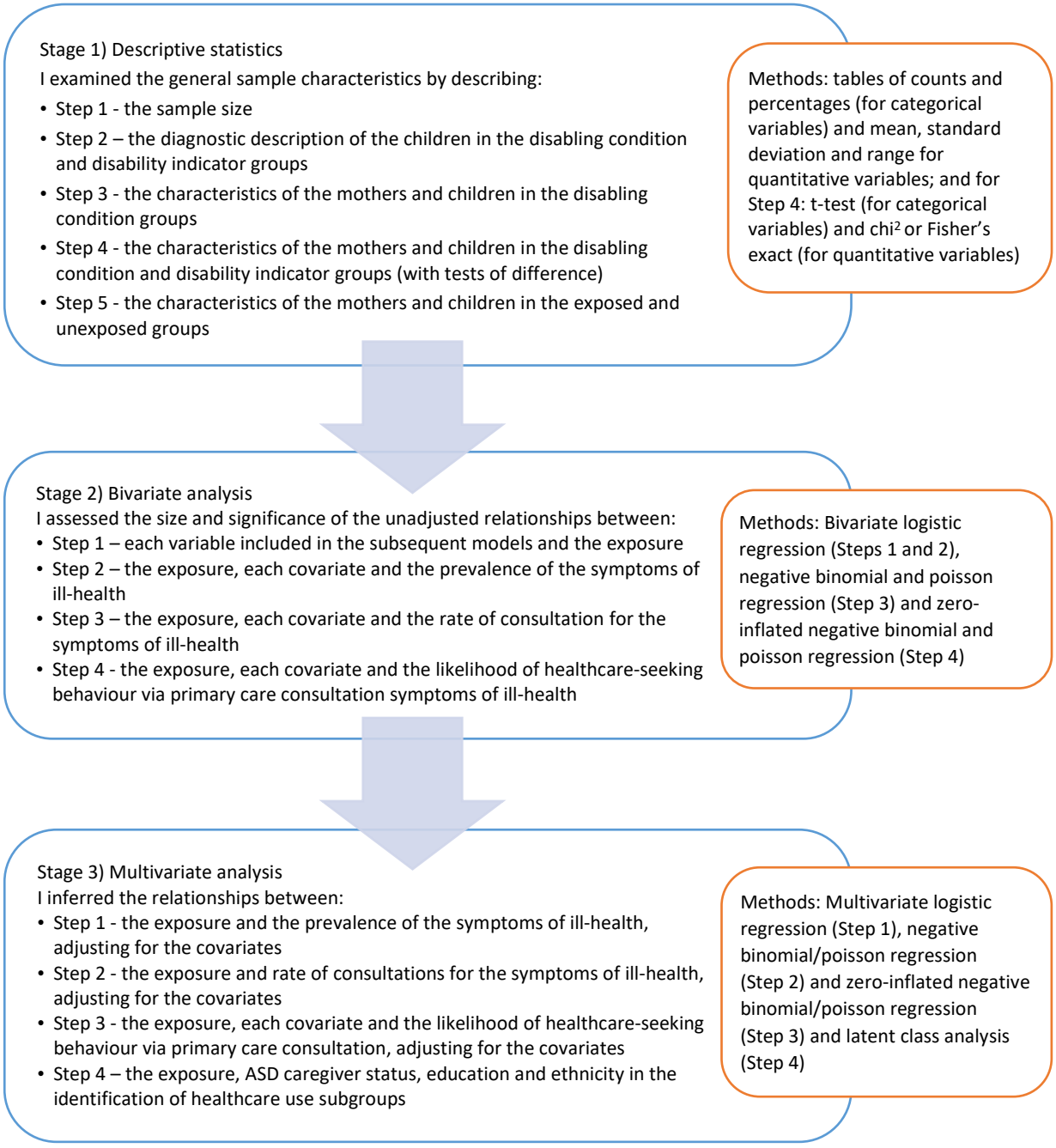
There were three stages to the statistical analysis, each conducted using Stata 15 (StataCorp LLC, 2018):

1. Descriptive statistics: to describe the general characteristics of the study population dichotomised by exposure (including the different disabling condition and indicator groups);

2. Preliminary (bivariate) analysis of the outcomes: to start identifying patterns in the data by investigating the theorised relationships between the exposure and covariates, and the outcomes and covariates; and
3. Main (multivariate) analysis of the outcomes: to identify the relationship between the exposure and the outcomes, exploring the effects of the covariates; and to identify and characterise subgroups based on the relationships between the covariates.

The steps I performed at the three analytic stages to answer the research questions (in Section 4.4.1) are summarised in Figure 17, then the methods described in detail.

Figure 17. Overview of the analysis plan



ASD caregiver status is the phrase used to indicate mothers of children with ASD.
Separate analyses for each of the symptoms of ill-health were performed: 1) psychological distress; 2) head and MSK pain; 3) exhaustion. Thus, each of the steps in the bi- and multivariate analysis stages were repeated three times (excluding Stage 2 Step 1 and Stage 3 Step 4). For the final step (Stage 4), one analysis was performed using the frequency of consultation for any/all of the symptoms.

4.12.1 Period prevalence and consultation frequency

In the analyses, I investigated the relationship of the exposure to the outcomes for the period of birth to age five (period prevalence) instead of incidence. Large datasets with accurate symptom recording are required for incidence studies using primary care data as these data are zero-inflated (Sharma, 2016; Rait, 2009). As outlined (in Sections 4.10.2 and 4.7.5.1), additional zero-

inflation due to the under-detection of symptoms was expected in my study and a small exposure group. Furthermore, children with disabling conditions and disability indicators do not receive their diagnoses at standardised time points (highlighted in Sections 4.7.7.1, Figure 13 and 4.8) and services that support children and families are largely not targeted at specific year groups.

As little research has been performed on caregiver health during the preschool period adjusting for pre-natal health and socioeconomic status, I decided to maximise the amount of data available for the analyses rather than disaggregating the data by year, which would have facilitated the investigation of incidence and changes in maternal health over time. Period incidence calculations ideally require the use of equal time periods, which for my study would have included the pre-natal period. As the pre-natal period is limited to 12 months (outlined in Section 4.10.4.1), too sparse data were expected for a 12 month post-natal period for incidence to be calculated reliably.

4.13 Descriptive statistics

I performed descriptive analyses to describe the study population and identify differences in the distributions of the outcome variables and covariates. These analyses were performed:

- to check the assumptions of sociodemographic differences and variation in the outcomes between the differing disabling condition and disability indicator groups; and
- to ensure awareness of the bias that the different groups may exert on the covariate results (mean and variation) for the combined group, affecting the precision of the measurement of the outcomes.

The following analyses were performed:

- Step 1: description of the sample based on the inclusion/exclusion criteria;
- Step 2: diagnostic description of the children in the disabling condition and disability indicator groups;
- Step 3: the sociodemographic and health characteristics of the mothers and children with each disabling condition;
- Step 4: the sociodemographic and health characteristics of the disabling condition and disability indicator groups, performing tests of between group difference; and
- Step 5: the sociodemographic and health characteristics of the analytic sample: the exposed and unexposed groups.

For Step 1, summaries of the Read codes found in the children's primary care records were included to describe the composition of the disabling condition and disability indicator groups [**A3.3,** Tables A12-13].

For Step 3, the chi squared test was used for categorical variables such as mother's education, and the Fisher's exact test for the categorical variables with cell counts of fewer than five. The t test was performed for continuous variables, such as maternal age at child's birth. As most women in the study population would not have visited the doctor before or after their child's birth, the variables for consultation frequency were expected to violate the assumption of normality (positive skew expected). The distribution of the variables was checked using the skewness, kurtosis, and Shapiro-Wilk tests of normality in Stata (Stata Press, 2017a). If the null hypothesis of normality was rejected ($p \leq 0.05$), the non-parametric Wilcoxon rank-sum test (also known as the Mann-Whitney test) for two independent samples would be used. The data were not transformed as the sample size was expected to be small and the interpretation would be more complicated (Feng, 2014).

For Step 4, if the between group differences for the maternal health characteristics were small and not significant, the condition and indicator groups were presumed not to differ substantially on disability severity and therefore on caregiver burden (described in Sections 4.7.7.3 and 4.10.4.5). Accordingly, it would be sensible to combine the groups to produce an exposed group comprised of mothers of children with disabling conditions and disability indicators. This exposed group would then be used to perform the three studies. Significant sociodemographic differences were expected but would not prohibit combining the groups.

In Step 5, I included an indication of the clinical level of the mothers' symptoms - the proportion of mothers with symptoms of ill-health that are classified as disorders (as opposed to signs/symptoms) in the Read code browser (described in Section 4.9.2).

4.14 Bivariate analysis

I performed bivariate analyses to explore whether there was evidence of the expected relationships between the exposure, covariates and outcome variables (Figure 17, Stage 2):

- Step 1: bivariate logistic regression to examine the relationship between the covariates (in the subsequent analyses) and the binary outcome of caregiver status (the exposure);

- Step 2: bivariate logistic regression to examine the relationship between the exposure, each covariate and the binary outcome of post-natal symptom detection;
- Step 3: bivariate negative binomial regression to examine the relationship between the exposure, each covariate and the post-natal outcome of frequency of healthcare use (based on the number of visits ≥1) for the symptom; and
- Step 4: bivariate zero-inflated negative binomial regression to examine the relationship between the exposure, each covariate and the probability of healthcare-seeking behaviour (based on the number of visits ≥0) for the symptom.

Step 1 examined the possibility of confounding, where one or more variables have a relationship to the outcome and the main explanatory variable (caregiver status) (Antonakis, 2014). Given the theorised association between each covariate and ill-health/healthcare use, and the evidence of associations between pre-natal ill-health, sociodemographic factors and caregiver status, confounding relationships were a possibility (described in Sections 4.10.4.1 and 4.10.4.2). Any confounders identified were not removed from the multivariate analyses. Their influence on the measurement of the relationship between the exposure and outcomes would be discussed.

4.14.1 Regression for binary outcomes

Logistic regression (used in Steps 1 and 2) is an analytic method for modelling relationships to binary variables (Hosmer, 2013). As each mother either had a Read code for the symptom recorded in her primary care data or did not, the outcome variable was binary. Likewise, the exposure variable was binary because the mother either had a child with a Read code in the case ascertainment strategies or did not [**A3.3,** Tables A12-13]. The estimates given by the model were presented as odds ratios: the odds of the outcome in the exposed mothers versus the unexposed mothers, expressed as a ratio.

4.14.2 Regression for count data

Positive (right-tailed) skew was expected for the consultation frequency variables as most women in the study population would not have visited the doctor during the study period. Of those that had, most would have visited only once. Thus, the assumption for poisson regression (the simplest model for count data) that the mean of the outcome variable is equal to the variance (equidispersion), would not be met.

The best model for the data was determined using descriptive statistics (Section 4.10.2), and assessments of equidispersion and goodness of fit. The results of Akaike and Bayesian Information Criterion (AIC and BIC) tests were used to compare whether:

- a poisson or negative binomial regression model best fits the data for the outcome of consultation frequency ≥1; and
- a zero-inflated negative binomial or zero-inflated poisson regression model best fits the data for the outcome of consultation frequency ≥0 (Greene, 1994).

The model with the lowest AIC/BIC score was the best fit.

4.14.2.1 Negative binomial regression

Negative binomial regression accommodates over-dispersion in the data (Hilbe, 2012). It assumes that the zero values in the dataset (women who did not visit a primary care service for the symptoms of interest after the child's birth) occurred by a random process where each visit (within and between mothers) occurred independently of every other visit, with an equal probability of occurring. Primary care consultation is not independent because if a mother visited the doctor once about a symptom after the child's birth, she has an increased likelihood of visiting again about the same symptom or for another symptom. However, this assumption can be mitigated by using cluster-robust standard errors (see Section 4.14.3). This analytic method was used to examine the relationship of the covariates to post-natal consultation frequency greater than or equal to one visit (Step 3).

4.14.2.1 Zero-inflated negative binomial regression

Zero-inflated negative binomial regression was used to model the relationship of the covariates to post-natal consultation frequency greater than or equal to zero visits (Step 4). This model accommodates the over-dispersion in the data and allows for a dual explanation for the high number of zeros in the outcome variable: that some mothers can only have a zero whilst others may have a zero (Min and Agresti, 2005). This model allows for the possibilities that:

- some mothers will not visit a primary care doctor after the birth of their child because they do not have the symptom (certain zeros); and
- some mothers will experience symptoms during the five years after the child's birth but will not visit a primary care doctor about the symptom (not certain zeros) (Stata Press, 2017a).

Accordingly, the analysis produced a two part model which: 1) calculated the probability of the mothers having certain zeros given the covariate; and 2) calculated the incidence rate ratio based

on some of the excess zeros not being certain zeros (i.e. more than the number of mothers that visited about the symptom are likely to have ill-health). In the multivariate analyses, the logit model (1) used the exposure or covariates to determine which variables/items (the categories within the variable) had a direct influence on the zero counts; then (2) a negative binomial regression model was used to produce estimates of the relationship between post-natal consultation frequency and the exposure or covariate that were less strongly affected by the presence of the excess zeros (Hilbe, 2012).

The results of the analyses were reported as odds ratios (the odds of a certain zero given the exposure or covariate) and incidence rate ratios (the rate at which the outcome will occur during the time period given the exposure or covariate). I describe this analysis as modelling the probability of healthcare-seeking behaviour (as opposed to the frequency of healthcare use) as its most useful function (in helping answer my research questions) is the measurement of whether the exposure and covariates increase or decrease the likelihood of mothers with a clinical need healthcare-seeking by visiting their doctor.

4.14.3 Standard errors

Stata's default standard errors (Observed information matrix) were used for Step 1. In Step 2, robust standard errors were specified to adjust for the high heterogeneity that was expected in the data, as was observed in my systematic review data (Chapter 3). The errors were derived from the observed variability in the data rather than producing the default standard errors derived from the variability predicted by the probability-based logistic model.

In Steps 3 and 4, cluster-robust standard errors were specified to adjust for the likely interdependence between the count data (number of visits, including zero) for each mother (described in Section 4.14.2.1). Cluster-robust standard errors relax the assumption of independence, only requiring the visits to be independent across clusters. Mother ID was specified as the cluster variable, to indicate that the visits are independent between but not within mothers. This adjustment to the standard errors associated with the outcome coefficient produced a more precise measurement of the standard errors (Stata Press, 2017b).

4.14.4 Test statistics

For each bivariate (and multivariate) regression analysis, the exponentiated coefficient was reported with 95% confidence intervals, and the test statistic (z) and corresponding p value provided. Results greater than 10,000 or smaller than 1 in 10,000 are given in the exponential form for readability. The results are given to two decimal places or two significant digits, where possible (Cole, 2015).

The z test is the ratio of the coefficient to the standard error of the covariate. The resultant p value indicated whether the null hypothesis that the coefficient was equal to zero should be rejected. In studies with a strong theoretical model but small samples, it is common for significance to be set at $p \leq 0.1$ (Gigerenzer, 2004; Biau, 2008). Thus, significance in interpreting the results of the bivariate (and multivariate) analyses $p < 0.05$ indicated strong evidence, whilst $p \leq 0.1$ indicated a tendency for a relationship between the exposure or covariate and the outcome.

4.14.5 Dropped records

By default, Stata drops records which contain missing values. Therefore, the number of observations included in the bivariate analyses varied depended on the number of missing observations per covariate. Records with any missing covariates were dropped from the multivariate analyses. Imputation was not performed (described in Section 4.11.1).

The covariate of pre-natal consultation frequency ≥0 visits for the symptom was used in the models of post-natal healthcare use and healthcare-seeking behaviour (Steps 3 and 4, steps 2 and 3 in the multivariate analyses described in Section 4.15.1). This prevented Stata from dropping mothers who had not visited the doctor before the child's birth (considered missing values) from the analyses.

4.15 Multivariate analysis

I used two different but complementary types of multivariate analysis in the investigation of the relationship of caregiving to symptoms of ill-health and healthcare use (Figure 17, Stage 3). I performed:

- Steps 1-3: regression analyses to understand how the exposure and covariates related to the outcome variables (described in Section 4.15.1); then
- Step 4: a latent class analysis to look for relationships between the categories/items of the exposure and covariates and different patterns of pre- and post-natal healthcare use to understand the interrelationships between the variables (including disability diagnosis) (described in Section 4.15.2).

4.15.1 Inference about the relationship of variables to the outcome

I performed:

- Step 1: multivariate logistic regression to investigate the relationship between the exposure and post-natal symptom detection, adjusting for the covariates;

- Step 2: multivariate negative binomial regression to investigate the relationship of the exposure to post-natal healthcare use (consultation ≥1 visit) for the symptom, adjusting for the covariates; and
- Step 3: multivariate zero-inflated negative binomial regression to investigate the relationship of the exposure to post-natal healthcare-seeking behaviour (consultation ≥0 visits) for the symptom, adjusting for the covariates.

Steps 1-3 were performed three times, once for each of the symptoms (psychological distress, head and MSK pain, exhaustion). Given the theorised interrelationships expected between the variables (outlined in Sections 4.10.3 and 4.10.4), all covariates were entered into the model together and left in, regardless of whether their relationship to the outcome was significant.

4.15.1.1 Standard errors

As in the bivariate analyses, robust standard errors and cluster-robust standard errors were used (described in Section 4.14.3).

4.15.1.2 Weighting

Weighting was not specified in either model as the factors across which the cohort vary were included in the analysis, and the sampling strategy for the BiB cohort was largely representative of the general population of metropolitan Bradford (Solon, 2013; Wright, 2013).

4.15.1.3 Independence

Independence of the observations between covariates was assumed for both the regression and latent class analyses. The risk of collinearity was limited by including only variables with a known independent relationship to the outcomes (outlined in Section 4.10.4). In the models with pre-natal healthcare use as a covariate, the binary covariate of symptom detection was not also included (and vice versa) as these variables are collinear (i.e. a mother could only have a symptom detected if she had visited the doctor about it). Furthermore, the number of primary care consultations a mother had, did not help explain the relationship of the exposure to the detection of ill-health.

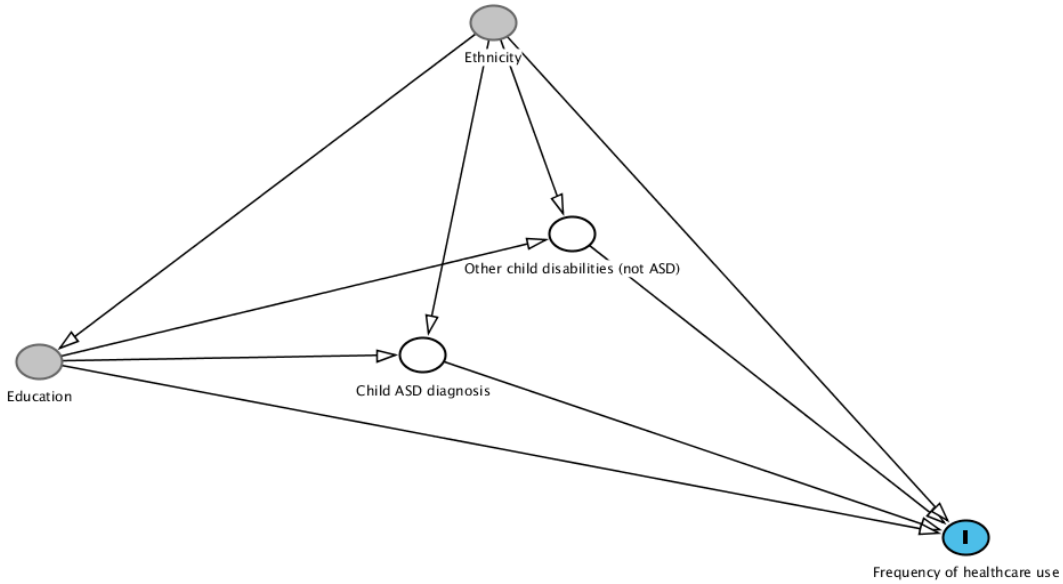
4.15.1.4 Interaction

Interaction between the covariates was not examined as these relationships were limited by the selection of the covariates included in the multivariate analyses. The small exposed group size expected would have limited the usefulness of the interpretation of any interactions performed (Bland, 2015).

4.15.2 Inference about the relationships between variables

The third multivariate analysis aimed to examine whether there might be differences in pre- and post-natal healthcare use associated with caregiving for children with ASD compared with other developmental disabilities or no developmental disabilities, when maternal education and ethnicity were included in the model (Figure 18).

Figure 18. Schematic of the conceptual model of the associations between the variables included in the latent class analysis



This is a schematic, not a causal model, as latent class analysis answers questions of association, not causation.
For completeness, the relationship between ethnicity and education is shown (unlike in the causal models presented in Section 4.10.3).

As discussed in Chapter 1 (Sections 1.4.3.4 and 1.5.1), child ASD has been associated with greater post-natal maternal ill-health than other developmental disabilities (Laxman, 2015; Hayes, 2013; Valicenti-McDermott, 2015). Caregivers may have poorer health and visit the doctor more often before as well as after the child's birth (Arim, 2019; Brehaut, 2019a). Greater pre-natal as well as post-natal psychological ill-health has been found in mothers of children with ASD than mothers of children with other disabilities and none (Vasa, 2012; Fairthorne, 2013; Fairthorne, 2016b). However, it is unknown whether UK caregivers of children with ASD and other disabilities have higher frequencies of pre- and post-natal primary care consultation than other mothers.

I used a subset of the study sample in the latent class analysis - only mothers who had visited the doctor about ill-health before the child's birth. This enabled investigation of whether caregivers and other mothers with pre-natal healthcare use had similar or different frequencies of pre- and post-natal healthcare use which could be associated with being a caregiver in general or

caregiving for a child with ASD specifically. Given the availability of literature on healthcare use and disability diagnosis for the largest ethnic groups in the BiB sample, a bi-ethnic sub-sample of only the Pakistani and white British mothers was used in the analysis (the 'Other' ethnicity mothers were dropped from the analysis).

The inclusion of maternal education and ethnicity in the model enabled examination of whether differences in the probability of subgroup membership by caregiver status varied with sociodemographic factors (which were also indicators of socioeconomic status, as explained in Section 4.10.4.2). As white British ethnicity and high maternal education are associated with earlier ASD diagnosis, a subgroup with more caregivers of children with ASD would also be expected to have more white British and higher educated mothers than other subgroups (Nowell, 2015). If so, the sociodemographic characteristics may be influencing maternal healthcare use to a greater extent than the child's disability diagnosis.

I produced a count variable of the total number of unique visits to the doctor for any of the individual symptoms (stress, common mental disorders, headaches, MSK pain, sleep problems, fatigue) dichotomised by the child's birth. This aimed to maximise the possibility of seeing the theorised relationships and enabled comparison with the findings from other studies (none of which have stratified analysis of healthcare use in caregivers by symptom) (Brehaut, 2019a; Arim, 2019; Ray, 2009; Willet, 2018). The use of individual symptoms would have resulted in very low cell counts, with subgroups characterised by symptom healthcare use rather than caregiving and the sociodemographic factors.

Consultation frequency was recoded to produce two variables: low (1 visit) and high (≥2 visits) pre-natal healthcare use; no (0 visits), low (1-5 visits) and high post-natal (≥6 visits) healthcare use. The analysis using binary variables (pre-natal healthcare use, education, ethnicity, caregiver status, ASD caregiver status) and ordinal variables (post-natal healthcare use) was performed in Mplus 8. Unlike Stata, Mplus does not drop records with missing observations from the analysis.

Latent class analysis determines classes (subgroups) from the probabilities of each item (category) of each variable being observed in each person compared with the population mean (Jung, 2008). Using the variables entered, individuals with an increased likelihood of clusters of items were identified as distinct subgroups. Descriptive labels were given to each subgroup based primarily on differences in the probabilities of the items in the two healthcare use variables, and with reference to any differences in caregiver status or sociodemographic characteristics (Collins, 2009).

As latent class analysis is not powered (sample size does not matter), this method could be used to perform an analysis by child diagnosis. Although using low numbers of exposed mothers affected the accuracy of the measurement of effect (Park, 2017), it gave an indication of whether differences in maternal healthcare use (low/high use, possibly related to differences in the prevalence of ill-health) might have been masked by the diagnostic heterogeneity of the exposed group. This approach built on the findings from the preceding multivariate analyses (Steps 1-3) by examining the variation in the study population with pre-natal symptoms and within in the exposed group.

4.15.2.1 Model diagnostics for latent class analysis

The best number of classes for the data was assessed by producing models with 1-5 classes and comparing the results of the diagnostic tests. The best model had:

- a combination of a small BIC and p value for the Vuong-Lo-Rubin likelihood ratio, and a large entropy and log-likelihood value;
- no groups with a disproportionately small membership (the number of mothers in each class); and
- distinct differences between group membership on the parameters of interest (i.e. pre- and/or post-natal consultation frequency) (UCLA Institute for Digital Research and Education, 2019; Collins, 2009).

4.15.2.2. Test statistics

Class membership was presented as the probability of each category and presented graphically.

4.16 Hypotheses

A total of three (alternative) hypotheses were tested in the multivariate analyses:

1. There is a greater prevalence of symptoms of ill-health in the exposed than unexposed mothers attributable to caregiver status, when adjusted for the detection of the symptoms in the 12 months before the child's birth and socioeconomic status;
2. There is a lower rate of primary healthcare use and probability of primary healthcare-seeking behaviour for symptoms of ill-health in the exposed than unexposed mothers attributable to caregiver status, when adjusted for consultation frequency for the symptoms in the 12 months before the child's birth and socioeconomic status; and
3. There is a higher probability of subgroups with pre-natal, low and high post-natal healthcare use containing exposed mothers, and mothers of children with ASD specifically, than unexposed mothers, with sociodemographic variation between

subgroups associated with known relationships between ASD diagnosis, education and ethnicity.

4.17 Chapter summary

I have outlined how and why three complementary studies of the BiB cohort were performed to answer conceptually linked research questions on differences in the health and healthcare use of mothers of preschool children with developmental disabilities compared with other mothers.

The next chapter presents the results of the descriptive analyses.

Chapter 5 Descriptive statistics for the study sample and disability subgroups

This chapter provides descriptive statistics for the study sample stratified by exposure and describes the rationale for combining the disabling condition and disability indicator groups in the subsequent analytic stages.

5.1 Introduction

This chapter provides a description of the mother-child dyads used in the subsequent analyses, as outlined in Chapter 4 (Section 4.12, Figure 17: Stage 1 Steps 1-4). The following descriptive analyses are presented:

- Sample selection and size (Section 5.2)
- Exposure:
    1. diagnostic description of the children in the (1) disabling condition and (2) disability indicator groups (Section 5.4.1);
    2. characteristics of the disabling condition groups (Section 5.4.2);
    3. characteristics of the diagnostic groups: (1) disabling conditions, 2) disability indicators (Section 5.4.3); and
- Analytic sample:
    4. characteristics of the analytic sample: the exposed and unexposed groups (Section 5.5)

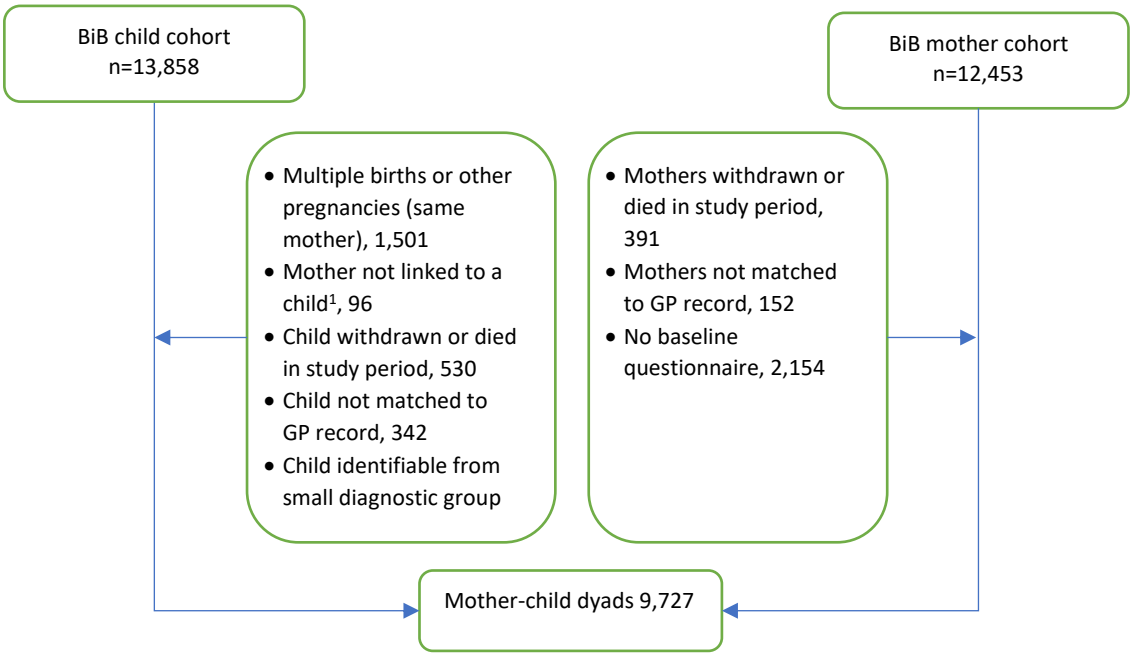
To inform the decision whether to combine the disabling condition and disability indicator groups, only the characteristics in which the groups were expected to vary are included in this chapter (outlined in Sections 4.7.7.3 and 4.10.4). Additional descriptive information (characteristics in which the groups were not expected to differ) is included in the Appendix 4. Three section summaries (Sections 5.4.4, 5.5.1.9 and 5.5.2.5) are included to highlight the key findings and their implications for the subsequent analyses.

The health characteristics described below are for the symptoms of ill-health: psychological distress, head and MSK pain, and exhaustion. Data suppression (collapsed categories or data not shown) was exercised where there was insufficient data to ensure study participant anonymity (approaches outlined in Section 4.3.1). For example, the disabling condition groups could not be described by the symptom of exhaustion. Descriptive statistics were rounded to 1 decimal place, except for the results of the tests of difference which are given to 2 decimal places.

5.2 Sample selection and size

The exclusion criteria were specified to obtain a study sample with only one child per mother and as complete mother-child dyad data as possible, whilst protecting the anonymity of individual study participants. A study sample of 9,727 mother-child dyads was produced (Figure 19).

Figure 19. Flow diagram of the eligible study sample from the BiB cohort



Exclusions not mutually exclusive (list of inclusion and exclusion criteria in Section 4.5
[1]No linked child if the mother moved away from Bradford between being recruited to the study and giving birth.

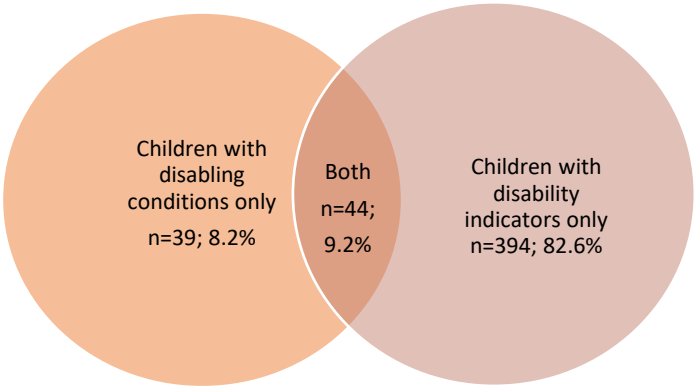
5.3 Missing data

The amount of missing data for the exposed and unexposed groups was low (≤0.6%). A complete case analysis of the data was performed without missing values being imputed (Section 4.11.1). This may have reduced the power of the statistical analyses slightly (Schafer, 1999). Missing observations are indicated in the relevant tables in this chapter but, for clarity, they are excluded from the visual representation of the information (due to the small number of missing observations).

5.4 Exposed group

Of the study sample (n=9,727), 477 (4.9%) had either a disabling condition or disability indicator or both (Figure 20).

Figure 20. The number of children identified as having disabling conditions and disability indicators



N=477

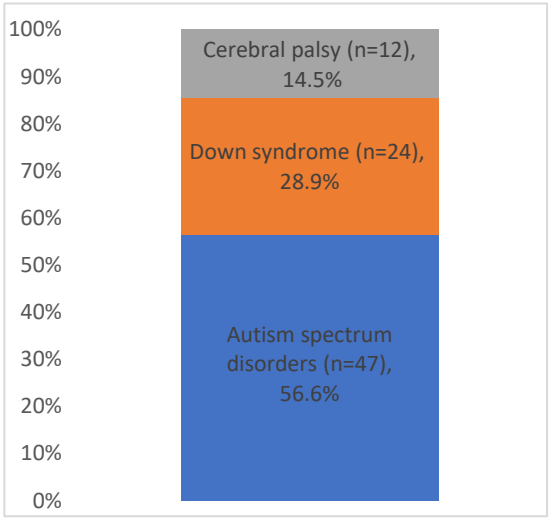
5.4.1 Diagnostic description

5.4.1.1 Children with specific disabling conditions

Of the sample (n=9,727), 83 children (0.9%) had a Read code for ASD, cerebral palsy or Down syndrome recorded in their primary care record between birth and age five. No children with diagnoses of moderate-profound learning disability or Fragile X syndrome were included in the disabling condition group.

Of the 148 Read codes searched for, 13 (recorded 97 times) were found in the primary care records (Figure 21).

Figure 21. Composition of the disabling condition group and frequency of the identifying Read codes



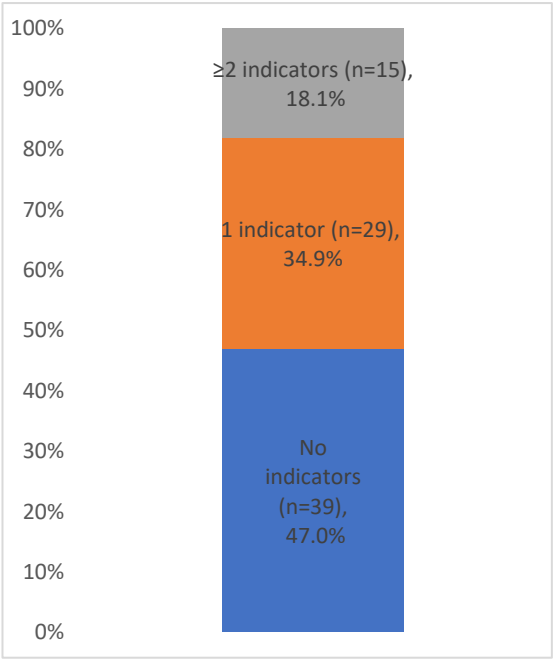
Descriptions for the Read codes identifying specific disabling conditions (n)
Cerebral palsy (9) Bilateral spastic cerebral palsy (1) Cerebral palsy with spastic diplegia (1) Other infantile cerebral palsy (1)
Down's syndrome (23) Down's syndrome not otherwise specified (4) Trisomy 21 – meiotic nondisjunction (4) Partial trisomy 21 in Down's syndrome (2)
Autistic spectrum disorder (38) Childhood autism (10) Atypical autism (2) Active infantile autism (1) Rett syndrome (1)

N=83

The frequency of each code is not equal to the number of children with each condition as 24 children had more than one code for the same disabling condition (the same or different codes) recorded on the same (n=3) or different dates (n=21) during the five year study period.

No children had more than one of the disabling conditions, but 53% (n=44/83) had at least one disability indicator (Figure 22). Of the 103 Read codes included in the secondary case ascertainment strategy, 16 (recorded 62 times) were found in the children's primary care records.

Figure 22. The frequency of disability indicators in children with disabling conditions and of the identifying Read codes



Descriptions for the Read codes identifying disability indicators (n)
Speech delay (15) Developmental delay (14) Developmental language delay (12) On learning disability register (4) Global developmental delay (3) Developmental disorder of scholastic skills, unspecified (2) Speech or language developmental disorder NOS (2) Developmental disorder (2) Disorder of psychological development (1) Disorder of speech (1) Expressive language delay (1) Mild learning disability (1) Motor developmental delay (1) Gross motor skills development delay (1) Social skills development delay (1) Unspecified mental retard with the statement no, or minimal, impairment of behaviour (1)

N=83

NOS, not otherwise specified

The same indicator was recorded on more than one occasion during the five year study period for five children.

As anticipated (in Section 4.7.7.1), the children with Down syndrome received their diagnoses earliest (soon after birth) and the children with ASD received diagnoses latest (Table 11); and a large proportion of children with ASD and cerebral palsy received a diagnosis of developmental delay prior to receiving a condition diagnosis. There is considerable variability in the age at which children with ASD and cerebral palsy received their first diagnosis (of either a condition or indicator).

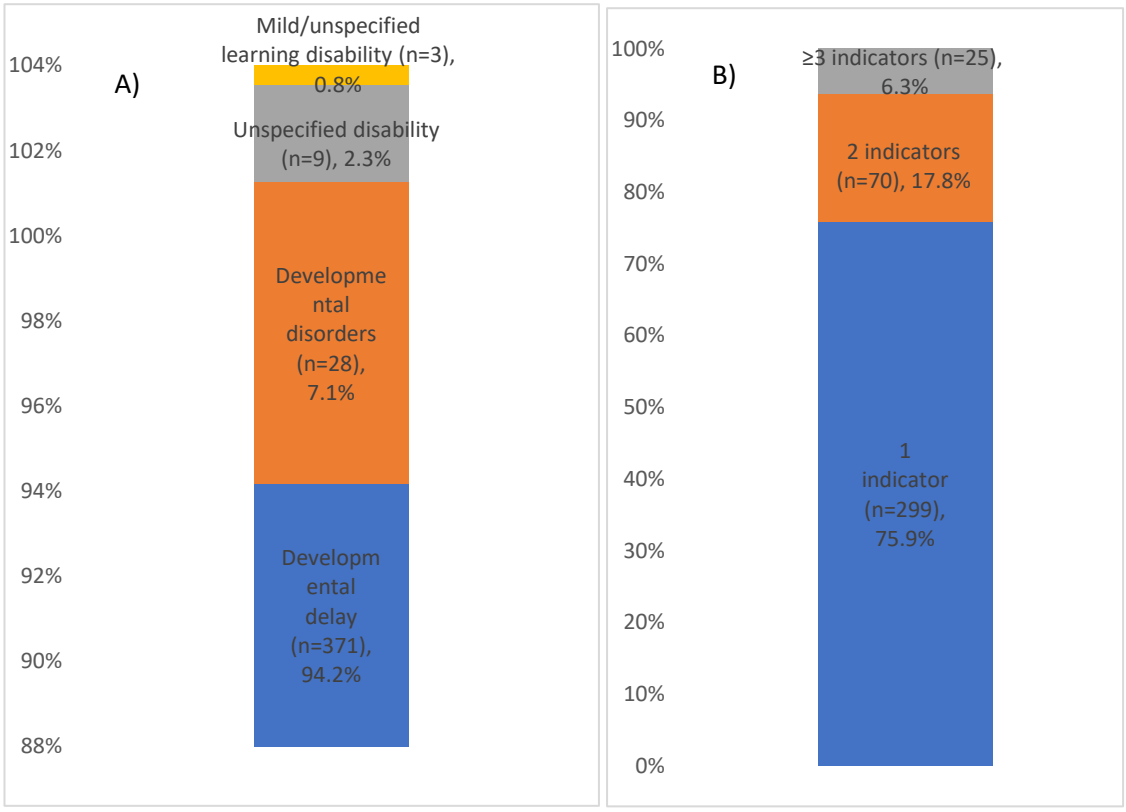
Table 11. Diagnostic characteristics of the children with specific disabling conditions by condition group

Variable	Cerebral palsy (n=12)	Down syndrome (n=24)	Autism Spectrum Disorders (n=47)	Total (n=83)
Children diagnosed with a disability indicator before receiving a disabling condition diagnosis, n column (%)	6 (50)	0 (0)	17 (36.2)	23.0 (27.7)
Child's age when a disabling condition is diagnosed (in months), mean (s.d.), range	29.6 (19.5), 0-58	0.3 (0.7), 0-3	48.7 (7.6), 32-60	32.0 (23.2), 0-60
Child's age when first disabling condition or indicator is diagnosed (in months), mean (s.d.), range	20.4 (18.3), 0-58	0.3 (0.7), 0-3	39.3 (13.0), 7-60	25.3 (21.0), 0-60

5.4.1.2 Children with disability indicators

Of the study sample, 4.1% of the children had disability indicators only (n=394/9,727) (Figure 23). Just under a quarter of these (24.1%) have more than one indicator (from the same or different categories: developmental delay, developmental disorders, mild/unspecified learning disability or other unspecified disability).

Figure 23. Bar graphs of the number of children with a Read code from the disability indicator categories (A), and percentage of children with one or more disability indicators (B)



N=394
The categories in graph A are not mutually exclusive.
Graphs A and B do not use the same scale.

Of the 103 Read codes in the secondary case ascertainment strategy, 33 (recorded 521 times) are found in the children's primary care records (Table 12).

Table 12. The frequency of each indicative Read code by indicator category

Descriptions for the Read codes identifying disability indicators (n)	
Mild/unspecified learning disability: On learning disability register (2) Mild mental retardation, IQ in range 50-70 (1)	Developmental delay: Speech delay (151) Developmental delay (134) Developmental language delay (101) Global developmental delay (21) Expressive language delay (16) Gross motor skills development delay (15) Motor developmental delay (10) Receptive language delay (5) Development delay NOS (5) Specific delays in development (5) Phonological delay (3) Communication skills development delay (3) Growth delay (3) Other development delays (3) Fine motor skills development delay (2) Social skills development delay (1) Delayed milestone (1) Neurodevelopmental delay (1)
Unspecified disability: DLA 370 Disability living allowance completed (6) Disability NOS[1] (1)	
Developmental disorders: Disorder of speech and language development (12) Speech or language developmental disorder NOS (5) Developmental disorder of motor function (3) Developmental disorder (2) Developmental disorder of scholastic skills, unspecified (2) Developmental disorder of speech and language, unspecified (2) Expressive language disorder (1) Developmental disorder NOS (1) Developmental language impairment (1) Developmental language disorder (1) Developmental speech disorder (1)	

[1] NOS, Not otherwise specified

Clinical codes for general developmental delay or delay in the area of speech and language development occurred most frequently in the children with disability indicators (Table 12) as well as those with disabling conditions (Figure 22).

5.4.2 Characteristics of the disabling condition groups

Compared with the other condition groups, the ASD group had a higher proportion of male than female children, mothers who were white British and educated above age 16 (Table 13). The average maternal age of the Down syndrome group was higher, but there was not a greater proportion of Pakistani (versus white British) or high (versus low) educated mothers compared with the other groups.

Table 13. Sociodemographic characteristics of the mother-child dyads by disabling condition group

Variable[1]	Cerebral palsy (n=12)	Down syndrome (n=24)	Autism Spectrum Disorders (n=47)	Total (n=83)
Sex, male, n column (%)	5 (41.7)	12 (50)	37 (78.7)	54 (65.1)
Mother's ethnicity, n column (%)				
White British	5 (41.7)	16 (66.7)	27 (57.4)	48 (57.8)
Pakistani	7 (58.3)	8 (33.3)	20 (42.6)	35 (42.2)
Missing	0	0	0	0
Mother's highest educational qualification, n column (%)				
Higher education (beyond age 16)	6 (50.0)	11 (45.8)	31 (66.0)	48 (57.8)
Compulsory education (to age 16)	6 (50.0)	12 (50.0)	16 (34.0)	34 (41.0)
Missing	0	1 (4.2)	0	1 (1.2)
Mother's age (in years) at child's birth, mean (s.d.), range	24.8 (6.6), 18-41	34.1 (8.1), 18-49	28.2 (5.3), 18-39	29.4 (7.1), 18-49

Compared with the other groups, fewer mothers in the Down syndrome group had psychological distress, but those that did had a higher average consultation frequency and a lower child age when the mother's symptoms were detected (Table 14). Fewer mothers in the ASD group visited the doctor about head and MSK pain but those that did, visited sooner on average than mothers in the other groups.

Table 14. The detection and primary care consultation for post-natal symptoms of ill-health by condition group

Variable	Cerebral palsy (n=12)	Down syndrome (n=24)	Autism Spectrum Disorders (n=47)	Total (n=83)
Symptoms detected, n column (%)				
Psychological distress	5 (41. 7)	5 (20.8)	19 (40.4)	29 (34.9)
Head and MSK pain	7 (58.3)	13 (54.2)	15 (31.9)	35 (42.2)
Consultation frequency (including zero visits)[1], mean symptom (s.d.), range				
Psychological distress	1.6 (3.0), 0-10	1.0 (2.4), 0-10	1.2 (1.8), 0-7	1.2 (2.2), 0-10
Head and MSK pain	1.2 (1.8), 0-6	1.3 (1.9), 0-7	0.8 (1.8), 0-8	1.0 (1.8), 0-8
Consultation frequency (only mothers who visited)[2], mean symptom (s.d.), range				
Psychological distress	3.8 (3.8), 1-10	4.8 (3.3), 2-10	2.9 (1.8), 1-7	3.4 (2.5), 1-10
Head and MSK pain	2.0 (1.9), 1-6	2.3 (2.1), 1-7	2.4 (2.5), 1-8	2.3 (2.2), 1-8
Child's age when mother's symptoms detected (in months), mean (s.d.), range				
Psychological distress	24.8 (14.6), 12-47	17.8 (13.1), 3-32	28.1 (20.7), 0-57	25.7 (18.6), 0-57
Head and MSK pain	33.3 (16.5), 13-57	31.8 (17.4), 11-58	19.9 (20.9), 1-59	27 (19.4), 1-59

[1] The mean number of consultations for the group including the zero counts for women who did not visit the doctor for the symptom during the time period.
[2] The mean number of consultations for the mothers who visited the doctor for the symptom during the time period.
Significant results are in bold.

5.4.3 Characteristics of the diagnostic groups

As anticipated, the disabling condition group (children with the above 3 conditions) had significantly more highly educated, older mothers and the children received an earlier diagnosis than the indicator group (children with disability indicators only) (Table 15). Although there is a greater proportion of males in the condition than indicator group the difference is not significant.

Table 15. Sociodemographic characteristics where significant variation was theorised between the condition and indicator groups

Variable	Disability indicators only (n=394)	Disabling conditions (n=83)	Tests of difference, test statistic (p-value)
Child's sex, n column (%)			
Female	114 (28.9)	29 (34.9)	1.2 (0.28)
Male	280 (71.1)	54 (65.1)	
Total	394 (100)	83 (100)	
Mother's education, n column (%)			
Higher education (beyond age 16)	182 (46.2)	48 (57.8)	**4.1 (0.04)**
Compulsory education (to age 16)	212 (53.8)	34 (41.0)	
Missing	0	1 (1.2)	
Total	394 (100)	83 (100)	
Mother's age (in years) at child's birth, mean (s.d.)[3], range	27.4 (5.7), 15-43	29.4 (7.1), 15-44	**-2.1 (0.03)**
Child's age (in months) at first diagnosis[1], mean (s.d.), range	34.8 (14.3), 0-59	24.9 (20.8), 0-59	**3.9 (0.00)**

[1] For the disabling condition group, this was a condition or disability indicator depending on which diagnosis was received first.
[2] Pearson chi[2] test was used for categorical variables. The t-test was used for the continuous variables. Two-sided p values were reported. Missing values were excluded from the tests. Statistically significant results are in bold.

The normality of the continuous variables was tested to determine which test of difference to use (t-test or Mann-Whitney) [**A4.1**]. There are no significant differences between the groups for the outcomes of ill-health and healthcare use (Table 16).

Table 16. Post-natal health characteristics where significant variation was theorised between the condition and indicator groups

Variable	Disability indicators only (n=394)	Disabling conditions (n=83)	Tests of difference, test statistic (p-value)
Symptoms detected, n symptom (%)			
Psychological distress	136 (34.5)	29 (34.9)	0.005 (0.94)
Head and MSK pain	172 (43.7)	35 (42.2)	0.1 (0.80)
Exhaustion	81 (20.6)	11 (13.3)	2.4 (0.13)
Consultation frequency (including zero visits), mean (s.d.), range			
Psychological distress	1.1 (2.1), 0-11	1.2 (2.2), 0-10	-0.28 (0.78)
Head and MSK pain	1.0 (1.7), 0-11	1.0 (1.8), 0-8	0.51 (0.61)
Exhaustion	0.3 (0.6), 0-4	0.2 (0.7), 0-5	1.46 (0.14)
Consultation frequency (only mothers who visited), mean (s.d.), range			
Psychological distress	3.1 (2.4), 1-11	3.4 (2.5), 1-10	-0.67 (0.51)
Head and MSK pain	2.2 (1.9), 1-11	2.3 (2.2), 1-8	-0.12 (0.91)
Exhaustion	1.3 (0.6), 1-4	1.6 (1.2), 1-5	-1.53 (0.13)
Child's age when mother's symptoms detected, (in months), mean (s.d.), range			
Psychological distress	21.6 (16.8), 0-60	25.7 (18.6), 0-57	-1.06 (0.29)
Head and MSK pain	24.4 (16.2), 0-59	27.0 (19.4), 1-59	-0.63 (0.53)
Exhaustion	28.2 (17.5), 2-59	22.9 (14.3), 6-52	0.85 (0.40)

The results for the characteristics where the groups were not expected to vary are in **A4.2**.

5.4.4 Section summary

These descriptive analyses highlight sociodemographic differences within and between the disabling condition and disability indicator groups (Tables 13 and 15). There may be some variation in the outcomes of ill-health and healthcare use by disabling condition, but there was no evidence of significant differences between the condition and indicator groups for the outcomes (Tables 14 and 16). This investigation tested the hypothesis that mothers in the condition group experience greater caregiver burden (and thus greater ill-health and barriers to healthcare use) than mothers in the indicator group.

The results support the clinical information for Bradford that during the preschool period:

- most children with developmental disabilities receive a diagnosis for disability indicators, not disabling conditions (except for Down syndrome); and
- the diagnosis of a disabling condition is not a more reliable indicator of greater disability or caregiver burden than the identification of a disability indicator.

The significant sociodemographic differences between the groups were likely to reflect the sociodemographic differences observed for the differing disabling condition groups:

- mothers of children with Down syndrome tend to be older than mothers of children with other disabling conditions or indicators (but in my sample they do not have higher education); and
- a greater number of mothers of children with ASD have higher education than mothers of children with other disabling conditions or indicators (Tables 11 and 15).

This preliminary analysis confirmed the expected sociodemographic variation and supported the decision to combine the disabling condition (n=83) and disability indicator groups (n=394) to produce the exposure group (n=477) for the subsequent analyses.

5.5 Analytic sample (exposed and non-exposed groups)

To highlight key findings, short summaries follow the description of the exposed and unexposed groups by sociodemographic (Section 5.5.1) and health characteristics (Section 5.5.2). Graphs are presented alongside tables when they aid interpretation of the data.

5.5.1 Sociodemographic characteristics by exposure group

5.5.1.1 Child's sex

Table 17. Children's sex

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Child's sex, n column (%)			
Female	4,595 (49.7)	143 (30.0)	4,738 (48.7)
Male	4,655 (50.3)	334 (70.0)	4,989 (51.3)
Missing	0	0	0

5.5.1.2 Parity

Table 18. Parity

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Parity, n column (%)			
First child	9,249 (100)	435 (91.2)	9,684 (99.6)
≥2 children	1[1] (0.0)	42 (8.8)	43 (0.4)
Missing	0	0	0

[1]Although there is a cell count of less than 5 for this variable, the data are presented as the individual was not considered at risk of re-identification from the summary data presented in this chapter.

5.5.1.3 Cohabitation status

Table 19. Cohabitation status

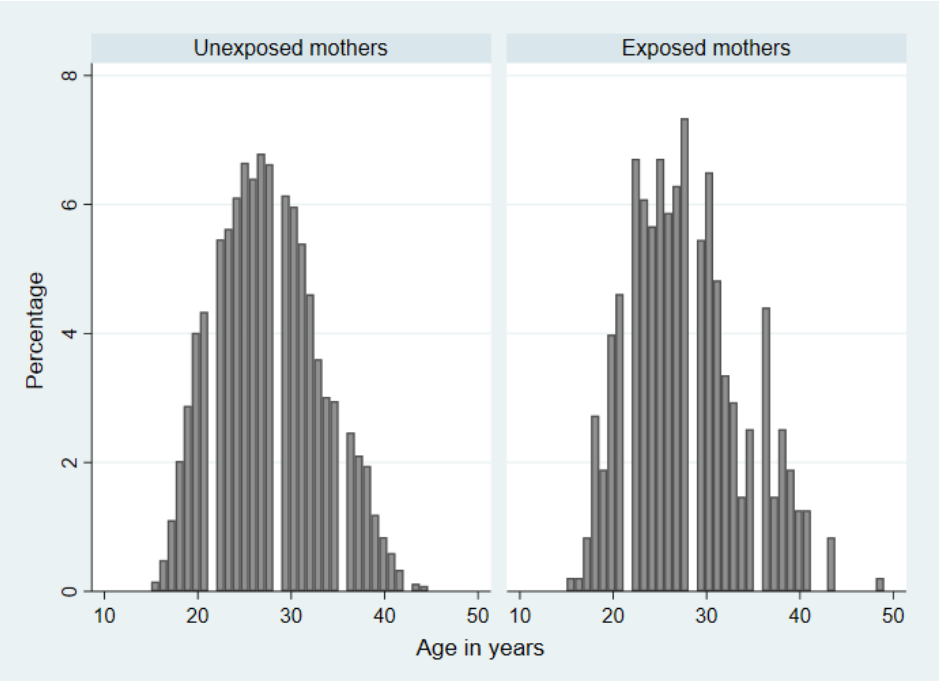
Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Cohabitation status, n column (%)			
Living with partner	7,642 (82.6)	401 (83.9)	8,042 (82.7)
Not living with partner	1,589 (17.2)	77 (16.1)	1,666 (17.13)
Missing	19 (0.2)	0	19 (0.2)

5.5.1.4 Mothers' age

Table 20. Mother's age at child's birth

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Mother's age (in years), mean (s.d.), range	27.5 (5.6), 15-44	27.6 (6.0), 15-49	27.5 (5.6), 15-49

Figure 24. Age distribution of the mothers at the child's birth



5.5.1.5 Ethnicity

Table 21. Mothers' ethnicity

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Ethnicity, n column (%)			
White British	3,729 (40.3)	193 (40.6)	3,922 (40.3)
Other	1,462 (15.8)	56 (11.7)	1,518 (15.6)
Pakistani	4,040 (43.7)	228 (47.8)	4,268 (43.9)
Missing	19 (0.2)	0	19 (0.2)

5.5.1.6 Education

Table 22. Highest educational attainment of the mothers

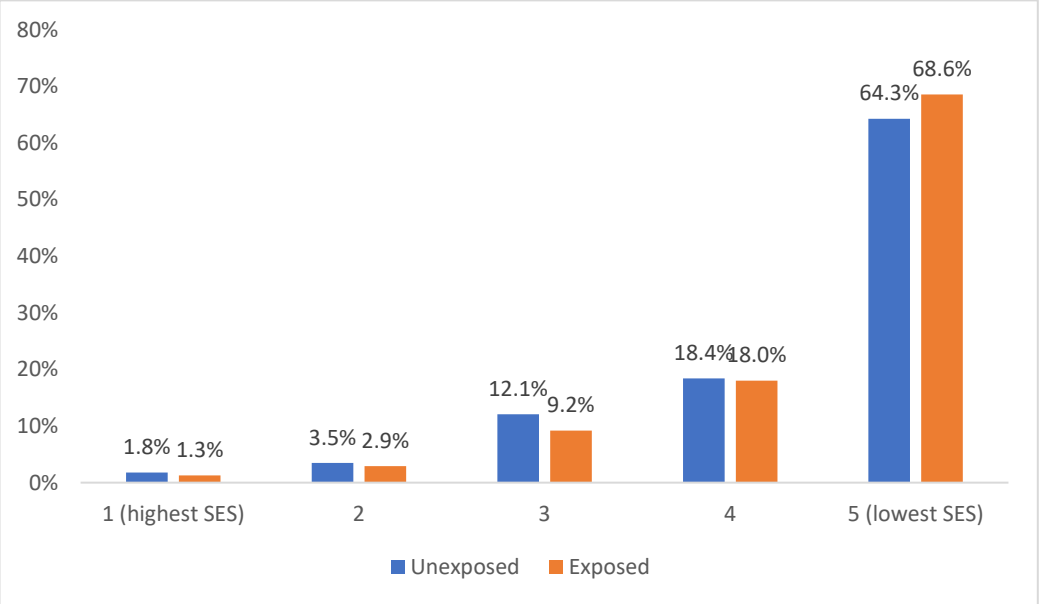
Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Education, n column (%)			
Higher education (beyond age 16)	4,440 (48.0)	230 (48.2)	4,670 (48.0)
Compulsory education (to age 16)	4,784 (51.7)	246 (51.6)	5,030 (51.7)
Missing	26 (0.3)	1 (0.2)	27 (0.3)

5.5.1.7 Index of Multiple Deprivation

Table 23. Index of Multiple Deprivation in quintiles

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Index of Multiple Deprivation			
1 (highest SES)	164 (1.8)	6 (1.3)	170 (1.8)
2	320 (3.5)	14 (2.9)	334 (3.4)
3	1,117 (12.1)	44 (9.2)	1,161 (11.9)
4	1,702 (18.4)	86 (18.0)	1,788 (18.4)
5 (lowest SES)	5,944 (64.3)	327 (68.6)	6,271 (64.5)
Missing	3 (0.0)	0	3 (0.0)

Figure 25. Bar graph of the Index of Multiple Deprivation in quintiles for the exposed and unexposed group



SES, socioeconomic status

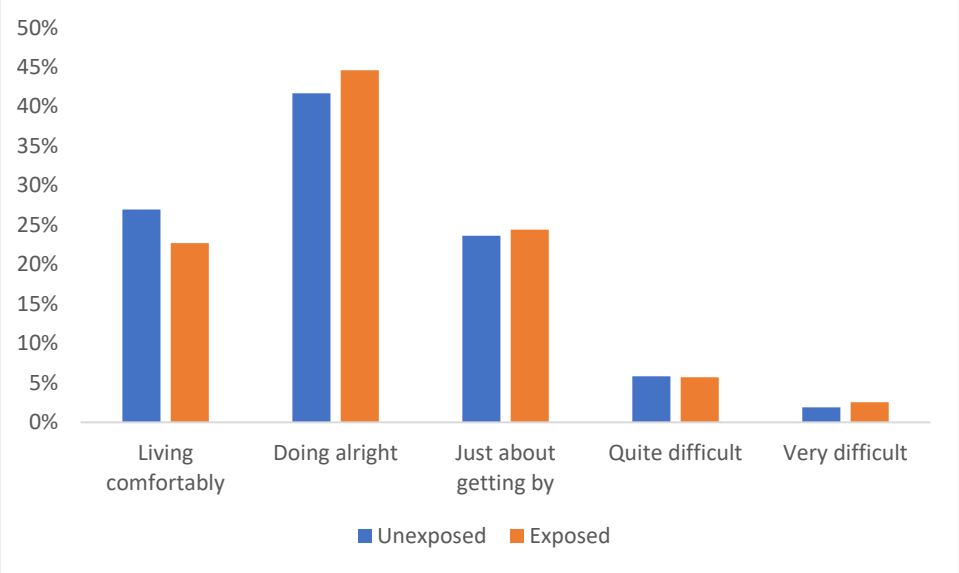
5.5.1.8 Subjective financial status

Table 24. Subjective financial status

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Subjective financial status, n column (%)			
Living comfortably	2,480 (26.8)	107 (22.4)	2,587 (26.6)
Doing alright	3,833 (41.4)	210 (44.0)	4,043 (41.6)
Just about getting by	2,174 (23.5)	115 (24.1)	2,289 (23.5)
Quite difficult	536 (5.8)	27 (5.7)	563 (5.8)
Very difficult	176 (1.9)	12 (2.5)	188 (1.9)
Missing	51 (0.6)	6 (1.3)	57 (0.6)

Missing includes does not wish to answer.

Figure 26. Bar graphs of subjective financial status



5.5.1.9 Section summary

These descriptive analyses highlight the lack of sociodemographic difference between the exposed and unexposed groups prior to the child's birth. Between the groups, there was little difference in the proportion of mothers in each item for cohabitation status, ethnicity, education and IMD, and in the mean mother's age (Tables 19-23). There were small differences in the proportion/mean for parity and subjective financial status (Tables 18 and 24), and a more sizeable difference for child's sex (Table 17).

These results show that there were not more exposed mothers with socioeconomic disadvantage than other mothers at the point of exposure (the child's birth). This strengthens the argument for any differences observed between the groups for the outcomes being due to the exposure and not to pre-existing sociodemographic differences between the groups.

5.5.2 Health characteristics by exposure group

Of the 1,136 Read codes for the symptoms of ill-health searched, 263 (23.15%) were found in the mothers' primary care records during the five year post-natal period [**A4.3**, Table A18]. The health characteristics for the individual symptoms by exposure group are included as an appendix [**A4.4**, Tables A19-20].

5.5.2.1 Detection of symptoms of ill-health

In addition to the number of mothers with pre- and post-natal symptoms of ill-health (Table 25), I provide summaries of:

- the number of symptoms before and after the child's birth (Table 25);
- the number of mothers with symptoms in both time periods (Table 26 and Figure 27); and
- the number of mothers with diagnoses of conditions of ill-health compared with signs/symptoms of ill-health (Table 27) – this indicates the extent of ill-health above the clinical threshold (a summary for the individual symptoms is in the Appendices [**A4.4**, Table 21]).

Table 25. The detection of symptoms of ill-health before and after the child's birth

Variable, n symptom (%)	**Unexposed (n=9,250)**	**Exposed (n=477)**	**Total (n=9,727)**
Symptoms detected before the child's birth			
Psychological distress	636 (6.9)	37 (7.8)	673 (6.9)
Head and MSK pain	1,429 (15.5)	72 (15.1)	1,501 (15.4)
Exhaustion	275 (3.0)	12 (2.5)	287 (3.0)
Number of symptoms before the child's birth, n column (%)[1]			
0	7,585 (82.0)	394 (82.6)	7,979 (82.0)
≥1	1,665 (18.0)	83 (17.4)	1,748 (18.0)
≥2	194 (2.1)	15 (3.1)	210 (2.2)
≥3	13 (0.1)	0	13 (0.1)
Symptoms detected after the child's birth			
Psychological distress	2,789 (30.2)	165 (34.6)	2,954 (30.4)
Head and MSK pain	3,612 (39.1)	207 (43.4)	3,819 (39.3)
Exhaustion	1,334 (14.4)	92 (19.3)	1,425 (14.7)
Number of symptoms after the child's birth[1]			
0	4,431 (47.9)	190 (39.8)	4,621 (47.5)
≥1	4,819 (52.1)	287 (60.2)	5,106 (52.5)
≥2	1,602 (17.33)	98 (20.55)	1,701 (17.5)
≥3	312 (3.4)	25 (5.24)	337 (3.5)

[1] Psychological distress, head and MSK pain and/or exhaustion

Table 26. Symptoms of ill-health detected both before and after the child's birth

Variable, n symptom (%)	**Unexposed (n=9,250)**	**Exposed (n=477)**	**Total (n=9,727)**
Psychological distress	420 (4.5)	24 (5.0)	444 (4.6)
Head and MSK pain	858 (9.3)	41 (8.6)	899 (9.2)
Exhaustion	86 (0.9)	8 (1.7)	94 (1.0)

If, for example, a mother had the symptom of stress recorded before the child's birth and anxiety after, she was classified as having symptoms of psychological distress in both time periods.

Figure 27. Bar graph of symptoms of ill-health detected before and after the child's birth and during both time periods

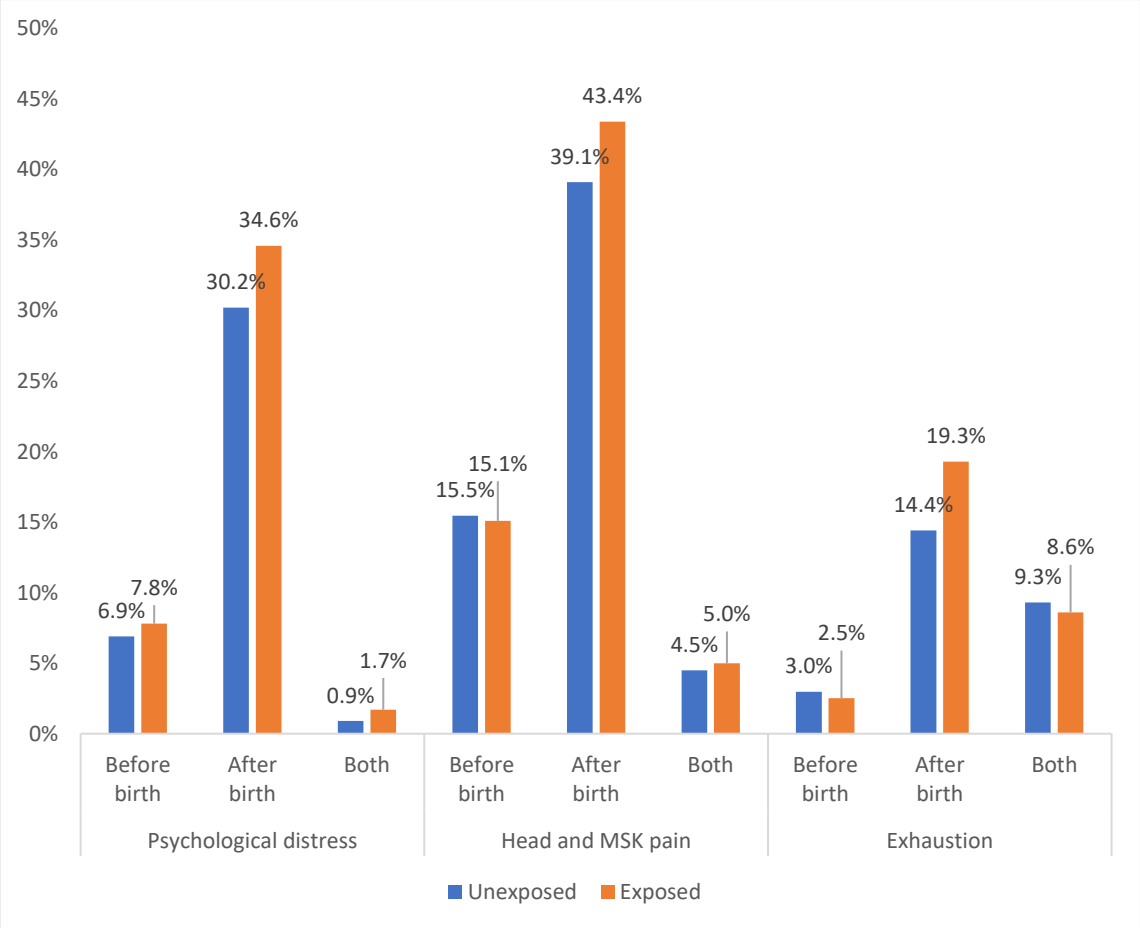


Table 27. Mothers with symptoms above the clinical threshold (diagnoses versus signs/symptoms)

Variable, n symptom (%)	**Unexposed**		**Exposed**		**Total**	
	Diagnoses	**Signs/symptoms**	**Diagnoses**	**Signs/symptoms**	**Diagnoses**	**Signs/symptoms**
Psychological distress	1,602 (50.7)	1,555 (49.3)	97 (50.3)	96 (49.7)	1,699 (50.7)	1,651 (49.3)
Head and MSK pain	985 (22.2)	3,448 (77.8)	53 (20.7)	203 (79.3)	1,038 (22.1)	3,651 (77.9)
Exhaustion	122 (8.6)	1,298 (91.4)	9 (9.2)	89 (90.8)	131 (8.6)	1,387 (91.4)

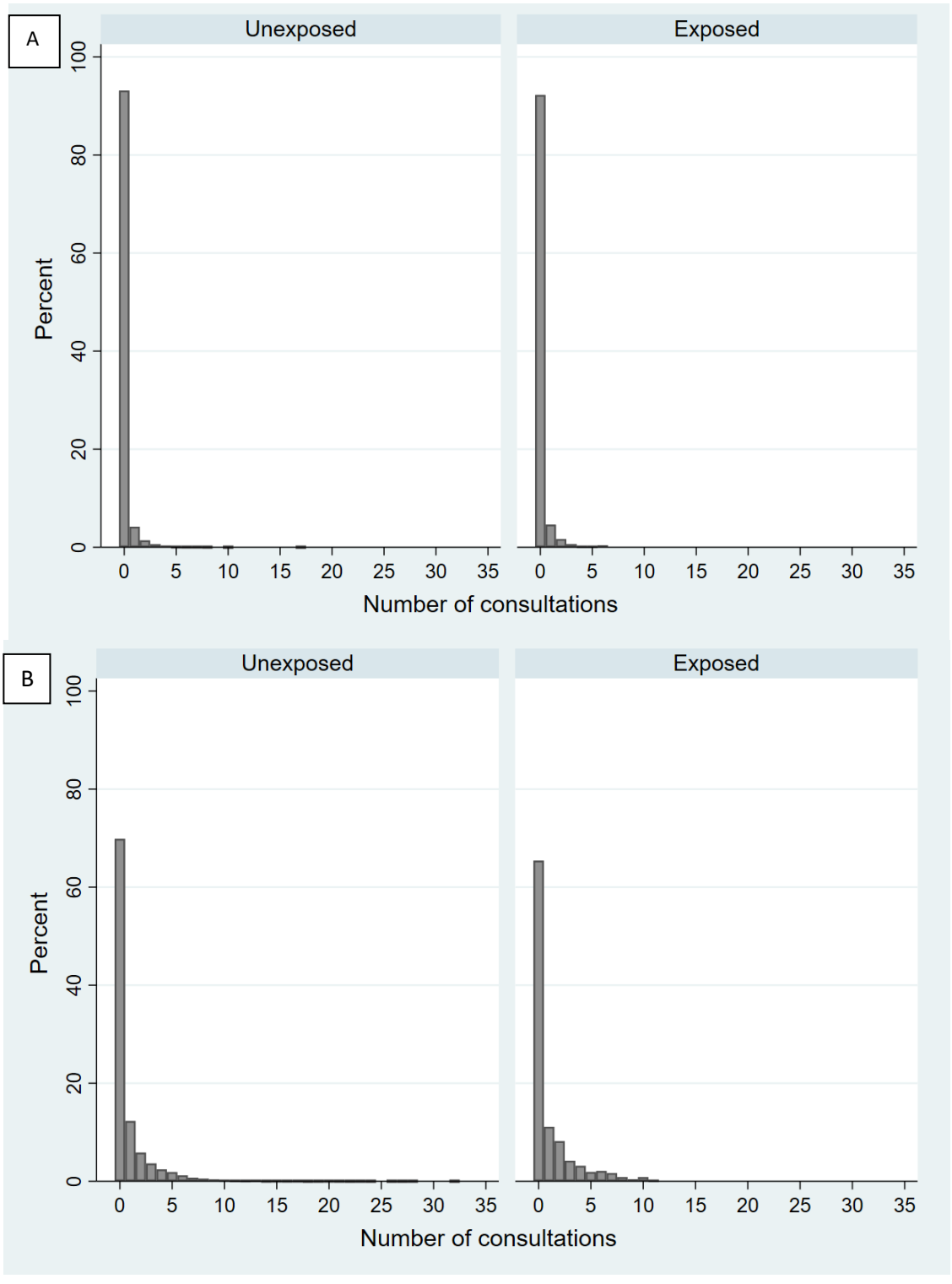
The Read codes classified as diagnoses or signs/symptoms for the individual symptoms are indicated in **A4.3**. There were no diagnoses for fatigue or MSK pain which skewed the above findings for head and MSK pain and exhaustion.

5.5.2.2 Primary care consultation

Table 28. The number of primary care consultations for the symptoms of ill-health before and after the child's birth

Variable	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Consultation frequency (including zero visits) before the child's birth, mean (s.d), range			
Psychological distress	0.1 (0.6), 0-17	0.1 (0.6), 0-6	0.1 (0.6), 0-17
Head and MSK pain	0.2 (0.6), 0-7	0.2 (0.5), 0-3	0.2 (0.6), 0-7
Exhaustion	0.03 (0.2), 0-4	0.03 (0.2), 0-2	0.03 (0.2), 0-4
Consultation frequency (including zero visits) after the child's birth, mean (s.d), range			
Psychological distress	0.9 (2.3), 0-56	1.1 (2.0), 0-11	0.9 (2.3), 0-56
Head and MSK pain	0.9 (1.7), 0-25	1.0 (1.7), 0-11	0.9 (1.7), 0-25
Exhaustion	0.2 (0.5), 0-6	0.3 (0.6), 0-5	0.2 (0.5), 0-6
Consultation frequency (only mothers who visited) before the child's birth, mean (s.d)			
Psychological distress	1.8 (1.5), 1-17	1.8 (1.4), 1-6	1.8 (1.5), 1-17
Head and MSK pain	1.3 (0.7), 1-7	1.3 (0.5), 1-3	1.3 (0.7), 1-7
Exhaustion	1.1 (0.4), 1-4	1.2 (0.4), 1-2	1.1 (0.4), 1-4
Consultation frequency (only mothers who visited) for the five years after the child's birth, mean (s.d)			
Psychological distress	3.1 (3.3), 1-56	3.1 (2.4), 1-11	3.1 (3.3), 1-56
Head and MSK pain	2.2 (2.1), 1-25	2.3 (1.9), 1-11	2.2 (2.1), 1-25
Exhaustion	1.3 (0.7), 1-6	1.4 (0.7), 1-5	1.3 (0.7), 1-6

Figure 28. Histograms of A) pre- and B) post-natal primary care consultation (≥0 GP visits) for psychological distress



To illustrate the comparative pre- and post-natal distributions clearly, one extreme post-natal observation was dropped for the unexposed group (but retained in Table 28).

Figure 29. Histograms of A) pre- and B) post-natal primary care consultation (≥0 GP visits) for head and MSK pain

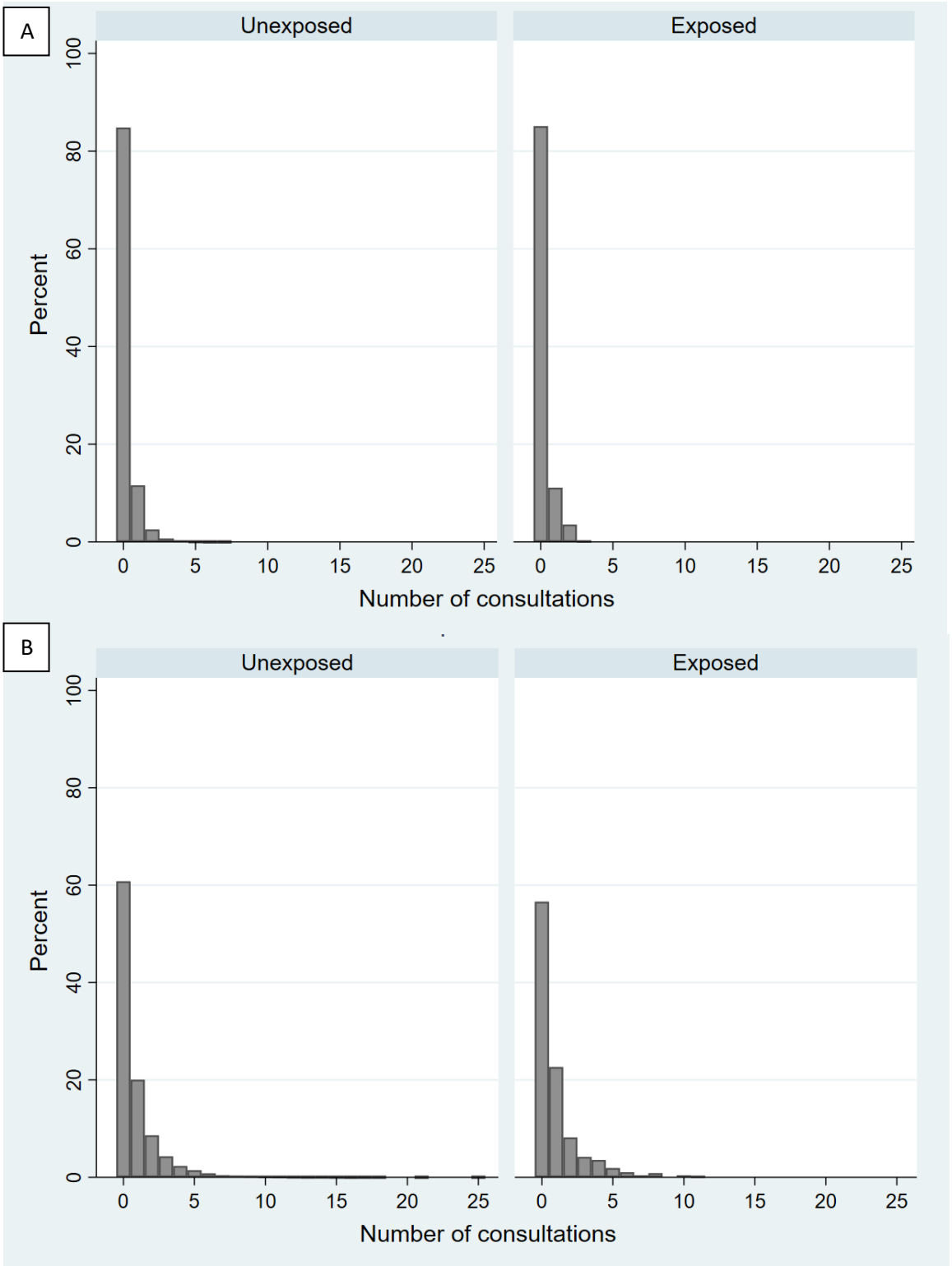
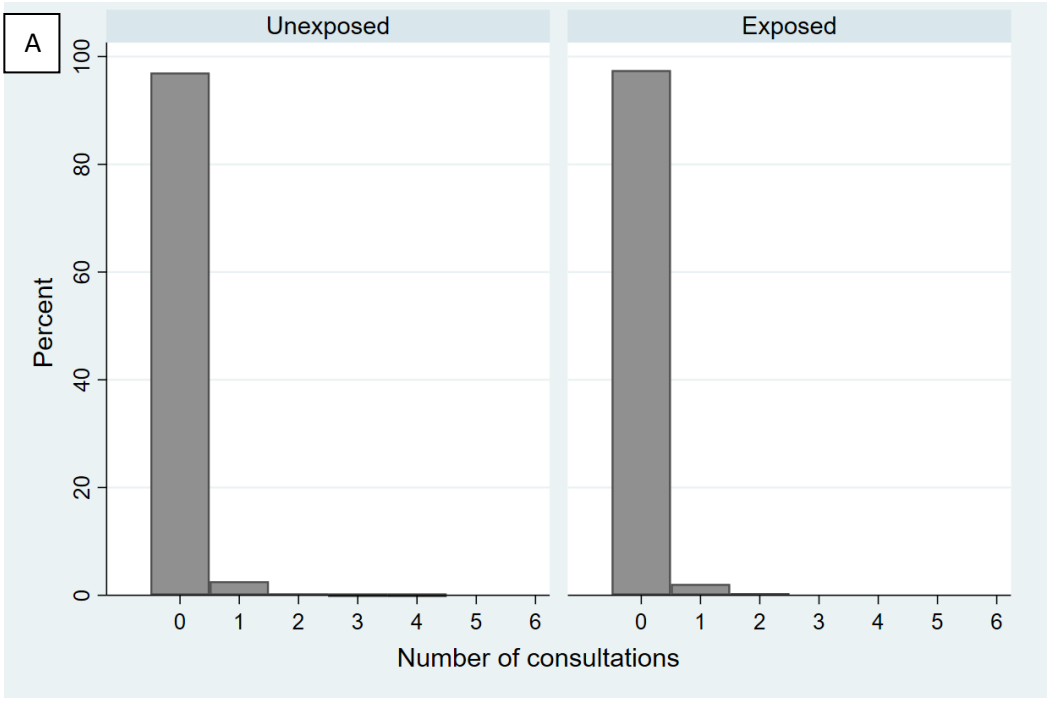
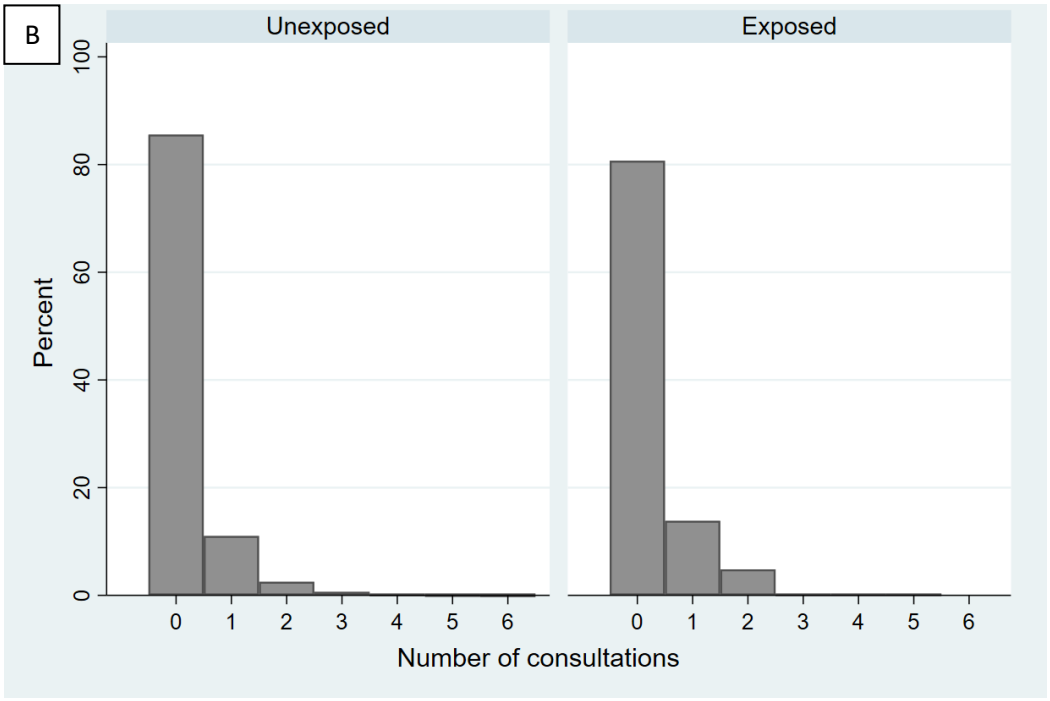


Figure 30. Histograms of A) pre- and B) post-natal primary care consultation (≥0 GP visits) for exhaustion





5.5.2.3 Child's age when mother's symptoms detected

Summaries of the child's age when the mothers' symptoms were detected are presented for the subset of mothers who had symptoms detected after the child's birth.

Table 29. Child's age (in months) when post-natal psychological distress detected

Variable	Unexposed (n=2,789)	Exposed (n=165)	Total (n=2,954)
Psychological distress, mean (s.d), range	23.0 (17.8), 0-60	22.4 (17.2), 0-60	22.9 (17.8), 0-60

Figure 31. Distribution of children's ages when mothers' post-natal psychological distress detected

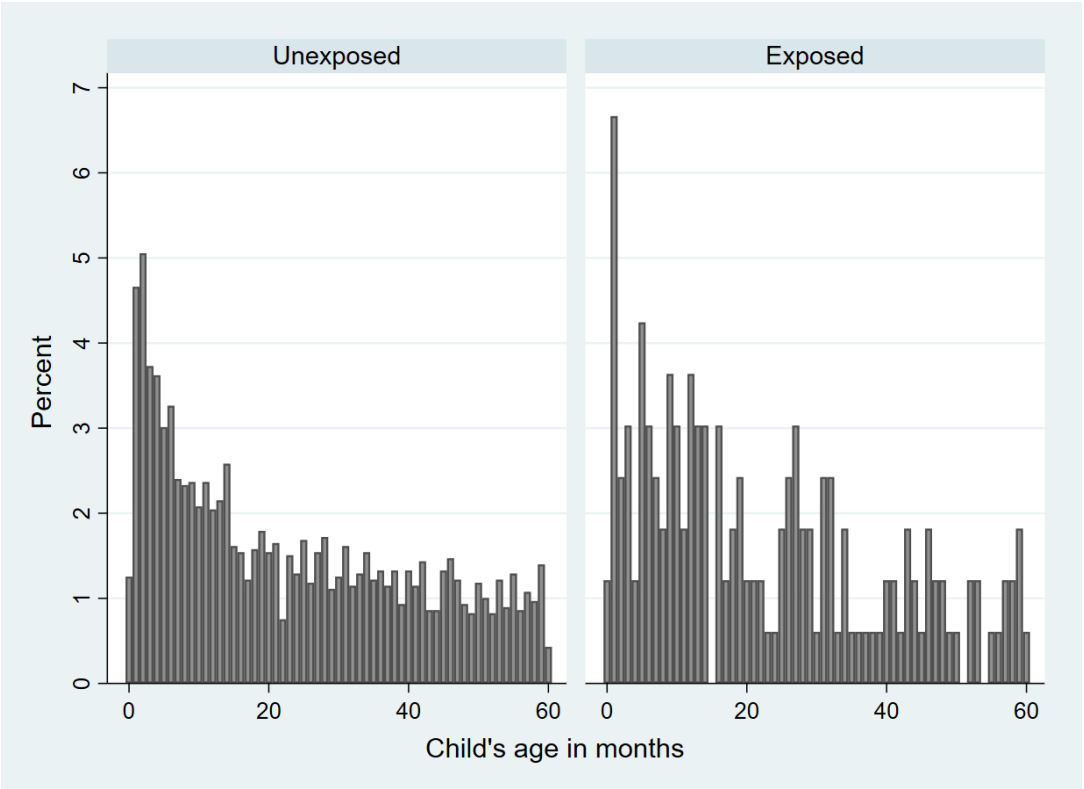


Table 30. Child's age (in months) when post-natal head and MSK pain detected

Variable	Unexposed (n=3,612)	Exposed (n=207)	Total (n=3,819)
Head and MSK pain, mean (s.d), range	22.8 (17.3), 0-60	24.9 (16.7), 0-59	22.9 (17.3), 0-60

Figure 32. Distribution of children's ages when post-natal head and MSK detected

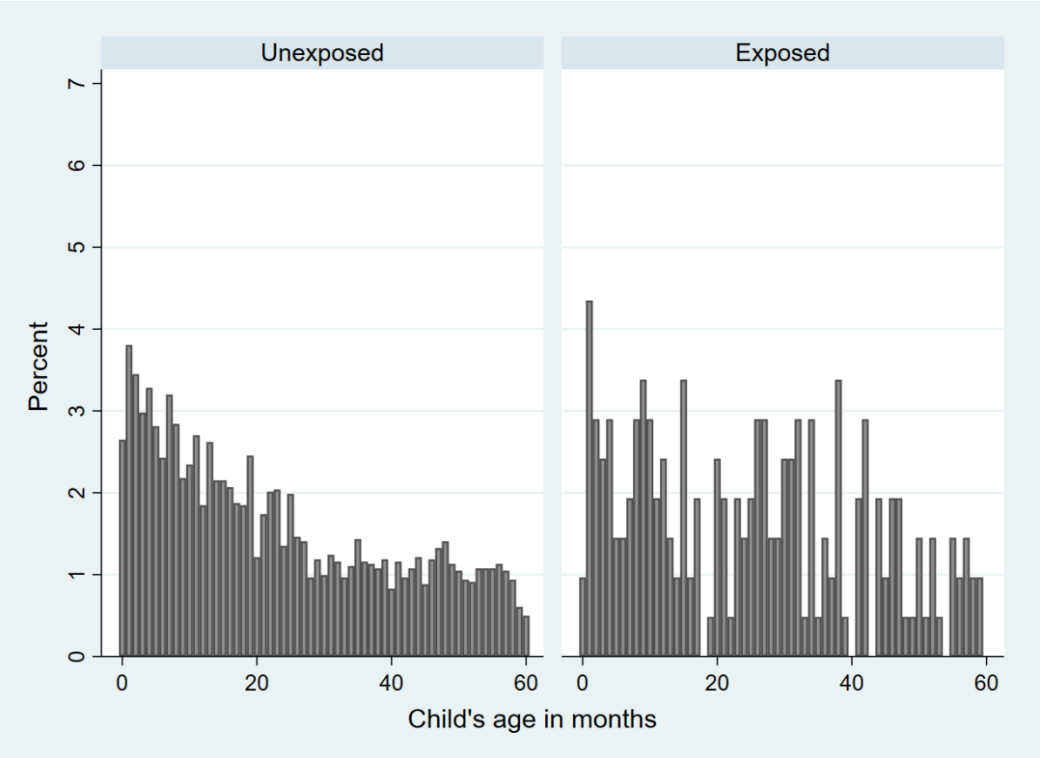
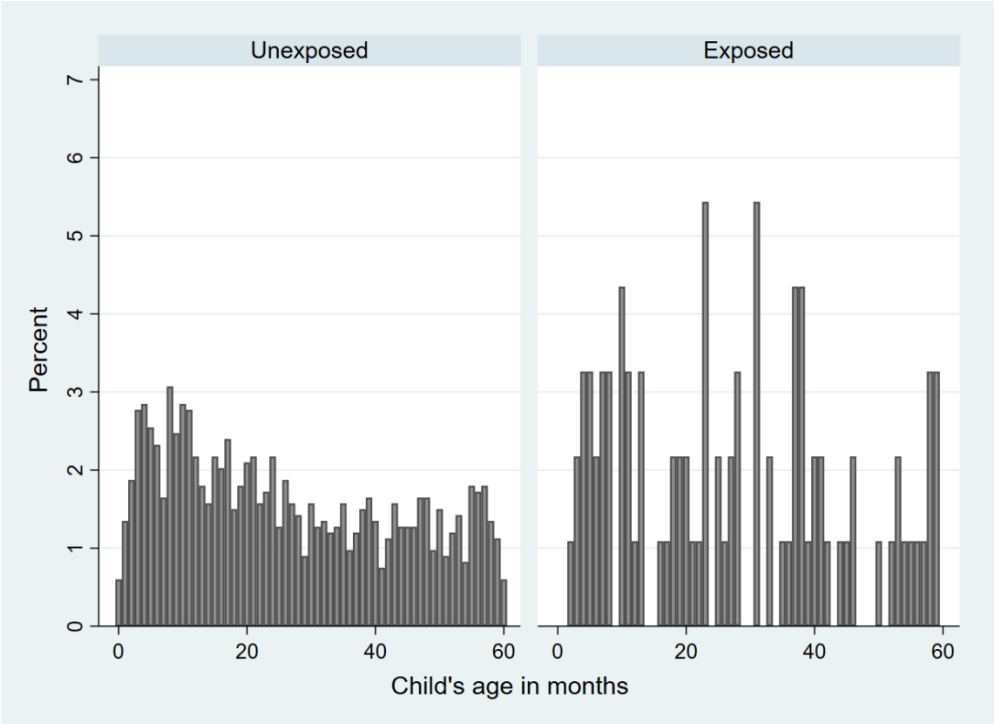


Table 31. Child's age (in months) when post-natal exhaustion detected

Variable	Unexposed (n=1,334)	Exposed (n=92)	Total (n=1,426)
Exhaustion, mean (s.d), range	26.4 (17.5), 0-60	27.5 (17.2), 2-59	26.4 (17.5), 0-60

Figure 33. Distribution of children's ages when mothers' post-natal exhaustion detected



5.5.2.4 Section summary

These descriptive analyses highlight that compared with the unexposed mothers:

- for all three symptoms, a greater proportion of exposed mothers had post-natal ill-health, but almost the same proportion had pre-natal ill-health;
- a similar proportion of exposed mothers had symptoms both before and after the child's birth;
- a similar proportion of exposed mothers with ill-health had symptoms above the clinical threshold;
- the exposed mothers had a similar mean pre- and post-natal consultation frequency for the symptoms; and
- the children in the exposed group had a slightly lower mean age when the mothers visited the doctor about psychological distress, but a slightly higher mean for the other symptoms.

5.6 Chapter summary

I have described the characteristics of the groups in the sample to identify possible sources of bias which may influence the subsequent analyses. The sociodemographic characteristics of the groups of children with the three disabling conditions varied as expected. There was insufficient evidence of differences between the disabling condition and disability indicator groups for caregiver burden to be considered greater in the disabling condition group. Thus, the groups were combined, and the characteristics of the exposed and unexposed groups described.

The results of the bi- and multivariate analyses are presented in the next three chapters (6-8). The next chapter presents the results and discussion of the association between the exposure and the prevalence of the symptoms of ill-health in the study sample.

Chapter 6 Analysis and discussion of the relationship between caregiving and ill-health

This chapter presents the results of the logistic regression analyses of the BiB cohort and discusses how they relate to the literature on caregiving and ill-health.

6.1 Introduction

In this chapter, I present the results of the logistic regression analyses of (Section 4.12, Figure 17: Stage 2 Steps 1-2 and Stage 3 Step 1):

1. the bivariate relationship between the covariates and the exposure (being a caregiver or not) (Section 6.3, Table 32); and
2. the bi- and multivariate relationship between the exposure and the detection of post-natal symptoms (the outcome) (Section 6.4, Tables 33-35).

Alongside the tables, summaries are provided of the relationships between the exposure and outcomes by symptom, and associations between the covariates and the outcomes which have implications for caregiver health.

In the discussion (Section 6.5), I contextualise the findings of the above analyses, referring to the descriptive findings in Chapter 5 and for the individual symptoms [**A4.4**], where useful). Discussion of the results for the covariates is included in Chapter 7 to avoid repetition as the associations between the covariates and the prevalence of ill-health were influenced by their association with healthcare use (and vice versa). Discussion of the study limitations is reserved until Chapter 9.

6.2 Collapsed covariates (applicable to Chapters 6 and 7)

This information is applicable for the analyses presented in this and the following chapter (Chapter 7).

Cross-tabulation by exposure revealed very low cell counts for some variables (<30) (n columns in Table 32). This compromises the reliability of the findings of the regression analyses for these variables as the risk of statistical significance by chance was high, especially in the multivariate analyses (Faber, 2014). Low cell counts for the binary variables could not be mitigated. Categories in multi-item covariates were collapsed when this did not obscure the categories in which the exposed and unexposed groups were theorised to differ (outlined in Section 4.10.4).

Financial status was collapsed to produce a binary variable, as used in other BiB analyses: 'managing financially' (living comfortably, doing alright or just about getting by) and 'not managing financially' (quite difficult or very difficult) (Stacey, 2016; Fairley, 2014). This adaptation maintained the distinction between socioeconomic advantage and disadvantage, albeit losing some of the gradation and precision of the estimate.

There was also a low cell count for exposed 'Other' ethnicity mothers (n=56) (including Indian, African, Chinese) but this category could not be collapsed. Given the number of exposed mothers in the other categories (n=193 white British; n=228 Pakistani), collapsing 'Other' into either item would have added considerable ethnic, and thus social and cultural, heterogeneity; all of which influence health and healthcare use (Prady, 2016b; Bishop, 2018). Some similarities have been observed between Pakistani and Other mothers in the BiB cohort in the tendency for lower socioeconomic status and lower detection of post-natal psychological distress compared with white British mothers (Prady, 2016a). However, this is insufficient to justify amalgamating the groups as the tendency towards lower socioeconomic status was inverted for Indian mothers, which comprised 32% of the exposed 'Other' group; and psychological distress was not the only symptom that I analysed (Wright, 2013; Fairley, 2014). A further option was to drop the 'Other' mother-child dyads from the analyses. To produce an accurate estimate of the relationship between the exposure and the outcomes, the largest sample size possible was required for the regression analyses. Therefore, ethnicity remained as three categories, but the results for the category of 'Other' (and all other covariates with low cell counts) were interpreted cautiously.

6.3 Results for the outcome of caregiver status

I investigated the potential for covariate confounders in the relationships between the exposure and the health and healthcare use outcomes by performing bivariate analyses of the relationship between the covariates and the exposure (caregiver status) (Table 32).

Table 32. Bivariate logistic regression of the relationship between the covariates and the exposure (caregiver status)

Covariates	N, unexposed	N, exposed	Odds ratio	95% confidence interval	P value
Pre-natal psychological distress detected					
No	8,614	440	1		
Yes	636	37	1.13	0.81, 1.61	0.46
Pre-natal head and MSK pain detected					
No	7,821	405	1		
Yes	1,429	72	0.97	0.75, 1.26	0.84
Pre-natal exhaustion detected					
No	8,974	465	1		
Yes	276	12	0.84	0.47, 1.51	0.56
Consultation (≥0) for pre-natal psychological distress	9,250	477	1.05	0.92, 1.21	0.47
Consultation (≥0) for pre-natal head and MSK pain	9,250	477	0.95	0.80, 1.13	0.58
Consultation (≥0) for pre-natal exhaustion	9,250	477	0.89	0.55, 1.44	0.63
Consultation (≥1) for pre-natal psychological distress	9,250	477	1.02	0.82, 1.27	0.84
Consultation (≥1) for pre-natal head and MSK pain	9,250	477	0.85	0.58, 1.25	0.42
Consultation (≥1) for pre-natal exhaustion	9,250	477	1.15	0.31, 4.27	0.84
Education					
Higher education (beyond age 16)	4,440	230	1		
Compulsory education (to age 16)	4,784	246	0.99	0.83, 1.19	0.94
Ethnicity					
White British	3,729	193	1		
Other	1,462	56	**0.74**	**0.55, 1.00**	**0.05**
Pakistani	4,040	228	1.09	0.90, 1.33	0.39
Cohabitation status					
Living with partner	7,642	400	1		
Not living with partner	1,589	77	0.93	0.72, 1.19	0.55
Subjective financial status					
Managing financially	8,487	432	1		
Not managing financially	712	39	1.08	0.77, 1.51	0.67
Mother's age at child's birth (in years)	9,250	477	1.01	0.99, 1.02	0.39

Significant results (p≤0.1) are in bold (rationale provided in Section 4.14.4).

Cases with missing covariates were dropped from the analyses. Education: unexposed 26; exposed 1. Ethnicity and cohabitation status: unexposed 19; exposed 0. Subjective financial status: unexposed 51; exposed 6.

Only one potential confounder was identified (shown in bold, Table 32). There was evidence of a 26% decrease in the odds of the exposure (being a caregiver) in mothers of 'Other' ethnicity (not white British or Pakistani) (n=56). The reliability and interpretability of this result was limited by both the ethnic heterogeneity of the group and the relatively low cell count for the exposed mothers (n=56) (discussed in Section 6.2). There may be under-diagnosis of child disability during the preschool period for these minority ethnic groups. Unlike for the Pakistani group, there was no established causal relationship between the ethnic groups that comprised this group and disability prevalence. This finding was not expected to influence the accuracy of the measurement of the relationship between the exposure and the health outcomes (in the analyses presented below and in the following two chapters). Thus, 'Other' ethnicity was not considered a confounder.

6.4 Results for the outcome of symptom detection after the child's birth

I investigated the relationship between the exposure and the consultation prevalence of each symptom for the five years after the child's birth, adjusting for the covariates:

- there was a 24% increase in the prevalence of post-natal psychological distress in caregivers compared with other mothers (which was not attenuated in the multivariate analysis) (Table 33);
- there was weak evidence (p=0.10) of an 18% increased prevalence of post-natal head and MSK pain in caregivers compared with other mothers (which was all but attenuated in the multivariate analysis) (Table 34);
- there was a 42% increase in the prevalence of post-natal exhaustion compared with other mothers (which was not attenuated in the multivariate analysis) (Table 35);
- for every symptom, increased post-natal prevalence was associated with the pre-natal detection of symptoms and socioeconomic disadvantage (Tables 33-35). Of note is the exception for ethnicity, whereby Pakistani and Other mothers had an increased prevalence of head and MSK pain and exhaustion compared with white British mothers (Tables 34 and 35), but a lower prevalence of psychological distress (Table 33).

Table 33. Bivariate and adjusted logistic regression analyses of the relationship between the exposure and psychological distress detected after the child's birth

	Bivariate (unadjusted) analysis					Multivariate (adjusted) analysis		
	N, No symptoms	**N, Has symptoms**	**Odds ratio**	**95% confidence interval**	**P value**	**Odds ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status								
No	6,461	2,789	1			1		
Yes	312	165	**1.23**	**1.01, 1.49**	**0.04**	**1.24**	**1.01, 1.53**	**0.04**
Covariates								
Symptom detected before the child's birth								
No	6,544	2,510	1			1		
Yes	229	444	**5.06**	**4.28, 5.97**	**0.000**	**4.37**	**3.68, 5.20**	**0.000**
Education								
Higher education (beyond age 16)	3,373	1,297	1			1		
Compulsory education (to age 16)	3,378	1,652	**1.27**	**1.17, 1.39**	**0.000**	**1.14**	**1.04, 1.26**	**0.01**
Ethnicity								
White British	2,302	1,620	1			1		
Other	1,171	347	**0.42**	**0.37, 0.48**	**0.000**	**0.47**	**0.41, 0.54**	**0.000**
Pakistani	3,291	977	**0.42**	**0.38, 0.46**	**0.000**	**0.47**	**0.42, 0.52**	**0.000**
Cohabitation status								
Living with partner	5,812	2,230	1			1		
Not living with partner	947	719	**1.98**	**1.78, 2.21**	**0.000**	**1.34**	**1.18, 1.52**	**0.000**
Subjective financial status								
Managing financially	6,274	2,645	1			1		
Not managing financially	457	294	**1.53**	**1.31, 1.78**	**0.000**	**1.40**	**1.18, 1.65**	**0.000**
Mother's age at child's birth (in years)	6,773	2,954	**0.98**	**0.97, 0.99**	**0.000**	1.00	0.99, 1.00	0.27
Total n Missing	-	-	**-**	**-**	**-**	9,615 112		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 34. Bivariate and adjusted logistic regression analyses of the relationship between the exposure and head and MSK pain detected after the child's birth

	Bivariate (unadjusted) analysis					Multivariate (adjusted) analysis		
	N, No symptoms	**N, Has symptoms**	**Odds ratio**	**95% confidence interval**	**P value**	**Odds ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status								
No	5,638	3,612	1			1		
Yes	270	207	**1.20**	**0.99, 1.44**	**0.06**	**1.18**	**0.97, 1.43**	**0.10**
Covariate								
Symptom detected before the child's birth								
No	5,306	2,920	1			1		
Yes	602	899	**2.71**	**2.43, 3.04**	**0.000**	**2.57**	**2.29, 2.88**	**0.000**
Education								
Higher education (beyond age 16)	3,019	1,651	1			1		
Compulsory education (to age 16)	2,873	2,157	**1.37**	**1.27, 1.49**	**0.000**	**1.28**	**1.18, 1.40**	**0.000**
Ethnicity								
White British	2,684	1,238	1			1		
Other	1,027	491	1.04	0.91, 1.18	0.58	1.09	0.96, 1.25	0.19
Pakistani	2,189	2,079	**2.06**	**1.88, 2.25**	**0.000**	**1.96**	**1.78, 2.16**	**0.000**
Cohabitation status								
Living with partner	4,832	3,210	1			1		
Not living with partner	1,065	601	**0.85**	**0.76, 0.95**	**0.004**	1.04	0.91, 1.18	0.58
Subjective financial status								
Managing financially	5,464	3,455	1			1		
Not managing financially	414	337	**1.29**	**1.11, 1.50**	**0.001**	**1.25**	**1.07, 1.46**	**0.006**
Mother's age at child's birth (in years)	5,908	3,819	1.01	**1.00, 1.01**	**0.07**	**1.01**	**1.00, 1.02**	**0.08**
Total n Missing	-	-	-	-	-	9,615 112		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 35. Bivariate and adjusted logistic regression analyses of the relationship between the exposure and exhaustion detected after the child's birth

	Bivariate (unadjusted) analysis					Multivariate (adjusted) analysis		
	N, No symptoms	**N, Has symptoms**	**Odds ratio**	**95% confidence interval**	**P value**	**Odds ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status								
No	7,916	1,334	1			1		
Yes	385	92	**1.42**	**1.12, 1.79**	**0.003**	**1.42**	**1.12, 1.80**	**0.004**
Covariate								
Symptom detected before the child's birth								
No	8,109	1,332	1			1		
Yes	193	93	**2.95**	**2.29, 3.80**	**0.000**	**2.94**	**2.28, 3.81**	**0.000**
Education								
Higher education (beyond age 16)	4,041	629	1			1		
Compulsory education (to age 16)	4,237	793	**1.20**	**1.07, 1.35**	**0.001**	**1.15**	**1.02, 1.30**	**0.02**
Ethnicity								
White British	3,517	405	1			1		
Other	1,325	193	1.27	1.05, 1.52	**0.000**	**1.32**	**1.10, 1.60**	**0.004**
Pakistani	3,443	825	2.08	1.83, 2.37	**0.000**	**2.09**	**1.83, 2.40**	**0.000**
Cohabitation status								
Living with partner	6,844	1,198	1			1		
Not living with partner	1,441	225	0.89	0.77, 1.04	0.14	1.09	0.91, 1.29	0.35
Subjective financial status								
Managing financially	7,667	1,252	1			1		
Not managing financially	588	163	**1.70**	**1.41, 2.04**	**0.000**	**1.06**	**1.35, 1.98**	**0.000**
Mother's age at child's birth (in years)	8,301	1,426	**1.01**	**0.19, 1.02**	**0.09**	1.01	1.00, 1.02	0.21
Total n Missing	-	-	**-**	**-**	**-**	9,615 112		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

6.5 Discussion of prevalence

Overall in the BiB sample, caregivers had greater ill-health in the five years after the child's birth than other mothers: 60.2% (n=287) visited the doctor at least once about symptoms of psychological distress, head and MSK pain or exhaustion compared with 52.1% (n=4,819) of other mothers (presented in Section 5.5.2.1, Table 25). I hypothesised that during the preschool period, there would be evidence of a greater prevalence of each symptom for the caregivers than other mothers due to the adverse impact of the additional burden (psychological and often physical stress) of the caregiving role (outlined in Chapters 1 and 2).

I found evidence of an adverse association between caregiving and health for all three symptoms. This is consistent with the published literature on stress and depression in mothers of preschool children with developmental disabilities (summarised in my systematic review (Chapter 3)) and the more limited literature on sleep problems, fatigue and head and MSK pain in caregivers of preschool and older children, which I will discuss.

Most of the published studies reviewed in this chapter used cross-sectional designs and survey data collection methods. These population prevalence estimates could be higher than in the BiB sample which relied on primary care consultation for symptom detection (known to under-detect ill-health, as discussed in Section 4.10.2). Although point and period prevalence are not directly comparable, these studies provide an indication of the amount of potentially under-estimated ill-health in the BiB sample (Webb, 2016).

6.5.1 Psychological distress

I found that in the five years after the child's birth, 35% of the exposed (versus 30% unexposed), had symptoms of psychological distress (presented in Section 5.5.2.1, Table 25). When looking across other studies (identified via literature and reference searching) at the proportion of caregivers (and other mothers) experiencing psychological distress during the preschool age group, there is considerable variability. The prevalence of psychological distress and depressive symptoms in my sample lies within the range of estimates (Table 36).

Table 36. A summary of studies reporting measures of the proportion of mothers with symptoms of psychological distress

Study	Location	Study sample (by child status: with/without disability)	Outcome measure	Proportion of exposed (versus unexposed, if reported) mothers with:		
				Psychological distress	Depression and/or anxiety	Stress
My results	UK	477 disabling conditions/disability indicators; 9,250 other children	Read codes for symptoms/diagnoses in primary care records	34.6% exposed versus 30.2% unexposed (of these, 50.7% versus 50.3% had clinical symptoms)	32%; 27%	9%; 7%
Romans-Clarkson, 1986	New Zealand	54 severe disability; 184 typically developing	GHQ-60	psychiatric diagnosis 35.2% versus 20.4%		
Cacciani, 2013	Italy	42 preterm with severe neuromotor and/or sensory disabilities	General Health Questionnaire (GHQ)-60	distress 31.3%; clinical distress 8.1%		
Demir, 2008	Turkey	48 ASD	Symptom Check List 90-Revised Turkish version	psychiatric diagnosis 50%	major depressive disorder; 6.2%; depressive disorder 16.7%; social phobia 12.5%	
Xu, 2014	USA	33 ASD and behavioural problems (2-5 years)	Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977)		clinical depressive symptoms 53.8%	
Scott, 1997	Canada	216 Down syndrome (<2 years)	Beck Depression Inventory		mild depressive symptoms 20.4% versus 13.0%; clinically depressed 5.6% versus 0.00%	
Jeans, 2013	USA	100 ASD; 900 developmental disabilities; 8,500 typically developing (age 4)	CES-D		moderate-severe depressive symptoms 32.1% ASD exposure; 23.3% other exposed; 18.1% unexposed	
Oelofsen, 2006	UK	59 developmental disabilities; 45 typically developing	Parenting Stress Index (PSI), 1995			clinically stressed 84% versus 5%
Glenn, 2009	UK	80 cerebral palsy	Parenting Stress Index (PSI), 1990			clinically stressed 43%

All or mostly mother-caregivers; all used a cross-sectional study design.
Individual symptom results from **A4.4**, Tables A19 and A21.

I found a 24% increase in the prevalence of psychological distress (depression and anxiety) in the exposed compared with other mothers attributable to caregiver status (Table 33). Also using longitudinal data and controlling for sociodemographic factors, Lach et al. (2009) found a 38% increase in the likelihood of depression in caregivers (≥90% mothers) of children with neurological disabilities aged 4-11 compared with unexposed mothers. This, and the results in Table 36 provide a point of comparison for my results, showing that they are broadly consistent with those of other caregiver populations during the preschool period (and above). However, it is a limitation to the generalisability of my results that none of the other studies are directly comparable with mine as the study design, data collection methods, symptoms of psychological distress, clinical thresholds, sample size and disability composition varied.

Most studies find a correlation between caregiver status and maternal psychological distress during the preschool period (Lee, 2013). However, given the small sample sizes typical for research in the preschool age group, few studies have performed regression analysis adjusting for sociodemographic factors (Emerson, 2006b; Emerson, 2008b). When these criteria were met, these studies have often not reported the exponentiated prevalence coefficient for caregiver status, which limits the ability to draw comparisons (they state whether there was a significant association but did not interpret the test statistic e.g. as an odds ratio) (Jeans, 2013; Laxman, 2015; Carter, 2009).

Furthermore, none of the studies cited used consultation prevalence (prevalence estimated from primary care records) to detect ill-health or to assess differences in the clinical magnitude of symptoms between exposed and unexposed mothers. The use of primary care data may explain the much lower prevalence of stress in caregivers in my study than other studies (Table 36). This may indicate a potential risk of symptom under-detection in primary care, whereby a high proportion of caregivers have clinical levels of stress but do not visit for or have these symptoms recorded by the doctor. For example, in other studies in BiB samples, 19.2% of mothers have been shown to have post-natal depression detected via two case-finding questions (in the three months after the birth) (Mann, 2012), whilst only 13% had post-natal common mental disorders detected via primary care consultation (Prady, 2016a).

Alternatively, this may indicate an issue of over-detection of stress and psychological distress via survey methods whereby more caregivers experience psychological distress than other mothers but not necessarily of a clinical magnitude. Caregivers (and other mothers) may also not perceive their symptoms to be above the clinical threshold (used in outcomes measures e.g. the Parenting Stress Index) and thus do not exhibit healthcare-seeking behaviour via primary healthcare use. As

indicated in Table 36, clinical depression has been identified in up to 53.8% and clinical stress in up to 84% of exposed mothers (respectively) (Xu, 2014; Oelofsen, 2006), with higher levels found in exposed than unexposed mothers (Jeans, 2013; Laxman, 2015; Oelofsen, 2006). In my study sample, more exposed than unexposed mothers had psychological distress, but their symptoms were not more acute – almost the same proportion of exposed and unexposed mothers received diagnoses (diagnoses: 50.7% versus 50.3%, as presented in Section 5.5.2.1, Table 27).

6.5.2 Head and MSK pain

I found that 43% of the exposed and 39% of the unexposed mothers had head and MSK pain detected in the five years after the child's birth (presented in Section 5.5.2.1, Table 25). Only three studies (to my knowledge) have examined the prevalence of headaches/migraines and back pain in caregivers of disabled children, and not exclusively for the preschool period (Table 37). The proportion of mothers with each symptom in my BiB sample was consistent with the highest of these estimates.

Table 37. A summary of studies reporting measures of the proportion of mothers with symptoms of head and musculoskeletal pain

Study	Location	Study sample (by child status: with/without disability)	Proportion of exposed (and unexposed, if reported) mothers with:	
			Headache/migraine	Back problems/pain
My results	UK	477 disabling conditions/disability indicators; 9,250 other children	22% exposed versus 20% unexposed (of these 48.9% versus 48.5% had clinical symptoms)	32% versus 28% (MSK pain, mostly back pain; of these 0 had clinical symptoms)
Brehaut, 2004	Canada	468 cerebral palsy; 2,414 parents from national samples (no age criterion)	24.2%; versus 11.2%	35.5% versus 12.2%
Lach, 2009	Canada	750 neurodevelopmental disorders; 7,236 typically developing (≥ 4 years)	14.4% versus 9.2%	11.9% versus 10.2%
Lee, 2017	USA	1,436 disabled; typically developing (< 18 years)	headaches 24.1% versus 16.6%	35.2% versus 26.7%

All or mostly mother-caregivers; all used a cross-sectional study design.
Individual symptom results from **A4.4**, Tables A19 and A21.

The above studies all found evidence of statistically significant differences between the exposed and unexposed mothers for each of the symptoms separately. Adjusting for indicators of socioeconomic status, Lee et al. (2017) found a 46% increase in the likelihood of headaches and a 33% increase for back pain associated with caregiving (children aged <18). In my analysis, there was a smaller increase and only weak evidence of an association between the exposure and the combined symptoms of headache and MSK pain (18% increase in prevalence for caregivers, $p<0.1$).

The decision to combine the individual symptoms may have masked the evidence of an association for one or both of the individual symptoms. Alternatively, the difference in child age

between mine and Lee's samples may explain the disparity. Brehaut et al.'s (2011) found that caregiver ill-health increased incrementally with child age (increasing between ages 4-6, 7-9 and 10-11). My results could indicate that disparities in the health of caregivers compared with other mothers emerge during the preschool years, however, the difference may only become significant for head and MSK pain in older child groups.

6.5.3 Exhaustion

I found that 19% of the exposed compared with 13% of the unexposed had symptoms of exhaustion (fatigue 17% versus 13%; sleep problems 3.6% versus 2.7%) (presented in Section 5.5.2.1, Table 25; **A4.4**, Table A19). Of these mothers, 52.9% of the exposed and 48.6% unexposed had clinical symptoms (e.g. insomnia) [**A4.4**, Table A21]. Although sleep problems and tiredness are commonly reported by caregivers (Green, 2007; Family Fund, 2013; Caicedo, 2014), little empirical research is available for comparison with my results. Of the individual symptoms, the fewest mothers in my sample visited the doctor about fatigue and sleep problems.

Giallo et al. (2013) found higher levels of fatigue in exposed than unexposed mothers; whilst Lee et al. (2017) identified unhealthy sleep (<7 or >8 hours in a 24-hour period) in 48% of caregivers and 41% other mothers (≥50% mothers). They also found evidence of a 21% increase in the prevalence of unhealthy sleep attributable to caregiving, when adjusting for sociodemographic factors. Although these studies found a higher absolute prevalence of the symptoms in caregivers, I found evidence of a more sizeable association - a 42% increased prevalence of exhaustion associated with the exposure.

Fatigue/tiredness are common during pregnancy, but also after childbirth, detected in 17% of mothers in the 3 months after the child's birth and persisting for 12 months in 6% (MacArthur, 1991; Atkinson, 1994). The low consultation prevalence may reflect mothers' assumptions that sleep problems and tiredness are not a health concern but an inevitable part of parenting, as they are responding to their child's sleep patterns and the demands of the role (Hubert, 2018; McQueen, 2003). Thus, as argued for psychological distress (especially stress) (in Section 6.5.1), the low consultation prevalence may underestimate the prevalence of symptoms of exhaustion in caregivers.

6.5.3.1 Links between psychological distress and exhaustion

A greater proportion of the exposed than unexposed mothers had two or three of the (grouped) symptoms (exposed 20.5% versus unexposed 17.33%) (presented in Section 5.5.2.1, Table 25). This could be due to the known association between stress and ill-health generally, and between stress, sleep problems/fatigue and general health in caregivers of disabled children specifically

(Bourke-Taylor, 2013; Chu, 2009; Gallagher, 2013; Schneiderman, 2005; Seymour, 2013). For example, sleep problems have been identified as a significant predictor of fatigue in mothers of preschool children with ASD (Giallo, 2013), and sleep quality is correlated with caregiving-related stress and depression in mothers of disabled children (Chu, 2009; Wayte, 2012). Sleep problems can also be a symptom of depression (Nutt, 2008). Therefore, the significant differences between exposed and unexposed mothers for exhaustion could reflect the increased prevalence of psychological distress in caregivers, rather than providing a measurement of a different pathology.

6.6 Chapter summary

This chapter has focused on the relationship between the exposure and the prevalence of ill-health, with my results discussed in relation to the available literature. My findings provide further evidence of an adverse relationship between caregiving for disabled children and ill-health and highlight the emergence of these relationships during the preschool period. However, as these prevalence estimates are based on primary care consultation, the results and discussion in the following chapter on healthcare-seeking via primary healthcare use also indicate whether the prevalence could be underestimated due to the theorised barriers that caregivers experience and the wider socioeconomic patterns of primary healthcare use.

The next chapter presents the results and discussion of the association between the exposure and healthcare-seeking behaviour via healthcare use in the study sample.

Chapter 7 Analysis and discussion of the relationship between caregiving and healthcare use

This chapter presents the results of the analyses of healthcare-seeking behaviour and healthcare use in the BiB cohort and discusses how they relate to the literature on caregiver healthcare use. This chapter includes discussion of the association between the covariates of socioeconomic status, pre-natal health and healthcare use and the outcomes of ill-health and healthcare use.

7.1 Introduction

In this chapter, the results of the following bi- and multivariate analyses of the relationship between the exposure and the frequency of post-natal primary care consultation for symptoms of maternal ill-health are presented (Section 4.12, Figure 17: Stage 2 Steps 3-4 and Stage 3 Steps 2-3). These analyses model:

1. The relationship between the exposure and primary healthcare use (the rate ratio for additional consultations by mothers who visited the doctor (≥ one visit) after the child's birth) (Section 7.3, Tables 38-40)

2. The relationship between the exposure and healthcare-seeking behaviour via primary healthcare (the probability and rate ratio for mothers visiting the doctor at all (≥ no visits) after the child's birth (Section 7.4; Tables 41-43)

Alongside the tables, summaries are provided of the relationships between the exposure and outcomes by symptom and the implications of the covariate results for caregivers are highlighted. In the discussion (Section 7.5), I contextualise the findings of the above analyses, referring also to the findings in Chapter 6 due to the close relationship between the prevalence of ill-health (the need for healthcare-seeking behaviour) and healthcare use. I discuss the results for the covariates, highlighting their association with ill-health and the implications for caregiver health and healthcare use.

7.2 Model fit

Equidispersion of the count outcome data and model goodness of fit were assessed to determine the best model to use [**A5.1**]. The data of the number of post-natal visits for exhaustion were approximately equidispersed, therefore poisson and zero-inflated poisson regression were used for the bi- and multivariate analyses. Negative binomial and zero-inflated negative binomial regression were used to model the relationship between the covariates and psychological distress

and head and MSK pain because the mean was substantially different from the variance (explained in Section 4.14.2).

7.3 Results for the outcome of one or more visits to the doctor

There was no evidence that caregiving influences how often mothers who have ill-health detected via primary care consultation visit the doctor during the preschool period (Tables 38-40). Mothers with socioeconomic disadvantage or who have visited the doctor about the symptom prior to the child's birth had an increased rate of post-natal visits. The exception was a lower consultation rate for psychological distress by ethnic minority mothers (an indicator of disadvantage) (Table 38).

Table 38. Bivariate and adjusted negative binomial regression analyses of the relationship between the exposure and the frequency of consultation (≥1 visit) for psychological distress after the child's birth

	Bivariate (unadjusted) analysis				Multivariate (adjusted) analysis		
	N, ≥1 visit	**Relative rate ratio**	**95% confidence interval**	**P value**	**Relative rate ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status							
No	2,789	1			1		
Yes	165	1.01	0.89, 1.15	0.84	1.01	0.89, 1.13	0.92
Covariates							
Consultation frequency (≥0) for psychological distress before the child's birth	2,924	**1.21**	**1.16, 1.26**	**0.000**	**1.19**	**1.15, 1.24**	**0.000**
Education							
Higher education (beyond age 16)	1,297	1			1		
Compulsory education (to age 16)	1,652	**1.11**	**1.03, 1.20**	**0.01**	**1.07**	**0.99, 1.15**	**0.08**
Ethnicity							
White British	1,620	1			1		
Other	347	**0.76**	**0.67, 0.85**	**0.000**	**0.78**	**0.69, 0.87**	**0.000**
Pakistani	977	**0.77**	**0.71, 0.83**	**0.000**	**0.77**	**0.71, 0.84**	**0.000**
Cohabitation status							
Living with partner	2,230	1			1		
Not living with partner	719	**1.16**	**1.07, 1.27**	**0.001**	1.05	0.96, 1.14	0.30
Subjective financial status							
Managing financially	2,645	1			1		
Not managing financially	294	1.07	0.97, 1.19	0.18	1.04	0.93, 1.17	0.47
Mother's age at child's birth (in years)	2,924	1.00	1.00, 1.01	0.71	**1.01**	**1.00, 1.01**	**0.03**
Total n Missing Dropped records (zero post-natal visits)	-	-	-	-	2,924 30 6,773		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 39. Bivariate and adjusted negative binomial regression analyses of the relationship between the exposure and the frequency of consultation (≥1 visit) for head and MSK pain after the child's birth

	Bivariate (unadjusted) analysis				Multivariate (adjusted) analysis		
	N, ≤1 visit	**Relative rate ratio**	**95% confidence interval**	**P value**	**Relative rate ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status							
No	3,612	1			1		
Yes	207	**1.00**	**0.89, 1.13**	**0.07**	1.03	0.91, 1.16	0.64
Covariates							
Consultation frequency (≥0) for head and MSK pain before the child's birth	3,783	**1.25**	**1.20, 1.30**	**0.000**	**1.22**	**1.17, 1.27**	**0.000**
Education							
Higher education (beyond age 16)	1,651	1			1		
Compulsory education (to age 16)	2,157	**1.14**	**1.07, 1.21**	**0.000**	**1.10**	**1.04, 1.17**	**0.001**
Ethnicity							
White British	1,238	1			1		
Other	491	1.06	0.96, 1.16	0.30	1.06	0.96, 1.17	0.27
Pakistani	2,079	**1.33**	**1.29, 1.46**	**0.000**	**1.25**	**1.25, 1.41**	**0.000**
Cohabitation status							
Living with partner	3,210	1			1		
Not living with partner	601	0.95	0.88, 1.03	0.21	**1.11**	**1.03, 1.21**	**0.01**
Subjective financial status							
Managing financially	3,455	1			1		
Not managing financially	337	**1.11**	**0.98, 1.25**	**0.10**	1.06	0.95, 1.19	0.29
Mother's age at child's birth (in years)	3,783	**1.01**	**1.01, 1.02**	**0.000**	**1.01**	**1.01, 1.02**	**0.000**
Total n Missing Dropped records (zero post-natal visits)	-	-	-	-	3,783 36 5,908		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 40. Bivariate and adjusted poisson regression analyses of the relationship between the exposure and the frequency of consultation (≥1 visit) for exhaustion after the child's birth

	Bivariate (unadjusted) analysis				Multivariate (adjusted) analysis		
	N, ≥1 visit	**Relative rate ratio**	**95% confidence interval**	**P value**	**Relative rate ratio**	**95% confidence interval**	**P value**
Exposure - Caregiver status							
No	1,334	1			1		
Yes	92	1.02	0.92, 1.14	0.69	1.01	0.91, 1.12	0.88
Covariates							
Consultation frequency (≥0) for exhaustion before the child's birth	1,424	**1.14**	**1.04, 1.25**	**0.004**	**1.14**	**1.04, 1.25**	**0.005**
Education							
Higher education (beyond age 16)	629	1			1		
Compulsory education (to age 16)	793	1.04	0.99, 1.10	0.12	1.04	0.98, 1.09	0.21
Ethnicity							
White British	405	1			1		
Other	193	1.00	0.92, 1.08	0.90	1.00	0.92, 1.09	0.93
Pakistani	825	**1.08**	**1.01, 1.15**	**0.02**	**1.08**	**1.00, 1.15**	**0.04**
Cohabitation status							
Living with partner	1,198	1			1		
Not living with partner	225	0.99	0.91, 1.07	0.74	1.02	0.93, 1.11	0.73
Subjective financial status							
Managing financially	1,252	1			1		
Not managing financially	163	1.00	0.93, 1.09	0.93	1.00	0.92, 1.08	0.93
Mother's age at child's birth (in years)	1,426	1.00	1.0, 1.01	0.37	1.00	1.00, 1.01	0.48
Total n Missing Dropped records (zero post-natal visits)	-	-	-	-	1,409 16 8,302		

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

7.4 Results for the outcome of zero or more visits to the doctor

7.4.1 Interpretation of the model

The results of the two-part zero-inflated negative binomial/poisson regression are presented for the bi- and multivariate analyses:

Part 1. The probability of the mothers having the symptom but not visiting the doctor i.e. having a health need but no healthcare-seeking behaviour. An odds ratio <1 means that mothers with this characteristic are more likely than mothers in the reference category to have ill-health but not visit the doctor. Conversely, those in the reference category are more likely to not have the symptom and so not visit the doctor (Tables 41-43, columns labelled 'logistic');

Part 2. The estimate of healthcare use (≥1 visit to the doctor) for each characteristic relative to the reference category (weighted to include the above probability) (Tables 41-43, columns labelled 'negative binomial' or 'poisson').

7.4.2 Results

There was a very small (1%) increase in the rate of post-natal healthcare-seeking via healthcare use for psychological distress associated with caregiving (Table 41). There was also weak evidence that compared with other mothers, caregivers were more likely to have symptoms of psychological distress but not visit the doctor (OR 0.64; 0.40, 1.02) (Table 41). There was no evidence that caregiving influences whether mothers consult the doctor after the child's birth for symptoms of head and MSK pain or exhaustion (Tables 42 and 43).

Pre-natal healthcare-seeking behaviour and socioeconomic disadvantage were both associated with a higher post-natal rate of healthcare-seeking behaviour via healthcare use (Tables 41-43). There was also evidence that mothers with socioeconomic disadvantage were more likely than advantaged mothers to have ill-health but not visit the doctor.

Table 41. Bivariate and adjusted zero-inflated negative binomial regression analyses of the relationship between the exposure and the frequency ≥0 of consultation for psychological distress after the child's birth

	Bivariate (unadjusted) analysis								Multivariate (adjusted) analysis					
			Logistic			Negative binomial			Logistic			Negative binomial		
	N, no visits	N, ≥1 visit	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value
Exposure Caregiver status														
No	6,461	2,789	1			1			1			1		
Yes	312	165	**8.9e-07**	**3.8e-08, 2.1e-5**	**0.000**	1.06	0.87, 1.28	0.58	**0.64**	**0.40, 1.02**	**0.06**	**1.01**	**0.83, 1.10**	**0.05**
Covariates														
Consultation frequency (≥0) for the symptom before the child's birth	6,773	2,954	**3.45e-13**	**1.22e-13, 9.78e-13**	**0.000**	**1.39**	**1.31, 1.47**	**0.000**	**5.48e-08**	**3.39e-09, 8.84e-07**	**0.000**	**1.36**	**1.28, 1.44**	**0.000**
Education														
Higher education (beyond age 16)	3,373	1,297	1			1			1			1		
Compulsory education (to age 16)	3,378	1,652	**2.5e-5**	**7.5e-10, 0.85**	**0.05**	**1.19**	**1.05, 1.36**	**0.01**	0.97	0.79, 1.18	0.74	**1.15**	**1.02, 1.29**	**0.02**
Ethnicity														
White British	2,302	1,620	1	1		1			1			1		
Other	1,171	347	5.2e+7	5.4e-28, 5.0e+42	0.67	**0.63**	**0.51, 0.77**	**0.000**	**2.66**	**1.95, 3.63**	**0.000**	**0.67**	**0.55, 0.80**	**0.000**
Pakistani	3,291	977	5.3e+7	6.1e-28, 4.6e+42	0.67	**0.64**	**0.55, 0.74**	**0.000**	**2.53**	**1.98, 3.22**	**0.000**	**0.64**	**0.56, 0.74**	**0.000**
Cohabitation status														
Living with partner	5,812	2,230	1			1			1			1		
Not living with partner	947	719	**1.2e-8**	**3.6e-09, 3.7e-08**	**0.000**	**1.31**	**1.14, 1.50**	**0.000**	**0.52**	**0.34, 0.80**	**0.03**	1.04	0.91, 1.19	0.60
Subjective financial status														
Managing financially	6,274	2,645	1			1			1			1		
Not managing financially	457	294	**6.8e-08**	**1.4e-08, 3.2e-07**	**0.000**	**1.17**	**0.97, 1.40**	**0.09**	**0.54**	**0.34, 0.86**	**0.01**	1.08	0.90, 1.30	0.39
Mother's age at child's birth	6,773	2,954	**1.05**	**1.03, 1.07**	**0.000**	1.00	0.99, 1.01	0.45	**1.02**	**1.00, 1.04**	**0.06**	**1.01**	**1.00, 1.02**	**0.03**
Total n Missing	-	-	-	-	-				9,615 112					

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 42. Bivariate and adjusted zero-inflated negative binomial regression analyses of the relationship between the exposure and the frequency ≥0 of consultation for head and MSK pain after the child's birth

	Bivariate (unadjusted) analysis								Multivariate (adjusted) analysis					
			Logistic			Negative binomial			Logistic			Negative binomial		
	N, no visits	N, ≥1 visit	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value
Exposure - Caregiver status														
No	5,638	3,612	1			1			1			1		
Yes	270	207	**0.10**	**0.02, 0.53**	**0.01**	1.11	0.95, 1.30	0.19	0.42	0.05, 3.19	0.40	1.06	0.86, 1.32	0.57
Covariates														
Consultation frequency (≥0) for the symptom before the child's birth	5,908	3,819	**1.53e-10**	**8.08e-11, 2.916e-10**	**0.000**	**1.59**	**1.49, 1.70**	**0.000**	**8.4e-07**	**1.47e-08, 0.000048**	**0.000**	**1.53**	**1.40, 1.67**	**0.000**
Education														
Higher education (beyond age 16)	3,019	1,651	1			1			1			1		
Compulsory education (to age 16)	2,873	2,157	**2.7e-09**	**2.1e-10, 3.5e-08**	**0.000**	**1.34**	**1.19, 1.50**	**0.000**	0.57	0.24, 1.32	0.19	**1.19**	**1.07, 1.32**	**0.02**
Ethnicity														
White British	2,684	1,238	1			1			1			1		
Other	1,027	491	1.45	0.36, 5.78	0.60	1.12	0.91, 1.38	0.29	0.61	0.22, 1.71	0.35	1.02	0.84, 1.25	0.82
Pakistani	2,189	2,079	**7.7e-10**	**2.5e-10, 2.4e-09**	**0.000**	**1.94**	**1.72, 2.20**	**0.000**	**0.33**	**0.13, 0.82**	**0.02**	**1.69**	**1.52, 1.89**	**0.000**
Cohabitation status														
Living with partner	4,832	3,210	1			1			1			1		
Not living with partner	1,065	601	**6.4e+7**	**1.2e+6, 3.329e+09**	**0.000**	**0.88**	**0.76, 1.03**	**0.10**	0.82	0.18, 3.80	0.80	1.10	0.92, 1.33	0.30
Subjective financial status														
Managing financially	5,464	3,455	1			1			1			1		
Not managing financially	414	337	**44.17**	**5.12, 381.24**	**0.001**	**1.28**	**1.11, 1.48**	**0.001**	0.59	0.06, 5.99	0.66	1.13	0.93, 1.37	0.24
Mother's age at child's birth	5,908	3,819	**0.44**	**0.26, 0.74**	**0.002**	**1.02**	**1.01, 1.03**	**0.000**	**1.07**	**0.99, 1.16**	**0.09**	**1.02**	**1.02, 1.03**	**0.000**
Total n Missing	-	-	-	-	-				9,615 112					

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

Table 43. Bivariate and adjusted zero-inflated poisson regression analyses of the relationship between the exposure and the frequency ≥0 of consultation for exhaustion after the child's birth

	Bivariate (unadjusted) analysis								Multivariate (adjusted) analysis					
			Logistic			Poisson			Logistic			Poisson		
	N, no visits	N, ≥1 visit	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value	Odds ratio	95% CI	P value	Relative rate ratio	95% CI	P value
Exposure - Caregiver status														
No	7,916	1,334	1			1			1			1		
Yes	385	92	0.69	0.40, 1.20	0.19	1.08	0.75, 1.57	0.68	0.70	0.40, 1.20	0.19	1.08	0.77, 1.52	0.65
Covariates														
Consultation frequency (≥0) for the symptom before the child's birth	8,302	1,425	**0.42**	**0.28, 0.66**	**0.000**	**1.45**	**1.21, 1.73**	**0.000**	**0.39**	**0.25, 0.63**	**0.000**	**1.43**	**1.21, 1.69**	**0.000**
Education														
Higher education (education beyond age 16)	4,041	629	1			1			1			1		
Compulsory education (education to age 16)	4,237	793	0.94	0.72, 1.22	0.64	1.17	0.96, 1.43	0.12	0.97	0.73, 1.29	0.84	1.14	0.94, 1.39	0.20
Ethnicity														
White British	3,517	405	1			1			1			1		
Other	1,325	193	0.73	0.45, 1.18	0.19	0.98	0.67, 1.42	0.90	0.66	0.37, 1.20	0.17	0.97	0.64, 1.48	0.89
Pakistani	3,443	825	**0.54**	**0.39, 0.74**	**0.000**	**1.33**	**1.04, 1.72**	**0.03**	**0.52**	**0.35, 0.77**	**0.001**	**1.31**	**0.96, 1.78**	**0.08**
Cohabitation status														
Living with partner	6,844	1,198	1			1			1			1		
Not living with partner	1,441	225	1.09	0.74, 1.61	0.65	0.95	0.70, 1.29	0.74	0.86	0.49, 1.51	0.60	0.99	0.67, 1.46	0.94
Subjective financial status														
Managing financially	7,667	1,252	1			1			1			1		
Not managing financially	588	163	**0.49**	**0.30, 0.82**	**0.006**	1.02	0.75, 1.39	0.93	**0.47**	**0.25, 0.86**	**0.02**	0.97	0.70, 1.34	0.85
Mother's age at child's birth	8,301	1,426	1.00	0.97, 1.02	0.89	1.01	0.99, 1.03	0.40	1.00	0.98, 1.03	0.80	1.01	0.99, 1.03	0.34
Total n Missing	-	-	-	-	-				9,615 112					

Significant results (p≤0.1) are in bold. P value=0.000 indicates <0.001.

7.5 Discussion of healthcare use and healthcare-seeking behaviour

Due to the additional barriers to healthcare use experienced by caregivers (outlined in Chapters 1 and 2), I expected to find evidence that caregivers with ill-health visited the doctor less frequently than other mothers and that caregivers had a greater likelihood of reduced healthcare-seeking behaviour (of having ill-health but not visiting the doctor - as modelled by the zero-inflated regression analyses). Instead, there was no evidence of a relationship between the exposure and the probability of healthcare-seeking behaviour and rate of healthcare use for most of the symptoms (except psychological distress).

This is at odds with the expectation and evidence from other studies of a difference in the rate of consultation between the exposed and unexposed groups and evidence of poorer health in the exposed mothers (presented in Chapter 6). As there is very little literature on primary healthcare use for the different symptoms and for caregivers, I discuss the results within the broader context of healthcare use, giving only a few symptom specific examples.

7.5.1 Relationship of caregiving to consultation frequency

In my sample, mothers (both exposed and unexposed) had a higher mean consultation frequency for psychological distress than for head and MSK pain or exhaustion; but there was no or very little difference between the mean consultation frequencies for the exposed versus unexposed groups (presented in Section 5.5.2.2, Table 28). In the adjusted analyses, caregivers had both a slightly higher rate of healthcare-seeking behaviour (visiting the doctor at least once) for psychological distress, and a lower probability of healthcare-seeking behaviour compared with other mothers (a greater risk of having psychological distress but not visiting the doctor).

No UK studies (and few elsewhere) have examined the relationship between caregiving for a disabled child and healthcare use; although lower healthcare use has been found in family-caregivers (including caregivers of children) compared with non-caregivers in the UK (Arksey, 2005). Despite the theory that caregiving presents barriers to maternal healthcare use, studies in the USA, Canada and Australia (some published during the course of my research) have found greater healthcare use (primary, secondary, emergency and psychological service visits and medication use) by caregivers of disabled children than other mothers. They have shown associations between higher healthcare use and caregiver psychological distress, high child healthcare use, child behavioural problems and the specific diagnoses of ASD and learning disability (not Down syndrome) (Thurston, 2011; Jeans, 2013; Brehaut, 2019b; Le, 2016; Fairthorne, 2016a; Brehaut, 2011).

My findings appear to contradict the results of these studies by indicating that for caregivers who demonstrate healthcare-seeking behaviour there is very little direct influence of caregiver burden on the rate of primary healthcare use. This could, in part be due to the frequent contact that caregivers have with primary care services during the preschool period due to routine appointments with GPs and health visitors who monitor the child's health and development and look for signs of post-natal maternal ill-health, especially depression (Miller, 2006). Another possible explanation is the observation that the exposed and unexposed mothers in the cohort study had similar clinical levels of ill-health (presented in Section 5.5.2.2, Table 27). More caregivers had symptoms (presented in Section 6.4) but they did not have a greater clinical need (i.e. they did not have more acute symptoms) than other mothers, so they had no reason to visit the doctor more often.

Although caregiver burden does not influence the frequency of healthcare use, it may hinder healthcare-seeking behaviour in some caregivers. As a result, there may be a greater risk of the under-detection of ill-health in caregivers compared with other mothers (despite the greater likelihood of ill-health in caregivers). This possibility is most likely for psychological distress. I am only aware of one other study which has found a similar relationship between caregiving and healthcare use. Willet et al. (2018) used a survey to assess healthcare-seeking behaviour for symptoms of ill-health by parents of children and adolescents with ASD in Australia. They found that caregiver distress (clinical need) was the greatest predictor of healthcare-seeking behaviour, but caregivers did experience barriers to healthcare use, which also informed their decision whether to visit the doctor. Thus, caregivers have a clinical need for which they are visiting the doctor, but there is also a risk of symptom under-detection for some caregivers.

7.5.2 The implications of the relationships between the covariates and ill-health/healthcare use for caregivers

As ill-health is the primary driver of healthcare use, I discuss the extent to which the covariates influence the outcomes of caregiver ill-health and healthcare use together.

7.5.2.1 Relationships between pre- and post-natal healthcare use

A few studies have also highlighted the possibility of greater pre-natal healthcare use (associated with greater ill-health) in caregivers compared with other mothers. Fairthorne et al. (2013) reviewed studies which measured pre-natal ill-health in mothers of children with ASD and/or learning disabilities and found consistent evidence of associations between psychological distress (and some evidence of impaired immune function) prior to and during pregnancy and caregiving for children with ASD. Two very recent studies looked at changes in caregiver healthcare use and

found a pattern of greater pre-natal ill-health and healthcare use in caregivers which rose at a similar rate to unexposed mothers after the child's birth (Table 44).

Table 44. A summary of studies reporting change in caregiver healthcare use from before to after the child's birth

Study	Location	Caregiver population by child disability	Average number of visits for exposed versus unexposed mothers (for periods before/after the child's birth)
Arim, 2019	Canada	1,847 children with neurodevelopmental disabilities (NDDs); 22,708 children without NDDs	12 months before: 10.5 versus 9 12 months after: 11 versus 9 36-48 months after: 9 versus 7.5
Brehaut, 2019a	Canada	1,351 children with chronic health problems (CHPs) including high healthcare needs and/or a major/chronic health condition[1]; 22,282 children without CHP	12 months before: 11 versus 8 12 months after: 11.5 versus 8.5 36-48 months after: 10 versus 6

[1] Including but not limited to disabling conditions

The authors of these studies raised concerns that:

- a failure to consider potential differences in pre-natal ill-health and healthcare use can give a potentially inflated measurement of the association between caregiving and post-natal ill-health and healthcare use outcomes; and
- the possibly false assumption that the relationship between caregiving and ill-health is entirely attributable to caregiver burden (Fairthorne, 2013; Brehaut, 2019a; Arim, 2019).

These and other studies on caregiver pre-natal ill-health have also reignited the debate around the possibility of a causal relationship of maternal ill-health to child disability (Brehaut, 2019a; Demir, 2008; Talge, 2007; Ray, 2009).

In my sample, I found little variation between the exposed and unexposed groups for pre-natal symptom detection or consultation frequency, and little difference between the groups in the proportion of mothers with symptoms in both time periods (presented in Section 5.5.2.1, Table 26 and 5.5.2.2, Table 28). Neither group visited more than once on average for any symptom in either time period. Additionally, there was no evidence of an association in the bivariate analyses of the relationships between the outcome of caregiver status and the covariates of pre-natal ill-health and healthcare use (presented in Section 6.3).

The absence of evidence for an association between pre-natal health and the exposure rejects the possibility of a causal relationship of maternal ill-health to child disability in my sample. Given the results from the studies cited in this section, it is possible that there is a relationship between pre-natal maternal ill-health and some child health problems or disabilities, which may vary by country. My findings provide evidence that this is not the case for a mixed diagnostic group of

children with Down syndrome, cerebral palsy, ASD and developmental delay in the UK. However, given the evidence from other studies (Fairthorne, 2013; Fairthorne, 2016b; Vasa, 2012), the potential for greater pre-natal and post-natal healthcare use (and ill-health) related to the specific diagnosis of ASD was investigated in the latent class analysis (presented in Chapter 8).

In my study, there were sizeable and significant relationships between pre- and post-natal ill-health and healthcare use for each symptom (Section 6.4, Tables 33-35, and Sections 7.3 and 7.4, Tables 38-43). Consistent with the literature, women who had a pre-natal episode of the symptom were at greatly increased risk of further episodes; and previous healthcare use for the symptom increased the likelihood of visiting again (Welch, 1999; Burcusa, 2007; da Silva, 2017). Gallagher et al. (2018) found that prior episodes of depression were predictive of future depression in caregivers of children with developmental disabilities aged 9-13 in Ireland. They concluded that caregiving together with a history of depression, increased the risk of subsequent episodes to a greater extent than previous episodes in unexposed mothers. In my study, I was unable to investigate the potential interaction between caregiver status and previous episodes of ill-health and healthcare use in the investigation of the post-natal health outcomes (explanation in Section 4.15.1.4). Within the context of the research on changes in caregiver health, my study provides evidence that when adjusting for pre-natal ill-health there remains an independent relationship between caregiving and post-natal ill-health which can be observed using routinely collected health data (Brehaut, 2019b).

7.5.2.2 Influence of sociodemographic factors on health/healthcare use

My sample came from a largely bi-ethnic socioeconomically disadvantaged population. I adjusted for socioeconomic status in the analyses due to the known adverse influence of disadvantage on health and healthcare use in the BiB cohort and more widely (outlined in Chapters 1, 2 and Section 4.10.4.2). In my sample, the caregivers were not more socioeconomically disadvantaged than the other mothers (descriptive results for the indicators of socioeconomic status presented in Section 5.5.1). Socioeconomic status (via the indicators e.g. education, subjective financial status, cohabitation status) was associated with increased ill-health and both increased healthcare use and decreased primary healthcare-seeking behaviour; thus, increasing the risk of symptom under-detection in disadvantaged mothers. This could, therefore, create health disparities between advantaged and disadvantaged caregivers as well as more generally between advantaged and disadvantaged mothers.

Studies in the BiB cohort have found that mothers with ill-health living in socioeconomically deprived areas and of Pakistani ethnicity visit their GP less often than more affluent, white British

mothers (Kelly, 2017a). My findings provide evidence that the relationship between socioeconomic status and primary healthcare use may vary by symptom, and that there can be both a high consultation rate and underuse within the same population. Shown for one or more of the indicators of socioeconomic status, disadvantage increased post-natal ill-health and healthcare use for psychological distress and exhaustion but not head and MSK pain (Section 6.4, Tables 33-35 and Sections 7.3 and 7.4, Tables 38-43). Further, disadvantaged mothers were more likely than advantaged mothers to have, but less likely to visit the doctor for, psychological distress and exhaustion but not head and MSK pain (Section 7.4, Tables 41 and 43). This is consistent with the findings of Adamson et al.'s (2011) review of the literature on sociodemographic factors associated with primary care consultation for back pain. They concluded that socioeconomic status did not influence healthcare-seeking behaviour for back pain.

There was also notable variation in the relationship of ethnicity to the outcomes by symptom, which deviated from the relationship of the other indicators of socioeconomic status. In my sample, Pakistani and Other mothers tended to have lower socioeconomic status than white British mothers and had increased prevalence and consultation rates for head and MSK pain and exhaustion (Section 6.4, Tables 34-35, Section 7.3, Tables 39-40 and Section 7.4, Tables 42-43). Thus, in this regard, ethnicity was consistent with the other indicators of socioeconomic status in their relationship to the outcomes. However, the Pakistani mothers had a 53% lower prevalence (Section 6.4, Table 33) and a lower consultation rate (Section 7.3, Table 38 and Section 7.4, Table 41) for psychological distress than the white British mothers. This could reflect some genuine variation in symptom prevalence by ethnicity, but also the phenomena of somatisation (outlined in Section 4.10.2) (Watson, 2019). Post-natal psychological distress is twice as likely to be missed in minority ethnic than white British mothers (in the BiB cohort). Thus, the raised consultation rate for head and MSK pain and exhaustion for Pakistani mothers in my study may reflect repeat visits due to the initial misidentification of psychological distress (Prady, 2016a). If so, the true consultation prevalence of psychological distress may be higher and the prevalence of exhaustion and pain unrelated to psychological distress lower.

7.6 Chapter summary

The relationship between caregiver status and post-natal healthcare use and healthcare-seeking behaviour has been presented and contextualised as far as possible given the limited literature on caregiver healthcare use. Key covariate results for the analyses reported in Chapters 6 and 7 have been discussed; highlighting potential variation in the relationship between caregiving, sociodemographic factors and healthcare use by symptom. My findings provide evidence that

although caregiving is largely not associated with healthcare use, symptoms may be under-detected in caregivers with psychological distress. The risk may be greater still for Pakistani and socioeconomically disadvantaged caregivers; with these risk factors leading to increasing health disparities between advantaged and disadvantaged caregivers and other mothers. My findings also provide counter-evidence for the finding in other studies of greater pre-natal ill-health in caregivers, which is examined further in the next chapter.

The results and discussion in the following chapter examine the potential influence of child disability diagnosis on healthcare use and the association of sociodemographic factors.

Chapter 8 Analysis and discussion of variation in patterns of pre- and post-natal healthcare use by disability diagnosis

This chapter presents the results of the latent class analysis in the BiB cohort. I discuss how the variation in subgroup membership by ASD and other child disability diagnoses relates to the literature on caregiver healthcare use and the relationship between socioeconomic status and child disability diagnosis.

8.1 Introduction

In this chapter, I present the results of the latent class analysis (Section 4.12, Figure 17: Stage 3 Step 4) to investigate whether there are subgroups of mothers with similar profiles of pre- and post-natal healthcare use, and how these groups vary by caregiver status, caring for a child with ASD specifically, and sociodemographic factors (ethnicity and education).

The results of the latent class analysis are discussed with reference to the findings of the earlier analyses (presented in Chapters 5-7) and the published literature.

8.2 Model fit

A three class model was used. The models with 2, 3 and 4 classes (subgroups) showed similar model fit for log-likelihood and BIC. For the three class model the Vuong-Lo-Mendell Rubin LR test p value was not significant, indicating that a model with one fewer classes would be a better fit for the data. However, the degree of classification accuracy (entropy) and interpretability (classes with different patterns of consultation frequency) was better for the three than for the two and four class models (Nylund, 2007) [**A6.1**].

8.3 Results for the identification of healthcare use subgroups

As I was interested in the relationships between pre- and post-natal healthcare use, only mothers who visited the doctor about any of the symptoms (stress, common mental disorders, headaches, MSK pain, sleep problems, fatigue) prior to the child's birth were included in the analysis (19% of the study sample (n=1,871/9,727)).

Descriptive labels were assigned to the three subgroups based primarily on the probabilities of each item in the healthcare use variables (explained in Section 4.14.2) (Figure 34, bar charts A-C):

A. Lower educated high healthcare users (43.5%, n=814/1,871) – there was a higher probability of mothers educated up to age 16 having both high pre- and post-natal

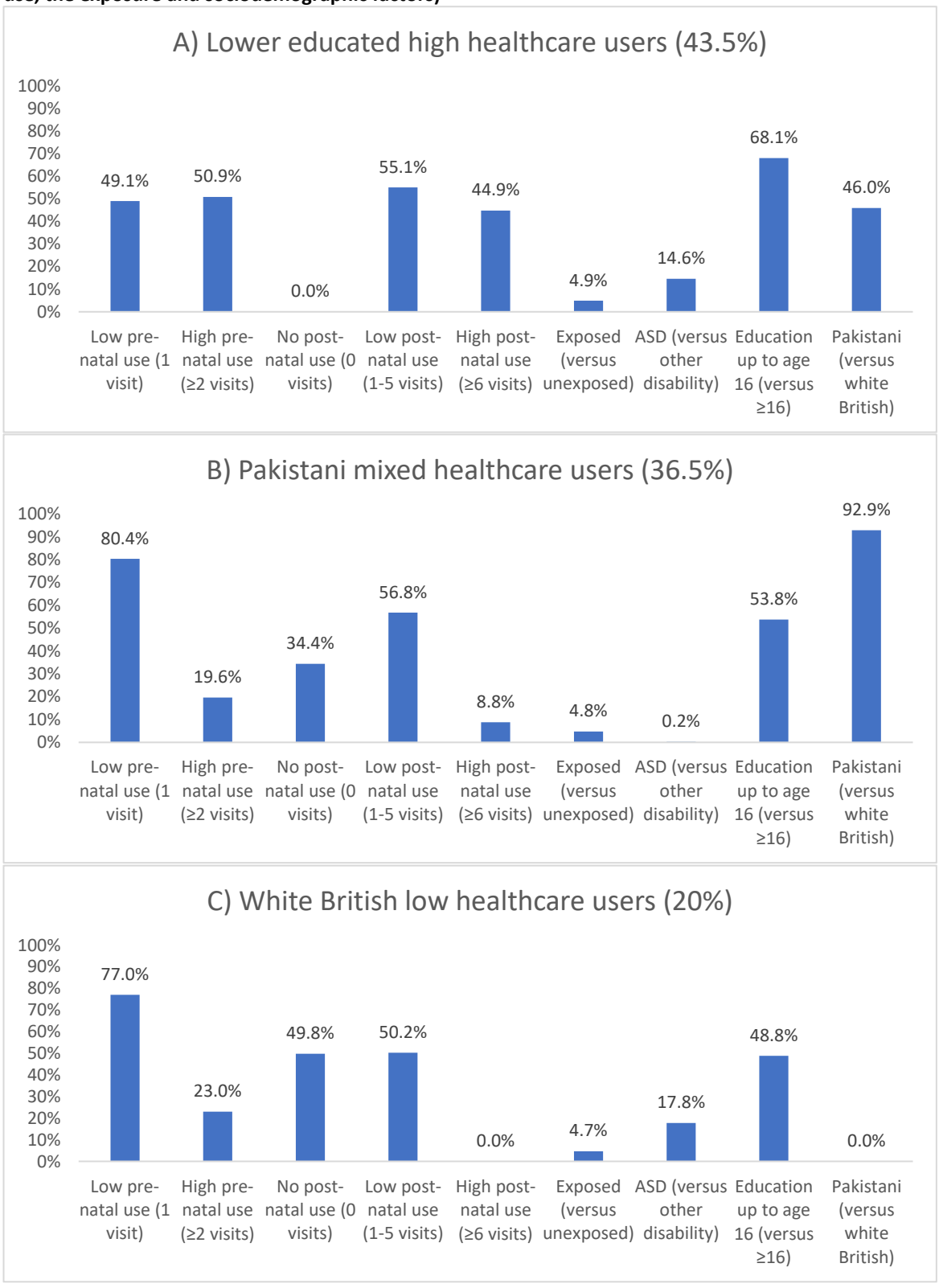
healthcare use compared with the other subgroups. Unlike the other subgroups (B and C), every mother had some (low or high) post-natal healthcare use.

B. Pakistani mixed healthcare users (36.5%, n=683/1,871) – this subgroup was comprised of mostly Pakistani mothers with low pre-natal healthcare use but more varied frequencies of post-natal healthcare than in subgroups A and C.

C. White British low healthcare users (20.0%, n=374/1,871) – this subgroup consisted solely of white British mothers, with a high probability of low pre-natal healthcare use and a higher probability of no post-natal healthcare use than subgroups A and B. Unlike the other subgroups, no mothers had high post-natal healthcare use.

A table of results is included as an appendix [**A6.2**].

Figure 34. The probability of subgroup membership for each characteristic (pre- and post-natal healthcare use, the exposure and sociodemographic factors)



There were 6 records with missing education and ethnicity data (n=6/1,871). Pre- and post-natal use was the number of visits by each mother to their doctor during the time period (i.e. healthcare use). Other disability was mothers in the exposed group with children with Down syndrome, cerebral palsy or the disability indicators (not ASD).

Ninety caregivers were included in the analysis, of which nine had children diagnosed with ASD (ASD caregivers). The probabilities for both exposure variables were very low due to the small number of caregivers in the sample. The probability of caregiver status (versus not being a caregiver) was 5% in every group. There was no evidence that caregivers (excluding those of children with ASD) were more or less likely to be members of any of the three subgroups defined by different maternal patterns of pre- and post-natal healthcare use.

The probability that caregivers of children with ASD were members of subgroups varied from 0-18%. ASD caregivers were most likely (18%) to be white British low healthcare users (subgroup C); and least likely (0%) to be Pakistani mixed healthcare users (subgroup B). The sociodemographic composition of these subgroups also varied. Subgroup C, where ASD caregivers were most likely, had more mothers with education above age 16 (51%) than any other group and only white British mothers. Subgroup B, where ASD caregivers were least likely, was comprised of only Pakistani mothers.

8.4 Discussion of patterns of healthcare use

I expected to find that compared with other mothers, caregivers were more likely to be in subgroups with low and high post-natal healthcare use due to the evidence of greater maternal pre- and post-natal ill-health and healthcare use but also of barriers to healthcare use (discussed in Chapter 7). Caregiving for children with ASD has been associated with greater maternal ill-health than caregiving for children with other disabilities (outlined in Section 1.4.3.2), and there is evidence of higher pre-natal healthcare use in ASD caregivers compared with other mothers (outlined in Section 4.15.2). I expected to find that ASD caregivers were more likely to be in the high pre- and high and low post-natal healthcare use subgroups than other caregivers and other mothers.

I found no evidence that caregiving for preschool children with developmental disabilities (excluding ASD) influenced post-natal healthcare use or that pre-natal healthcare use was associated with caregiving. There was evidence that variation in subgroup membership was associated with the being an ASD caregiver, but much of this variation may be associated with sociodemographic factors known to influence ASD diagnosis (maternal education and ethnicity). Thus, sociodemographic factors may influence patterns of healthcare use more than caregiving for a child with developmental disabilities or ASD specifically.

I discuss the consistency of my findings within the context of my other analyses in the BiB cohort and the published literature.

8.4.1 Patterns of healthcare use and caregiving

The findings of this analysis are consistent with those of my regression analyses, where there was (largely) no evidence of a relationship between pre- or post-natal healthcare use and caregiver status (as the outcome) (Section 6.3) or (largely) between caregiver status and post-natal healthcare use (as the outcome) (Sections 7.3 and 7.4). The findings for ASD caregiving could be explained by sociodemographic factors associated with ASD diagnosis, but there may also be some evidence of an association between high maternal healthcare use and caregiving for a child with ASD.

In my subsample of mothers with pre-natal healthcare use, no patterns of greater healthcare use by caregivers compared with other mothers were identified (using the total number of visits for any of the individual symptoms). Although I found evidence of greater caregiver ill-health (presented in Chapter 6), I have consistently found no evidence that caregiving influences post-natal healthcare use for mothers with healthcare-seeking behaviour (Sections 7.3 and 8.3). Additionally, the above findings of no difference between the pre-natal healthcare use of exposed and unexposed mothers provide contradictory evidence to that of other studies where caregivers have greater pre-natal ill-health (Brehaut, 2019a; Arim, 2019; Fairthorne, 2013).

8.4.2 Patterns of healthcare use, ASD and sociodemographic factors

Without awareness of the complex interrelationships between sociodemographic factors, child disability, caregiver health and healthcare use, results for disability and caregiver research can easily be misinterpreted (Emerson, 2006b; Hatton, 2009b; Stoneman, 2007; Woolfson, 2005). My findings for the ASD caregivers highlight the importance of considering sociodemographic factors in the analysis and interpretation of studies on caregiver health and healthcare use.

Kelly et al. (2017b) found that children of ethnic minority mothers in the BiB cohort were 70% less likely to have a diagnosis of ASD by the age of eight compared with white British mothers; whilst children of mothers educated to age 18 or above had twice the risk of ASD diagnosis compared with mothers with lower education. Elsewhere, these same relationships have also been found (e.g. Emerson, 2012; Nowell, 2015).

In my sample, and unexpectedly, the ASD caregivers had a (slightly) higher likelihood of being in the low (subgroup C: 18%) rather than higher (pre- and post-natal) healthcare use subgroups (subgroups B: 0%; A: 15%). It was highly likely that most of this between-group variation was explained by the differences between the groups for ethnicity and education and their association with ASD diagnosis,

and not by true differences in healthcare use. Subgroup C consisted of only white British mothers and had the highest number of mothers educated above aged 16 (51%). For comparison, subgroup B had only Pakistani mothers and 46% educated above age 16; whilst subgroup A was 46% Pakistani and 32% educated above age 16.

However, the 15% probability of ASD caregivers in the lower educated high healthcare use subgroup (A) compared with the other exposed mothers was not explained by sociodemographic factors as low maternal education is not associated with early ASD diagnosis (Mandell, 2005). This subgroup also had a higher likelihood of high pre-natal healthcare use than the other groups (51% versus B: 20%; C: 23%). This could, therefore, reflect a genuine between-group difference in health and healthcare use.

In the descriptive analyses (presented in Sections 5.4.2, Table 14 and 5.4.3, Table 16), a greater proportion of mothers of children with ASD had psychological distress (40%) than all but one other caregiver group (cerebral palsy 42%; Down syndrome 21%, disability indicators 35%). However, they did not have greater head and MSK pain or visit the doctor more often, on average (presented in Sections 5.4.2, Table 14 and 5.4.3, Table 16). Notably, of the exposure groups, the greatest maternal proportion with psychological distress and head and MSK pain was the cerebral palsy group. High proportions of back pain and stress associated with cerebral palsy have also been found in other samples (Kaya, 2010; Byrne, 2010).

Studies consistently find that more mothers of children with ASD have higher levels of stress and depression than mothers of other disabled children; and mothers of children with disabilities and development delay have a greater prevalence of these symptoms than unexposed mothers (Laxman, 2015; Jeans, 2013; Herring, 2006; Baker, 2003; Estes, 2009; Emerson, 2010; Eisenhower, 2005). The findings of my latent class analysis may show some consistency with other studies that find an association between child ASD and high maternal healthcare use (Willet, 2018; Fairthorne, 2013). They may also support the finding in other studies that ASD caregivers experience greater ill-health than other caregivers (Jeans, 2013). These patterns may be independent of socioeconomic status, but this could not be tested in the latent class analysis.

However, the reliability of my evidence is low, given the very small number of ASD caregivers in the analysis (n=9). Although I found an association between ASD and greater healthcare use in the latent class analysis, I also observed differences in the proportion of caregivers with ill-health and the frequency of healthcare by symptom and child disability diagnosis in the other analyses. These

differences may relate to the different disability characteristics associated with diagnoses. For example, cerebral palsy is associated with mobility problems, whilst ASD is most strongly associated with behavioural problems and learning disability (Allgar, 2008; Hauser-Cram, 2001). Thus, the assumption of greater ill-health in ASD caregivers should not be made.

8.5 Section summary

I have presented the results of the latent class analysis and related them to the findings of the other analytic chapters in this thesis and the available literature. I have highlighted what this method of analysis adds to the understanding of caregiver healthcare use for my sample and identified the risk of unobserved variation by disability diagnosis, symptom and sociodemographic factors when analyses do not stratify by these characteristics.

In the next chapter, I present the strengths and limitations of the comparative cohort study.

Chapter 9 Strengths and limitations of the comparative cohort study

This chapter presents a discussion of the strengths and limitations of the comparative cohort study.

9.1 Introduction

My comparative cohort study has investigated the relationship between caregiving for a child with developmental disabilities and the prevalence of ill-health and primary healthcare use for a range of symptoms of ill-health during the preschool period. I have explored the effects of disability diagnosis, pre-natal symptoms, and socioeconomic status on the relationship between the exposure and the health outcomes.

The limitations of the study design were minimised where possible, although several remained. They must be considered in the interpretation of the results as they affect their generalisability and the conclusions that can be drawn.

9.2 Overview of the strengths

This study provides new understanding of the relationships between health, healthcare use and caregiving during the preschool period, and highlights correlates of ill-health and low healthcare use in the UK. It also provides an insight into the process of disability diagnosis in children under the age of five; whereby identifying preschool children with disabilities is likely to require a different case ascertainment strategy than for school age and older disabled people.

I have shown how routinely collected health data available via primary care records can be used to investigate caregiver-health. By using a variety of statistical analyses to examine caregiver ill-health detected via primary care records, I have highlighted the strengths and uncertainties of using primary care data to determine symptom prevalence (e.g. primary care data is an indicator of a clinical need but will underestimate prevalence). I have also identified that factors that influence ill-health may not also influence healthcare use or can both increase healthcare use and the risk of symptom under-detection (e.g. caregiver burden and socioeconomic status).

Adjusting for indicators of socioeconomic status and pre-natal ill-health, I have measured and found a relationship between caregiving and ill-health during the preschool period as theorised. Despite expectations, I broadly found no evidence of a relationship between caregiving and primary healthcare use, although caregivers may have lower healthcare-seeking behaviour for symptoms of psychological distress than other mothers. Unlike other studies I did not find greater pre-natal ill-

health or healthcare use in caregivers than unexposed mothers. These findings are contrary to those of other studies, highlighting the importance of sociodemographic factors in determining healthcare use and the possibility of national variation. I have shown the close relationship between pre-natal and post-natal ill-health and healthcare use, and the interrelationships with sociodemographic factors that may vary within and between samples and by symptom, which necessitates their inclusion in caregiver-health research.

It is highly likely that the greater prevalence of ill-health found in the exposed mothers is due to the additional burden of caregiving for a disabled child. The use of a nested prospective cohort study design enabled investigation of whether following the exposure there were differences in the ill-health of exposed and unexposed mothers for a time period (Webb, 2016). As an observational study design was used, causality can be inferred but not proven (Vandenbroucke, 2016). The reliability of this causal inference was strengthened by the prospective study design (investigating health going forwards in time from the point of exposure) and investigating the risk of confounding relationships in the association between caregiving and ill-health/healthcare use. The use of a nested design meant that the decisions about covariates (described in Section 4.10.4) could be supported and interpretation of the results contextualised using published research for the cohort.

The benefits and limitations of the study design are now presented.

9.3 Case ascertainment strategy

I developed a practical strategy for identifying preschool children with developmental disabilities via primary care records. Combining the groups produced a large enough exposure group to perform the planned bi- and multivariate analyses and resulted in a more realistic estimate of disability prevalence for the sample. An unexpected outcome of this process was to reveal a potential issue of generalisability for all studies in the preschool age group that only include children with disabling conditions in exposure groups.

As I have shown (in Section 5.4), it is a minority of children with disabling conditions that receive definitive diagnoses during the preschool period. I compared the maternal and child characteristics of the disabling condition and disability indicator groups and found few between-group differences. The same may not be true for other study populations; thus, the exposed groups may not be representative of the caregiver population, limiting the generalisability of the results.

9.3.1 Disability prevalence in the preschool age group

The prevalence of the disability indicators was higher than expected; however, fewer children in the indicator group than expected had more than one disability indicator (n=90 versus the 120 expected) - an indicator of global development delay (described in Section 4.7.7.2) (Mithyantha, 2017). When I combined the disabling condition and disability indicator groups, they produced an exposure group that was 4.9% of the sample (n=477/9,727). This was within the 4.2-5.1% disability range estimated for the BiB cohort (described in Section 4.7.5.1). The prevalence of the disabling conditions was lower than anticipated (except for Down syndrome and ASD) (Table 45).

Table 45. Comparison of the UK and BiB prevalence of the disabling conditions and disability indicators

Condition	**UK prevalence estimate (per 10,000)[1]**	**Prevalence in the exposure group (n=9,727)[3]**
Disabling conditions	419[2]	83
Moderate-profound learning disability	350 (aged 5-18) (Public Health England, 2018)	0
Autism Spectrum Disorders (ASD)	38 (aged 8) (Taylor, 2013)	47
Cerebral palsy	20 (Cans, 2008)	12
Down syndrome	9 (Alexander, 2016)	24
Fragile X syndrome	2 (Song, 2003)	0
Disability indicators (a proxy for developmental delay)	320 (aged 3) (Emerson, 2008a)	438[4]

[1] Denominator of 10,000 used for comparison as close to the sample size. The estimate is for children aged 0-5 unless stated otherwise. For cerebral palsy the estimate is per 10,000 live births

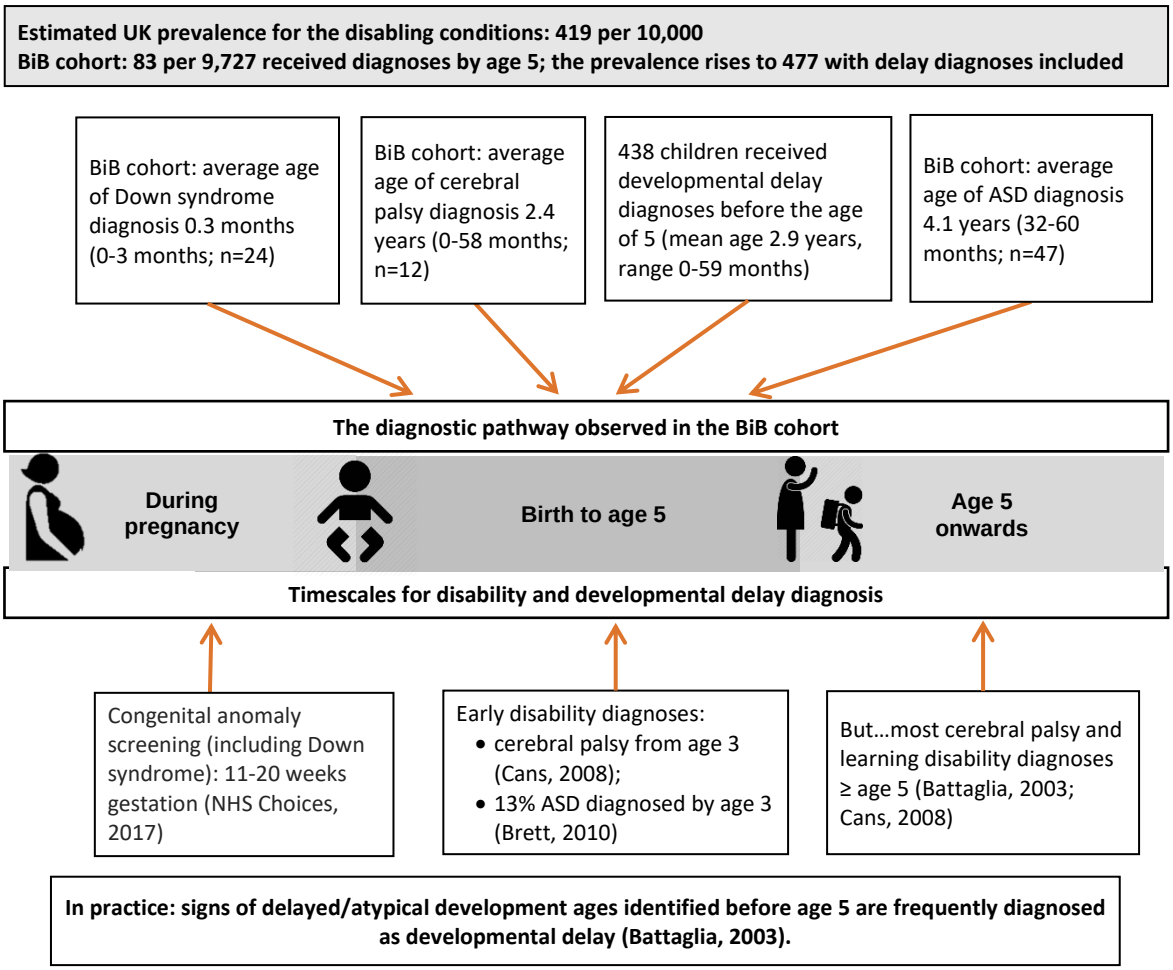
[2] Combined prevalence of the specific disabling conditions.

[3] BiB prevalence below 5 was rounded down to protect participant anonymity.

[4] Including the children with both disabling conditions and disability indicators (n=44).

As advised by the paediatric clinicians (described in Section 4.7.7.1), many of the children with the disabling conditions (excluding Down syndrome) received an initial diagnosis of a disability indicator (36% (n=17) of the ASD group; 50% of the cerebral palsy groups) (Figure 35).

Figure 35. Schematic of the diagnostic pathway for the BiB cohort mapped onto the pathways to disability diagnosis from gestation to age five



The timescales for disability and developmental delay diagnosis (lower half of the figure) were introduced in Section 4.7.7.1, Figure 13.

The practice of deferring giving a definitive (condition) diagnosis until the child is older could explain why there were no or very few children with moderate-severe learning disability or Fragile X syndrome in the cohort. Accordingly, it was highly likely that some of the children in my sample who received indicator diagnoses before the age of five had, as yet, undiagnosed ASD, cerebral palsy and moderate-profound learning disability.

The 4.5% disability indicator prevalence in the sample superficially appeared higher than in other samples, such as the 3.2% prevalence of developmental delay in the UK Millennium Cohort (n=12,689 children aged 3) (Emerson, 2008a). However, this sample consisted of only monolingual English-speaking families as the multilingual families had extremely high rates of developmental delay. The

BiB cohort includes multilingual families, and I used a different sampling strategy (clinical codes in electronic health records rather than cross-sectional assessment). Given these differences and the broader age range in my study, it is likely that the prevalence in the cohorts are roughly equivalent. Thus, I have shown that by using a dual case ascertainment approach which combines the two strategies, a realistic estimate of disability in children aged 0-5 can be obtained. However, questions remain about misclassification error, disability severity and heterogeneity in the children identified via the two strategies and its impact on the measurement of the outcomes.

9.3.2 Disability verification

The two strategies were developed to try and balance the risk of false positive misclassification error and the risk of generating too small an exposure group to perform the planned analyses. Both strategies aimed to identify children with clinical codes strongly associated with disability. Neither strategy could eliminate the risk of false positive misclassification error entirely, with a greater expected risk of misclassification for the disability indicator strategy. However, in practice, this risk was low as it was expected that a disabling condition or disability indicator would, largely, only be diagnosed during the preschool period if the characteristics were distinct, which is more likely for moderate and severe than mild impairment (described in Section 4.7.7.3).

Sensitivity analysis to assess and compare the extent to which the case ascertainment strategies resulted in misclassification error (false positive and false negative) was not performed as this would have necessitated the use of a gold standard comparison strategy. As discussed (in Section 4.7.4), none of the existing strategies were suitable or could be swiftly adapted solely to gauge the extent of the misclassification error.

Attempts were made to identify differences in disability severity by measuring the number of diagnoses and age of the child when the mother's symptoms were detected. Differences between the exposure groups were observed but no inferences about the possible relationship between them and the maternal outcomes could be made. For example, the mothers of children with Down syndrome visited the doctor soonest about psychological distress; whilst mothers of children with ASD visited soonest about head and MSK pain. Over half (53%, n=44) of the children with disabling conditions also had a disability indicator, and 24% (n=95) of the disability indicator group had two or more indicators. This could suggest greater disability severity in the condition group or reflect parenting or sociodemographic differences, whereby the parents who receive definitive diagnoses for their children before the age of five were more assertive or persistent in seeking them (Nowell, 2015).

The measures (number of diagnoses and age of the child when the mother's symptoms were detected) could not distinguish between the potential mediators of severity and behavioural problems which have both been identified as predictors of maternal ill-health (Raina, 2005; Marrón, 2013; Marquis, 2019). These factors could not be independently verified as additional data collection was not possible. The small group size prevented their inclusion in the multivariate analyses or from any additional post hoc analyses by disability diagnosis. Thus, it is likely that they influenced the outcomes in my sample, but the extent and which disability-related factor they measured, is unknown.

9.3.3 Limitations of combining the strategies

Combining the disabling condition and disability indicator groups produced a large enough exposure group to perform the planned analyses (requirements in Section 4.7.6). However, it increased the clinical heterogeneity in the group which largely prevented bi- and multivariate investigation of whether variation in maternal ill-health and healthcare use could be attributable to specific disability diagnoses and related sociodemographic differences. For example: low socioeconomic status is associated with an increased risk of developmental delay; there is a greater risk of Down syndrome in children of older mothers; and high maternal education is associated with higher rates of ASD diagnosis (Emerson, 2008a; Kelly, 2017b; Allen, 2009).

These patterns were present in my study and visible in the descriptive statistics but, probably because the groups were combined, there was no evidence of relationships between the sociodemographic factors and the exposure. These sociodemographic factors all have a relationship to either the prevalence or healthcare use for the symptoms, but between-group differences in their influence on the maternal outcomes by disability could not be examined.

9.4 Primary care records

9.4.1 Symptom identification

Primary care records are a good indicator of clinical need as people largely visit the doctor when their symptoms are adversely affecting their daily lives, and thus clinically significant (Martin-Merino, 2010). In my crude assessment of clinical levels of the symptoms (diagnoses versus signs/symptoms), only half the mothers had individual symptoms classified as above the clinical threshold; none for fatigue and MSK pain (presented in **A4.4**, A21). However, as stated earlier, the clinical coding system of primary care records does not classify disability. Although, for example, none of the mothers are

classified as having a fatigue disorder, this does not mean that their symptoms were not acute and having a negative impact on their daily lives. Instead, I suggest that my findings may represent an accurate indicator of clinical significance as perceived by the mothers that visited their GP.

My prevalence estimates are an underestimation of the true prevalence of symptoms (both above and below the clinical threshold) as both the prevalence and consultation frequency estimates are predicated on mothers with symptoms visiting the doctor, the identification and recording of the symptoms using appropriate clinical codes and their detection via my symptom identification strategy. The extent of the under-detection of ill-health in the sample may also vary by symptom. For example, most people purchase over-the-counter medication as the primary strategy for pain management (Latinovic, 2006); whilst psychological distress is under-recorded in primary care records due to low accuracy in the identification of depression by non-specialist psychiatric clinicians (National Institute for Health and Care Excellence, 2011; Cepoiu, 2008).

To mitigate the risk of under-detecting common mental disorders, an existing code list including drug codes was used (Prady, 2016a). Drug codes could not be used for the other symptoms as they did not definitively identify the symptoms of interest (e.g. as they are not prescribed for only that condition (described in Section 4.9.1). Thus, there was likely to be a greater prevalence under-estimation for head and MSK pain and exhaustion than for psychological distress. It was not possible to conduct a sensitivity analysis for the symptom identification strategies, and suitable population prevalence estimates were not available for each symptom for comparison (as described in the discussion sections of Chapter 6). Thus, the extent of the underestimation for my sample and whether it varies by exposure group is unknown; for example, whether it is more in caregivers than unexposed mothers (which was theorised given the model of health services utilisation and my finding that caregivers may have reduced healthcare-seeking behaviour for psychological distress).

The primary care records of the mothers were searched for clinical codes (signs, symptoms and diagnoses) specified for six common symptoms associated with caregiver burden and which have a relationship to acute as well as chronic stress. Evidence of an association between caregiving and each symptom had been found in the literature. As the number of mothers visiting the doctor about each symptom was low, the symptoms were combined into three groups for the analyses (one group for the latent class analysis). Although grouped because of clinical similarities, the amount of unavoidable clinical heterogeneity was increased. It was not possible to assess the extent to which each individual symptom was associated with caregiver status. For example, far fewer mothers visited

the doctor about stress than common mental disorders. Whether there were differences in the size or significance of the influence of caregiving on these outcomes is unknown. Combining the individual symptoms also skewed the estimates of clinical levels as, for example, combining sleep problems (52.9%) and fatigue (0%) in the caregivers resulted in an estimate of 9.2% with symptoms above the clinical threshold.

9.4.2 Pre-natal factors

Unlike other studies, I found no evidence of greater pre-natal ill-health or healthcare use in caregivers than other mothers, or of an association between pre-natal ill-health or healthcare use and caregiver status (as the outcome). My study design may have limited the ability to detect patterns between caregiving and health as found in other studies including those using health record data. Possible reasons for this include: my sample differed from those in the other studies; it may not have been possible to discern these patterns for my selected symptoms; or the relationship between pre-natal ill-health and caregiving had greater latency (identifiable over a longer time period than 12 months).

Mothers recruited to the BiB cohort were asked to complete the General Health Questionnaire-28 (GHQ-28) at 26-28 weeks gestation (GL Assessment, 2019). It is a measure of psychological distress, including items to detect somatic symptoms, anxiety and insomnia, social dysfunction and severe depression (Goldberg, 1979). Prady et al. (2016a) identified a large disparity between the number of mothers with psychological distress detected via the GHQ-28 versus primary care records. In a subsample of BiB mothers, 14% had elevated GHQ-28 scores above the clinical threshold for distress three years after the child's birth, but Prady et al. estimated that as many as half of the mothers with distress would be missed if prevalence was estimated via primary care records alone. I did not request the GHQ-28 total factor or individual item scores for my sample (or for the subset used in Prady et al.'s study) as issues of its reliability in the minority ethnic groups have been identified (partially mitigated by the total score) (Prady, 2013a). The GHQ-28 data could have presented an opportunity to examine the extent to which the symptom prevalence in my sample differed from those of other studies or if there was greater pre-natal psychological distress in the exposed than unexposed mothers that was not identified via primary care data. However, the data was only applicable to psychological distress, which was not the only symptom of interest in my study, and the post-natal GHQ-28 data was not available for the full cohort.

As shown for the post-natal outcomes, ill-health and healthcare use are influenced by sociodemographic factors. The same will be true of pre-natal ill-health and healthcare use. Thus,

some of the sizeable association between pre- and post-natal ill-health and healthcare use will be accounted for by the sociodemographic factors. Mothers with specific sociodemographic characteristics which make them less likely to visit the doctor after the child's birth, will also make them less likely to visit before the child's birth. The risk of symptom under-detection in these groups may be even greater than identified. Caution must also be exercised in over-stating the importance of pre-natal healthcare use as less than a quarter of mothers with post-natal ill-health visited the doctor about the symptom both before and after the child's birth (presented in Section 5.5.2.1, Table 26).

9.5 Measurement accuracy

A disadvantage of performing a secondary analysis of an existing cohort was the inability to independently verify the exposure or maternal symptoms or to collect additional data. The characteristics of the BiB cohort and aspects of the study design limited the comparability of my results with those of other studies. Other studies have provided evidence of relationships between a wider range of maternal and child characteristics and caregiver ill-health and/or healthcare use than could be included in my analyses.

9.5.1 The point of exposure

I used the child's date of birth as a proxy for the point of exposure, performing comparisons of mothers' health and healthcare use before and after this date. This was inaccurate as children with disabling conditions and disability indicators rarely receive a diagnosis at birth. Mothers of children with Down syndrome and other congenital anomalies (that can be tested for in utero) will often know the child's diagnosis before they are born; whilst the average age of ASD diagnosis in the UK is 4.8 years (57.6 months) (Brett, 2016). These typical pathways to diagnosis were also found in my sample (mean age in months (range) at diagnosis: Down syndrome 0.3 (0-3); ASD 48.7 (32-60)) (presented in Section 5.4.1.1, Table 11).

Some mothers find the period of noticing and seeking a diagnosis for their child's atypical development highly stressful, and others find adjusting to the diagnosis very challenging (Sloper, 1993; Trute, 2009). I have highlighted the low number of children in the BiB sample to receive disabling condition diagnoses during the preschool period. Instead, the majority had disability indicators. By using the child's date of birth, my study assessed the relationship between caregiving and ill-health and healthcare use during the period when every child received a condition or indicator diagnosis and every mother was (I have assumed) experiencing caregiver burden related to their

child's disability. I did not know when the mothers first noticed or sought help from a healthcare professional about their child's atypical development, so I could not look at the relationship between the period directly around diagnosis (including time taken to receive a diagnosis) and the outcomes.

9.5.2 Excluded covariates

There was strong theory supporting the expectation of an independent relationship between caregiving and ill-health and healthcare use due to caregiver burden, yet some of the estimate of effect may have been due to inaccurately or unmeasured factors. Although a few more covariates were included in the descriptive analyses, the number of covariates included in the bi and multivariate analyses was restricted to mitigate overadjustment.

The decision to exclude was based on the covariate:

- not being available for the BiB cohort e.g. caregiver self-perception and personality which are included in the model of caregiving process and caregiver burden (see Section 2.2.1);
- difficulties accessing or limitations with the data (discussed in Section 4.10.4) e.g. child behavioural problems, health behaviours and preterm birth;
- only being applicable to the exposed mother-child dyads e.g. disability diagnosis and child's age at their first condition or indicator diagnosis

The inclusion of excluded factors applicable to all mothers could have improved the precision of the estimate but would have required the exclusion of some or all the covariates used in the models to avoid over-fitting. A separate analysis of the exposed mothers, including only the variables applicable to this group could have investigated variation in the relationship between caregiver burden and ill-health and healthcare use; but was precluded by the sample size.

9.5.3 Socioeconomic status

Efforts were made to adequately measure socioeconomic status using a range of variables that are strongly associated with socioeconomic status (Galobardes, 2006b). The sample was from the largely bi-ethnic and economically disadvantaged cohort, thus variables which were reliable and distinguished between different levels of this disadvantage within the sample (e.g. the Index of Multiple Deprivation) (Wright, 2013; Department for Communities and Local Government, 2015) were included in the bi- and multivariate analyses (Fairley, 2014). However, these covariates were also limited (to an extent) by missing data, and none was a perfect measure of the multidimensional

concept of socioeconomic status. As such, inferences about the association between socioeconomic status and the outcomes could not be made based on the results of a single variable – evidence produced for one variable may be erroneous or indicative of a mechanism other than socioeconomic status (Galobardes, 2007). The ability to distinguish between levels of disadvantage was also inhibited by the necessity to exclude and collapse several variables in the analyses to protect anonymity and prevent overadjustment (Office for National Statistics, 2006).

The mother's sociodemographic information was collected during pregnancy, without routine follow up to measure change in socioeconomic status. Families of disabled children have been shown to have greater expenses than other families, and are more likely to be in receipt of benefits related to low income (with loss of income related to unemployment due to their caregiving role) (Kassa, 2019; The Children's Society, 2011) (described in Section 1.3.4). As economic disadvantage is a predictor of ill-health, some of the increased prevalence in the caregivers may be due to adverse economic circumstances related to caregiving, rather than directly attributable to caregiver status (McManus, 2011). However, this data was not available and its inclusion in the multivariate regression analyses and investigation of possible interaction between changes in socioeconomic status and caregiving and the health outcomes would not have been possible due to the exposure group size. Other potential moderators have been identified in the relationship of caregiving to healthcare use but could not be investigated for the same reason. Family breakdown and lack of social support increase caregiver isolation and socioeconomic disadvantage which increases the risk of ill-health (Hatton, 2009b; Montes, 2008; Cantwell, 2015; Carlson, 2017; Fonseca, 2014; Hassall, 2005; Kyzar, 2012), but raises barriers to accessing primary care services (Reisinger, 2018).

9.6 Generalisability

The generalisability of the findings of my study might be limited by the unique ethnic and social composition of the sample and the disability diagnoses that comprised the exposure group. However, caregiver burden is not unique to the exposed group or to Bradford – over 1.1 million children in the UK are disabled (8% of children aged 0-18) (Department of Work and Pensions, 2018; Office for National Statistics, 2018). The mechanism by which caregivers of disabled preschool children experience greater ill-health and which may be under-detected due to low primary healthcare-seeking behaviour is generalisable to other caregiver groups; although the size and significance of the association between caregiving and the outcomes may vary.

The proportion of mothers with symptoms was within the range found in other studies (as contextualised in the discussion section of Chapter 6). The BiB cohort is largely representative of the general population of metropolitan Bradford (although differences between the sample and the cohort were not assessed) (Wright, 2013), with some generalisability to other deprived urban multi-ethnic populations in UK cities (Prady, 2016a; World Health Organization, 2003). Due to high socioeconomic deprivation in the BiB sample, greater maternal physical and psychological health could be expected than in more affluent, white British or rural locations.

By adjusting for sociodemographic factors in the regression analyses, the influence of deprivation on the measurement of the relationship of caregiving to ill-health was restricted. However, the measurement of the relationship between the exposure and the outcomes in the adjusted models was still predicated on healthcare use, which is influenced by sociodemographic factors (discussed in Section 9.4.2). Thus, the generalisability of the findings to wider urban maternal and caregiver populations was increased but not mitigated.

The findings show an adverse association between caregiving and ill-health for a clinically heterogeneous group of preschool children with many unknown disability characteristics (behavioural problems, severity, additional health problems). Thus, the size and significance (and possibly direction) of the association may vary in exposure groups comprised of e.g. more children with Down syndrome and fewer with developmental delay of unknown severity. Although my findings are consistent with the findings of other studies, their generalisability to the wider population of preschool children with developmental disabilities cannot be assumed.

9.7 Chapter summary

In this chapter, I have discussed the overall strengths and limitations of the comparative cohort study.

In the next (and final) chapter of this thesis, I provide an overview and discussion of my entire research project and its relevance and implications for practice and research.

Section C: Discussion and recommendations

Chapter 10 Overall discussion and recommendations

This chapter discusses the wider relevance of my research findings to caregiver burden, the new understanding my research has contributed and the implications for practice and research.

10.1 Introduction

It is accepted that "health reflects the patterns of social, psychological and biological advantages and disadvantages experienced by the individual over time" (Bartley, 2004, p. 115). My thesis reflects the veracity of this statement for the population of caregivers of preschool disabled children, extending it to healthcare-seeking behaviour via primary healthcare use and discussing how caregiver burden can be understood as a disadvantage due to its social, psychological and biological impact.

The chapters of this thesis address the theory and evidence behind the assumption that caregiver burden (the additional demands and obstacles experienced by caregivers compared with other mothers) adversely affects caregiver health and presents barriers to primary healthcare-seeking behaviour and healthcare use, with variation associated with different disability diagnoses, pre-natal symptoms and socioeconomic factors.

I summarise the extent to which the findings from my research and knowledge of the literature presented in this thesis (Chapters 1-8) support the thesis hypotheses (originally stated in Section 2.5):

1. Mothers of children with developmental disabilities have greater ill-health than other mothers during the preschool period.
2. Mothers of children with developmental disabilities have lower healthcare-seeking behaviour and primary healthcare use for maternal symptoms of ill-health than other mothers during the preschool period.
3. Mothers of children with ASD have greater pre- as well as post-natal ill-health and healthcare use than caregivers of children with other developmental disabilities during the preschool period.

4. Caregivers of children with developmental disabilities with socioeconomic disadvantage have greater ill-health and healthcare use than more advantaged caregivers during the preschool period.

5. Caregivers with pre-natal episodes of ill-health and healthcare use have greater ill-health and healthcare use during the preschool period.

I will then discuss other important contributions made by my results and the limitations of the thesis overall, before moving on to a discussion of the implications of my research for practice and research.

10.2 Hypothesis 1 - Caregiver burden influences health

The existing literature (theory and research) on caregiver burden highlights the additional challenges experienced by caregivers of disabled children including during the preschool period (Chapters 1 and 2) and the evidence of greater ill-health in caregivers of preschool disabled children compared with mothers of typically developing children (Chapter 3). The evidence from my systematic review (Chapter 3) and cohort study supports the first hypothesis - there is greater ill-health in mothers of preschool children with developmental disabilities compared with other mothers during the preschool period (Chapters 5 and 6).

My research contributes new understanding to the existing evidence on the relationship between caregiving and ill-health. My systematic review (Chapter 3) summarises the evidence to show that the disparity in the health of caregivers of children with developmental disabilities compared with mothers of typically developing children is present during the preschool period, indicating that caregiver burden during this period is sufficiently great that the health of caregivers is affected. The most evidence is for stress and depression as few studies looked at other symptoms. My cohort study (Chapter 5-6) shows that caregiving is associated not only with a higher prevalence of psychological distress (stress and common mental disorders) in caregivers than other mothers, but also of exhaustion (fatigue and sleep problems) and possibly headaches and musculoskeletal pain. Thus, caregiver burden has a wider adverse influence on health during the preschool period than previously recognised.

10.3 Hypothesis 2 - Caregiver burden influences healthcare use

The background section of my thesis (Chapters 1 and 2) shows that there is reason to expect caregivers of disabled children to experience additional barriers to healthcare use for their symptoms of ill-health, such as additional time constraints, unsuitable transportation, stigma and lack of childcare. There is evidence of low healthcare use by caregivers in the UK context, despite the evidence of greater healthcare use by caregivers in other high income countries.

My cohort study (Chapters 5, and 7-8) produced evidence which largely rejects the second hypothesis and contributes new understanding of the relationship between caregiving and healthcare use. In Bradford during the preschool period, caregiver burden may not prevent mothers with healthcare-seeking behaviour from visiting the doctor as often as other mothers. However, it may prevent caregivers from visiting the doctor in the first place (no healthcare-seeking behaviour) for some symptoms, particularly psychological distress. Unlike other studies, I have shown that these mother-caregivers do not have the higher post-natal healthcare use observed in other studies, and that the relationships between caregiver burden and healthcare use may vary by symptom.

10.4 Hypothesis 3 - Disability diagnosis may influence caregiver ill-health and healthcare use

Variation in child disability diagnosis (e.g. whether a child has Down syndrome or ASD) was theorised and has been found to mediate caregiver burden and the relationship of caregiving to ill-health. The specific diagnosis of ASD has been associated with higher maternal ill-health and healthcare use (Chapters 1 and 2). In my research, I observed and found evidence of variation in caregiver ill-health and healthcare use by disability diagnosis but insufficient evidence to accept the hypothesis (Chapters 5 and 8).

In my systematic review (Chapter 3), disability diagnosis only explained a small amount of the heterogeneity in the data on caregiver ill-health. Whether between-group differences observed (e.g. a smaller effect of caregiving on health for mothers of children with Down syndrome versus ASD or mixed disability groups) were due to differences in socioeconomic status, rather than disability diagnosis, could not be investigated due to the inadequate sociodemographic data provided in most of the studies. In the descriptive analysis of the BiB sample (Chapter 5), small differences by disability diagnosis were seen for the mothers in the proportion with and mean consultation frequency for the symptoms of ill-health.

Due to the small specific disabling condition group sizes, no further investigation of the influence of disability diagnosis on ill-health was possible via regression techniques. Using latent class analysis, there was some evidence of variation in healthcare use by diagnosis, although only ASD was investigated. There was some evidence that caregivers (with pre-natal healthcare use) of children with ASD had a greater likelihood of high pre- and post-natal healthcare use but the reliability of the finding is limited. This analysis also highlighted the importance of awareness of the relationships between maternal sociodemographic factors and child disability diagnosis (discussed in Section 4.10.4.2).

What I can say with confidence, given the results of the aforementioned analyses, is that during the preschool period there is a relationship between caregiving for a child with a developmental disability and maternal ill-health, for a mixed sample of children diagnosed with specific disabling conditions (ASD, Down syndrome and cerebral palsy) and disability indicators. It is of note that, during the preschool period, not only is caregiving for children with disabling conditions associated with increased caregiver ill-health, so is caregiving for children with disability indicators.

10.5 Hypothesis 4 - Socioeconomic status influences ill-health and healthcare use

In investigating the influence of caregiver burden on ill-health and healthcare use, I explored the effects of socioeconomic status (using proxy measures e.g. education, ethnicity). These factors are known to have a considerable influence on health and healthcare use (Chapters 1, 2 and 4).

In my systematic review, there was insufficient/inadequate data to assess whether socioeconomic status might explain the high heterogeneity in the data on the association between caregiving and ill-health. By including a range of indicators of socioeconomic status in my cohort analyses, I found evidence of a greater likelihood of ill-health and its under-detection in mothers with socioeconomic disadvantage, and of the under-detection of psychological distress in Pakistani mothers (Chapter 7). These findings highlight sociodemographic characteristics associated with an additional risk of ill-health and associated with undetected and therefore untreated symptoms. Thus, socioeconomically disadvantaged caregivers may be at greater risk of under-detected ill-health and Pakistani mothers at greater risk of under-detected psychological distress than white British and more affluent caregivers. This is likely, therefore, to result in health disparities between caregivers as well as in the health disparities shown between caregivers and other mothers during the preschool period.

The inclusion of indicators of socioeconomic status in the analyses also aided the interpretation of the associations observed in the subgroups identified in the latent class analysis. For example, in my BiB sample, I found evidence of the known association between preschool child ASD diagnosis and high maternal education and white British ethnicity (Chapter 5). Instead of assuming that caregiving for a child with ASD increased the probability of low healthcare use (in the latent class analysis), I could identify the association between maternal high education and low healthcare use (i.e. that there were more ASD caregivers in this subgroup because mothers with high education receive earlier ASD diagnoses for their children).

10.6 Hypothesis 5 - Pre-natal influences post-natal ill-health and healthcare use

The existing literature and theory show that pre-natal influences post-natal ill-health, healthcare-seeking behaviour and healthcare use (Chapters 1 and 2). The relationship of pre-natal to post-natal ill-health was not investigated in my systematic review as this factor has not typically been included in caregiver-health research. In the cohort study (Chapters 5-8), I found a strong association between pre- and post-natal ill-health, health-seeking behaviour and healthcare use for all mothers. By using a cohort study design and adjusting for pre-natal ill-health, my findings support (but cannot prove) the causal pathway in the theoretical model of caregiving process and burden from caregiving to ill-health (Chapter 2). Based on my findings, I recommend the inclusion of pre-natal ill-health as an additional background or contextual factor in this model.

I found no evidence of significant differences in pre-natal health or healthcare use between the exposed and unexposed mothers or between caregivers of children with ASD and other disabilities (the evidence for ASD caregivers was unreliable as explained in Section 10.4). My results offer a counterpoint to other studies that found greater post-natal healthcare use due to greater pre-natal ill-health in caregivers compared with unexposed mothers (Brehaut, 2019a; Arim, 2019) (Chapters 7 and 8). The chief difference between mine and these other studies is the composition of the exposure group. They included children with different disabilities (from those in my case ascertainment strategies) or health problems, whilst I may have included children with health problems (in addition to disabilities) but did not select for them (Arim, 2015). The disparity between our findings cautions against the blanket assumption that pre-natal factors could have a causal relationship to caregiver status and account for the greater post-natal ill-health and healthcare use observed in caregivers.

10.7 Additional contribution - Identifying disabled preschool children via primary care records

In meeting the primary objectives to advance the understanding of the relationship between caregiver burden and ill-health and healthcare use during the preschool period, I necessarily developed a strategy to identify children with developmental disabilities. Through this, I have highlighted the issue of deferred condition diagnosis, whereby most children with disabling conditions do not receive a condition diagnosis until above the age of five (outlined in Section 9.3.1). This has implications for research that uses strategies to identify caregivers and disabled children via primary care records (resulting in under-identification).

10.8 Reflection on the limitations of the research project

I started the thesis with an idea to investigate the health of mothers of disabled children with an approach that included the social determinants of health. As I got to know the literature, I was struck by how little was known about maternal symptoms other than stress and depression, and the lack of focus on the preschool period. The results of the studies I read were limited by small disability groups, they often focused on a specific disability, and did not include a comparison group or did not draw it from the same population. The extent to which caregivers' symptoms were of a clinical magnitude was frequently unreported. I was aware of criticisms of the assumption of caregiver ill-health due to the burden of caregiving but also of charities' research highlighting the challenges of the lived experience of raising disabled children. I became interested in understanding whether caregivers did have higher levels of clinical symptoms and if they were demonstrating healthcare-seeking behaviour via primary care services. As a result of my aim to fill these gaps, a series of pragmatic decisions were taken which made the studies possible but limited the generalisability of the findings.

In developing and interpreting my research, I encountered three major challenges: operationalising disability; unmeasured mediators and moderators; and comparability with other studies. These and other limitations have been discussed in depth in the context of the systematic review (Section 3.5.5.2) and cohort studies (Section 8.6). I present a brief overview of the issues as they have major implications for the overall recommendations that I can make from this thesis for practice and research.

10.8.1 Operationalising disability

Operationalising the definition of disability and its application in the different studies in this thesis was a major challenge. I did not want to focus on a specific disabling condition (e.g. ASD) because caregiver burden is experienced by all caregivers of disabled children due to additional demands and not only by caregivers of children with specific disabilities. However, defining disability in this way required the exclusion of children who would not be expected to increase the caregiver burden. In the systematic review this restriction limited the number of papers and thus the accuracy of the meta-analysis; and studies from non-UK countries were included, despite the UK focus of the thesis. In my cohort study, it necessitated the inclusion of children with developmental delay and unspecified developmental disorders, thus increasing, rather than decreasing, the heterogeneity.

10.8.2 Mediators and moderators

Given the limited literature and the challenge identifying disabled children via primary care clinical codes, the mediating influence of additional disability characteristics (severity and behavioural problems) in the relationship of caregiving to ill-health and healthcare use was not investigated in either the review or the study. These characteristics were subsumed in my measurement of the relationship between caregiver status and the health outcomes. Their contribution to these estimates and whether it varies by symptom is unknown. These factors may explain the high variability observed in the effect estimates produced in the meta-analysis. As such, the results of the thesis are broadly applicable to mothers of preschool children with developmental disabilities but the magnitude of the relationship between caregiving and ill-health may vary depending on the disability composition of the population and presence of behavioural problems and/or high care needs which increase caregiver burden (Woodman, 2014b; Bramlett, 2009).

The same issues prevented the inclusion of many of the factors associated with ill-health and healthcare use as described in Chapters 1, 2 and 4. I prioritised the inclusion of factors in my analyses that were likely to have a substantial influence on both health and healthcare use, to produce research that would make a valuable contribution to the understanding of caregiver burden. Efforts were made to include disability diagnosis, socioeconomic status and pre-natal ill-health and healthcare use in the analyses. However, the intrapsychic and coping factors in the model of caregiving process and caregiver burden and many factors in the fields of environment, population characteristics, health behaviour and outcomes in the model of health services utilization were exempt from the analyses for a variety of reasons (outlined in Chapter 4). As such, these maternal

factors were potential but unmeasured moderators in the relationship between caregiving and the health outcomes.

My thesis provides support for the theory that caregiver burden causes ill-health and evidence of healthcare underuse by mothers during the preschool period, but I cannot provide any insight into protective factors (other than inference about socioeconomic advantage and healthcare-seeking behaviour). This criticism has been levelled at many studies in this field (Gardiner, 2012).

10.8.3 Comparability

My focus on the preschool age group, limited the ability to contextualise my findings as most studies in caregivers of disabled preschool children used cross-sectional study designs (highlighted in Chapters 3 and 6). I focused on the preschool period due to the amount of childcare required by the mother (typically more than after the child has started school), and it is when developmental divergence between disabled and other children may be noticed if not diagnosed (discussed in Chapter 1). However, I could not infer whether caregiver burden increased over time or the extent to which noticing developmental differences is a trigger for stress and associated with subsequent ill-health.

The ability to contextualise my findings was further hampered by the lack of UK research on parent-caregiver healthcare use and of a specific theoretical model of caregiver healthcare use. Unlike caregiver health, it remains largely unknown whether any child or caregiver characteristics (e.g. caregiver strain or intrapsychic) influence healthcare-seeking behaviour via primary care services. No research linking caregiver clinical need (e.g. via survey) with caregiver healthcare use (e.g. via patient records) had been performed for me to draw on. Although this presents a limitation, it also highlights an opportunity for future research.

10.8.4 Impact of these limitations

The overall impact of these limitations is that I do not know what specific aspects of the caregivers' experience causes the burden that is associated with ill-health and whether they are the same for caregivers of children with the disabling conditions and disability indicators. I do not know if these aspects are the same for children with disabilities associated with conditions not included in my research (e.g. spina bifida, hearing and visual impairment) or other age groups. I do not know whether and how the burden of caregiving changes over the preschool period. I theorise that the unique burden of the preschool period is identifying atypical child development and seeking/receiving

a diagnosis; but, based on my research, I cannot prove that this is a cause or even associated with caregiver ill-health. Indeed, I cannot rule out the possibility that the greater ill-health found in caregivers compared with other mothers is due to the (unmeasured) influence of child behavioural problems, disability severity, the impact of increased financial hardship or social isolation associated with caregiving (among other possible factors).

The outcome of my research is to show that caregivers of children with disabling conditions and disability indicators have poorer health than other mothers during the preschool period. There is a risk of even greater ill-health or the under-detection of ill-health in some sociodemographic groups (e.g. psychological distress and Pakistani mothers). The consequence of the above-stated limitations is that I do not have the evidence to make recommendations on:

- how to reduce caregiver burden (which aspects of the burden needs reducing and how (e.g. reduce the time to child disability diagnosis, more financial or formal (childcare/short breaks) support);
- how to improve caregiver health (prevent or reduce clinical levels of ill-health via what interventions);
- whether the reduction of particular symptoms should be prioritised (whether some symptoms/conditions of ill-health have a greater adverse impact on the caregiver, their child and family than others e.g. depression versus headaches);
- when (at which time point during the preschool period) might interventions or other forms of support have the most positive or long-term impact;
- which barriers to healthcare-seeking behaviour via primary care could be addressed to try to prevent the under-detection of caregiver ill-health (e.g. the perception that the doctor cannot help or lack of childcare); and
- which caregivers might benefit from any specific interventions to reduce burden or ill-health and low healthcare-seeking behaviour (e.g. specific disability or sociodemographic groups).

10.9 Implications for practice

To reduce the differences observed in the ill-health and healthcare-seeking behaviour of caregivers and other mothers in this thesis, and given the strengths and limitations of the research outlined (Section 10.8), I cautiously recommend:

1. that support aimed at reducing the caregiving burden of mothers of disabled children:

   a. is also available to caregivers of children with disability indicators during the preschool period;

   b. includes consideration of the widespread social and financial implications of caregiving; and

2. promoting cultural awareness in approaching and discussing ill-health with caregiver groups with lower healthcare-seeking behaviour for symptoms of psychological distress.

Few studies have evaluated the efficacy of specific interventions to reduce parent-caregiver burden and improve health (e.g. well-being, stress and depression) including during the preschool period (Barlow, 2018). Those performed show some evidence to support the use of cognitive behavioural and psychoeducational approaches, but the studies were not exclusively in the preschool age group and not in the UK (Schultz, 1993; Nixon, 1993; Singer, 2007; Canary, 2008; Tomasello, 2010). There is evidence that parenting programmes can reduce maternal anxiety or depression; but few studies have assessed effectiveness for caregiver groups (Barlow, 2002; Barlow, 2012). There is some evidence for specific disability groups (e.g. caregivers of children with ASD) (McConachie, 2007), but my findings are more broadly for caregivers of children with developmental disabilities and delay. Furthermore, most public services that provide support to families with disabled children in Bradford and the UK (e.g. Child Development Centres and Family Hubs) are generic, not only for children with a particular disability (Bradford Local Offer, 2019). Thus, I cannot recommend any specific interventions to reduce caregiver burden or reduce the risk of caregiver ill-health.

Instead, I identify how the existing health and social care system could be optimised to identify caregiver ill-health and provide support without increasing the burden experienced by the caregiver in trying to healthcare-seek via primary care services. I identify how my findings and the arguments presented in this thesis support early intervention and signposting or information approaches. First, I discuss the role and limitations of primary care services in supporting caregivers.

Please note that ‘early intervention’ is not a specific intervention or programme but the generic term used for taking a preventative approach in health and social care services (i.e. trying to give caregivers support before ill-health emerges) (World Health Organization, 2012). Early intervention approaches to support children and families of children with developmental delay and disabilities are recommended by the World Health Organisation: “if children with developmental delays or disabilities and their families are not provided with timely and appropriate early intervention, support

and protection, their difficulties can become more severe—often leading to lifetime consequences, increased poverty and profound exclusion" (World Health Organization, 2012, p. 4).

10.9.1 Barriers to supporting caregivers in primary care

In this thesis, I highlight the greater risk of caregivers not visiting the doctor about symptoms of psychological distress than other mothers; and that this risk may be higher for Pakistani and socioeconomically disadvantaged caregivers. Primary care doctors and Carers UK have highlighted the role of GPs and other primary healthcare staff in identifying and supporting caregivers (including parent-caregivers) when they attend a healthcare service (Greenwood, 2010; Carers UK, 2012). They highlight the especial need for identifying unrecorded caregivers and those with high caregiver burden which may be affecting their capacity to perform the caregiving role.

Carers UK states that GPs and other staff in primary care services should inform and signpost family-caregivers to ensure they maintain good health as part of an early intervention and prevention approach (Carers UK, 2012). However, 76% of over 1,000 families of disabled children surveyed said that their GP had never offered them support with their caregiving role (Contact a Family, 2011b). GPs have identified the following barriers to supporting caregivers:

- healthcare professionals' lack of awareness of the risks of caregiving to caregiver health;
- medical records not specifying when someone is a caregiver and the extent of their caregiving role (e.g. providing more than 20 hours care per week);
- language and cultural barriers experienced by minority ethnic groups;
- caregivers' and healthcare professionals' assumptions that caregivers will experience stress and ill-health due to the demands of the caregiving role; and
- caregivers' feeling that they do not have time or energy to support their own health e.g. not finding time to exercise or rest (Arksey, 2005).

Arksey and Hirst (2005) looked at healthcare use by informal caregivers of someone of any age and concluded that the main challenge is making primary care services accessible to caregivers so that they can easily consult a GP about their health issues. Children with disabilities and health problems

have greater primary, secondary and emergency healthcare use than other children, including in Bradford (Ray, 2009; Bishop, 2018; Newacheck, 2005; Schieve, 2012; Liptak, 2006; Boulet, 2009; Swensen, 2003; Russell, 2019). Some parents of disabled children say they prefer to use emergency services to primary healthcare, especially if their child has complex health needs (Brehaut, 2019b; Fairthorne, 2016a; Contact a Family, 2011b). There is also an association between clinically significant levels of parenting stress and increased healthcare use for mild acute illnesses in children by parents in the process of seeking a developmental disability diagnosis (Voigt, 2009). Therefore, highly stressed parents may visit the GP more often. Greater awareness of the relationship between caregiving and ill-health is needed by GPs but also by other healthcare professionals, otherwise caregiver ill-health could be missed.

10.9.2 Asking about caregiver health during child healthcare appointments

I recommend that healthcare professionals (including health visitors and secondary care staff) in contact with caregivers receive training to be aware of the risk of ill-health in caregivers from the point at which significant concerns about atypical child development are raised. These professionals could then identify high caregiver burden and ill-health at scheduled appointments for the child without increasing caregiver burden via having to make a separate appointment to discuss their own health (Brehaut, 2019b). This training should highlight the risk of caregiver physical as well as psychological ill-health, and signs that caregivers are at risk of ill-health. For example, in a survey of 2,000 parents of disabled children in the UK, 31.5% had sought advice and 68.5% had asked for help with their child's sleep difficulties from GPs and other health and social care professionals involved in their child's care (such as health visitors, learning disability nurse, paediatrician, occupational therapists and physiotherapists) (Family Fund, 2013). If the mother visits about the child's sleep, it is a strong indication of clinical levels of tiredness in the caregiver (Weiss, 2014; Crabtree, 2003; Robinson, 2004) - if the child is not sleeping well, the mother's sleep quality will also be affected (Chambers, 2015). Awareness of the under-detection of psychological distress and somatisation in minority ethnic mothers (including caregivers) should be included (Bekker, 2009; Prady, 2013a; Farooq, 1995); and awareness that there may be cultural differences in identifying and coping with child disability that could affect the caregiver's health and willingness to healthcare-seek via primary care (Chambers, 2015).

Health visitors, in particular, are ideally placed to support families and identify ill-health in the high stress period of early disability identification (especially as it is part of their remit to identify disability

or concerns about developmental delay) (Department of Education, 2015). They have an essential role in monitoring mothers' mental health during the early years (birth to 2.5 years) (NHS, 2017), so are well placed to discuss symptoms of mental ill-health and possible causes of these issues (Chu, 2009; Wayte, 2012). They are required to ask mothers about their past and present mental health and deliver early intervention support (Department of Health and Social care, 2018). Some localities have a specialist health visitor for children with disabilities who is particularly aware of the challenges experienced by families during this period and can train generic health visitors (Contact a Family, 2015). This training should include the factors highlighted above.

However, I note that a Freedom of Information request in 2012 showed that this role has not been provided in Bradford since 2006 (Ballinger, 2012). Then, between 2015 and 2019, the health visitor workforce in the UK fell by 25% (from 10,000 to 8,000 following the transition from the commissioning of health visitors by the NHS to local authorities in 2015) (Bunn, 2019; Mitchell, 2019). GPs have also noticed increasingly little contact with health visitors. Only 23% reported seeing or communicating with a health visitor at least once a week and 33% 1-2 times a month (Bryar, 2017). In the face of inconsistent and inadequate service provision, it may be more important than ever that awareness is raised across health (and social) care services, and not assumed that caregiver health issues will be detected via health visitors or GPs.

10.9.3 Family support

This thesis largely uses the stress-health mechanism via caregiver burden to understand caregiver ill-health. I have shown that caregivers of preschool disabled children have worse health than other mothers, with limited variation by disability diagnosis and including mothers of children with disability indicators. This supports early intervention and signposting and information aimed at reducing caregiver burden, as recommended by other researchers (Tomasello, 2010; Canary, 2008; McConachie, 2007). There are many areas in which caregivers would like health and social care services improved to reduce their burden. For example, not having to attend appointments with different professionals in different locations on different days; navigating the health and social care systems; and repeating information to every new professional involved in their child's care (Bourke-Taylor, 2010). From my research, I cannot endorse any specific changes or improvements; but I can highlight the need to reduce caregiver burden as early as possible (i.e. during the preschool period), with a focus on limiting the socioeconomic impact of caregiving (to prevent disadvantaging further already disadvantaged families).

10.9.3.1 Early intervention

Based on my thesis and supported by other research, all caregivers should be able to access support from when the child receives a disability indicator or disabling condition diagnosis (Clavering, 2007; Davis, 1991). Families are referred to a specialist paediatric or child development centre in response to concerns raised about the child's development. Interventions at this point, the point of entry to the highly stressful disability diagnosis process, have been shown to prevent the development of caregiver ill-health as well as child behavioural problems and improve parent-child attachment (Neece, 2014; McConachie, 2007). In recognition of the risk of psychological ill-health in parents of disabled children, the Department for Education and Skills and Department of Health (2002) recommended early intervention (birth to age 2) which includes support for the child, parents and parent-child relationship.

However, early intervention is not routinely offered or available to families at this point and does not necessarily take the family's individual circumstances into account, including their cultural background, (Borek, 2018; Canary, 2008; Department for Education and Skills, 2002).

10.9.3.2 Signposting and information

Interventions that take the family's sociodemographic circumstances into account and aim to reduce burden whilst being realistic about the child's characteristics and families' circumstances may be most effective (Borek, 2018; Davis, 1991; National Academies of Sciences, 2016). I showed that socioeconomic disadvantage (prior to the child's birth) is associated with increased ill-health and healthcare use but decreased healthcare-seeking behaviour during the preschool period (and most likely before). Therefore, disadvantaged caregivers are at the greatest risk of under-detected and therefore untreated ill-health. Further, (although not examined in the studies in this thesis) disadvantage is likely to grow as caregiving has a direct and indirect impact on socioeconomic status (discussed in Chapter 1) (Saunders, 2015; Emerson, 2006b). The most obvious way to reduce caregiver burden and its impact on socioeconomic status is via signposting to information and services (Contact a Family, 2018; Scope UK, 2017). Not least because this is a low cost approach, when many paediatric services cannot extend to funding counselling or interventions to reduce caregiver stress and ill-health (Pickering, 2010; Davis, 1991; Case, 2000).

Caregivers report that good quality and personalised information provided by health and social care professionals and signposting to information reduces caregiver burden and stress during the diagnosis stage (Mitchell, 2002; Järvelin, 2002). For example, signposting to benefits and support for

which disabled children aged under five and their caregivers may be eligible (such as an education, health and care needs plan, disabled living allowance for children, free education and childcare for two year olds, and grants for holidays (Contact a Family, 2018; Contact, 2019; GOV.UK, 2019b; Family Fund, 2019). Caregivers receive information from healthcare professionals about their child's condition and prognosis (to varying degrees and satisfaction), but do not as routinely receive information about their health, social and financial support available, and about local as well as national resources (Pain, 2001; Lotze, 2010).

A huge amount of information is available for and to parents online via statutory and third sector organisations (NHS, 2018b), including information on stress and depression in caregivers (Carers UK, 2019). Every local authority now publishes and maintains online information on the education, health and social care provision available for disabled children and their families (called the Local Offer) (HM Government, 2014). However, the amount of information can be overwhelming and hard to navigate, and parents who are less web-literate or are not fluent in English will be disadvantaged; thus, people at risk of social (and health) inequalities can be further disadvantaged. Parents may not know what it reliable and relevant to them at different times, such as at diagnosis, during the preschool period, starting school etc. (Blackburn, 2005; Mitchell, 2002). Health and social care professionals in primary, secondary and community services are well placed to signpost caregivers to support and information (including but not limited to the Local Offer as it has its limitations (Butler, 2017)). A clear pathway for the communication of relevant information at this point should be established.

10.10 Future directions for research and development

In the background chapters (1-3), I identified the research gaps that I aimed to fill through performing my systematic review and cohort study. I now give a brief overview of the main areas (largely informed by the limitations and unanswered questions arising from my cohort study) where I believe research and development is needed to further understand my findings and the wider field of caregiver health and healthcare-seeking behaviour via healthcare use.

10.10.1 Healthcare use

To my knowledge, I have performed the only UK study on the frequency of primary healthcare use by caregivers of disabled children for their own health, and guided by a theoretical model of healthcare use. Repeating my research in different cohorts would provide an understanding of geographical variation both in caregiver healthcare-seeking behaviour via healthcare use and in support received

by caregivers via primary care services. If similar results were found, this could show more widespread healthcare underuse by caregivers and increase the generalisability of my findings. To investigate the potential extent of under-detected caregiver ill-health, identification of the barriers and enabling maternal and child-related factors for caregivers' healthcare-seeking via primary care services is needed and whether these vary by symptom or child age. This could include investigation of the relationship between pre- and post-natal ill-health and healthcare use by UK caregivers using a longer pre-natal period than 12 months.

To assess the scale of the potential problem of under-detection, the assessment of clinical levels of ill-health in caregivers using gold standard assessment tools is required with comparison against measures of consultation prevalence (Bailey, 2007). For example, 72% of 1,148 UK families of disabled children surveyed had experienced psychological distress due to anxiety, depression or breakdown and 49% reported bad enough psychological distress to ask their GP for medication or had seen a counsellor (Contact a Family, 2011a). In my study, 35% of caregivers of preschool children visited their GP about psychological distress, but I have shown that this probably does not reflect the extent of the caregivers' clinical need (due to diminished healthcare-seeking behaviour).

Further research is needed to understand variation between reported and recorded ill-health and healthcare-seeking by parent-caregivers, such as sociodemographic differences between samples and how many caregivers are using alternatives to primary care e.g. third or private sector counselling, or accident and emergency services.

Appraisal of the extent to which healthcare services in contact with caregivers assess caregiver burden and provide family-centred support (that includes information and signposting about local and national benefits and support) is required. Improvements in this area could reduce the risk of growing socioeconomic and health inequalities between caregivers and other mothers and between advantaged and disadvantaged caregivers.

Replicating my research in a larger cohort and expanding the child age range would allow investigation by disability diagnosis and adjusting for factors excluded in my analyses (e.g. social support and child behavioural problems). A larger cohort would enable a more nuanced investigation of whether and how symptom prevalence and primary healthcare use for differing symptoms varies by disability diagnosis; and the interaction between disability and sociodemographic factors, including changes in socioeconomic status as a result of caregiving.

10.10.2 The period of child diagnosis

I have developed the only strategy for identifying preschool children with disabilities via primary care records. It can be used as a template for research and built on to incorporate more disabling conditions or behavioural problems. Further research is required to improve case ascertainment via primary care records for this age group, such as identifying how disability severity can be inferred using only routinely collected data (without accessing the free text content of primary care records), and to understand the pathway to child disability diagnosis.

I have highlighted the clinical practice of deferring disability diagnosis during the preschool period. Investigation of the impact of diagnostic uncertainty on caregiver health is required as this stressor may be a contributor in the caregiver-ill-health process. For data systems with linked mother and child health records, my strategy could be used to investigate regional variation in time to diagnosis and thus variation in practice. It could be used to examine whether there is greater caregiver ill-health in services with the longest time to child diagnosis, and thus the burden of the diagnostic process.

Despite caregiver statements that the period of disability identification and diagnosis are highly stressful, there is little empirical research on this period in relation to caregiver ill-health (Sloper, 1993). Studies have looked at caregiver adjustment but encompassing a wider child age range (Noojin, 1997; Sanders, 1997; Witt, 2003). The longitudinal investigation of changes in caregiver adjustment and health over time, and at key points of disability identification, diagnosis, and transitions between preschool, school and adult services have not been investigated. By identifying key points of caregiver burden and whether these vary by disability diagnosis, services and interventions that support families at high-risk intervals across the life course could be developed.

10.10.3 Qualitative and participatory research

In developing the background for this research project, I drew on many reports produced from survey data by UK charities and other organisations that support families with disabled children. Although providing invaluable background information, there were significant limitations with this research and its representativeness of the UK parent-caregiver population. Further, little of the published research was conducted by or in collaboration with these organisations or involved caregivers in the research process beyond the role of research subject. I would recommend that future research adopts a co-production approach (NIHR Involve, 2018), which could also ensure that the identified gaps in our

understanding of protective factors in the relationship of caregiving to ill-health and healthcare underuse receive greater attention (discussed in Section 10.8.2).

I used a quantitative approach to investigate caregiver ill-health and healthcare use, but qualitative research is needed to understand the phenomenon of caregiver burden, and if and how this varies between caregivers. My research shows that caregivers of preschool children with developmental disabilities have a greater risk than other mothers of ill-health. However, as highlighted in Section 10.8.4, my research does not show what stressors in the daily lives of these mothers or during the preschool period causes them the greatest stress. Qualitative research methods (e.g. in depth interviews or focus groups) could be used to investigate, for example:

- what caregivers of disabled children in Bradford think are the greatest stressors during the preschool period (including seeking, receiving and adjusting to the diagnosis), what might help reduce the burden of caregiving most, and whether the stressors and potential solutions vary by sociodemographic factors, particularly ethnicity;
- if and how the caregiving experience changes from preschool to school age and whether the experience of mothers of children with disabling conditions is different from those with disability indicators;
- what the barriers to healthcare-seeking behaviour are, and if or how these differ for healthcare-seeking behaviour and healthcare use; and
- whether the approaches recommended in Section 10.7 (awareness and training for health and social care professionals, early intervention, signposting and information approaches) would be effective or may still fail to detect and reduce ill-health in mother-caregivers.

10.11 Summary

In this chapter I have summarised how the research and discussions presented in this thesis have explored and added new understanding to the field of caregiver health and healthcare use, with recommendations for practice and implications for research. This thesis highlights differences in the health of caregivers of preschool children with developmental disabilities and other mothers, with caregiver ill-health (which may increase over time) known to adversely affect caregivers, their child and family. If caregiver burden and the risk of under-detecting (and thus under-treating) caregiver ill-health is not limited during this period, health inequalities not only between caregivers and other

mothers but also between advantaged and disadvantaged caregivers may persist and grow. The fact that the caregiver-health relationship extends to caregivers of children with developmental delay suggests that these associations emerge even earlier than expected - they are present when atypical development is identified and before the child has received a developmental disability diagnosis.

Appendices

Appendix 1 Further information for Chapter 2

A1.1 Permission to use the Model of Health Services Utilization

Figure A1. American Sociological Society permission form

AMERICAN SOCIOLOGICAL ASSOCIATION

Permission No. 006997

Date: August 12, 2019

1430 K Street NW, Suite 600
Washington, DC 20005
(202) 383-9005 • fax (202) 638-0882
permissions@asanet.org

Requestor's Name: Sarah Masefield, University of York
Address:
Email: scm541@york.ac.uk
Requestor's Reference:

Permission Granted for ASA 9/4/19

Author(s) of original work: Ronald M. Andersen
Full Article Citation: *"Revisiting the Behavioral Model and Access to Medical Care: Does It Matter?" Journal of Health and Social Behavior 36, no. 1 (1995): Fig. 1, pg. 2.*

Material will Appear In: *The hidden ill-health of mothers of young disabled children* Author(s): Sarah Masefield
Print order: Approximate list price: $ Media: Thesis Publication

Fees for print or online use:

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Appendix 2 Further information for Chapter 3

A2.1 PRISMA-P checklist

Table A1. PRISMA-P checklist for reporting systematic reviews and meta-analyses

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	54
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	N/A
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	54-55
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, controls, outcomes, and study design (PICOS).	55-57
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	55
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	53-54
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	55-61
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	57-59 & A2.2-A2.4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	59-61 & A2.5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	62 & A2.6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	A2.6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	59-60 & A2.7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	62-64
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g. I^2) for each meta-analysis.	64-72

A2.2 Search strategy development details

The keyterms used in the search strategy were generated from scoping searches, reading around the topic, and using the online tools, pubreminer and MeSH browser. Appropriate subject headings (Medical Subject Headings (MeSH) in medical databases e.g. Medline) were identified using pubreminer and the databases' function to map keyterms onto subject headings (Table 1).

Table A2. Subject Headings relating to each research concept included in the search strategy

Mother-carers	Disabled preschool children	Conditions and symptoms of ill-health
Mother	Disabled children	Depression
Mother-carer	Child	Back pain
Parent	Children	Neck pain
Parent-carer	Infant	Common cold
Parenting	Infant, Newborn	Symptoms
Carer	Child, pre-school	Physical health
Care givers	Developmental disabilities	Psychological health
Care-giver	Behaviour disorders	Psychological distress
Caregivers	Cognition disorders	Emotional problems
Family Caregivers	Child	General health
Maternal	Learning disorders	Asthma
Female	Intellectual disability	Bronchitis, Chronic
Woman	Child Development Disorders,	Bronchitis
Women	Pervasive	Diabetes mellitus
	Mentally Disabled Persons	Hypertension
	Mental disorders	Sinusitis
	Chronic disease	Headache
	Speech disorders	Migraine without aura
	Language development disorders	Anxiety
	Motor Skills disorders	
	Cerebral palsy	
	Down syndrome	
	Deafness	
	Epilepsy	
	Spasms, infantile	
	Attention Deficit Disorder with Hyperactivity	

Key terms and subject headings were used to maximise the retrieval of studies focusing on mother-caregivers, but it was important not to exclude studies with parents as the study population so that studies which stratified the analysis by sex were also retrieved. Subject headings to specify the child's age of interest (preschool) were included but were not prescriptive so that studies that included the preschool age group within a wider age range (e.g. 0-10) were not excluded. Likewise, keyterms and subject headings for specific child disabilities (e.g. Down syndrome) associated with parent ill-health in the literature identified during the scoping searches and reading around the concepts were included. Broader subject headings such as 'disabled children' and 'developmental disabilities' were included so that studies with children with disabilities not explicitly covered in the keyterms would

still be retrieved. The disability keyterms and subject headings reflected the developmental disability definition:

- Population umbrella terms e.g. disabled children
- Types of disability e.g. sensory disability
- Categories of disability e.g. congenital anomalies
- Groups of conditions e.g. cerebral palsy

The search strategy was constructed with Boolean operators linking keyterms within and between the research concepts: 'or' linked the keyterms within each concept; 'and' linked the concepts.

In Ovid, the keyterm search was conducted using the multi-purpose (.mp) search across the fields of title, abstract, original title, name of substance word, subject heading word, keyterm heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier. In CINAHL, an equivalent .mp search is not available so the database's own default search was used, consisting of the fields of title, abstract and subject headings. Searches using only subject headings were conducted in Medline to explore whether greater precision in the relevancy of the papers retrieved could be achieved using this method. However, due to the complexity and breadth of the concepts of child disability and maternal conditions and symptoms of interest, the search with subject headings exclusively yielded too many papers without relevance to the aims of the literature review. As a result, separate subject heading searches were not conducted, but the subject headings were still employed in identifying relevant papers via the databases' default searches which include keyterm searching in the subject headings.

The scoping searches and reading around the search concepts also informed the decisions regarding phrase and keyterm (proximity) searching. Search phrases were included for general child disability or maternal health keyterms e.g. 'psychological health' and 'disabled child'. Proximity searches were included to ensure that keyterms relating to the different concepts would be identified as related. For example, in the proximity search the words 'autis*' and 'disorder*' have a proximity (adj) of one (adj1), i.e. only one word can be between the two keyterms, therefore papers which include the phrases 'autistic spectrum disorder' and 'autism disorder' will be retrieved. Accordingly, adj1 was used to link names of medical conditions and keyterms for disorders, which were then linked with adj2 to child and age keyterms such as 'infant' and 'children'; thus, ensuring that phrases such as

'preschool children with congenital anomalies' would be retrieved. Likewise, conditions and symptoms of ill-health were related to carergiver keyterms using adj2. Specifying these proximities linked keyterms within each concept to reduce the number of inappropriate papers returned, such as papers on disabled parents or adults with disabilities. Using the proximity search function traded some search precision for breadth as using adj3 to relate child age ranges to disabilities resulted in a greater number of inappropriate papers being retrieved than if the keyterms were related more directly (e.g. adj or adj1). However, it also ensured that papers with longer expressions of the phenomena of interest were retrieved, such as 'preschool children with neurodevelopmental disorders', where the age and disorder keyterms are separated by 3 words (preschool).

A number of databases were searched as each indexes different journals, depending on its focus. For example, CINAHL indexes a greater number of nursing and allied health professional journals, while PsycINFO indexes more on psychology journals. For thoroughness, an initial search was also performed in the Cochrane Library, but no relevant papers were identified. Further, to ensure that relevant social sciences research was included searches were attempted in ASSIA and Web of Sciences. However, despite consultation with the University of York Health Sciences Academic Liaison Librarian and both databases' technical teams, the complex use of proximity searches in my search strategy could not be interpreted by either database. Adapted searches were attempted using 'AND' instead of proximity terms to link keyterms within each search concepts, with the effect of greatly reducing the specificity of the search. Using this adapted search in ASSIA returned 52 articles, and title screening found none to be relevant. The search in Web of Science retrieved 76,966 citations, of which screening the first 100 found none to be relevant. These outcomes, and the presence of papers from social sciences in the citations exported from the databases which could apply the original search strategy, informed the decision not to export and screen the Web of Science citations.

A2.3 Search strategy used in CINAHL

Table A3. Literature search strategy used in CINAHL

1.(((mother-carer* or “mother carer*” or “mother caregiver*” or “mother care-giver*” or parent-carer* or “parent carer” or “parent care giver*” or “parent care-giver*” or carer* or care-giver* or caregiver* or “care giver*” or “family caregivers” or mother* or parent* or parenting or caring) N2 (asthma or arthritis or allergies or food allergies or rheumatism or “joint pain” or “joint symptom*” or “neck pain” or “neck problem*” or “back pain” or “back problem*” or migraine* or headache* or diabetes or hypertension or “high blood pressure” or sinusitis or “heart condition*” or “heart disease” or “chronic bronchitis” or bronchitis or emphysema or “sleep problem*” or “sleep disturbance” or “sleep deprivation” or “poor quality of sleep” or fatigue or exhaustion or “stomach ulcer*” or “intestinal ulcer*” or “gastrointestinal problem*” or “gastrointestinal condition*” or pain or stress or “low mood” or depression or back or neck or stomach or mobility or vision or hearing or sleep or joint or anxiety or “depressive symptom*” or cold or “common cold” or “cold symptom*” or flu or “flu symptom*” or symptom* or “physical health” or “physical problem*” or “psychological health” or “psychosocial problem*” or “general health” or ill-health or “ill health” or “poor health” or “chronic conditions” or “mental health” or “mental health problems” or “psychological distress” or “emotional problem*”)) or (“burden of care” or “burden of caring” or “care* burden” or “caregiver burden” or “care-giver burden”) or "caregiver strain" or "care-giver strain" or "strain" or "burden").mp.
2. (((behaviour* or emotion* or conduct or development* or communication or social* or “mental health” or anti-social or learning or cognition or intellectual or psychomotor or growth or congenital or chronic or speech or mental* or “language development” or language or motor skills or neurodevelopmental or sensory or rare or complex or “childhood-onset” or “intellectual development” or anti-social behaviour or “attention deficit hyperactivity” or “autis* spectrum”) N1 (disorder or problem or need* or behaviour or behavior or disabil* or disabl* or handicap* or impair* or condition or anomal* or abnormalit or retard*) N2 (child* or infant or newborn or “new born” or pre-school or preschool or “primary school” or neonat*)) or (“disabled child*” or “child* with disabilities” or “child* with disability” or “handicapped child*” or “child* with handicap*” or “impaired child” or “child with impairment” or “disabl* infant*” or “disabl* newborn*”)).mp.
3. ((“cerebral palsy” or autis* or “Down* syndrome” or deaf* or blind* or epilepsy or attention-deficit-hyperactivity-disorder) N2 (child* or infant or newborn or “new born” or pre-school or preschool or “primary school” or neonat*)).mp.
4. 2 or 3
5. 1 and 4
6. 5 not (“adults with disabilities” or “disabled adults” or “disabled parent*” or “disabled mother” or “mother with disabilities”).mp.

A2.4 Study design filter in Embase

Table A4. British Medical Journal study design search filter: Embase (Ovid) cohort and case-control strategy

1. exp cohort analysis/
2. exp longitudinal study/
3. exp prospective study/
4. exp follow up/
5. cohort$.tw.
6. exp case control study/
7. (case$ and control$).tw.
8. or/1-7

Appended to the search strategy (Table 1 and above).

A2.5 Abstract screening form

Table A5. Abstract screening form

First Author, Year: Endnote Reference ID #:

Primary Inclusion/Exclusion Criteria	Yes	No	Cannot determine
Study measures and reports at least one sign, symptom or condition of ill-health			
Parents or mothers			
Children diagnosed with at least one developmental disability			
Inclusion of a typically developing control group			
Child age range or mean <5			
Quantitative studies			
Publication in English			
Study conducted in an OECD country			

Retain for:

Discussion Review of references Other

Comments:

A2.6 Data extraction form

Table A6. Data extraction form

Domain	Field	Extracted information
A. Citation	Authors	
	ID no.	
	Title	
	Publication Date	
	Journal	
B. Methods	Study design	
	Data collection method	
	Group allocation	
	Missing data (for the exposed or comparison mothers)	
	Geographic location	
	Variation factors	
C. Exposure	Exposure	
	Comparator group(s)	
	Total and no. in each group	
	Age range and mean	
	Sex	
	Disability criteria	
	Exposure ascertainment	
	Presence of behavioural problems (in addition to primary disability)	
	Disability severity indicator	
	Group inclusion/exclusion criteria	
	Between group differences	
D. Population	Total number	
	Sample composition (mothers or parents)	
	Age range and mean	
	Place of residence	
	Ethnicity	
	Employment	
	Education	
	Marital/cohabitation status	
	SEP/Income	
	Inclusion/exclusion criteria	
	Between group differences	
E. Outcome	Outcome	
	Outcome ascertainment	
F. Findings	Type(s) of statistical analysis used	
	Findings	
G. Other	Miscellaneous	

A2.7 Newcastle-Ottawa Scale for assessing the quality of longitudinal and cross-sectional studies

The ❋ symbol indicates where stars are awarded if the standard is met by the study. A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories.

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE COHORT STUDIES

Selection

1. Representativeness of the exposed cohort:
    a. truly representative of the general maternal population in the community ❋
    b. somewhat representative of the general adult female population in the community ❋
    c. selected group of users e.g. nurses, volunteers
    d. no description of the derivation of the cohort
2. Selection of the non-exposed cohort
    a. drawn from the same community as the exposed cohort ❋
    b. drawn from a different source
    c. no description of the derivation of the non exposed cohort
3. Ascertainment of exposure
    a. secure record (e.g. surgical records) or clinical assessment ❋
    b. structured interview ❋
    c. written parent report
    d. no description
4. Demonstration that outcome of interest was not present at start of study
    a. yes ❋
    b. no

Comparability

1. Comparability of cohorts on the basis of the design or analysis
    a. yes ❋
    b. no

Outcome

1. Assessment of outcome
    a. independent blind assessment ❋
    b. record linkage ❋
    c. self-report
    d. no description
2. Was follow-up long enough for outcomes to occur
    a. yes (≥3 months) ❋
    b. no
3. Adequacy of follow up of cohorts
    a. complete follow up - all subjects accounted for ❋
    b. subjects lost to follow up unlikely to introduce bias - small number lost - > 80 % follow up, or description provided of those lost, proving a non-selective loss to follow up ❋
    c. follow up rate < 80% and no description of those lost, or a selective loss to follow up
    d. no statement

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE (adapted for cross-sectional studies)

Selection: (Maximum 3 stars)

1. Representativeness of the sample
    a. Truly representative of the average in the maternal population. ❋ (all subjects or random sampling)
    b. Somewhat representative of the average in the target population. ❋ (non-random sampling)
    c. Selected group of users
    d. No description of the sampling strategy
2. Non-respondents
    a. Comparability between respondents and non-respondents' characteristics is established, and the response rate is satisfactory ❋
    b. The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory
    c. No description of the response rate or the characteristics of the responders and the non-responders
3. Ascertainment of the exposure (risk factor)
    a. Validated measurement tool/clinical assessment ❋
    b. Non-validated measurement tool, but the tool is available or described
    c. No description of the measurement tool

Comparability (Maximum 1 star)

1. The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled
    a. yes ❋
    b. no

Outcome: (Maximum 2 stars)

1. Assessment of the outcome
    a. Independent blind assessment ❋
    b. Record linkage ❋
    c. Self-report
    d. No description
2. Statistical test
    a. The statistical test used to analyse the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value) ❋
    b. The statistical test is not appropriate, not described or incomplete

A2.8 Sociodemographic characteristics of the exposed and comparison groups for each study

Table A7. Sociodemographic characteristics of the cases and comparison groups for each study

	Mothers				Children	
Study	**Age in years (mean (s.d))**	**Education (%)**	**Married (%)**	**Ethnicity: White (%)**	**Age in years (mean (s.d., if reported))[1]**	**Male (%)**
Dyson, 1991	exposed 34.5 (4.9); comparison 34.9 (3.9)	>14 years in education: study sample 52.7%; comparison 63.6%	91% (study population)	87%	4.4 (1.4) exposed; comparison 4.3 (1.7)	
Eisenhower, 2005	exposed 34.1 (5.6); Down syndrome 33.6 (5.6); ASD 35.6 (5.6), cerebral palsy 30.7 (5.5)	graduated from college: comparison 61.0%; Down syndrome 75.0%; ASD 42.9%; cerebral palsy 10.0%	exposed 91.7% Down syndrome; 85.7% ASD; 70.0% cerebral palsy; 88.2% comparison	58.3% Down syndrome; 78.6% ASD; 40.0% cerebral palsy; 59.6% comparison	2.9 (0.26) exposed; comparison 2.9 (0.26)	Down syndrome 58.3%; ASD 100%; cerebral palsy 40.0%; comparison 50.0%
Eker, 2004	exposed 26.4 (.59); comparison 28.2 (.71)	mean years in education: exposed 7.0 (0.54); comparison 7.5 (0.59)	97.5% cases; 93.2% comparison		4.7 both groups	exposed 52.5%; comparison 50.0%
Giallo, 2013	exposed 35.28 (4.66)	56.6% high school, 44% tertiary (cases)	exposed 88.0% married		exposed 4.20 (1.26)	exposed 88.0%
Glenn, 2009	exposed 30.9 (2.0)	46.25% education up to age 16, 23.75% education age 16-18, 30% tertiary education (cases)	96.25% exposed	92.5% study sample	1.6 (0.74); comparison 2	61.25%
Gowen, 1989	exposed 31.15 (6.64); comparison 30.16 (3.68)	education beyond high school: exposed 90.47%; 100% comparison	100% exposed; 90% comparison	90.47% exposed; 90% comparison	2.25 both groups at time 3	exposed 61.9%; comparison 50%
Hedov, 2002	exposed 37.6 (5.5); comparison 35.2 (4.9)	more than 9 years of education (higher education): 86%; comparison 87%	90%; 86% comparison		4.7 both groups	57%; comparison 55%
Jeans, 2013			70% exposed	specified for the ASD children: 45% study sample (ASD)	4 both groups	70%

	Mothers				Children	
Study	**Age in years (mean (s.d))**	**Education (%)**	**Married (%)**	**Ethnicity: White (%)**	**Age in years (mean (s.d., if reported))[1]**	**Male (%)**
Laxman, 2015	exposed (ASD) 31.8 (SD 4.81); comparison 29.1 (SD 5.48)		100% both groups	60% exposed (ASD), 61% comparison	4.0 both groups	
Norlin, 2013	exposed 34.0 (SD 5.3); comparison 33.8 (5.3)	low educated (less than 12 years schooling) 28.1%; comparison 21.3%	100% both groups		exposed 4.42 (2.32); comparison 4.44 (1.71) at time 2	Exposed 62.1%; comparison 55.8%
Oelofsen, 2006	exposed 33.9 (SD 5.35); comparison 33.5 (3.83)		exposed 81%; 89% comparison	exposed 94%; 96% comparison	exposed 3.66 (0.76); comparison 3.64 (0.78)	exposed 68%; comparison 62%
Quintero, 2010	exposed 36.35 (SD 4.97); comparison 36.64 (4.29).	tertiary education (BA/BS): exposed 58.8%; comparison 77.3%	100% both groups	exposed 88.2%; comparison 95.4%	exposed 4.35 (1.12); comparison 3.72 (0.71)	exposed 64.7%; comparison 63.6%
Roach, 1999	exposed 35.80 (SD 5.7); comparison 31.95 (4.0)	median educational level for the parents in both groups was a college degree	100% both groups		exposed 3.04 (0.89); comparison 2.43 (1.14)	exposed 63.41%; comparison 50%
Scott, 1997			100% both groups		exposed 1.21; comparison 1.17	exposed 54.2%; comparison 56.3%

Characteristics included as reported.

[1]Age at point of measurement used in the meta-analysis.

A2.9 Summaries of the quality assessments for the studies

Table A8. Newcastle-Ottawa Scale for longitudinal studies

	Newcastle-Ottawa Scale for longitudinal studies (n/8)									
	Selection				Comparability	Outcome				
Authors	1) Representativeness of the exposed cohort	2) Selection of the non-exposed cohort	3) Ascertainment of exposure	4) Demonstration that outcome of interest was not present at start of study	1) The subjects in different outcome groups are comparable[1]	1) Assessment of outcome	2) Was follow-up long enough for outcomes to occur[2]	3) Adequacy of follow up of cohorts	Star total	Quality rating
Eisenhower, 2005	1	0	0	0	1	0	1	0	3	Fair
Gowen, 1989	0	0	1	0	1	0	1	1	4	Fair
Jeans, 2013	1	1	0	0	0	0	1	1	4	Fair
Laxman, 2015	1	1	0	1	1	0	1	1	6	Fair
Norlin, 2013	0	0	1	0	1	0	1	0	3	Fair

[1] Comparability based on the study design or analysis. Confounding factors are controlled.
[2] Follow up period of at least 3 months

Table A9. Newcastle-Ottawa Scale for cross-sectional studies

	Newcastle-Ottawa Scale for cross-sectional Studies (n/6)							
	Selection			Comparability	Outcome			
Study	1) Representativeness of the exposed cohort	2) Non-respondents	3) Ascertainment of exposure	1) The subjects in different outcome groups are comparable[1]	1) Assessment of the outcome	2) Statistical test	Stars total	Quality rating
Dyson, 1991	0	0	1	1	0	1	3	Fair
Eker, 2004	0	0	1	1	0	1	3	Fair
Giallo, 2013	0	0	0	0	0	1	1	Poor
Glenn, 2009	0	0	1	0	0	1	2	Fair
Hedov, 2002	0	1	0	1	0	1	3	Fair
Oelofsen, 2006	0	0	1	1	0	1	3	Fair
Quintero, 2010	0	0	0	1	0	1	2	Fair
Roach, 1999	0	0	0	1	0	1	2	Fair
Scott, 1997	0	0	0	1	0	1	2	Fair

[1] Comparability based on the study design or analysis. Confounding factors are controlled.

Appendix 3 Further information for Chapter 4

A3.1 Born in Bradford application

Expression of Interest

Collaborator's request to access data and/or biological samples from
the Born in Bradford study

1. Details of lead applicant

Title	Forename	Surname	Affiliation	Email
Ms	Sarah	Masefield	University of York	scm541@york.ac.uk

2. Name(s) of co-applicant(s)

Title	Forename	Surname	Affiliation	Email
Dr	Stephanie	Prady	University of York	stephanie.prady@york.ac.uk
Prof.	Kate	Pickett	University of York	kate.pickett@york.ac.uk

3. Title of project (less than 30 words)

The hidden ill-health of mothers of preschool disabled children

4. Brief description of project (no more than 2 sides A4 with up to 10 key references)

Please include the following: Background / Research Questions / Methods (including data and/or biological samples required) / Planned outputs / Timescales for completion of the project. Include relevant pilot data and reference the applicants' previous experience in this area. For a list of available data please consult: https://borninbradford.nhs.uk/research/documents-data/

Overview

I am applying for BiB cohort data linked with medical records to perform three complementary studies with secondary analysis. The studies will comprise the major component of my PhD research project. The intended output is my thesis and the submission of at least two papers for publication.

Background

There is substantial evidence that mothers of children with disabilities experience higher levels of stress and depression than mothers of typically developing children (Singer and Floyd, 2006). There is also evidence of higher rates of other symptoms of ill-health, including headaches, sleep problems, and musculoskeletal pain (Lee, 2017). The greatest ill-health has been associated with caregiving for children with ASD, and the lowest for children with Down syndrome (Roper, 2014). But caregivers are less likely to visit the doctor about their health than people without caregiving responsibilities (Hirst, 2005).

Many disabilities can be diagnosed before the age of five but caregiver-health research has largely focused on parents of school-age and older children. Other under-researched potential confounders are: the relationship of socioeconomic status (SES) to caregiver ill-health, despite SES being the greatest single predictor of human health; and the relationship of symptoms detected in the 12 months prior to the exposure (the birth of a disabled child) to post-exposure symptoms. Research in this field has mostly been performed in White samples, who are engaged with family support services.

Ill-health adversely affects mother-child attachment, child development, and mothers' perception of the difficulties and demands of caregiving (Shonkoff, 1992). Identifying whether there is greater ill-health but lower primary care consultation in caregivers of preschool children with disabilities compared with other mothers, can be used to raise awareness of the health needs of caregivers and to develop targeted early interventions to prevent the development or increase of ill-health.

The BiB cohort study is ideal for research in this field because of the availability of extensive sociodemographic data for mothers; primary care data to examine healthcare utilisation; ethnic and socioeconomic diversity of the population.

Research questions

I will seek to answer the following research questions using the methods outlined below:

Is there a difference in the prevalence of symptoms of ill-health in mothers of preschool children with significant learning and complex disabilities compared with mothers of children of the same age without these disabilities?

1. To what extent does prevalence vary by whether symptoms were detected in the 12 months prior to the birth and indicators of socioeconomic status?
2. Is there a difference in the frequency of primary care consultation for symptoms in mothers of preschool children with significant learning and complex disabilities compared with mothers of children of the same age without these disabilities?
3. Does the consultation rate vary by consultation frequency for the symptoms in the 12 months prior to the birth and indicators of socioeconomic status differently for the exposed and unexposed mothers?

4. What are the differing probabilities of caregiver status and categories of socioeconomic status as characteristics of membership for subgroups of mothers of preschool children with differing clusters of pre- and post-natal symptoms and consultation frequencies?
5. What are the probabilities of specific child disability diagnoses and differing categories of socioeconomic status as characteristics of membership for subgroups of the mother-caregivers with differing clusters of pre- and post-natal symptoms and consultation frequencies?

Methods (including data required)

I will perform three studies using the same exposed and unexposed groups and most of the same variables. The analysis will be performed in Stata 15. The data requested will be used to derive variables for disability detection, symptom detection, and consultation frequency. The requested sociodemographic factors will be used as provided. Two ethnicity variables are requested in order to describe the groups, but it is likely that the variable with fewer categories will be used. New variables that I derive will be lodged with the BiB database (at the end of the project or if requested by the BiB Director) as required under the conditions of collaboration.

I am asking the BiB data team to provide me with a data set of exposed and unexposed mothers of preschool children for the study period of 12 months before the child's date of birth (time period 1) to five years (≤5 years) after the child's birth (time period 2). The exposed group are to be identified by searching the primary care records for children with any of the child disability case ascertainment Read codes entered at any time between birth and their fifth birthday. These are diagnoses for moderate-severe learning and complex developmental disabilities which have been selected as having long term care implications additional to those of typically developing children and have been associated with caregiver ill-health in the literature (Horridge, 2016b; Dyson, 1991). These diagnoses are cerebral palsy, ASD and Down syndrome, with the possible addition of others following consultation with a BiB paediatric specialist.

The unexposed group are all mothers with children who have not had one of the codes recorded in their medical record before their fifth birthday. Once the groups have been identified, mother-child dyads who do not meet the inclusion criteria (Table A10) should be removed from the data set. No additional restrictions will be placed on the size of the exposed or unexposed groups as unbalanced groups are desirable as a larger unexposed group will increase the reliability of any differences observed between the groups. Please provide a summary of the numbers of mothers/children in each group excluded for each criterion.

Table A10. Study population inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
An electronic primary care record available for the full study period (from 12 months before and five years after the index child's birth).	Women who: • relocated to Bradford up to one year before the child's birth or relocated from Bradford within 5 years of the index child's birth (identified using NHS tracing files); • withdrew from the BiB cohort within the study period
A BiB cohort recruitment questionnaire	No BiB recruitment questionnaire
Linked primary care records available for the index child from ages 0-5	Children who were withdrawn from the BiB cohort within the study period
The index child surviving beyond age five	Children who died before the age of five
One child per mother - if a mother has more than one child in the BiB cohort: • if one child has a disability code and the others do not, the disabled child will be selected; • if more than one child has a disability code, the first born child will be selected (including if multiple births); • if more than one child does not have a disability code, the first born child will be selected (including if multiple births).	More than one child per mother - subsequent children in the BiB cohort will be excluded.

For use in the analysis, the following BiB baseline questionnaire data and medical record data are requested for the mothers (Table A11). The symptoms of interest are: stress, anxiety, depression, fatigue, sleep problems, headache and musculoskeletal pain. There is a causal relationship between stress and each of these symptoms. Codes which definitively indicate the presence of each symptom will be included. Codes for assessments, referrals, and drugs will not be included as they can indicate unconfirmed or different symptoms. The exception is for anxiety and depression, where drug and treatment codes will be included. This is due to the availability of a comprehensive code list which positively identifies the presence of these symptoms and has been used in BiB (Prady, 2016a).

Table A11. Requested data

Data for	Data source	Time period (see above)	Variable
All mothers	Primary care record (Read codes)	Time 1	Symptom Read codes and dates detected in the primary care records in time 1
All mothers	Primary care record (Read codes)	Time 2	Symptom Read codes and dates detected in the primary care records in time 2
All mothers	BiB baseline questionnaire	Time 1	Mother's ethnic group - 9 categories
All mothers	BiB baseline questionnaire	Time 1	Mother's ethnic group - 3 categories
All mothers	BiB baseline questionnaire	Time 1	Subjective poverty - How well mother and husband/partner managing financially
All mothers	BiB baseline questionnaire	Time 1	Highest educational qualification (equivalised)
All mothers	BiB baseline questionnaire	Time 1	Marital and cohabitation status combined (derived)
All mothers	BiB baseline questionnaire	Time 2	Mother's age (at child's birth)
All mothers	BiB baseline questionnaire	Time 1	IMD_2007_decile_nat
All children	Maternity record	Time 2	sex
Disabled children	Primary care record (read codes)	Time 2	Disability diagnosis read codes and dates recorded in the primary care record in time 2
All children	Birth record	Birth	Month and year of birth

I will derive binary variables for the symptoms of ill-health (yes/no) at time 1 and time 2 and use logistic regression to examine the log odds of the symptoms of ill-health. I will derive a count variable for the frequency of consultation for each symptom at time 1 and time 2 and use poisson regression to examine differences in the rate of consultation by group. I will derive a categorical variable for the disability diagnoses. Separate regression models will be constructed for each symptom in the logistic and poisson analyses. The derived variables will all be included in the latent class model.

If there are too few instances of each symptom in the exposed group for the assumption of at least 10 observations in each category per variable, I will combine symptoms to produce three symptom groups: psychological distress; sleep problems and fatigue; pain. If there are still insufficient counts for each category, symptoms may be dropped from the analysis. If there is overdispersion in the count data, negative binomial regression will be performed instead of poisson.

Timescales for completion of the project

I am requesting a transfer of the requested data to me at the University of York, as soon as possible. I will commence cleaning the data as soon as it is received, with the intention to have cleaned the data and have preliminary results for my Thesis Advisory Panel (of which Mr Neil

Small is a member) meeting in February 2019. I intend to write up my results for publication before the end of June 2019, submitting my thesis in September 2019.

Applicants' previous experience in the area

I have completed three quantitative data analysis Masters modules at the University of York, a module on epidemiology and courses on latent class analysis, longitudinal data analysis and Stata. In the analysis, I will be closely supervised by Prof Kate Pickett and Dr Steph Prady who both have an extensive knowledge of the BiB cohort and experience of analysis BiB data, with access to statisticians at the University of York if required. Steph Prady also has experience of analysing BiB primary care data.

Thank you very much for completing this form.

Please send via email to Rosie.McEachan@bthft.nhs.uk and we will contact you as soon as we can.

A3.2 Born in Bradford collaboration agreement (unsigned)

Bradford Teaching Hospitals NHS
NHS Foundation Trust

Collaboration and Information Sharing Agreement between Bradford Teaching Hospitals NHS Foundation Trust and University of York ("The Investigator's Institution") in relation to Born in Bradford approved study SP304 ("The Study").

i. Background to the Agreement:
Born in Bradford is a family of research studies including three longitudinal multi-ethnic birth cohorts (Born in Bradford; Born in Bradford's Better Start and BiB4All). These cohort studies aim to examine the impact of environmental, psychological and genetic factors as well as specific interventions on maternal and child health and wellbeing. Ethical approval for the data collection was granted by Bradford Research Ethics Committee, as follows:

07/H1302/112	Born in Bradford: A longitudinal cohort study of babies born in Bradford and their mothers and fathers
15/YH/0455	Born in Bradford's Better Start Cohort Study. A cohort study of babies born in Bowling and Barkerend, Bradford Moor and Little Horton areas of Bradford, and their mothers and partners
17/YH/0202	BiB4All: A data linkage cohort study of babies born in Bradford and their mothers

The studies are referred to collectively as "Born in Bradford" or "BiB".

It is critical to the success of the Born in Bradford approved study SP304 The hidden ill-health of mothers of preschool disabled children ("The Study") that the information to which this agreement relates is handled in accordance with relevant UK data protection regulations.

This agreement sets out the roles of each party to the agreement in relation to the information shared and their responsibilities therein.

1. Parties to the Agreement:

Details be included for all agencies which are party to the Agreement:

a) **Professor John Wright, Director of Research**
Bradford Teaching Hospitals NHS Foundation Trust
Bradford Royal Infirmary
Duckworth Lane
Bradford
BD9 6RJ

b) **"The Investigator"**
Sarah Masefield
"The Investigator's Institution"
University of York

2. Purposes of the Agreement:

This agreement is in place to ensure the protection and security of data shared between Bradford Teaching Hospitals NHS Foundation Trust (BTHFT) and The Investigator's Institution for the purposes of The Study.

3. Information to be shared

Research data from Born in Bradford cohort participants will be shared between the parties. Only data necessary for the Investigator to carry out the Study will be shared ("The Data"), and this will be determined by the Born in Bradford Executive Group. Person identifiable data will not be shared. The Data will be pseudonymised.

4. Methods used for sharing:

The Data will be transferred from BTHFT to The Investigator at The Investigator's Institution using the IronPort encrypted email service or the Kiteworks secure filesharing service. If the file size is too big for Ironport or Kiteworks, or there are other barriers to accessing these at The Investigator's Institution, one of two transfer methods will be used:

1. A secure sftp or secure https connection will be provided by The Investigator's Institution to allow BTHFT to upload The Data. The folder to which The Data is uploaded will only be accessible by The Investigator.
2. The Data will be downloaded to a SafeXs encrypted memory stick and transferred physically to The Investigator at The Investigator's Institution by a member of BTHFT staff.

5. Need to know

For BTHFT:
Prof John Wright, Director of Research, BTHFT

BTHFT staff members in the Born in Bradford Data Team involved in processing The Data.

For The Investigator's Institution:
The Investigator.

6. Supporting processes:

The Investigator has read and will abide by the "Guidance for BiB Collaborators" set out in Appendix 1.
The Investigator has read and will abide by the "Terms and Conditions for Data Transfers" set out in Appendix 2.

7. Information retention issues:

The Investigator will retain all information for as long as necessary to complete The Study. The Investigator will delete The Data and any data items derived from The Data from the Investigator's Institution's information systems at the request of BTHFT or upon completion of The Study, whichever is earlier.

Participant data will be held in accordance with the relevant legislation (in particular the Data Protection Act 1998); Records Management: NHS Code of Practice and each agency's relevant policies and procedures.

8. Staff development issues:

Both parties to this agreement will ensure that their staff carry out information governance training appropriate to their role. All staff at BTHFT complete annual mandatory training in Information Governance procedures. Staff are made aware of their responsibilities under the Data Protection and Freedom of Information Acts, which are laid out in the Trust's DPA and FOI policies and procedures.

9. Consent from service users:

All participants in Born in Bradford give explicit consent for their data to be used for research purposes. The consent forms make clear that they can withdraw their consent at any time by contacting the Born in Bradford office, at which point a member of the Born in Bradford team follows a standard operating procedure to action the withdrawal..

10. Incident Reporting

Incidents are to be reported immediately and in writing to the Director of Research, BTHFT

11. Any other relevant issues

Further information in relation to the Born in Bradford Cohort Study can be obtained by contacting the project office on +441274 364474 This agreement to be reviewed annually.

Approved by (PRINT NAME):

Signature:

Institution: Bradford Teaching Hospitals NHS Foundation Trust

Date:

Approved by (PRINT NAME):

Signature:

Institution: University of York

Date:

Copies of this Agreement should be retained by the named persons above and be made available for inspection on request.

A copy should be sent to the DP Officer of each party.

Appendix 1 – Guidance for BiB Collaborators

Use of existing data or existing biological samples

1. Requests for existing data and biological samples will be reviewed, prioritised and authorised by the BiB Executive Group. The Investigator should complete an outline proforma available on the Born in Bradford website (www.borninbradford.nhs.uk) and submit to the BiB Director.

2. Any new data derived from BiB participant data (interview, physical measurements, new variables derived from existing data) must be lodged with the BiB database at the end of the project (or at any time at the request of the BiB Director). The nested study Principal Investigator must supply adequate documentation concerning new variables (including statistical programs) to permit their use in future analyses of the data.

3. The Investigator must notify the BiB Director of any potential errors discovered whilst using BiB data or biological samples.

4. Any residues of biological samples or excess materials must be returned to BTHFT or to the Bristol Bioresource Laboratory, whichever is the originating laboratory, within 6 months of the completion of the research. The expense of transferring both from and back to the BiB site must be met by the applicants.

Collection of new data or new biological samples

In addition to the Guidance for existing data or samples, Investigators collecting new data or samples are expected to adhere to the following Guidance:

1. Full proposals *must* be reviewed by the BiB Executive Group *prior to submission for funding*. The Investigator should complete an outline proforma available on the Born in Bradford website (www.borninbradford.nhs.uk) and submit to the BiB Director.

2. The Investigator should ensure that there is genuine local research partnership and where appropriate a strong link to practitioners to promote translation of findings into practice.

3. The Investigator will be required to meet additional costs (administrative, data management, laboratory etc) that are incurred by the Born in Bradford programme for new data and sample collection. Where a new grant will be submitted to fund the study, the final copy of

the grant including the finances must be sent to the BiB Director for approval at least two weeks before the submission date.

4. Researchers working on new studies will be employed wherever possible by the Born in Bradford programme in order to promote efficient integration, good research governance and research capacity-building locally.

5. In addition to the review by an appropriate ethics committee, researchers will be expected to obtain review and advice from relevant patient/public involvement groups, including Born in Bradford's parent governors group. Please contact the BiB Community Engagement Officer for advice on the most appropriate form of PPI (borninbradford@bthft.nhs.uk).

6. The Born in Bradford Executive Group will act as data guardians and provide peer review for the scientific merit of research ideas and the use of the collected data and biological samples.

Governance and intellectual property

1. The BiB Director will be responsible for the design and conduct of the Born in Bradford platform study, ethical approval and compliance with research governance requirements. The Investigators will be responsible for the governance of their specific study.

2. Bradford Teaching Hospitals Foundation Trust is the Sponsor of the project.

3. Intellectual Property developed from the Born in Bradford platform study will be owned by Bradford Teaching Hospitals Foundation Trust. We will consider dividing intellectual property rights where collaborators will be making a particular contribution. Any such division must be considered and agreed before the collaboration starts.

Publications and reports

1. We would like to have all work linked to Born in Bradford to be easily identified, including in electronic searches. We encourage collaborators to include Born in Bradford in article titles e.g. Obesity in a bi-ethnic population: a Born in Bradford study. If this is not possible then authors should include Born in Bradford as a keyword and in the abstract. A protocol and cohort description of the study [1, 2] and BiB 1000 study [3] have been published and should be referred to in all methods sections

2. Authorship on papers must follow standard practice that all authors must have made a substantial contribution to the conception and design of the study, or analysis and interpretation of data, and drafting the paper. In a long running study such as Born in Bradford there are likely to be a number of people whose work makes production of a paper possible but who may not meet authorship criteria. In such cases we encourage the use of the contributorship (see BMJ guidelines).

3. The Investigator should agree authorship guidelines with their team and collaborators at the start of any new research project to avoid later disputes. Studies where new data or biological samples will be collected should have a local (Bradford) investigator in the study team.

4. The following acknowledgement must be included in all papers using BiB data:

   "Born in Bradford is only possible because of the enthusiasm and commitment of the Children and Parents in BiB. We are grateful to all the participants, health professionals and researchers who have made Born in Bradford happen."

5. For papers using Born in Bradford GP primary care data, the following additional acknowledgement must be included:

   "We gratefully acknowledge the contribution of TPP and the TPP ResearchOne team in completing study participant matching to GP primary care records and in providing ongoing informatics support."

6. When a paper or abstract is ready to be submitted authors will be required to submit a copy (in confidence) to the BiB Director for review by the BiB Executive Group. All papers will be reviewed within two weeks of receipt to check confidentiality is protected; to ensure that the paper will not bring the study into disrepute; to try to identify overlap with other papers published or in preparation. Advice and feedback will be offered to authors where we feel this may be helpful.

7. Born in Bradford is committed to the translation of research into practice. All authors are required to send the BiB Director a summary of key policy and commissioning implications from their analysis upon conclusion of their project.

8. Collaborators must send copies of the final submitted draft and an electronic copy of the final published version to the BiB Director. All press releases on research arising from the study must be approved by the BiB Director.

Contact

Please send all enquiries via email to the Born in Bradford Programme Director (rosie.mceachan@bthft.nhs.uk).

References

Born in Bradford Collaborative Group. Born in Bradford, a cohort study of babies born in Bradford and their parents: protocol for recruitment phase. BMC Public Health 2008; 8:327 doi:10.1186/1471-2458-8-327
Wright, J., Small, N., Raynor, P., Tuffnell, D., Bhopal, R., Cameron, N., Fairley, L., Lawlor, D.A., Parslow, R., Petherick, E.S., Pickett, K.E., Waiblinger, D., & West, J, on behalf of the Born in Bradford Scientific Collaborators Group (2012). Cohort profile: The Born in Bradford multi-ethnic family cohort study. International Journal of Epidemiology. 2012; 1-14 doi:10.1093/ije/dys112
Bryant M, Santorelli G, Fairley L, West J, Lawlor DA, Bhopal R, Petherick E, Sahota P, Hill A, Cameron N, Small N, Wright J. Design and characteristics of a new birth cohort, to study the early origins and ethnic variation of childhood obesity: the BiB1000 study Longitudinal and Life Course Studies 2013 4(2) 119-135 doi:10.14301/llcs.v4i2.221

Appendix 2 – Terms and Conditions for Data Transfers

1. The Investigator and other relevant employees of The Investigator's Institution involved in the research have read and will abide by the "Guidance for BiB Collaborators" given in Appendix 1 of this Agremeent.

2. The data remains the property of the Born in Bradford study. This agreement does not restrict the rights of Born in Bradford to distribute the data to other institutions or to publish any document relating to the data.

3. The Investigator will retain The Data in a secure location at The Investigator's Institution and will not permit The Data or any part of it to come into the possession or control of any other organisation or any individual other than those employees of The Investigator's Institution who are involved in The Study under direct supervision of The Investigator.

4. The Investigator will not transfer The Data in whole or in part to third parties without the relevant third party entering into a separate Information Sharing Agreement with Born in Bradford.

5. The Investigator will use the data only to carry out the research described in the proforma relating to The Study as approved by the Born in Bradford Executive Group ("The Proforma"), and only for research that has appropriate ethnical approval. The Investigator will not use The Data or any parts thereof for any commercial purposes or any purpose that is subject to consulting or licensing obligations to third parties.

6. The Investigator will use all reasonable endeavours to ensure that The Data and any data items derived from The Data shall as soon as possible be returned or destroyed upon (i) the request of BTHFT, (ii) on termination of this agreement, (iii) in the event that The Investigator or The Investigator's Institution are in breach of any of the conditions of this agreement or (iv) the withdrawal of consent of a relevant study participant. If The Investigator is required to destroy The Data then it will confirm in writing to the Director of Research, BTHFT that The Data has been destroyed and no further copies of the data are held by The Investigator or The Investigator's Institution.

7. All data and information (including the results of chemical and biological analyses and cleaned or derived variables) relating directly to study participants will be returned to BTHFT upon the request of BTHFT or within 6 months of the completion of The Study, whichever is sooner, for incorporation into the Born in Bradford data warehouse and shall be owned by BTHFT.

8. The Investigator will provide the Director of Research, BTHFT with a fully documented electronic copy of the full results of The Study before its publication in any form or within 6 months of the completion of The Study whichever is sooner.

9. The Investigator will keep the data confidential and will not attempt to identify study participants.

10. The Investigator will not attempt to link The Data to other Born in Bradford data held by different individuals or by The Investigator for different projects.

11. The Investigator will not try to link The Data to data from other sources other than those that may be set out in The Proforma.

A3.3 Read code lists for case ascertainment and symptom data extraction

Table A12. Disabling condition code list

Cerebral palsy											
XE2Q8	XE15M	X00En	Xab3R	XaYgp	XaYfK	X00Eo	XE2se	XM1Pw	XE2Q9	F2300	F230z
X00Ep	XM1Px	F230.	X00Eq	F231.	F234.	XE15V	X00Er	X00Es	XM1Pv	X00Eu	XaadE
XE2Q7	X00Ew	Xa0lM	F23y0	Xa0ll	X00Ex	F23y1	X00Ey	X00Ez	XaNWb	X00F1	X00F2
X00F3	F23y.	F23yz	F23z.	X00Em	Fyu90	XM1Pu	XaBE2	F1371	F23..	XE181	F23y0
Xa0lM	F2B2.	Xab3R	.F32Z	F23y.	F23yz	F23z.	F2B..	F2By.	F2Bz.	Fyu90	X00Em
F23y6	XaadE	XM1Pu	F23y3	X00Eu	F2301	F23y2	X00En	XE2Q9	XM1Pv	XaaVG	XaaWF
XaaVJ	XaaWE	XaaVK	XaaWD	XaaVI							
Down syndrome											
.N721	XE1MZ	PJ00.	PJ01.	PJ02.	X78El	PJ0z.	X78Ek	XE1MZ			
Fragile X syndrome											
X78FB	PJyy2	X78FC	X78FD								
Autism Spectrum Disorders											
X00TM	XaesO	XE2v2	E1400	E1401	E140z	X00TN	X005S	E141.	E1410	E1411	E141z
X00TP	Ub1Ts	Eu844	Eu84y	Eu84z	XE1aA	E140.	Eu840	Eu841	Eu84.	Eu84y	Eu845
.E2Z3	Eu844	XE1aA	Eu84z	Ub1Tr	Ub1Tw						
Mod-severe learning disability											
E310.	Eu710	Eu711	Eu71y	Eu71z	E311.	Eu720	Eu721	Eu72y	Eu72z	E312.	Eu730
Eu731	Eu73y	Eu73z	Xa3HI	Eu7y1	Eu7z1	XaREu	Xabk1	Xa00k	Eu73.	Eu71.	.E512
Xa01E	.E513	Eu72.	Xa00l								

Table A13. Disability indicators code list

Developmental delay											
X76B7	XaX18	Ua14s	Xa40J	XaXCG	XaBBv	E2F..	E2Fy.	XaIsc	XaO45	XaO46	XaO47
Ub1US	XacSD	Ub1UM	Ub1UO	Ub1UQ	E2E1.	Xa09f	Ub1U6	Ub1U2	R0340		
Generalised developmental disorders											
X00TQ	XE1Z4	XM1MS	X00TI	Eu8..	XE1Z3	XE1a4	XE1a3	Ub1UL	E2F3z	X00TK	XE1a6
XE1a7	XE2bB	XE1Z5	Ub1Tf	E2F5.	E2Fz.	Eu83.	Eu8z.	XE1aB	Ub1S4	X00F0	XM0zA
XE1gX	XM1AJ	Ub1UG	XacL0	XacKx	Ub1UR	Ub1UT	Ub1UU	Ub1UV	Ub1UW	Ub1UX	XE1a5
Ub1U0											
Generalised disabilities											
E3...	XE2a3	Eu700	Eu701	Eu70y	Eu70z	Xa0ER	Xa3HI	E31..	E31z.	Eu7y0	Eu7y1
Eu7yy	Eu7yz	E3z..	Eu7y.	Eu7z0	Eu7z1	Eu7zy	Eu7zz	XE1a2	XabmM	XacF5	X00TL
XaaiS	XacF6	XaREt	Eu813	E2F2.	Eu81.	Eu81z	XE1a9	13ZK.			

Generic disability											
13VC5	13VC1	13VC2	13VC3	13VCZ	XaKYb	XaDyv	.6664	6665.	9EB4.	6972.	

Table A14. Individual symptom code list

Stress											
1B1L.	E28..	E280.	E281.	E282.	E283.	E2830	E2831	E283z	E284.	E29..	E290.
E290z	E291.	E292.	E2921	E2922	E2923	E2924	E2925	E292y	E292z	E293.	E2930
E2931	E2932	E293z	E294.	E29y.	E29y0	E29y1	E29y2	E29y3	E29y5	E29yz	E29z.
Eu4..	Eu40.	Eu40y	Eu40z	Eu41.	Eu413	Eu41z	Eu430	Eu432	Eu43y	Eu43z	Eu46.
Eu46z	K586.	Ry15.	Ryu58	Ua165	Ub014	X00Sf	X301U	X76AY	Xa18j	Xa18v	Xa7mz
Xa8HQ	Xa8HR	XaA2F	XaBUD	XaEFB	XaI8j	XaJgP	XaWye	XaX55	XaX56	XaX58	XE0pM
XE0rR	XE1bo	XE1Ym	XE1Yn	XE1Yp	XE1Zj	XE2Nh	XM0As	XM1aI	XM1Am	XM1Q3	ZV4B2
ZVu4E											
Common mental disorders											
1B17.	E1131	E2112	Eu331	X00SS	XE1Y1	XM1GC	XaCHs	1B19.	E1132	E2B..	Eu33y
X00SU	XE1YC	XSEGJ	XaCIs	1B1U.	E1135	E2B0.	Eu33z	X00TX	XE1ZY	XSGok	XaCIt
2257	E1136	E2B1.	Eu34.	X40Dl	XE1Za	XSGol	XaCIu	62T1.	E1137	Eu320	Eu340
X40Dm	XE1Zb	XSGom	XaImU	E112.	E113z	Eu321	Eu34y	X760u	XE1Zc	Xa02E	XaJWh
E1120	E118.	Eu322	Eu34z	X7617	XE1Zd	Xa0wV	XaKUk	E1121	E11y2	Eu324	Eu3y.
X761I	XE1Zf	Xa110	XaPKm	E1122	E11z0	Eu325	Eu3y1	X761J	XE1Zg	Xa17z	XaPOv
E1123	E11z1	Eu326	Eu3yy	X761K	XE1Zh	Xa1eL	XaX0C	E1125	E11zz	Eu327	Eu3z.
X761L	XE1Zi	Xa9E0	XaY2C	E1126	E204.	Eu32B	Eu53.	XE0re	XE1aY	Xa9J0	XaAyL
E112z	E210.	Eu32y	Eu530	XE0uv	XE1ae	Xa9K0	XaB5v	E113.	E211.	Eu32z	X00SO
XE1Xy	XM0Ar	XaCHr	XaB95	E1130	E2110	Eu330	X00SR	XE1Y0	XM0CR	XaB9J	1B13.
E2011	E2022	E2030	E283.	Eu41y	XE0rb	Xa0XM	XaEFB	1B1V.	E2012	E2023	E2031
E2830	Eu41z	XE1Y7	Xa0XN	XaP8d	2258	E2013	E2024	E203z	E2831	Eu42.	XE1YA
Xa0XO	XaX55	225J.	E2014	E2025	E205.	E283z	Eu420	XE1Ym	Xa0XP	XaX56	E0300
E2015	E2026	E207.	E284.	Eu421	XE1Yn	Xa0XQ	XaX58	E0310	E2016	E2027	E20y.
E28z.	Eu422	XE1Zj	Xa0XR	E200.	E2017	E2028	E20y0	Eu40.	Eu42y	XE1aW	Xa0XX
E2000	E2018	E2029	E20y1	Eu400	Eu42z	XE1bo	Xa0XY	E2001	E201A	E202A	E20y2
Eu401	Eu515	XM1MZ	Xa0Xd	E2002	E201B	E202B	E20y3	Eu402	Eu51y	Xa0XG	Xa18j
E2004	E201C	E202C	E20yz	Eu40y	Eu51z	Xa0XH	Xa18v	E2005	E201z	E202D	E20z.
Eu40z	Ub1T9	Xa0XI	Xa19B	E200z	E202.	E202E	E28..	Eu41.	X00Sc	Xa0XJ	Xa3Xk
E201.	E2020	E202z	E280.	Eu410	X00Sf	Xa0XK	Xa3Ys	E2010	E2021	E203.	E281.
Eu411	X761N	Xa7kB	E282.	6655	8G120	8G91.	8HJ3.	X71bp	Xa8Ik	XaAKy	XaAZI
XaBHK	XaINy	XaIP0	XaIT8	XaIW3	XaIWY	XaIXZ	XaIkd	XaJON	XaJQV	XaKEz	XaLCP
XaMJ8	XaOxM	XaR4s	ZV663	6659	8G121	8G9Z.	8HK9.	X79sL	Xa8Is	XaAMj	XaAbC
XaBIg	XaIOf	XaIP1	XaITA	XaIW4	XaIWZ	XaIXa	XaIkg	XaJPu	XaJQW	XaKGq	XaLCQ

XaMhM	XaP6T	XaR5D	ZV673	66590	8G2..	8HlB.	8HkK.	XE0iL	Xa8It	XaAMz	XaAbH
XaBJb	XaIOg	XaIP2	XaITG	XaIW5	XaIWa	XaIXb	XaIku	XaJPz	XaJQX	XaKbb	XaLFL
XaN3a	XaP7x	XaWzW	ZV69.	6779	8G21.	8HVO.	8HM9.	XE1Sa	Xa8Iu	XaAOd	XaAdM
XaBJc	XaIOh	XaIP3	XaITH	XaIW6	XaIWb	XaIXh	XaIm4	XaJQ1	XaJQY	XaL03	XaLFk
XaN4b	XaPRF	XaX04	ZV690	6G00.	8G2Z.	8H23.	9HZ..	XE1Sb	Xa8Ix	XaAOe	XaAel
XaBT1	XaIOi	XaIPw	XaITI	XaIWD	XaIWx	XaIXi	XaIpA	XaJQD	XaJQZ	XaL0o	XaLNF
XaN4c	XaPTT	XaXEJ	ZV691	8BK0.	8G4..	8H230	9N0T.	XSBbs	Xa8J0	XaAOf	XaAem
XaBTD	XaIOj	XaISp	XaIUv	XaIWM	XaIWy	XaIXk	XaItc	XaJQE	XaJRr	XaL0p	XaLQw
XaN4d	XaPTU	XaXH8	ZV692	8BM0.	8G43.	8H34.	9N1M.	Xa8IB	XaA8Z	XaAOg	XaAen
XaBtN	XaIOk	XaISv	XaIUx	XaIWN	XaIWz	XaIXl	XaItx	XaJQF	XaJWg	XaL0q	XaLnp
XaN4e	XaPlZ	XaXHm	ZV6D.	8CQ..	8G4Z.	8H38.	9N2B.	Xa8IG	XaA8c	XaAOh	XaAfJ
XaBvV	XaIOl	XaISw	XaIUy	XaIWR	XaIX0	XaIXm	XaIuR	XaJQG	XaJr3	XaL0r	XaLnq
XaN4f	XaPvy	XaXe3	ZV701	8CR7.	8G5..	8H49.	9N6h.	Xa8IJ	XaA8d	XaAQi	XaAh4
XaBvW	XaIOn	XaISy	XaIUz	XaIWS	XaIXS	XaIXn	XaIvk	XaJQH	XaK1f	XaL0s	XaLnr
XaN4g	XaPvw	XaXiH	ZV702	8F85.	8G51.	8H7A.	9NJ1.	Xa8IP	XaA8u	XaAQo	XaAiE
XaBvX	XaIOp	XaIT1	XaIV0	XaIWT	XaIXT	XaIXo	XaIvp	XaJQI	XaK5q	XaL0t	XaLs
XaNPL	XaQBz	XaXl2	8G...	8G5Z.	8H7B.	9NJR.	Xa8IR	XaA8v	XaAS4	XaAil	XaCFD
XaIOq	XaIT2	XaIV1	XaIWU	XaIXU	XaIXp	XaIvq	XaJQJ	XaK5r	XaL0u	XaLsu	XaNTc
XaQC0	XaY6o	8G1..	8G6..	8H7T.	9NJT.	Xa8If	XaA9W	XaAU5	XaAkB	XaECG	XaIOs
XaIT3	XaIV2	XaIWV	XaIXV	XaIXq	XaIyU	XaJQR	XaK6K	XaL0v	XaLsv	XaONq	XaQWJ
XaY7i	8G10.	8G6Z.	8H7Z.	9Ol..	Xa8Ig	XaA9g	XaAUA	XaAkI	XaEVq	XaIOu	XaIT4
XaIV3	XaIWW	XaIXW	XaIXs	XaJ4V	XaJQS	XaK70	XaL0w	XaM2K	XaOOT	XaQvz	XaYgS
8G100	8G7..	8HHp.	Ub0qs	Xa8Ih	XaABP	XaAXe	XaAkU	XaI8j	XaIOv	XaIT5	XaIV4
XaIWX	XaIXX	XaIXt	XaJ4w	XaJQT	XaK71	XaL2L	XaM7s	XaObo	XaR4n	XaZIW	8G11.
8HHq.	X71Ec	Xa8Ii	XaABQ	XaAnb	XaINQ	XaIOy	XaIT6	XaIV5	XaIXY	XaIXu	XaJ4x
XaJQU	XaKAx	XaLBl	XaMGz	XaZcf	8G12.	8G9..	Xa8Ij	XaIOz	XaIT7	XaIV6	XaIYN
XaJOA	665..	6654	6658	66580	665A.	665A0	665Z.	8A21.	8A2Z.	9H90.	9H91.
9H92.	9HA0.	9Ov..	9Ov0.	9Ov1.	9Ov2.	9Ov3.	9Ov4.	X74WN	XaJuG	XaJuK	XaJuT
XaJuV	XaJuW	XaK6d	XaK6e	XaK6f	XaK9p	XaKAK	XaLIb	XaMGL	XaMGN	XaMGO	XaMGP
XaMGQ	XaMGR	XaR9y	XaZ2p	8A2..	E2003	Eu412	Eu413	X00Sb			
Fatigue											
XabDw	XaPeC	XaR7C	XaRAz	X76Ae	X76Af	X76Ag	XM09R	1682.	XM0D3	XM1AV	XM06l
XaEJ8	R007.	R0070	R0071	R0072	R0073	R0074	XaBEA	XM0yx	L168.	L1680	L1681
L1682	L1683	L1684	L168z	XaPoo	XaPon	XaPom	R0075	R007z	Xa96S	1683.	Ua150
XaEXl	X76Ac	X76Ad	168Z.	XE0qj	1686.	1687.	XE0qk	X761D	X76qY	XM0D5	
Sleep problems											
1B1B0	1B1B1	1B1B2	E274.	E2740	E2741	E2742	E2743	E2744	E2747	E2748	E2749
E274A	E274C	E274D	E274E	E274y	E274z	Eu510	Eu515	Eu51y	Eu51z	F27..	F271.
Fy00.	Fy01.	Fyu58	R0050	R0054	R0055	R0056	R0057	R0058	R0059	R005z	Ua1ZQ
X007s	X007u	X007v	X007w	X007x	X007y	X007z	X0080	X0081	X0082	X0083	X008C

X008D	X008E	X008F	X008G	X008H	X7649	X764A	X764K	X76AE	X76AF	X76AG	X76AJ
X76AK	X76AL	X76AM	X76AN	X76AO	X76AQ	X76AR	Xa0Kl	Xa7wV	XaC0p	XaJEd	XaYGN
XaYGO	XaZKa	XE0ux	XE1bI	XE1gP	XE1Yg	XE1Yh	XE1Yi	XE1Yj	XE1Zr	XE2Pv	XE2Q5
XM06i	XM06k	XM1GE	XSGLz	1B1B0	1B1B1	1B1B2	E274.	E2740	E2741	E2742	E2743
E2744	E2745	E2746	E2747	E2748	E2749	E274A	E274B	E274C	E274D	E274E	E274F
E274z	Eu510	Eu512	Eu515	Eu51y	Eu51z	F27..	F270.	F271.	F27z.	Fy00.	Fy01.
Fy03.	Fyu58	R005.	R0050	R0052	R0058	R005z	Ua15W	Ua1ZQ	Ua1ZR	X007q	X007s
X007u	X007v	X007w	X007x	X007y	X007z	X0080	X0081	X0082	X0084	X0085	X0086
X0087	X0088	X0089	X008A	X008C	X008H	X7649	X764A	X764B	X764C	X764K	X76AE
X76AF	X76AG	X76AJ	X76AK	X76AL	X76AM	X76AN	X76AO	X76AQ	X76AR	Xa0Kk	Xa0Kl
Xa2bY	Xa7wV	XaFqr	XaIti	XaIv5	XaJEd	XaP4v	XaYGN	XaZKa	XE1gP	XE1Yg	XE1Yh
XE1Yi	XE1Yj	XE1Zr	XE2Pv	XE2Q5	XM06i	XM06j	XM06k	XM06R	XM0yu	XM1GE	XSGLz
Headache											
1BA7.	1474	61461	1B1G.	1B1G0	1B1G1	1BA..	1BA2.	1BA3.	1BA4.	1BA5.	1BA6.
1BA8.	1BAZ.	1BB..	1BB4.	1BB5.	E2781	F26..	F2611	F261z	F2620	F2623	F2624
F262z	F26y0	F26yz	F2900	Fyu54	Fyu5A	Fyu5B	K5A22	L384.	L3840	L3841	L387.
X007c	X007d	X007f	X007h	X007i	X007J	X007K	X007L	X007M	X007N	X007o	X007T
X007U	X007V	X007Y	X007Z	XaMIU	XaQZd	XaXpZ	XaXsc	XaXsF	XE0s6	XE15e	XE187
XE1Yl	1BA3.	1BA6.	1BA8.	1BAZ.	1BB1.	1BB2.	1BB3.	1BBZ.	F260.	F261.	F2610
F262.	F2620	F2623	F26y.	F26y1	F26y3	F26z.	Fyu53	R040.	R0400	X007a	X007b
X007e	X007h	X007I	X007N	X007O	X007p	X007Q	X007R	X007S	X007T	Xa07H	XaIsz
XaJLO	XaLSP	XaNTh	XaNTj	XaXkr	XaXkv	XaXpZ	XaXrD	XaXsF	XE0rh	XE1Yl	XE2rs
XM0CV	X007U	X007V	X007W	X007X							
MSK pain											
16C..	16C2.	16C3.	16C4.	16C5.	16C6.	16C7.	16CZ.	1DC8.	N131.	N142.	N1420
N145.	N2410	R00z2	R00z2	X75rs	X75rt	X75rz	X75s1	X75s3	Xa0sK	Xa0sM	Xa0wj
Xa0wk	Xa0wl	Xa0wp	Xa0wq	Xa0wr	Xa0ws	Xa0wt	Xa0wu	Xa0wv	Xa0ww	Xa0xt	Xa0yK
Xa6tC	Xa6YH	Xa7mB	Xa7mE	Xa7ws	Xabu2	XaIIv	XaINe	XE0rW	XE1F4	XE1FB	XE1FE
XE1Fm	XE1He	XE1HU	XM1GI								

Appendix 4 Further information for Chapter 5

A4.1 Tests of normality

Table A15. Tests of normality for the continuous variables where differences are theorised between the diagnostic groups

Variable	Skewness test, p[1]	Kurtosis test, p	Shapiro-Wilk test, z (p)
Age (in months) at child's first diagnosis	0.00	0.00	5.92 (0.00)
Mother's age (in years) at child's birth	0.00	0.00	10.67 (0.00)
Consultation frequency for psychological distress after the birth	0.00	0.00	19.42 (0.00)
Consultation frequency for head and MSK pain after the birth	0.00	0.00	18.67 (0.00)
Consultation frequency for exhaustion after the birth	0.00	0.00	15.63 (0.00)
Child's age when mother's post-natal psychological distress detected	0.00	0.00	12.43 (0.00)
Child's age when mother's post-natal head and MSK pain detected	0.00	0.00	12.89 (0.00)
Child's age when mother's post-natal exhaustion detected	0.00	0.00	9.88 (0.00)

[1] Results of all three tests given to 2 decimal places. $p \leq 0.05$ indicates that the data are not normally distributed.

A4.2 Characteristics of the diagnostic groups (in which the groups are not expected to vary)

Table A16. Sociodemographic characteristics by diagnostic group

Variable[1]	Disability indicators (n=394)	Disabling conditions (n=83)
Parity, n column (%)		
First child	358 (90.9)	77 (92.8)
≥2 children	36 (9.1)	6 (7.2)
Total	394 (100)	83 (100)
Cohabitation status, n column (%)[3]		
Living with partner	328 (83.3)	72 (86.8)
Not living with partner	66 (16.8)	11 (13.3)
Total	394 (100)	83 (100)
Mother's ethnicity, n column (%)		
White British	159 (40.4)	34 (41.0)
Other	1,462 (15.8)	14 (16.9)
Pakistani	4,040 (43.7)	35 (42.2)
Missing	19 (0.2)	0 (0.0)
Total	394 (100)	83 (100)
Subjective financial status, n column (%)[2]		
Living comfortably	82 (20.8)	25 (30.1)
Doing alright	176 (44.7)	34 (41.0)
Just about getting by	97 (24.6)	18 (21.7)
Quite difficult	23 (5.8)	4 (4.8)
Very difficult	10 (2.5)	2 (2.4)
Missing	6 (1.5)	0
Total	394 (100)	83 (100)
IMD quintiles[3], n column (%)		
1 (highest SES)	5 (1.3)	1 (1.2)
2	10 (2.5)	4 (4.8)
3	33 (8.4)	11 (13.3)
4	68 (17.3)	18 (21.7)
5 (lowest SES)	278 (70.6)	49 (59.0)
Missing	0	0
Total	394 (100)	83 (100)

[1] Row totals are not given as these are provided elsewhere (5.5.1)

[2] Variables with cell counts of <5 were not suppressed because the identity of study participants cannot be deduced from the data summaries provided.

[3] IMD, Index of Multiple Deprivation

Table A17. The detection and primary care consultation for pre-natal symptoms of ill-health by diagnostic group

Variable	Disability indicators (n=394)	Disabling conditions (n=83)
Symptoms detected, n symptom (%)		
Psychological distress	30 (7.6)	7 (8.4)
Head and MSK pain	59 (15.0)	13 (15.7)
Exhaustion	9 (2.3)	3 (3.6)
Risk of consultation, mean symptom (s.d.), range		
Psychological distress	0.1 (0.5), 0-4	0.3 (1.1), 0-6
Head and MSK pain	0.2 (0.5), 0-3	0.2 (0.5), 0-2
Exhaustion	0.03 (0.2), 0-2	0.05 (0.3), 0-2
Consultation frequency, mean (s.d.), range		
Psychological distress	1.5 (0.8), 1-4	3.3 (2.3), 1-6
Head and MSK pain	1.3 (0.5), 1-3	1.2 (0.4), 1-2
Exhaustion	1.1 (0.3), 1-2	1.3 (0.6), 1-2

A4.3 Read codes for the individual symptoms of ill-health recorded after the child's birth

Table A18. Individual symptom Read codes recorded for the exposed and unexposed mothers' after the child's birth

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Stress:				
Stress-related problem	D	295	19	314
Stress at home	S	100	4	104
Feeling stressed	S	88	9	97
Stress incontinence - female	S	84	4	88
Stress at work	S	41	3	44
Stress and adjustment reaction	D	24	1	25
Genuine stress incontinence	S	15	1	16
[X]Other stressful life events affecting family & household	S	5	0	5
Stress management	S	3	0	3
Work stress	S	3	0	3
Adjustment reaction NOS	D	1	0	1
Adjustment reaction with mixed disturbance of emotion	D	1	0	1
Carer stress syndrome	D	1	0	1
[V]Stressful work schedule	S	1	0	1
Total		**662**	**41**	**703**
CMDs:				
Depressed mood	S	342	22	364
Depressive disorder	D	225	12	237
Postnatal depressive disorder	D	196	10	206
Depression NOS	D	164	7	171
Mixed anxiety and depressive disorder	D	132	9	141
Anxiety disorder	D	114	9	123
Feeling anxious	S	116	6	122
Referral to counselling service	S	87	6	93
Referral to primary care mental health team	S	80	6	86
Referral to mental health team	S	77	4	81
Anxiety state NOS	D	75	3	78
Discussion about maternal wellbeing - postnatal depression	S	71	2	73
Moderate depression	D	59	7	66
Mild postnatal depression	S	37	4	41
Referral to mental health counselling service	S	41	0	41
Panic disorder	D	32	3	35
Mood disorder	D	26	4	30
[X]Moderate depressive episode	D	28	2	30
Depression interim review	S	25	3	28
Unstable mood	S	24	1	25
Reactive depression	D	22	2	24
Referral to counsellor	S	20	3	23
[X]Depressive episode, unspecified	D	22	1	23
Mild depression	S	22	0	22
On depression register	S	20	2	22
Referral to community mental health team	S	21	0	21
Depressive disorder NEC	D	18	1	19
Depression medication review	S	16	2	18
Referral to psychiatry service	S	15	2	17
Severe depression	D	16	1	17
Mental health review	S	14	2	16
Symptoms of depression	S	13	2	15
[X]Anxiety disorder, unspecified	D	13	0	13

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
[X]Mild depressive episode	S	13	0	13
Anxiety attack	S	12	0	12
[X]Severe depressive episode without psychotic symptoms	D	11	0	11
(Neurotic depression reactive type) or (postnat depression)	D	10	0	10
Referral for mental health counselling	S	10	0	10
Acute stress reaction	D	8	1	9
C/O - feeling depressed	S	9	0	9
Counselling	S	9	0	9
Mental health medication review	S	9	0	9
Seen by counsellor	S	9	0	9
Seen in mental health clinic	S	8	1	9
Discharge by mental health counsellor	S	8	0	8
Generalised anxiety disorder	D	8	0	8
(Depressed) or (C/O feeling: [depressed] or [unhappy])	S	7	0	7
Crying associated with mood	S	7	0	7
Did not attend mental health appointment	S	7	0	7
Recurrent depression	D	7	0	7
(Depressed (& symptom)) or (unhappy)	S	6	0	6
Acute stress reaction NOS	D	6	0	6
Mental health assessment	S	6	0	6
Obsessive-compulsive disorder	D	6	0	6
Referral to psychologist	S	6	0	6
Referral to psychology service	S	5	1	6
Seen by primary care mental health gateway worker	S	6	0	6
Discharge by counsellor	S	4	1	5
Discharged from primary care mental health team	S	5	0	5
Post-traumatic stress disorder	D	5	0	5
Recurrent anxiety	D	4	1	5
Seen by mental health counsellor	S	4	1	5
Anxiety and fear	S	4	0	4
Anxiety state unspecified	D	4	0	4
Referral to mental health counsellor	S	4	0	4
Referral to primary care mental health gateway worker	S	4	0	4
Seen by community mental health nurse	S	3	1	4
[X](Depressn: [episode unsp][NOS (& react)][depress dis NOS]	D	3	1	4
Except from mental health quality indicators: Patient unsuit	S	3	0	3
Mental health personal health plan	S	3	0	3
Refer to mental health worker	S	3	0	3
Referral to psychiatric nurse	S	3	0	3
Anxiety counselling	S	2	0	2
Depression worse in morning	S	2	0	2
Discharged by mental health primary care worker	S	2	0	2
Discharged from community mental health service	S	2	0	2
Feeling of loss of feeling	S	2	0	2
Mental health monitoring first letter	S	2	0	2
Mental health review follow-up	S	2	0	2
Obsessional neurosis	D	2	0	2
Obsessive-compulsive disorder NOS	D	2	0	2
Postnatal counselling	S	2	0	2
Referral to diabetes preconception counselling clinic	S	2	0	2
Referral to mental health crisis team	S	2	0	2
Seasonal affective disorder	D	2	0	2
Seen in psychology clinic	S	1	1	2

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Stress counselling	S	1	1	2
Under care of mental health home treatment team	S	2	0	2
[X]Panic disorder [episodic paroxysmal anxiety]	D	2	0	2
(Anxiety state (& [states][panic attack])) or (pseudocyesis)	D	1	0	1
Admission to mental health specialist services	S	1	0	1
Anxiousness (& symptom)	S	1	0	1
Chronic anxiety	D	1	0	1
Claustrophobia	D	1	0	1
Cyclic mood swings	S	1	0	1
DNA - Did not attend mental health review	S	1	0	1
Depression: [reactive (neurotic)] or [postnatal]	D	1	0	1
Dissociative convulsions	D	1	0	1
Dysthymia	D	1	0	1
Endogenous depression	D	1	0	1
Except from mental health quality indicators: Informed diss	S	1	0	1
Exception reporting: mental health quality indicators	S	1	0	1
Hypochondriacal disorder	D	1	0	1
Mental Health Care Programme Approach	S	1	0	1
Mental health annual physical examination done	S	0	1	1
Mental health crisis resolution	S	1	0	1
Mental health home treatment team	S	1	0	1
NHS ment hlth nurs home/residentl care - 24hr not intensive	S	1	0	1
Performance anxiety	S	1	0	1
Psychiatric disorder monitoring	S	1	0	1
Psychiatric monitoring	S	1	0	1
Rebound mood swings	S	1	0	1
Recurrent brief depressive disorder	D	0	1	1
Referral by mental health service	S	1	0	1
Referral for cognitive behavioural therapy	S	1	0	1
Referral for guided self-help for depression	S	1	0	1
Referral to community psychiatric nurse	S	1	0	1
Seen by psychologist	S	1	0	1
Social prescribing for mental health	S	1	0	1
Stress reaction causing mixed disturbance of emotion/conduct	D	0	1	1
Variability of mood	S	0	1	1
[X]Mixed anxiety and depress disord (& mild anxiet depressn)	D	1	0	1
[X]Other depressive episodes	D	1	0	1
[X]Unspecified mood affective disorder	D	1	0	1
Total		**2,495**	**152**	**2,647**
Fatigue:				
Tired all the time	S	693	48	741
Tiredness	S	197	14	211
Tiredness symptom	S	107	3	110
Fatigue	S	56	3	59
C/O - "tired all the time"	S	26	1	27
Feeling tired	S	24	1	25
[D]Tiredness	S	16	2	18
Tiredness symptom NOS	S	9	3	12
Malaise and fatigue	S	9	0	9
Tired	S	6	2	8
Fatigue - symptom	S	4	1	5
[D]Lethargy	S	4	1	5

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
[D]Malaise and fatigue	S	4	1	5
[D]Malaise and fatigue NOS	S	4	0	4
[D]Fatigue	S	4	0	3
Exhaustion	S	3	0	1
Muscle fatigue	S	1	0	1
Referral to chronic fatigue syndrome specialist team	S	1	0	1
[D]Malaise [symptom]	S	1	1	1
Total		**1,165**	**81**	**1,246**
Sleep problems:				
Insomnia	D	91	6	97
Poor sleep pattern	S	60	3	63
Difficulty sleeping	S	16	2	18
[D]Sleep disturbances	S	16	0	16
[D]Insomnia	S	11	0	11
Insomnia NOS	D	9	1	10
Sleep hygiene behaviour education	S	8	1	9
[D]Insomnia NOS	S	5	1	6
Delayed onset of sleep	S	3	1	4
Sleep apnoea	D	4	0	4
Difficulty getting to sleep	S	3	0	3
Drowsy	S	3	0	3
Not getting enough sleep	S	3	0	3
Obstructive sleep apnoea	D	2	1	3
Sleep paralysis	D	3	0	3
Transient insomnia	D	3	0	3
Dyssomnia	D	2	0	2
Excessive sleep	D	2	0	2
Initial insomnia	D	1	0	1
Irregular sleep-wake pattern	D	0	1	1
Middle insomnia	D	1	0	1
Nightmares	D	1	0	1
Persistent insomnia	D	1	0	1
Sleep-wake disorder	D	1	0	1
Sleepwalking	D	1	0	1
Sleepy	S	1	0	1
Total		**251**	**17**	**268**
Headache:				
Headache	S	719	33	752
Migraine	D	323	18	341
Tension-type headache	D	236	18	254
Headache disorder	D	89	4	93
C/O - a headache	S	85	6	91
Migraine with aura	D	72	5	77
[D]Headache	S	70	5	75
Migraine without aura	D	42	2	44
Migraine NOS	D	32	3	35
Frontal headache	S	30	3	33
Increased frequency of headaches	S	16	2	18
Unilateral headache	S	13	0	13
Sinus headache	S	10	0	10
Occipital headache	S	9	0	9
Generalised headache	S	7	0	7
[D]Facial pain	S	7	0	7
Atypical migraine	D	5	0	5
Chronic headache disorder	D	5	0	5
Chronic tension-type headache	D	5	0	5

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Temporal headache	S	5	0	5
Migraine with typical aura	D	4	0	4
Muscular headache	D	4	0	4
Common migraine NOS	D	3	0	3
Heavy head	S	2	1	3
Migraine prophylaxis	S	3	0	3
Referral to headache special interest general practitioner	S	3	0	3
Viral headache	S	2	1	3
Cluster headache syndrome	D	2	0	2
Headache character	S	2	0	2
Medication overuse headache	D	2	0	2
Migraine - menstrual	D	2	0	2
Episodic tension-type headache	D	1	0	1
Headache site	S	1	0	1
Headache site NOS	S	0	1	1
Hemiplegic migraine	D	1	0	1
Idiopathic stabbing headache	D	1	0	1
Low pressure headache	D	1	0	1
Migraine aura without headache	D	1	0	1
Migraine variant NOS	D	1	0	1
Migraine with ischaemic complication	D	1	0	1
Ophthalmic migraine	D	1	0	1
Parietal headache	S	0	1	1
Sick headache	D	1	0	1
[D]Pain in head NOS	S	1	0	1
[X]Drug-induced headache, not elsewhere classified	D	1	0	1
[X]Other migraine	D	1	0	1
Total		**1,822**	**103**	**1,925**
MSK pain:				
Low back pain	S	802	40	842
Back pain	S	517	31	548
Neck pain	S	258	18	276
Generalised aches and pains	S	252	18	270
C/O - low back pain	S	140	11	151
Backache	S	82	4	86
Mechanical low back pain	S	75	4	79
Muscle pain	S	72	2	74
Acute low back pain	S	59	6	65
[D]Pain, generalised	S	51	0	51
Thoracic back pain	S	40	4	44
Lumbago with sciatica	S	35	2	37
Chronic low back pain	S	27	1	28
Pain of head and neck region	S	26	1	27
Backache, unspecified	S	22	0	22
Acute back pain with sciatica	S	17	1	18
Backache symptom	S	15	2	17
Myalgia unspecified	S	17	0	17
C/O - upper back ache	S	15	1	16
Chronic back pain	S	13	1	14
Back pain without radiation NOS	S	12	0	12
Pain in lumbar spine	S	9	1	10
Acute thoracic back pain	S	7	2	9
Pain in cervical spine	S	8	1	9
Pain in neck (& [cervical spine])	S	8	0	8
Muscle tension pain	S	7	0	7
Sacral back pain	S	5	2	7

Individual symptom Read code descriptions recorded, N code	Diagnosis (D)[1] or sign/symptom (S)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Postural low back pain	S	6	0	6
Pain on movement of skeletal muscle	S	4	0	4
(Backache NOS) or (back pain [& low])	S	3	0	3
Backache symptom NOS	S	3	0	3
Backache with radiation	S	2	0	2
(Back pain:[lumb sp][low][ac lum]) or (lumbalg) or (lumbago)	S	1	0	1
Nuchal pain	S	1	0	1
Total		**2,611**	**153**	**2,764**

[1] As a measure of clinical levels of the symptoms, I classified the codes recorded in the mothers' health records as diagnoses (clinical) or signs/symptoms (subclinical). Only codes listed in the Read code browser hierarchy under 'disorder', excluding codes specifying 'mild', were considered a diagnosis. Codes listed under 'history and observations', treatments and interventions, referrals and discharges were designated as signs/symptoms. Although e.g. stress counselling is indicative of high stress levels, it is not a definitive diagnosis. This results in a conservative estimate of the number of clinical cases in the exposed and unexposed mothers for the post-natal period.

A4.4 Detection and consultation for the individual symptoms of ill-health by exposure group

Table A19. Individual symptoms of ill-health by diagnostic group stratified by child's birth

Variable, n symptom (%)	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Symptoms detected before the child's birth			
Stress	154 (1.7)	4 (0.8)	158 (1.6)
Common mental disorders	515 (5.6)	34 (7.1)	549 (5.6)
Headache	582 (6.3)	30 (6.3)	612 (6.3)
MSK pain	961 (10.4)	49 (10.3)	1,010 (10.4)
Fatigue	232 (2.5)	11 (2.3)	243 (2.5)
Sleep problems	57 (0.6)	2 (0.4)	59 (0.6)
Symptoms detected after the child's birth			
Stress	662 (7.2)	41 (8.6)	703 (7.2)
Common mental disorders	2,495 (27.0)	152 (31.9)	2,647 (27.2)
Headache	1,822 (19.7)	103 (21.6)	1,925 (19.8)
MSK pain	2,611 (28.2)	153 (32.1)	2,764 (28.4)
Fatigue	1,165 (12.6)	81 (17.0)	1,246 (12.8)
Sleep problems	251 (2.7)	17 (3.6)	268 (2.8)

Table A20. Consultation frequency for the individual symptoms by exposure group stratified by child's birth

Variable, mean symptom (s.d), range	Unexposed (n=9,250)	Exposed (n=477)	Total (n=9,727)
Risk of consultation before the child's birth[1], mean (s.d), range			
Stress	0.02 (0.2), 0-4	0.01 (0.1), 0-1	0.02 (0.2), 0-4
Common mental disorders	0.1 (0.6), 0-15	0.1 (0.6), 0-6	0.1 (0.6), 0-15
Headache	0.1 (0.3), 0-4	0.1 (0.3), 0-2	0.1 (0.3), 0-4
MSK pain	0.1 (0.4), 0-6	0.1 (0.4), 0-2	0.1 (0.4), 0-6
Fatigue	0.03 (0.2), 0-3	0.03 (0.2), 0-2	0.03 (0.2), 0-3
Sleep problems	0.1 (0.1), 0-3	0.1 (0.1), 0-2	0.1 (0.1), 0-3
Consultation frequency before the child's birth[2], mean (s.d)			
Stress	1.3 (0.6), 1-4	-[3]	1.2 (0.6), 1-4
Common mental disorders	1.9 (1.5), 1-15	1.9 (1.4), 1-6	1.9 (1.5), 1-15
Headache	1.2 (0.5), 1-4	1.2 (0.4), 1-2	1.2 (0.5), 1-4
MSK pain	1.3 (0.7), 1-6	1.1 (0.3), 1-2	1.3 (0.6), 1-6
Fatigue	1.1 (0.4), 1-3	1.2 (0.4), 1-2	1.1 (0.4), 1-3
Sleep problems	1.1 (0.4), 1-3	1.2 (0.4), 1-2	1.3 (0.5), 1-3
Risk of consultation after the child's birth, mean (s.d), range			
Stress	0.1 (0.4), 0-6	0.1 (0.4), 0-3	0.1 (0.4), 0-6
Common mental disorders	0.8 (2.2), 0-56	1.0 (1.9), 0-11	0.8 (2.2), 0-56
Headache	0.3 (1.0), 0-22	0.4 (0.9), 0-7	0.3 (1.0), 0-22
MSK pain	0.5 (1.3), 0-25	0.6 (1.2), 0-8	0.6 (1.2), 0-25
Fatigue	0.2 (0.5), 0-6	0.2 (0.5), 0-4	0.2 (0.5), 0-6
Sleep problems	0.03 (0.2), 0-5	0.1 (0.3), 0-5	0.03 (0.2), 0-5
Consultation frequency after the child's birth, mean (s.d)			
Stress	1.3 (0.7), 1-6	1.3 (0.6), 1-3	1.3 (0.7), 1-6
Common mental disorders	3.1 (3.3), 1-56	3.1 (2.3), 1-11	3.1 (3.3), 1-56
Headache	1.7 (1.6), 1-22	1.7 (1.3), 1-7	1.7 (1.6), 1-22
MSK pain	1.9 (1.7), 1-25	1.9 (1.4), 1-8	1.9 (1.7), 1-25
Fatigue	1.3 (0.6), 1-6	1.3 (0.6), 1-4	1.3 (0.6), 1-6
Sleep problems	1.2 (0.6), 1-5	1.4 (1.0), 1-5	1.2 (0.6), 1-5

[1] The mean risk of a women in this group visiting the doctor during the time period is the average number of consultations for the women who did and did not visit the doctor for the symptom during the time period.

[2] The mean number of visits for women who visited the doctor one or more times during the time period are included in the calculation.

[3] Result suppressed as fewer than five observations.

Table A21. Individual symptom diagnoses versus signs/symptoms

Variable, n symptom (%)	**Unexposed**		**Exposed**		**Total**	
	Diagnoses	**Signs/ symptoms**	**Diagnoses**	**Signs/ symptoms**	**Diagnoses**	**Signs/ symptoms**
Stress	322 (48.64)	340 (51.36)	20 (48.78)	21 (51.22)	703 (48.65)	361 (51.35)
CMDs	1,233 (49.42)	1,262 (50.58)	76 (50)	76 (50)	1,309 (49.45)	1,338 (50.55)
Fatigue	0 (0)	1,169 (100)	0 (0)	81 (100)	0 (0)	1,246 (100)
Sleep problems	122 (48.61)	129 (51.39)	9 (52.94)	8 (47.06)	131 (48.88)	137 (51.12)
Headache/ migraine	837 (45.94)	985 (54.06)	50 (48.54)	53 (51.46)	887 (46.10)	1,038 (53.92)
MSK pain	0 (0)	2,611 (0)	0 (0)	153 (0)	0 (0)	2,764 (0)

Appendix 5 Further information for Chapter 7

A5.1 Assessment of equidispersion in the count data of post-natal maternal consultation

Table A22. Equidispersion in the data for the count of post-natal visits ≥1 to the doctor for the sample

Variable	Mean	Variance
Psychological distress (n=2,954)	3.1	10.7
Head and MSK pain (n=3,833)	2.2	4.4
Exhaustion (n=1,427)	1.3	0.4

Table A23. Equidispersion in the data for the count of post-natal visits ≥0 to the doctor for the sample

Variable	Mean	Variance
Psychological distress (n=9,727)	0.9	5.3
Head and MSK pain (n=9,727)	0.9	3.0
Exhaustion (n=9,727)	0.2	0.3

Appendix 6 Further information for Chapter 8

A6.1 Latent class analysis model diagnostics

Table A24. LCA model fit statistics to identify the best number of classes (1-5) for data

N classes	Log-likelihood	BIC	Entropy	Vuong-Lo-Mendell_Rubin LR test (P value)	Class count (proportion)
1	-6012.706	12078.152	-	-	1 1871 (1.00)
2	-5969.492	12051.997	0.390	85.018 (0.0033)	1 807.17024 (0.43) 2 1063.82976 (0.57)
3	-5962.285	12097.857	0.561	14.179 (0.0895)	1 813.76256 (0.44) 2 683.36429 (0.37) 3 373.87315 (0.20)
4	-5959.164	12151.890	0.484	5.308 (0.1604)	1 726.41516 (0.39) 2 492.55022 (0.26) 3 619.63042 (0.33) 4 32.40420 (0.02)
5	-	-	-	-	-

Missing values when the model could not produce a result (-)

A6.2 Latent class analysis results

Table A25. Characteristics of the study sample and probabilities of each characteristic by class

Variable	N, column (%)	Class 1. Lower educated high healthcare users (probability)	Class 2. Pakistani mixed healthcare users (probability)	Class 3. White British low healthcare users (probability)
Consultation frequencies				
Pre-natal consultation frequency				
1 visit	1,237	0.491	0.804	0.770
≥2 visits	634	0.509	0.196	0.230
Post-natal consultation frequency				
0 visits	421	0.000	0.344	0.498
1-5 visits	1,024	0.551	0.568	0.502
≥6 visits	426	0.449	0.088	0.000
Exposure				
Caregiver status				
Unexposed	1,781	0.951	0.952	0.953
Exposed	90	0.049	0.048	0.047
ASD caregiver				
Other disabilities	81	0.854	0.998	0.822
ASD	9	0.146	0.002	0.178
Sociodemographic factors				
Education				
Higher education (education beyond age 16)	764	0.319	0.462	0.512
Compulsory education (education to age 16)	1,101	0.681	0.538	0.488
Ethnicity				
White British	859	0.540	0.071	1.000
Pakistani	1,006	0.460	0.929	0.000

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