Estimating the effect of child poverty on health in Wirral

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Executive summary

Child poverty has been shown to have long lasting negative effects on health throughout the life course of a person. The objective of this work is to quantify the impact of childhood poverty on health in Wirral Primary Care Trust. To reach this objective we reviewed the literature on negative health outcomes associated with child poverty at different stages in life and then use the evidence to quantify the burden of childhood poverty on health in Wirral.

Childhood poverty is a distal cause of ill health and the relationship between poverty and health is complex as a number of associated risk factors will determine the outcome. The negative effects of childhood poverty on health may start as early as prenatal through exposure by the mother (smoking, stress, poor nutrition etc.). Children born to mothers living in poverty are at an increased risk of being born premature, having a lower birth weight and dying of sudden infant death syndrome. Children growing up in poverty are more likely to report poor health, die from injury and poisoning, suffer from iron deficiency and anaemia and have a higher prevalence of asthma, obesity and infections. Other outcomes which have been associated with child poverty are mental health problems, limiting long term illness, speech and language disorders, learning difficulties and behavioural problems. Adults who grew up in poverty are at a higher risk of mortality, hypertension, coronary heart disease and mental health problems. Adult type II diabetes, obesity and respiratory have also been suggested to be associated with childhood poverty. Other adult diseases, which have been linked with social class such as arthritis, osteoporosis and Alzheimer's disease, might also be influenced by childhood poverty due to its link with adult socioeconomic status, though a relationship has not been shown yet. The individual health outcomes are reviewed in detail in the report.

Utilising the findings of the literature review we estimated morbidity and mortality associated with childhood poverty in Wirral. Detailed information on the methods and underlying assumptions are outlined in the report. Based on the assumption that children living in poverty could achieve the same morbidity and mortality rates as their more affluent counterparts, the following number of cases of morbidity and mortality were estimated to be attributable to childhood poverty in Wirral:

Child health outcomes

- 2.4 deaths due to infant mortality per year
- Up to 1361 cases of childhood obesity
- 616 cases of Limiting long term Illness
- 1973 cases of dental caries
- 1648 cases of mental health problems
- 978 cases of asthma
- 5.3 cases of deaths due to all causes per year
- 921 excess spells in hospital per year (246 in men and 675 in women)

Adult health outcomes

- 1697 excess cases of mental health problems in men and 2734 cases in women
- Up to 21 excess cases of heart disease in men and 10 in women per year
- 1717 cases of prevalent heart disease in men and 629 in women
- 65 excess deaths in men and 76 in women from all causes per year

More detailed information on the outcome by sex and age groups are outlined in the report.

Our calculations clearly highlight the negative effects of childhood poverty on morbidity and mortality in Wirral. While our estimates are based on the best available evidence from large population studies, there are uncertainties around these estimates. These are discussed in detail in

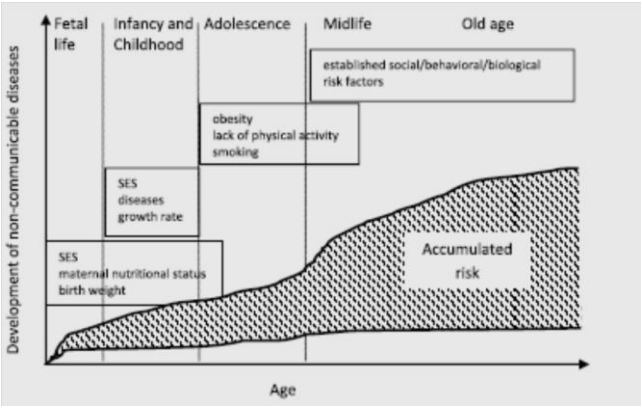
the full report. Estimates for childhood obesity and asthma need to be considered with caution as the evidence for a relationship between childhood poverty and asthma is still limited and for obesity some studies have reported no differences by socioeconomic class at small geographical levels.
The true effect of childhood poverty on health is likely to be even greater as we only included health outcomes in our calculations where the evidence was strong enough using risk estimates controlled for confounding of competing risk factors. Most of our estimates were derived from national data; however the true burden of disease for Wirral might be greater as has been shown for heart disease. In real life childhood poverty is often interlinked with other risk factors and behaviours, thus also likely to increase the burden of disease due to childhood poverty.

Future analysis will look in more depth at Hospital Episode Statistics data in order to obtain a more detailed local picture.

Background

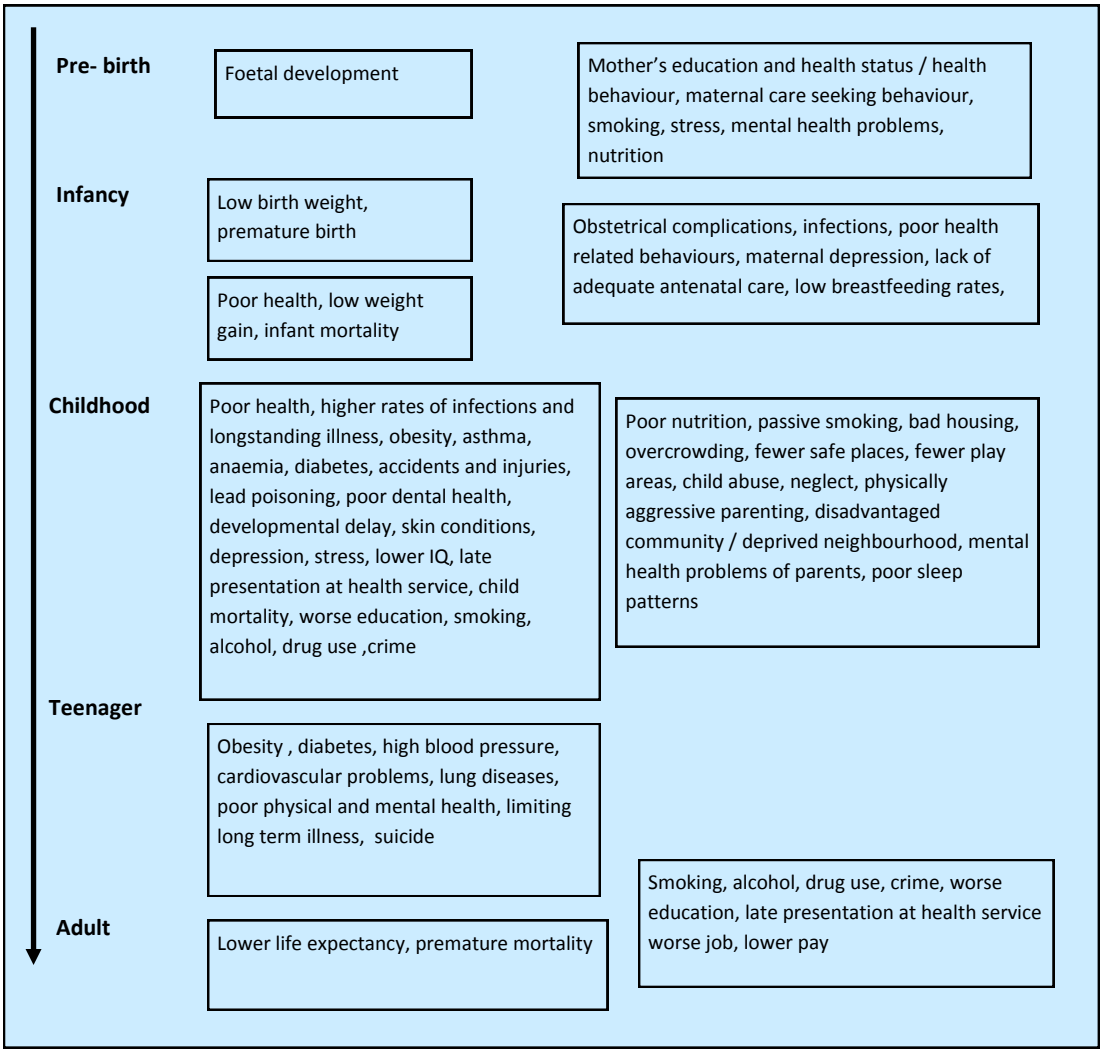
Poverty at any stage in life has been shown to negatively affect the health of a person (Wilkinson and Marmot 2003). The effects of poverty on health might start as early a pre-natal and may persist throughout the life course of a person (Davey Smith 2007, Raphael 2011, Shlomo Kuh 2002, Davey Smith 2007). Childhood poverty is a distal cause of ill health and the relationship between poverty and health is complex as a number of associated risk factors will determine the outcome. A variety of models have been established to conceptualise the effects of child poverty on health (Ben Shlomoand Kuh 2002, Darton Hill, Nishida and James 2004, Aboderin et al. 2002, Van de Mhun et al. 1998, Wood 2003, Blom et al. 1989, Heikinnen 2011, Raphael 2010a). For example, at policy level the relationship between child poverty and health has been illustrated by the social determinants of health (Dahlgren and Whitehead 1991). From a population perspective, life course epidemiology has become increasingly popular in recent years to study the effects of adverse exposures throughout life (Davey Smith 2007). Ben-Shlomo and Kuh (2002) differentiated two main approaches to studying life course processes: the critical periods and the accumulation of risks model. The critical period model proposes that exposure during a specific period in life has a lasting or lifelong effect on structure and function of organs, tissues and body systems which are not modified in any dramatic way by later experience (Ben-Shlomo and Kuh 2002). The accumulation model expands on the critical period approach and proposes that health modifying risk factors accumulate throughout the life course (figure 1) (Ben-Shlomo and Kuh 2002).

Figure 1: Accumulation of risks model adapted from Heikinnen (2011).



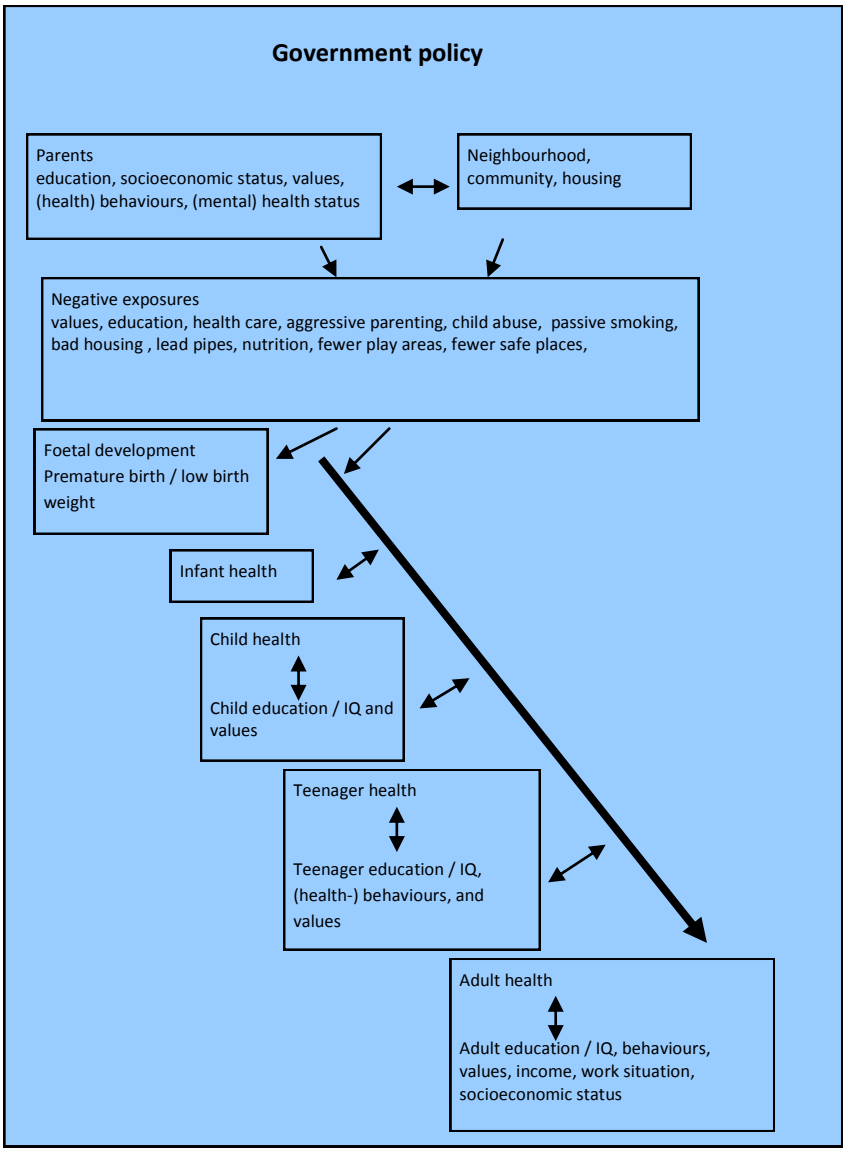
In figure 2 we summarise main risk factors and outcomes at different ages; however this illustration does not capture pathways and relationships. Some outcomes may in turn act as risk factors and exposure earlier in life may have negative influences later in life. Trying to incorporate this into the model, results in a similar approach as the accumulation of risks model (figure 3). To capture all possible relationships would result in a much more complex model.

Figure 2: Risk factors and negative (health) outcomes associated with childhood poverty.



Note: Some of the outcomes are also risk factors and negative health outcomes at earlier stages in life might influence health negatively later in life.

Figure 3: Risk factors, their interaction and negative (health) outcomes associated with childhood poverty.



Different measures and definitions have been used for childhood poverty, the most common measure being family income. In 2007 the UN General Assembly defined childhood poverty as *"deprivation of nutrition, water and sanitation facilities, access to basic health-care services, shelter, education, participation and protection, leaving children unable to enjoy their rights, to reach their full potential and to participate as full members of the society"* (UN 2007). This definition adopts a human rights approach and clearly extends beyond the definition of poverty in mere financial terms. Nevertheless, the most common way to measure childhood poverty is by setting an absolute or relative monetary threshold. International consensus identifies individuals or families receiving less than half the median income of the jurisdiction as living in relative poverty (Raphael 2011). In England childhood poverty is measured as the number of children living in families in receipt of Child Tax Credit whose reported income is less than 60 per cent of the median income or in receipt of Income Support or (Income-Based) Job Seeker Allowance, divided by the total number of children in the area (determined by Child Benefit data) (HM Revenue n.d.). While household income is an easily available indicator for measuring childhood poverty, initiatives have been undertaken to develop

more detailed and more sensitive indicators to meet the wider definition of childhood poverty. (Notten, Geranda and Keetie Roelen 2011)

The objective of this work is to quantify the impact of childhood poverty on health in Wirral Primary Care Trust. To reach this objective we review the literature on negative health outcomes associated with child poverty at different stages in life and the use the evidence to quantify the burden of childhood poverty on health in Wirral. The review on child poverty and health is split into two parts: (i) adverse health effects in childhood and (ii) adverse health effects in adulthood. The primary focus of the literature review is to identify health outcomes associated with child poverty and to derive risk estimates for quantification of the effects of child poverty on health in Wirral.

Literature review

We carried out a two step literature search using the EBSCO Discovery database health and life science profile of the electronic database of the University of Liverpool and GOOGLE internet search. In the first step we focussed on review articles on child poverty and health to identify health outcomes which have been linked with child poverty. In the second step we reviewed the health outcomes identified in step one in more detail to derive estimates that can be used in a local quantification. The following search terms were used:

Child AND poverty AND health
Child AND deprivation AND health
Child AND socioeconomic AND health

In the second step the same search strategy was applied, but the term “health” was replaced with the respective health outcome under investigation. In addition to the above database search we also hand searched the references of relevant articles for further literature. Search results were sorted by relevance and scanned by title and / or abstract. Particular focus was put on review articles, systematic reviews, meta-analyses, longitudinal studies and studies from the UK and England.

Summary articles

The negative effects of childhood poverty on health may start as early as prenatal (figure 1-3) through exposure by the mother (smoking, stress, poor nutrition etc.) (Davey Smith 2007). Children born to mothers living in poverty are at an increased risk of being born premature, having a lower birth weight and dying of sudden infant death syndrome (Spencer 2008, Bradshaw 2002, Arber et al. 1997). Children growing up in poverty are more likely to report poor health, die from injury and poisoning, suffer from iron deficiency and anaemia and have a higher prevalence of asthma, obesity and infections (Spencer 2008). Other outcomes which have been associated with child poverty are mental health problems, speech and language disorders, learning difficulties and behavioural problems. Adults who grew up in poverty are at a higher risk of mortality, coronary heart disease, type II diabetes, obesity, respiratory diseases, hypertension and psychiatric disorders (Raphael 2011, Barker et al. 2001). Other adult diseases, which have been linked with social class such as arthritis, osteoporosis and Alzheimer’s disease, might also be influenced by childhood poverty due to its link with adult socioeconomic status, though a relationship has not been shown yet (Raphael 2011).

While a number of reviews have been published summarising the effects of childhood poverty on health (Oberg et al. 2003, Phipps 2003, Arber et al. 1997, Egbuonu and Starfield 1982, Spencer 2008a, Attree 2011, Wood 2003, Bradshaw 2002, Giggs and Walker 2008, Raphael 2011) none provides the level of detail required for a quantification of the effects of childhood poverty on health in Wirral. In the following we will review the health outcomes identified in the overview studies in more detail.

Child health outcomes

Infant mortality

Babies born to deprived, unemployed or little educated parents are at a greater risk of dying during the first year of their lives. Preterm birth and low birth weight, which in turn are linked with deprivation, also greatly influence survival during the first year. In an analysis of all live birth in England and Wales between 2005-06 Oakley, Maconochie and Doyle (2009) reported a 57% increased risk of infant mortality for the most deprived group and a 71% increased risk for babies born to unemployed parents after adjusting for age, sex, deprivation, registration status and ethnicity of the baby (table 1). These findings are in line with those reported in a meta analysis of nine studies for the eastern Mediterranean region (Jahan 2007).

Table 1: Studies on infant mortality and socioeconomic status of parents.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Smith et al. 2010	England	1997-2007	Cause specific neonatal mortality by deprivation (IMD at super output area level)	In 2006-07 children born in most deprived areas were at 2.35 (95% CI 2.10-2.63) fold increased risk of infant mortality. The risk increased from 2.08 (95% CI 1.92-2.27) in 1997-99 and 80% of this difference was explained by premature birth and congenital abnormalities	<28 days	18524 neonatal deaths	
Jahan 2007	Eastern mediteraenaen countries	1980-2000	Infant mortality by socioeconomic status and illiteracy of mother	Babies born to illiterate mother have a 1.72 (95% CI 1.45-2.08) fold increased risk of infant mortality compared to those born to literate mothers. Low socioeconomic status is associated with a 1.6 fold (95% CI 1.30-1.96) increased risk compared to most affluent household and 1.37 fold increased risk (95% CI 1.25-1.49) compared with better SES households.	< 1 year		Meta analysis of 9 studies
Oakley, Maconochie and Doyle 2009	England and Wales	2005-06	Neonatal, post neonatal and infant mortality by deprivation and parent's employment status	Babies born to most deprived parents have a 1.57 fold (95% CI 1.41-1.75) increased risk of infant mortality. Unemployment was associated with a 1.71 fold (95% CI 1.18-2.47) increased risk of infant mortality	< 1 year	1,276,198 live birth and 5,571 infant deaths	Adjusted for age, sex, deprivation, registration status and ethnicity of baby. Further factors considered in analysis: birth weight, gestation, maternal age and marital status

Obesity

Studies from England show that rates of childhood obesity have been increasing across all social classes (Sherburne Hawkins, Cole and Dezateux 2007, NOD 2011) and evidence from surveys and cross sectional studies points towards higher obesity rates in the more deprived children (NOD 2011, Nelder et al. 2009, Sherburne Hawkins, Cole and Dezateux 2007). The magnitude of the difference in obesity rates by socioeconomic status differs between studies. Possible explanations are regional variation; change over time and difference in study design and age of study groups. While childhood obesity has been increasing across all social classes, Brunt et al. (2008) found that obesity rates have been increasing at a higher rate in the most deprived groups (table 2). Data from the National Obesity Observatory (NOO 2011) reported 5.8% and 10.8% higher obesity prevalence in the most deprived groups in 4-5 and 10-11 year olds respectively. These findings are in line with those reported by (Nelder et al. 2009) for Plymouth. However both studies are of ecological study design, thus not allowing any conclusion at the individual level. In an analysis of small geographical areas, Edwards et al. (2010) reported increased levels of obesity in affluent and deprived areas in Leeds and Dummer et al. (2005) found no differences in childhood obesity by deprivation at the ward level in Liverpool. Other factors, associated with deprivation, might also influence childhood obesity

which cannot be considered in ecological studies. The UK Millenium study, a cohort study of around 19,000 children born in the UK in 2000/1 (Sherburne Hawkins, Cole and Dezateux 2007) reported 1.5% higher obesity prevalence in disadvantaged 3 year olds in England. Due to its design, this study can classify deprivation at the individual level as opposed to neighbourhood characteristics and adjust for confounding. Updates from this study will show if the socioeconomic differences change with increasing age.

Table 2: Studies on childhood poverty and childhood obesity.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comments
Kinra, Nelder and Lewendon 2000	Plymouth, England	1994-96	Townsend score	No significant results for 5.1 to 11.7 year olds, 1.95 increased risk of obesity for most deprived 11.8 to 14.6 year olds (3.3% higher prevalence)	5.1-14.6	20,973	
National obesity observatory (NOO) 2011	England	2008-09	Income Deprivation Affecting Children Index (IDACI)	Obesity at reception: least deprived 6.7%, most deprived 12.5%; at year six: least deprived 12.6%, most deprived 23.4%	4 to 5 and 10 to 11	Around 1 million measurements	Data from national child measurement programme
Sherburne Hawkins, Cole and Dezateux (2007)	UK	2003-05	Income poverty measured as family income (below 60% median)	Disadvantaged children had 1.5% higher obesity prevalence and 1% higher prevalence of overweight in England	3 years	13.771, of these 3785 advantaged and 3409 disadvantaged in England	Millennium cohort study
Edwards et al. 2010	Leeds, England	2000-03	IMD and 2001 census classification of output areas	Increased obesity in affluent and deprived areas	3-13 years	n=37,173	Study used three different data sources for obesity
Dummer et al. 2005	Liverpool, England	1998-2003	IMD	No association of obesity with deprivation	9-10 years	15416	
Nelder et al. 2009	Plymouth, England	2005	Townsend score	7.3% higher obesity prevalence in most deprived 5-6 year olds and 4.8% higher prevalence in most deprived 10-11 year olds	5-6 and 10-11 years	3314	Update of 1995 survey
Brunt et al. 2008	South Wales	1995-2005	Townsend score	Obesity prevalence In 2005: 20.4% in least deprived and 24.6% in most deprived. BMI varied by year and increased in deprived group to close gap to affluent, who had higher BMI in 1995.	3-4 years	44525	
Ruijsbroek et al. 2011	Netherlands	1997-2005	BMI by maternal education	Low maternal education was associated with a 2.82fold (1.80-4.41)increased risk of obesity	0-8	3963	Risk factors considered were breastfeeding, smoking during pregnancy, smoking during first 3 months and day care centre attendance

Asthma

Childhood poverty and asthma has been studied by looking at differences in asthma severity and prevalence. Mielck et al. (1996) reported higher severity of asthma in children from more deprived backgrounds, but they found no conclusive evidence of higher asthma prevalence in more deprived children in a review of 24 studies. As possible explanations for the difference in asthma severity Mielck et al. (1996) identified differences in asthma management and treatment which were influenced by medical advice seeking and access to specialised asthma management. More recent studies reported higher asthma prevalence and higher frequency of asthma attacks with decreasing socioeconomic status (Serguin et al. 2007, Nikiema et al. 2010, Kozyrskyj et al. 2010, Ruisbroek et al.

2011) (table 3). Serguin et al. (2007) reported a 2.4 fold (95% CI 1.3-4.2) [1] increased risk of asthma attacks in 2.5-3.5 year old children who had experienced 3-4 periods of poverty since birth. In summary, asthma prevalence was reported to be 1.27 to 2.21 times higher in the deprived group in the different studies (table 3). Besides differences in study designs and study population, the number of confounders considered also contributed to the range in outcome.

Table 3: Studies on childhood poverty and childhood asthma.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Mielck et al 1996	Munich, Germany	1989-1990	Asthma severity by education of parents	2.3 fold increased risk of severe asthma in most deprived children (0.9% in least deprived versus 2.1% in most deprived, measured per all children) and 2.5 fold increased risk of severe asthma in those suffering from asthma (16% in least deprived versus 40% in most deprived)	9-11	7455 enrolled, 6490 responded	As part of the study Mielck and colleagues also reviewed the literature (24 studies) for a link between increased asthma prevalence and deprivation, but found no conclusive evidence.
Serguin et al. 2007	Quebec Canada	1998-2001	Occurrence of asthma attack in last 12 month by parent's income	Children who had experienced 3-4 periods of poverty had a 2.4 (1.3-4.2) fold increased risk of asthma attacks	3.5	1950	
Nikiema et al. 2010	United Kingdom and Quebec, Canada	1998-2001 Canada and 2000-2003 UK	Asthma prevalence by income support or social welfare	Poverty in first year of life: UK 1.67 (1.39-2.02), Quebec 1.52 (0.84-2.75); Poverty 4'th year of life: UK 1.55 (1.24-1.93) Quebec 1.17 (0.48-2.85)	3-3.5	14556 in UK and n=1950 in Quebec	
Kozyrskyj et al. 2010	Perth, Western Australia	1989-2005	Asthma prevalence by family income	Increased risk in most deprived at age 6: male & female 1.17 (0.82-1.65), male 1.64 (1.04-2.57), female 1.11 (0.68-1.81); risk at age 14: male & female 2.21 (1.17-4.17, male 1.27 (0.59-2.73), female 2.95 (1.22-7.11)	6 and 14	2868	At age 6 adjusted for gender, preterm birth, maternal asthma and dog ownership in first year and chronic family stress ; at age 14 adjusted for gender, maternal history of asthma, cat ownership in first year and chronic family stress
Ruijsbroek et al. 2011	Netherlands	1997-2005	Asthma prevalence by maternal education	Most deprived have an increased risk of asthma of 1.27 (1.08-1.49) (prevalence = 15.9% compared to 12.2%), inclusion of lifestyle risk factor in the analysis decreases the risk, greatest effect was seen for smoking during pregnancy (OR=1.2).	0-8	3963	Risk factors considered were breastfeeding, smoking during pregnancy, smoking during first 3 month and day care centre attendance

Diabetes 1

The aetiology of diabetes 1 is not fully understood, current theories propose gene – environmental interactions. A number of studies have investigated the relationship between childhood poverty and diabetes (Du Prel 2007) and the evidence seems conflicting. While some studies have reported increasing diabetes incidence with increasing deprivation, others have shown the opposite (table 4). The majority of studies were of ecological study design, meaning that possible confounders at the individual level could not be considered. The studies indentified in the literature review indicate a slight trend towards a higher diabetes 1 incidence in more deprived children, but the evidence seems insufficient to date.

[1] Adjusted for gender, birth order, mothers age, education, social support, physical violence, child care use, family type and smoking in the house,

Table 4: Studies on childhood poverty and diabetes 1.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comments
Crow, Alberti, Pertuin 1991	North England	1977-1986	Diabetes incidence by deprivation	Diabetes prevalence in most deprived: 18.7 (16.2-21.5), least deprived: 7.0 (5.6-8.75)	<16	919	
Du-Prel et al. 2007	North Rhine Westphalia, Germany	1996-2000	Diabetes incidence by deprivation	Diabetes incidence was 30% (14%-48%) higher in most deprived areas	<15	2499	
La Porte et al. 1981	Pennsylvania, USA	1965-1976	Diabetes incidence by deprivation	Diabetes incidence: Least deprived: 13.74 +/- 2.12; most deprived: 15.21 +/- 2.26	< 20	939	
Soltesz et al. 1994	Hungary	1990	Mother's education (highest level: university)	Odd ratio lowest versus highest education of mother: 1.69 (0.95-3)	<15	163	
Blom et al. 1989	Sweden	1985-86	Education mother (non university); employment of farther (manual worker).	Odds ratio lower versus higher education of mother: 1.58 (1.03-2.42); Odds ratio lower versus higher employment status of farther: 1.37 (1.03-1.83)	<15	393	
Patterson 2001	Europe	1989-1994	Infant mortality rate and GDP	Both measures were significantly related with diabetes incidence	<15	16362	
Patterson & Vaugh 1992	Scotland	1977-1983	Deprivation by geography	Odds ratio deprived versus non deprived group: 0.8 (0.71-0.89)	<19	2125	
Baumer, Hunt and Shield 1998	South West of England	1994	Deprivation by geography	No association	<16	801	
Gopinath et al. 2008	Stockholm, Sweden	1990-2003	Parent's income	No significant association with income, but higher incidence (24.3) in affluent compared to deprived (20.2)	<18	733	
Grigsby Toussaint et al. 2010	Chicago, USA	1994-2003	Neighbourhood characteristics	No clear association	<18	1252	
Siemiatycki et al. 1988	Montreal, Canada	1971-1985	Social class	Slightly higher risk in wealthier children	<14		Abstract only
Stewart-Brown, Haslum and Butler 1983	UK	1946, 1958 and 1970 birth cohorts	Farther's occupation	Slightly higher risk in wealthier children	<11	cohort of 13 823	Small number of cases (18)

Accidents and injuries

Injuries are a major cause of premature deaths and disability in children and studies have shown that more deprived children are affected disproportionately (Laflamme, Burrows and Hasselberg 2009). Extensive reviews of the literature on childhood poverty and premature deaths, accidents and injuries have been published by the World Health Organisation (WHO) (Laflamme, Burrows and Hasselberg 2009, Laflamme and Hasselberg 2010). The single most investigated cause are traffic injuries. Northern European countries, in particular the UK (37 studies) and Sweden (25 studies), contribute the largest amount of studies. Given the large number of studies carried out in the UK, we restricted our summary to UK studies as they are most relevant to Wirral (table 5).

The studies on injury and deprivation indicate higher risk of injury as well as a higher risk of more severe injuries in children from deprived backgrounds (Laflamme et al. 2009). The majority of evidence has been derived from ecological studies. A multilevel study from the UK indicated that some of these findings might be due to individual factors, thus highlighting the possible impact of confounding (Reading et al. 1999). There also seem to be differences by age groups with the social gradient being less profound at younger ages (Laflamme et al 2004. Kendrick and Marsh 2001).

Table 5: Summary of selected studies on childhood poverty and morbidity and mortality from accidents and injuries based on Laflamme et al. (2009).

Author	Place	Year	Measure	Outcome	Age	Sample size
Hippisley Cox et al. 2002	Trent, UK, 862 electoral wards	1992-1997	Hospital admission by Townsend deprivation score	Most accidents were caused by falls (39.3% in 0-4 year olds and 48.9% in 5-14 year olds), increased risk in most deprived compared to least deprived: Falls: 1.6; pedal cycling: 1.8; pedestrian accidents: 3.7; other transport accidents: 1.2; poisoning: 3.2 and burns: 3. The social gradient was higher in younger age groups	0-14	56629 hospital admissions
Edwards et al. 2006	England and Wales	4 years around 1981, 1991 and 2001 census	Deaths rates from injury and poisoning by national statistics socioeconomic classification	Overall rates of deaths from injury and poisoning fell from 11.1 per 100,000 in 1981 to 4 per 100,000 in 2001, but socioeconomic differences remained. Overall difference between most and least deprived was 13.1 (10.3-16.5) times higher in most deprived. Difference by cause: pedestrians 20.6, car occupants 5.5, cyclist 27.5, threats to breathing 16.7, smoke and fire 37.7, unintentional intent 32.6	0-15	1163 deaths in 2001-03
Coupland et al. 2003	Trent, UK, 862 electoral wards	1992-1997	Hospital admissions by Townsend score	Risk in most deprived versus least deprived: cyclists 1.8, pedestrians: 4 and other transport: 0.7	0-14	1936 incidents

Hippsley Cox et al (2002) and Coupland et al. (2003) reported a steep social gradient in morbidity from accidents and injuries in 0-14 year olds. The highest difference was a 3.7 to 4 fold increased risk for pedestrian accidents (table 5). The socioeconomic differences were even more profound for mortality from traffic injuries. Edwards et al. (2006) reported an overall 13.1 fold higher risk of deaths from injury and poising in the most deprived group of 0-15 year olds in England and Wales from 2001-03 (table 5).

Cancers

Our literature review revealed no conclusive evidence of an increased risk of childhood cancers in children from a more deprived background. In fact children from a deprived background might be at a lower risk of childhood cancers or at least certain types of childhood cancers. A study from England of 13-24 year olds reported higher incidence of lymphomas, central nervous tumours and gonadal germ cell tumours in less deprived wards and higher incidence of chronic myeloid leukemia and carcinoma of the cervix in more deprived wards (Alston et al. 2007). In comparison, a study from the USA of 21,300 children aged 0–19, reported lower incidence of childhood cancers in more deprived counties (Pan, Daniels and Zhu 2010) and a UK study found no difference in childhood leukaemia (Stiller 2008).

Infections

Childhood exposure to infections has been discussed to be a determinant of later life morbidity and has been associated with chronic diseases and mortality (Dowd Zajacova and Aiello 2009). The biological mechanism has been explained by the reallocation of energy away from development needed for immune and inflammatory responses. Studies have investigated the relationship between childhood poverty and the number and severity of infections (table 6). Ruijsbroek et al (2011), Hawker et al (2003) and Margolis et al. (1992) reported higher rates of respiratory infections in deprived children and Malcom et al. (2004) found higher prevalence of H pylori infections in children from deprived areas (table 6). These findings are supported by those from Dowd et al. (2009), who investigated serostatus of common infections in 6-16 year olds by family income and parental education. In contrast Bessel et al. (2010) reported a lower risk of Campylobacter infection in more deprived children. However, the findings by Dowd et al (2009) provide strong evidence for higher rate of infections in more deprived children. The data in this study is at the individual level and measures serostatus thus not being prone to recall bias. A large proportion of these infections are related to environmental risk factors associated with childhood poverty which could be changed (Margolis et al 1992).

Table 6: Studies on childhood poverty and childhood infections.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Ruijsbroek et al. 2011	Netherlands	1997-2005	Respiratory infections by maternal education (3 or more of the following infections during the previous 12 months: bronchitis, pneumonia, middle ear infection, sinusitis, throat infection, or flu or a serious cold)	Most deprived had a 1.57 fold (1.35-1.83) increased risk of respiratory infections	0-8	3963	Risk factors considered were breastfeeding, smoking during pregnancy, smoking during first 3 month, day care centre attendance.
Malcom et al. 2004	Glasgow, Scotland	1995-2002	H pylori colonisation by social deprivation (Carstairs and Morris index of deprivation)	Significant higher prevalence of H pylori in children from most deprived areas (34% compared to 22% in least deprived)	2-16, median =10	626	
Bessel et al. 2010	Scotland	2000-2006	Campylobacter infection by deprivation and population density	Most deprived children had a decreased risk 0.965 (0.959-0.971), increased population density has also been found to be protective (0.745 (0.700-0.792))	Results for under 15 year olds	33,967 for all ages	If results are true or due to underreporting in poor is unclear, more deprived could have developed immunity due to earlier infections
Dowd, Zajacova and Aiello 2009	USA	1998-1994	Serostatus of H pylori, CMV, HSV1, HAV and HDV by family income and education of reference person	Family income, parental education, race and ethnicity were significantly associated with the likelihood of infections in US children.	6-16, mean = 11.1	4319	Subsample from NHANES III survey
Hawker et al 2003	West Midlands Health Region, England	1990-1995	Hospital admissions for respiratory infections (ICD 9 460.0-519.9) by deprivation at postcode level	Most deprived had highest rate 150.7 (148.3-153.1) and most affluent lowest 118.8 (109.2-114.4).	Results for 0-4 year olds	76680 (all ages)	
Serguin et al. 2007	Quebec Canada	1998-2001	Occurrence of an infection (respiratory, otitis, gastroenteritis, other) in the previous 3 months	No significant difference was found, children who had experienced 3-4 periods of poverty had a 1.1 (0.8–1.6) increased risk of infections	3.5	1950	
Margolis et al. 1992	Alamce and Chatham counties, North Carolina, USA	1986-1988	Acute lower respiratory illness and chronic respiratory symptoms by education of parents	Lowest socioeconomic class had a 2.9 (1.9-4.5) fold increased risk.	<=1 year	393	Other risk factors considered: ethnicity, birth weight, born in non respiratory season, family history of allergies and / or respiratory diseases, high maternal stress, smoking, crowding, woodstove, gas cooking and bottle feeding

Lead poisoning

Blood lead levels have decreased significantly in children since lead has been banned in paint and petrol (Bradbury 2009). However children are still at risk of being exposed to lead in the living environment, the main risk being ingestion of lead paint flakes (Bradbury 2011). Other common routes of exposure are lead water pipes and smoking in the house (Dixon 2009). Children from deprived backgrounds are at greater risk due to worse housing conditions. Limited data is available for England, for this reason the HPA initiated a study to assess the burden of lead poisoning in children in the UK and to identify vulnerable groups (HPA 2011). The US Centre for Disease Control monitors blood lead levels in children as part of the National Health and Nutrition Examination Survey. While overall blood lead levels have been decreasing social and racial inequalities remained in the USA (CDC 2005, Dixon 2009).

Limiting long term illness (LLTI)

Two recent studies have reported higher prevalence and higher risk of LLTI in children from more deprived families (Spencer et al. 2009, Nikiema et al. 2010) (table 7). In an analysis of 2001 UK census data, providing a large sample size of 462,679, Spencer et al. (2009) reported a 2.3-2.4 fold increased risk of LLTI in children aged 0-19 from deprived families. This difference was evident for all age groups considered in the analysis.

Table 7: Studies on childhood poverty and LLTI.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Spencer et al. 2009	UK	2001	Prevalence of LLTI / disability by ONS socioeconomic classification	More than 2 fold increased risk of LLTI in most deprived children. OR=2.29 (2.65-3.21) for children of parents who never worked and 2.39 (2.11-2.69) for children of long term unemployed parents	0-19 by 5 year age bands	462,679 children, 51.3% male	Census data, additional analysis by education of parents and overcrowding to control for confounding
Nikiema et al. 2010	United Kingdom and Quebec, Canada	1998-2001 Canada and 2000-2003 UK	LLTI prevalence by received income support or social welfare	Poverty in first year of life: UK 1.39 (0.94-2.06); Poverty 4'th year of life: UK 3.11 (2.23-4.34)	3-3.5	14556 in UK and 1950 in Quebec	UK results only numbers for Quebec study are too small

Oral health

Studies show higher prevalence of dental caries in children from deprived families (Levin et al. 2009; Dye and Thornton 2007, Steele and Lader 2004). In England 5, 8 and 15 year old children from deprived families were found to have 16%, 24% and 18% higher prevalence of tooth decay respectively (Steele and Lader 2004) (table 8). Only in the 12 year olds prevalence of tooth decay was 1% lower in the most deprived compared to the more affluent children (Steele and Lader 2004). Severity of decay was greater in the most deprived in all age bands. One explanation are different dental health habits (Eckersley and Blinkhorn 2001; Jones 2001). Eckersley and Blinkhorn (2001) found children from deprived wards in Salford to be more likely to be fed non milk extrinsic sugars before bed time and to begin brushing teeth later in life. Jones (2001) reported children from deprived wards to be less likely to be registered with a dentist and to be more likely to lapse checkups.

Table 8: Studies on child poverty and oral health.

Author	Place	Year	Measure	Outcome	Age	Sample size
Levin et al. 2009	Scotland	1993-2003	Prevalence and amount of decayed missing and filled primary teeth (d3mft) by deprivation	From 1993-2003 prevalence decreased more in the most deprived (11.3%) compared to the least deprived (4.8%). In 2003 most deprived had a 4.6 (3.47-6.14) increased risk of d3mft compared to least deprived. While overall gap in prevalence between most and least deprived decreased, the difference in the amount of fillings persisted.	5 years	Ranged from 5656 in 1993 to 9858 in 2002
Steele and Lader 2004	England	2003	Prevalence and severity of tooth decay by parents deprivation and school deprivation	5, 8 and 15 year old children from deprived families had 16%, 24% and 18% higher prevalence of tooth decay respectively. Only in the 12 year olds prevalence of tooth decay was 1% lower in the most deprived compared to the more affluent children. Severity of decay was greater in the most deprived in all age bands.	5,8,12 and15	10381
Dye and Thornton Evans 2007	USA	1988-1994 and 1999-2004	Untreated caries, filled teeth and teeth missing due to disease by poverty income threshold	In 1999-2004 prevalence of dental caries was 19.6% higher in the most deprived 2-4 year olds (34.1%). Compared to the least deprived (14.5%) and 25.8% higher in most deprived (67.4%) 6-8 year olds. Caries experience increased in both age groups from 1988-94 to 1999-2004. Most of this was due to increase of caries in male.	2-4 years and 6-8 years	1830 2-4 year old and 1597 6-8 year olds

Anaemia

Iron deficiency is the most prevalent nutritional deficiency disorder in the world (WHO 2011). Childhood Anaemia due to malnutrition is a significant heath problem in many developing countries (WHO 2008). In the UK, anaemia prevalence was estimated to be 12% in 1.5 to 2 year olds (Booth and Aukett 1998) and around 8% (haemoglobin <110g/l) in preschool children (WHO 2008). There is a significant increase in anaemia with deprivation. In socioeconomically deprived children between 6 and 24 month anaemia prevalence was estimated to vary between 25-40% in the UK (Booth and Aukett 1998). However these estimates are based on survey data from 1992-93 and might have changed over time. Skalicky et al. (2006) found a 2.4 fold (CI 1.1–5.2) increased risk of iron deficient anaemia in children younger than 36 month suffering food insecurity in the USA. Food insecurity can be regarded as an indicator for socioeconomic status as it is closely linked with family income. We did not identify any more recent studies for the UK.

Mental health

Studies have highlighted higher prevalence of mental health problems in children from deprived backgrounds (Sharan 2007, McLeod and Shannan 1993, Samann 2000, Offord 2001, McLeod and Shannan 1996, Costello et al. 2003) and mental health problems may be linked with developmental problems (Green et al. 2004). Poor parenting has been identified as a key factor affecting mental health of children (Offord 2001), but other factors associated with poverty such as parent education, maternal distress, negative coping strategy and single parenthood might also influence mental health status of children (Offord 2001, Samaan 2000). The prevalence of mental disorders (emotional disorders, conduct disorders and hyperkinetic disorders) in children in the UK has been assessed in the children's mental health survey (Green et al. 2005). In this survey, socio demographic variation was measured using a number of different measures ranging from parents education over income to neighbourhood characteristics. All different measures of poverty showed a decrease in children's mental health status with increasing poverty. Boys generally had a higher prevalence of mental health problems compared to girls and the 11-16 year olds had higher prevalence compared to the 5-10 year olds. Lone parenting, neither parent working, weekly income less than £400 and no qualification were associated with 75%, 39% and 46% and 55% increased risk of mental health problems in 5-15 year old children respectively. Measured by employment status, parent's qualification and income as indicators of socioeconomic status, the prevalence of mental health problems was 10.8-12.0% higher in the most deprived (11.7-13.5% in boys and 9.5-12.4% in girls). For these three indicators, the difference between the deprived and well off was greater for the 11-16 year olds (14-15%) compared to the 5-10 year olds (7.8-10.6%).

General health

Given the different diseases related to child poverty discussed above, it is seems hardly surprising that deprived children rate their health worse compared to their more affluent counterparts. A Dutch study assessed general health in school children using a general health index (Ruijsbroek et al. 2011). They reported children from families with low socio-economic backgrounds to be at a 1.36 fold increased risk (95% CI 1.16-1.60) to experience poor general health.

Adult health outcomes

High quality studies on the effects of childhood poverty on adult health are limited. Long follow up times required in cohort studies are a major drawback. Often, results have been derived from cohort studies that were not primarily designed to investigate the effect of childhood poverty on adult health. This means that they might be limited in their analysis options and not all relevant confounders can be considered. Another area of research has been low birth weight and adult health. These studies also cover to some extent the effects of deprivation on adult health, due to the strong link of deprivation and low birth weight. Another route of analysis has been child IQ which again is closely linked to child poverty and adult health (Hart 2003).

Coronary heart disease

In a systematic review of 40 studies on childhood socioeconomic status and adult cardiovascular disease, Galobardes et al. (2006) found a robust inverse relationship between childhood circumstances and adult CVD risk in 31 studies. While Galobardes et al. (2006) do not show the magnitude of the association, they state that it varied by studies, outcomes, socioeconomic measures and sex. The majority of studies in the review focussed on mortality as the main outcome measure, in the following we only look at incidence as mortality will be covered in more detail in the next section. In a study on the relationship between childhood socioeconomic status (SES) and coronary heart disease in 3,444 British women aged 60-79, Lawlor et al. (2004) reported a linear association between childhood SES and adult coronary heart disease with a 17% increase in CHD per increase in deprivation category. However the risk was attenuated by 68% after adjusting for a number of competing risk factors. Based on the UK Whitehall II study, Singh et. al (2004) reported an age adjusted increased risk for CHD incidence of 1.54 (1.21-1.97) in men and 1.32 (0.91-1.91) in women. In an analysis of 698 middle aged Finnish men, Kauhanen et al. (2006) reported a 1.63 (1.09-2.44) fold increased risk of acute coronary events in adults who were socially disadvantaged during childhood. After excluding persons with a previous CHD event from the analysis the risk increased to 1.99 (1.17-3.38).

Risk factors play a major role in the onset of CHD and are related to childhood poverty as shown in the study by Lawlor et al. (2004), where the RR decreased significantly after adjusting for confounding risk factors. Studies have specifically investigated the relationship of childhood and adult socioeconomic position and disease risk factors (Poulton et al. 2002, Blane et al 1996, Power et al. 2007, Mckenzie 2011). Blane et al. (1996), reported cholesterol level, FEV_1 score and BMI to be likewise influenced by childhood and adult socioeconomic status. These findings were confirmed by Power et al. (2007), who reported a positive association between childhood deprivation and increased adult systolic blood pressure, BMI, HbA1c, triglycerides, fibrinogen and decreased FEV1.

Mortality

Two British cohort studies have reported higher mortality in adults, who were exposed to childhood poverty. In a study of 5,648 35-64 year old Scottish men, Davey Smith et al. (1998) reported statistically significant increased risk of mortality from all causes (1.19, 95%CI 1.04-1.37), coronary heart disease (1.26, 95% CI 1.01-1.58) and stroke (1.74, 95% CI 1.05-2.9) after adjusting for nine confounders[2]. Increased mortality, albeit not statistically significant, was also reported for lung cancer (1.23, 95% CI 0.81-1.88), stomach cancer (2.03, 95% CI 0.86-4.78) and respiratory diseases (1.6, 95% CI 0.88-2.9). Power, Hypponen and Davey Smith (2005) reported similar results for a cohort of 11,855 British women initially screened in 1958 and followed up for 45 years. After

[2] age, adult social class, deprivation category, car ownership and smoking, diastolic blood pressure, cholesterol, body mass index and lung function measured as forced expiratory volume in 1 second (FEV_1 score).

adjusting for age, adult social class, smoking and BMI, they reported statistically significant increased mortality risks of 1.13 (1.01-1.27) for deaths from all causes, 1.29 (1.06-1.56) for deaths from circulatory diseases, 1.37 (1.04-1.79) for deaths from coronary heart disease and 1.51 (1.02-2.22) for deaths from respiratory diseases. Mortality risk for stroke (1.28 (0.83-1.94)), COPD (1.48 (0.91-2.39)), lung cancer (1.21 (0.81-1.81)) and stomach cancer (4.15 (0.93-18.5)) were also higher in those who experienced childhood poverty, but results were not statistically significant. Similar results were reported by Naess, Strand and Davey Smith (2007) for Norway and Kauhanen et al. (2006) for Finnland. However the Norwegian study was not able to consider competing risk factors other than adult socioeconomic position and age (table 9).

Table 9: Studies on childhood poverty and adult mortality.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Davey Smith et al. 1998	West Scotland, UK	1970-73 initial data plus 21 year follow up	Adult mortality by childhood socioeconomic status measured as father's occupation	Lowest social class in childhood had increased risk of mortality from all causes 1.19 (1.04-1.37), coronary heart disease 1.26 (1.01-1.58), stroke 1.74 (1.05-2.9) lung cancer 1.23 (0.81-1.88), stomach cancer 2.03 (0.86-4.78) and respiratory diseases 1.6 (0.88-2.9)	35-64 at examination, recruited 1970-73	5766 men-	Adjusted for age, adult social class, deprivation category, car ownership and smoking, diastolic blood pressure, cholesterol, body mass index and lung function measured as forced expiratory volume in 1 second (FEV_1 score)
Power, Hypponen and Davey Smith (2005)	England, Wales and Scotland	1958 birth cohort, mortality up to 2003	Adult mortality by childhood socioeconomic status measured as father's occupation	Higher risk in most deprived during childhood of mortality from all causes 1.13 (1.01-1.27), circulatory diseases 1.29 (1.06-1.56), coronary heart disease 1.37 (1.04-1.79), respiratory diseases 1.51 (1.02-2.22), stroke 1.28 (0.83-1.94), COPD 1.48 (0.91-2.39), lung cancer 1.21 (0.81-1.81) and stomach cancer 4.15 (0.93-18.5)	45 years	11855 women	Adjusted for age, adult social class, smoking and BMI
Naess, Strand and Smith (2007)	Norway	Aged 0-20 in 1960, mortality 1990-2001	Adult mortality by childhood socioeconomic status measured as father's occupation	Increased risk of mortality in most deprived group for men for stomach cancer 2.76 (1.6-4.75), lung cancer 1.53 (1.17-2.00), CHD 1.86 (1.59-2.18), other violent deaths 1.3 (1.07-1.57) and all causes 1.25 (1.17-1.34) and for women for lung cancer 1.73 (1.25-2.39), cervical cancer 1.77 (1.09-2.87), COPD 2.35 (1.18-4.68) and all causes 1.2 (1.1-1.31).	41-61 at end of follow up	795,324 at follow up	No information on other confounders
Kauhanen et al 2006	Finland	Men aged 42, 48, 54, or 60 enrolled 1984 to 1989, mortality up to 2002	Adult mortality by childhood socioeconomic status (measured by four indicators from school data and questionnaire)	Most deprived in childhood had increased mortality from all causes 1.33 (0.92-1.92), CVD 1.42 (0.85-2.38) and CHD 1.64 (0.91-2.99)	55-78	2682 men	Study primarily focussed on heart diseases. Adjusted for age, examination year, biological and behavioural risk factors: cholesterol, BMI, SBP, physical activity, smoking and alcohol consumption
Davey Smith et al. 2001	Glasgow, Scotland	Deaths up to 1998	Adult mortality by childhood socioeconomic status measured as parents occupation	Most deprived during childhood had increased risk of all cause mortality of 1.32 (0.78-2.24) and CVD 2.31 (1.09-4.89)		8396 male students at Glasgow university 1948-68	CVD mortality adjusted for smoking and blood pressure

Table 9 continued

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Frankel. Davey Smith et al. 1999	Scotland and England	Survey 1937-39, mortality up to 1997	Adult mortality by childhood socioeconomic status measured by parents occupation and food expenditure	Increased mortality risk for children of unskilled parents of 1.19 (0.93-1.51) for all causes, 1.12 (0.71-1.76) for CHD, 1.40 (0.46-4.24) for stroke		3750	Boyd Orr cohort, five social classes, social position III as reference (not I or II), hence lower RRs Adjusted for age and adult deprivation, stratified by sex and district

Mental health problems and depression

Adverse experiences during childhood have been found to predict adult mental health status (Korkeila 2010). While Korkeila and colleagues (2010) reported increased risk of adult depression in relation to a range of childhood adversities including child poverty, other studies have specifically investigated the effects of childhood poverty on adult mental health outcomes (Gilman et al.2002, Power et al. 2007, Lynch et al. 1997). Results of a study from the UK reported a 4.6% higher prevalence of depressive symptoms (10.6%) in adults of the lowest socio economic class during childhood (Power et al. 2007). After adjusting for sex and adult socioeconomic status a small but significant increased risk of 1.09 (1.03-1.16) remained. These results were confirmed by Mesah and Hobcraft (2008) in a pooled analysis of the 1958 and 1970 UK birth cohorts. After adjusting for cohort, gender and all childhood measures the most deprived group during childhood had a 1.57 fold (1.34-1.83) increased risk of poor mental well being, measured as a malaise score >7. In comparison a US study from Rhode Island reported a higher difference (9.4%) in the prevalence of adult depression between most (26.5%) and least deprived group (17.1%) during childhood. After adjusting for adult socioeconomic status an increased risk of 1.71 (1.15-2.55) remained (table 10).

Table 10: Studies on childhood poverty and adult mental health.

Author	Place	Year	Measure	Outcome	Age	Sample size	Comment
Power et al 2007	England, Scotland and Wales	2002-2004	Prevalence of depressive symptoms by childhood socioeconomic class measured as parents income	Prevalence of depressive symptoms in most affluent in childhood 6%, least affluent 10.6%. RR per increase in social class adjusted for sex and socioeconomic symptoms =1.09 (1.03-1.16)	45, 1958 birth cohort	9377	Adjusted for sex and adult socioeconomic status. (measured as last job)
Mensah and Hobcraft 2008	England, Scotland and Wales	1991 and 2000	Mental well being measured by Rutter malaise scale by childhood deprivation	Most deprived during childhood had a 1.57 (1.34-1.83) fold increased risk of poor mental well being as adult (malaise score >7)	30 in 1970 and 33 in 1958 birth cohort	11,327 in 1958 cohort and 11,177 in 1970 cohort	Adjusted for cohort, gender and all childhood measures. Socioeconomic class was derived from a number of indicators outlined in web appendix
Singh et al. 2005	London, UK Whitehall II study	1997-99	Mental well being measured by GHQ 32 (>5) by father's social class and socioeconomic circumstances in childhood.	Men in lowest socioeconomic class during childhood had 1.76 (1.32-2.35) and women 1.62 (1.01-2.59) fold increased risk of adult mental health problems.	35-55 at baseline in 1985	10,308 (6895 men and 3413 women)	Adjusted for age
Gilman et al. 2002	Rhode Island USA	1988-1995	Prevalence of depression measured via diagnostic interview schedule by childhood socioeconomic status measured as parent's occupation	9.4% higher prevalence of depression in adults who were in most deprived childhood group (26.5%) compared to least deprived group (17.1%). Adjusted OR = 1.71 (1.15-2.55)	Average age 29 years	1132, 1959-1966 cohort	

Type II diabetes and obesity

Tamayo, Herder and Rathmann (2010) systematically reviewed the evidence between childhood socioeconomic status and type II diabetes and obesity in later life. After extensive review of the literature they included 10 papers on diabetes and 14 papers on obesity in their review. Seven out of the ten studies on socioeconomic status and diabetes showed an increase in diabetes risk with decreasing socioeconomic status, whereas two studies reported a protective effect and one study a protective effect for women and no association for men (Tamayo et al 2010). The effect sizes from four cohort studies were small (1.08-1.40) and only the results of one study were statistically significant. For obesity six studies showed a very small or no influence of childhood socioeconomic status on adult obesity. Other studies showed a positive association. Tamayo, Herder and Rathmann (2010) concluded that there is evidence that childhood socioeconomic status is associated with diabetes and obesity in later life, but more studies are needed.

Other health outcomes

In addition to the adult health outcomes discussed above, which have attracted a lot of research interest; other adverse health effects during adulthood have also been associated with childhood deprivation. Poulton et al. (2002) reported 3.18 fold (95% CI: 1.66-6.1) increased risk of dental caries[3] for adults in New Zealand, who were in the lowest social class as children. Power et al. (2007) found a 1.13 (1.07-1.19) fold increased risk of chronic widespread pain in adults per increase in childhood socioeconomic class. Mensah et al. (2008) reported adjusted non significant increased risks for childhood poverty and adult general health and limiting long standing illness of 1.22 (95% CI 0.99-1.51[4]) and 1.2 (95% 0.98-1.47) respectively. In a Mexican study, Huang et al. (2011) showed a 1.46 (95% CI 1.34-1.60) fold increased risk of lower body functional limitations in adults who experienced childhood poverty[5]. In a cross sectional study in six European countries Drakopoulous, Lakioti and Theodossio (2010) reported a negative effect of childhood deprivation on adult physical and mental health. Each additional unit of childhood deprivation resulted in a decrease in the index of the mobility, physical health and psychological health status by 0.19, 0.28 and 0.41 respectively (Drakopoulous, Lakioti and Theodossio 2010).

[3] measured as the proportion with >= 4 surfaces affected, adjusted for sex, infant health and adult socioeconomic status
[4] adjusted for cohort, gender and all childhood measures
[5] measured as often went to bed hungry

Calculations / Methods

Based on the review of the evidence, we estimated the effect of childhood poverty on health in Wirral. The underlying assumption in our calculations was that children from deprived families could achieve the same health status as their more affluent counterparts. Depending on the available evidence we estimated the excess number of morbidity and mortality in the deprived using two approaches:

a.) the formula for the population attributable fraction (PAF) (Murray et al. 2003)

$$PAF = \frac{\sum_{i=1}^{n} P_i(RR_i - 1)}{\sum_{i=1}^{n} P_i(RR_i - 1) + 1}$$

where P_i = current exposure level for category i and
RR_i=Relative risk of morbidity or mortality for exposure category i

b.) by applying the rates observed in the more affluent children to the deprived population assuming that they could achieve the same rates (Soerjomataram 2007)

$N_{ex} = (P_{cp} * N_{cp}) – (P_{ref} * N_{cp})$

where N_{ex} *is* the number of excess cases in children exposed to childhood poverty, P_{cp} is the proportion of children with the condition exposed to childhood poverty, N_{cp} the number of children affected by childhood poverty in Wirral and P_{ref} the proportion of children with the condition in the reference population. If prevalence in those exposed to childhood poverty was not available it was estimated:

$P_{cp} = P_{ref} * RR_{cp}$

where P_{cp} is the proportion of children with the condition exposed to childhood poverty, P_{ref} the proportion of children with the condition in the reference population and RR_{cp} the increased risk in those exposed to childhood poverty.

This PAF approach was chosen, when increased risk in the deprived was expressed as a relative risk and the outcome was incidence or mortality. The second approach was chosen when values were given as rates.

Results

Prevalence of childhood poverty

Compared to other countries, the UK is performing particularly poorly with regards to child poverty. In a study that compared child well being in 20 OECD countries, the UK ranked last (UNICEF 2007). In this study, child well being was measured by six categories: material well being, health and safety, educational well being, family and peer relationships, behaviours and risks and subjective well being. The UK was in the bottom third for all indicators except health and safety where it ranked in the middle third. In England 2,429,305 (21.3%) children were estimated to live in poverty in 2009 (DWP 2010). In Wirral a higher proportion of children under the age of 20 years were living in poverty[6] (24.9%; 17,615 children) compared to the North West (23.1%) and England (21.3%) (table 11). Of these 30.3% were 0-4 year old, 31.2% were 5-10 years old, 25.5% were 11-15 years old and 12.9% were 16-19 years old (DWP 2010). Three quarter of these children (75.9% / 13,375) were living in single parent families in Wirral compared to 68.3% in the North West and 67.7% in England. From 2006 to 2009 the number of children in poverty increased by 1.4% (980 children) in Wirral, compared to 0.5% in the North West and England.

Table 11: Children living in poverty in Wirral, North West and England in 2009 (source: DWP 2010).

	Children in IS/JSA families		Children in families receiving WTC and CTC, and income <60% median income		Children in families receiving CTC only, and income <60% median income		Children in families in receipt of CTC (<60% median income) or IS/JSA		% of Children in "Poverty"	
	Under 16	All Children	Under 16	All Children	Under 16	All Children	Under 16	All Children	Under 16	All Children
England	1,674,395	1,879,670	169,250	213,130	287,710	336,505	2,131,350	2,429,305	21.90%	21.30%
North West	249,095	282,240	23,305	30,015	38,280	45,425	310,680	357,675	23.70%	23.10%
Wirral	13,015	14,750	665	870	1,655	1,995	15,335	17,615	25.90%	24.90%

Historic childhood poverty

Only limited data is available for the early 19th century from surveys from different cities in England (Glennerster et al. 2004). Based on these surveys population poverty levels in England were below 10% and childhood poverty[7] around 10% before 1930 (Glennerster et al. 2004). In the early 30s childhood poverty increased significantly above 35% percent and poverty increased above 20%. Measured in relative terms, childhood poverty has been increasing in England since the 1950s with a sharp rise from the 1980s to 1990s (Glennerster et al. 2004, Gregg, Harkness and Machin 1999) (table 12). Adjusted for after housing costs (AHC) around 10% of children were living in poverty in 1968 and 32.9% in 1996 (measured as proportion living in households with below 50% of median income). During the 1990s and 2000s child poverty levels remained more or less stable at a high level of around 30% (measured as children living in households below 60% of median income and adjusted for AHC) (Matejic, Stevens and Whatley 2009) (table 12).

[6] measured as children in families in receipt of CTC (<60% median income) or IS/JSA

[7] measured as couple with 3 children

Table 12: Estimated historic levels of child poverty used in calculations based on Glennerster et al. (2004), Gregg, Harkness and Machin (1999) and Matejic, Stevens and Whatley (2009).

Current age	Estimated prevalence of child poverty (%)
80	30
70	30
60	4
50	10
40	12
30	14
20	30

Child health outcomes

Infant mortality

Based on the findings by Oakley, Maconochie and Doyle 2009 of a 57% increased risk of infant mortality in children born to socioeconomically deprived mothers, we estimated that 2.4 infant deaths could be avoided in Wirral per year, if children living in poverty had the same risk of infant mortality as more affluent children (table 13).

Obesity

Applying national data from the NOO showed that around 1050 cases of childhood obesity in 5-19 year olds might be caused by childhood poverty in Wirral (NOO 2011). In comparison, when using the results reported by by Nelder et al. (2009) for Plymouth in the calculations, around 726 cases of childhood obesity in the 5-19 year olds might be associated with childhood poverty in Wirral. These estimates need to be considered with caution as some studies at small geographical level indicated a rise in childhood obesity regardless of socioeconomic class and reported no difference between classes (table 13).

Limiting long term illness

Assuming that deprived children could achieve the same rates of LLTI as their more affluent counterparts and applying national LLTI prevalence data to Wirral (Spencer et al. 2009), 616 cases of LLTI could be averted in Wirral. These are 151 cases in the 0-4 year olds, 198 cases in the 5-10 year olds, 170 cases in the 11-15 year olds and 97 cases in the 16-19 year olds (table 13).

Dental health

Based on the findings of the 2003 children's dental health survey for England (Steele and Lader 2004) and assuming that children in Wirral have the same prevalence of tooth decay as the national average, 1973 cases of caries in children might be attributable to childhood poverty. That is 1,180 cases of tooth decay in the 5-10 year olds, 383 cases in the 11-15year olds and 410 cases in the 16-19 year are attributable to childhood poverty (table 13).

Mental health

Applying the findings of the 2004 mental health survey of children and young people in England (Green et al. 2004) to Wirral suggest that 1647 cases of mental health problems in children might be attributable to childhood poverty. Stratified by age band these are 553 cases in the 5-10 year olds, 437 cases in the 11-15 year olds and 658 cases in the 16-19 year olds (table 13).

Asthma

Based on the findings by Ruijbrock et al. (2011) of a 1.27 fold increased risk of asthma in children from deprived families and applying the national average asthma prevalence to Wirral, around 851 cases of asthma might be associated with childhood poverty in Wirral (table 13).

Table 13: Estimates of childhood poverty attributable morbidity and mortality in children in Wirral.

Outcome	Measure	Risk	Source	Data source for calculations	Outcome
Infant mortality	PAF	Increased risk of infant mortality in deprived RR=1.57	Oakley, Maconochie and Doyle 2009	ONS 3 year average mortality data	2.4 deaths per year
Obesity	Rate	5.8% higher in deprived 4-5 year olds and 10.8% higher in 10-11 year olds	National obesity observatory (NOO) (2011)		Applying estimates to: 0-19 year olds: 1361 cases, 5-15 year olds: 804 cases and 5-19 year olds: 1050 cases.
	Rate	7.3% higher in deprived 5-6 year olds and 4.8% higher in 10-11 year olds	Nelder et al. (2009)		Applying estimates to: 0-19 year olds: 1116 cases, 5-15 year olds: 617 cases and 5-19 year olds: 726 cases.
LLTI	Rate	2.8% increased risk in deprived 0-4 year olds, 3.6% in 5-10 year olds, 3.8% in 11-15 year olds and 4.3% in 16-19 year olds	Spencer et al. (2009)		Excess cases 0-4 year olds:151, 5-10 year olds: 198, 11-15 year olds: 170 and 16-19 year olds: 97.
Dental health	Rate	Increased risk of tooth decay in deprived 5-10 year olds of 21.5% (average 5-8 year olds), 8.5% 12-15 year olds (average 10 and 15 year olds) and 18% in 16-19 year olds	Steele and Lader (2004)		Excess cases in deprived 5-10 year olds: 1,180, 11-15 year olds 383 and 16-19 year olds 410
Mental health	Rate	7.6% increased risk of mental health problems in deprived 5-10 year olds and 15% in 11-15 year olds.	Green et al. (2004)		Excess cases in 5-10 year olds: 553, 11-16 year olds: 437 and 16-19 year olds 658
Asthma	Rate	RR= 1.27	Ruijsbroek et al. (2011)	Prevalence of asthma in children from HSE 2004	851 excess cases in 0-15 year olds and 978 excess cases 0-19 year olds
All cause mortality	Rate	n.a. local data		ONS mortality data 2003-2007	Five year average deaths: 14.4 in most deprived and 14.8 in least deprived. Rate per 100,000 most deprived: 48.8 (23.6-74.0) rest: 30.7 (15.0-46.3). Excess most deprived: 5.3 per year.
Mortality accidents and injuries	Rate	n.a. local data		ONS mortality data 2003-2007, ICD 10 S00-T98, V01-Y98	Five year average deaths: 3.2 in most deprived and 4 in least deprived. Rate per 100,000 most deprived: 48.8 (23.6-74.0) rest: 30.7 (15.0-46.3). Excess in most deprived 1 case per year.
Hospital admission all causes	Rate	n.a. local data		HES inpatient data 2009-2011 analysis of spells	Significant higher rate in most deprived children compared to rest. Rate per 1000 pop in most deprived male: 114 and female 146. Compared to male: 98.6 and female: 99.9. Excess spells in deprived male: 246, female: 675.

Hospital admissions

Hospital admission and mortality were analysed using local data. These calculations are not directly comparable with the other calculations as deprivation was analysed at the local area level as opposed to the individual level in the other calculations. While this provides the best estimate where individual data is not available it needs to be considered that the most deprived group is with around 37% larger compared to those estimated to be suffering from childhood poverty (25%).

A first analysis of Hospital Episode Statistics (HES) data showed significantly higher rates of spells due all causes in male and female from most deprived areas (table 13). If deprived children had the same rates as the rest of the population 246 spells could be avoided in male and 675 in female per year.

All cause mortality

Analysis of local mortality data showed higher mortality rates in under 19 year olds living in most deprived areas (48.8 per 100,000; 14 cases per year) compared to the rest (30.7 per 100,000; 15 cases per year), however rates were not statistically significantly different at the 95% confidence interval level (table 13). If the most deprived had the same mortality rates as the rest of the population, 5.3 deaths could be avoided in Wirral each year.

Mortality from accidents and injuries

Children from most deprived areas had higher, though statistically non significant, mortality rates from accidents and injuries of 10.8 per 100,000 (95%CI 2.7-33.4) compared to 8.3 per 100,000 (8.3 (95% CI 3.3-24.3) in the rest (table 13). However average annual numbers are small with 3 cases in the most deprived group and 4 cases in the rest of the population. If the most deprived had the same mortality rate as the rest of the population, one death from accidents and injuries could be prevented in Wirral per year.

Adult health outcomes

Mental health problems

Exposure to poverty during childhood might be attributable to 1697 excess cases of mental health problems in men and 2734 in women in Wirral (table 14). These estimates are based on the findings by Singh et al. (2005) of a 62% and 76% increased risk of mental health problems in women and men exposed to childhood poverty respectively. Prevalence data by age band for Wirral was adapted from England from the Adult Psychiatric Morbidity Survey (2007).

Heart disease

Between 20-21 cases of heart disease in men and 6-10 in women might be caused by childhood poverty in Wirral per year (table 14). These estimates are based on the findings by Singh et al. (2004) who reported a 32% increased risk of heart disease in women exposed to childhood poverty and a 54% increased risk in men and those by Lawlor et al. (2004) who reported a 17% increased risk of heart disease per increase in social class. Heart disease incidence data for Wirral was extrapolated from national data reported by the British Heart Foundation (2010). Applying the same risk estimates to prevalence data showed that around 1717 cases of prevalent heart disease in men and 629 in women might be caused by childhood poverty.

Mortality

Based on the findings of a 13% increased risk of mortality in people exposed to childhood poverty reported by Power, Hypponen and Davey Smith (2005), 65 excess deaths in men and 76 excess deaths in women are attributable to childhood poverty in Wirral per year (table 14).

Table 14: Estimates of childhood poverty attributable morbidity and mortality in adults in Wirral.

Outcome	Measure	Risk	Source	Data source for calculations	Outcome
Mental health	Rate	RR=1.62 for women and 1.76 for men	Singh et al. (2005)	Age stratified prevalence of mental health problems from APMS 2007 survey	Excess cases men: 1697, women: 2734
Heart disease incidence (I20-22)	PAF	RR=1.32 for women and 1.54 for men (model 1), RR=1.17 per increase in social class (model 2)	Singh et al. (2004), Lawlor et al. (2004)	Heart disease incidence rates for England from BHF (2010) applied to Wirral population	Model 1: 20 excess cases in men and 6 in women per year. Model 2: 21 excess cases in men and 10 in women per year.
Heart disease prevalence	Rate	RR=1.32 for women and 1.54 for men	Singh et al. (2004)	Heart disease prevalence rates stratified by age for England (2006) from BHF (2010)	Age stratified results: 1717 attributable cases in men and 629 in women for all ages and 1216 in men and 335 in women under 75 years.
All cause mortality	PAF	RR=1.13	Power, Hypponen and Davey Smith (2005)	2009 age stratified mortality rates from ONS	65 excess deaths in men and 76 in women

Discussion

Our calculations clearly highlight the negative effects of childhood poverty on morbidity and mortality in Wirral. The negative health effects of childhood poverty become particularly obvious when looking at adult health outcomes, with childhood poverty estimated to contribute a considerable number of adult deaths and heart disease. Our study provides a comprehensive up to date review of the evidence on the effects of childhood poverty on health. Compared to previous reviews (Oberg et al. 2003, Phipps 2003, Arber et al. 1997, Egbuonu and Starfield 1982, Spencer 2008a, Attree 2011, Wood 2003, Bradshaw 2002, Giggs and Walker 2008), we identified conflicting areas, where more recent studies provided new evidence.

To our knowledge these calculations are the first approach to estimating the health effects of childhood poverty using best available evidence from large population based studies in England. There are however uncertainties around these estimates. Studies have used different measures for childhood socioeconomic status with common measures being parent's income, education and social class. These groups are likely to be broader compared to those affected by childhood poverty, meaning that the true effect of childhood poverty could be even greater. The majority of our calculations are based on national data extrapolated to Wirral, as local data is not available. While these calculations provide the best available estimates, the true situation in Wirral might be different. For example in 2009 heart disease mortality rates were 22 and 10 percent above the national average for male and female respectively and heart disease prevalence was also estimated to be higher in Wirral compared to England (The Information Center 2011), indicating that heart disease incidence might also be higher in Wirral. The same might be the case for other estimates derived from national data. Estimates on adult health outcomes related to childhood poverty rely on national exposure data which again might have been different in Wirral. Estimates for childhood obesity and asthma need to be considered with caution. Evidence for a relationship between childhood poverty and asthma is still limited and for obesity some studies have reported no differences by socioeconomic class at small geographical levels (Edwards et al. 2010, Dummer et al. 2005).

The true effect of childhood poverty on health is likely to be even greater as we only included health outcomes in our calculations where the evidence was strong enough. Other health outcomes might be associated with childhood poverty, this might particularly be the case for adult's health outcomes which are more difficult to assess due to the long follow up times required in epidemiological studies. Additionally our calculations were limited by the availability of local data and not all health outcomes could be included in our estimates, for example, the local burden of disease caused by lead poising and infections could not be calculated. Our calculations were based on the best available evidence linking childhood poverty with adverse health outcomes, using risk estimates controlled for confounding of competing risk factors. In real life childhood poverty is often interlinked with other risk factors and behaviours, thus likely to increase the burden of disease due to childhood poverty.

Future analysis will look in more in depth at Hospital Episode Statistics data in order to obtain a more detailed local picture.

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