



Research paper

Lifetime costs of perinatal anxiety and depression

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ABSTRACT

Background: Anxiety and depression are common among women during pregnancy and the year after birth. The consequences, both for the women themselves and for their children, can be considerable and last for many years. This study focuses on the economic consequences, aiming to estimate the total costs and health-related quality of life losses over the lifetime of mothers and their children.

Method: A pathway or decision modelling approach was employed, based on data from previous studies. Systematic and pragmatic literature reviews were conducted to identify evidence of impacts of perinatal anxiety and depression on mothers and their children.

Results: The present value of total lifetime costs of perinatal depression (anxiety) was £75,728 (£34,811) per woman with condition. If prevalence estimates were applied the respective cost of perinatal anxiety and depression combined was about £8500 per woman giving birth; for the United Kingdom, the aggregated costs were £6.6 billion. The majority of the costs related to adverse impacts on children and almost a fifth were borne by the public sector.

Limitations: The method was exploratory in nature, based on a diverse range of literature and encountered important data gaps.

Conclusions: Findings suggest the need to allocate more resources to support women with perinatal mental illness. More research is required to understand the type of interventions that can reduce long-term negative effects for both mothers and offspring.

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1. Introduction

The World Health Organization recognises perinatal mental health as a major public health issue; at least one in ten women has a serious mental health problem during pregnancy or in the year after birth (WHO, 2008; 2014). The impact on mothers can be considerable during the perinatal period because of new emotional, social, financial and physical challenges. Additionally, the pre- and postnatal periods have significant impacts on future physical, mental and cognitive development of offspring: children of mothers with perinatal mental illness are exposed to higher risks of low birth-weight, reduced child growth, intellectual, behavioural and socio-emotional problems (Hay et al., 2010; Surkan et al., 2011; Conroy et al., 2012; Kingston and Tough, 2014; Pearson et al., 2013a, 2013b; O'Donnell et al., 2014).

We focus on perinatal depression and anxiety, the most prevalent conditions during the perinatal period. Despite their high prevalence they are often overlooked by health professionals: the likelihood of women seeking help or being identified is below 50% even in well-funded health systems (Vesga-López et al., 2008; Ko et al., 2012; Howard et al., 2014). Of those who are clinically detected, only 10–15% get effective treatment (Woolhouse et al., 2009; Goodman and Tyer-Viola, 2010; Gavin et al., 2015). The impacts of perinatal mental illness on mothers and children are many; here we focus on the wide-ranging and intergenerational economic consequences.

2. Methods

In summary, our approach was to consider the life-course from the perspective of both mother and child. We used decision-analytic modelling to determine incremental costs associated with adverse effects, discounted to present value at time of birth. Modelling helps to utilise data from many sources, attaching costs and outcomes to events that happen with estimated probabilities. Our modelling reflected the additional risks of adverse child developments for offspring exposed to perinatal depression and anxiety, and their

Abbreviations: ALSPAC, Avon Longitudinal Study of Parents and Children; ED, Education; HRQoL, Health-related quality of life; HSC, Health and social care; OOP, Out-of-pocket expenditure; NHS, National Health Service; *p*, probability; PL, Productivity loss; pp, percentage points; PTB, Pre-term birth; RD, Risk difference; UC, Unpaid care; UK, United Kingdom; wks, weeks; yr, years

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associated public sector costs, health-related quality of life and productivity losses. Data were taken from previous studies following a literature review. We extracted effect sizes of child development problems and transformed them into additional risk differences applied to different ages. Costs of adverse effects of perinatal depression and anxiety were calculated from a societal perspective, including costs to government and individuals.

2.1. Literature review

Systematic searches were conducted to identify studies measuring the impact of perinatal anxiety and depression for mothers and children, including adverse birth and child development outcomes, health-related quality of life, loss of life (infanticide and suicide), productivity, unpaid care, victim costs of crime and public service use. Searches were performed on PsycINFO, CINAHL, Global Health, SocINDEX, Social Care Online, covering the period January 2000–May 2014.

Additional pragmatic searches were carried out to fill evidence gaps, including searches on Google, Google Scholar and national websites. Websites included those of the National Collaboration for Women's and Children's Health, the National Collaborating Centre for Mental Health and the Avon Longitudinal Study of Parents and Children. We also checked bibliographies of relevant articles identified in the systematic searches.

Our searches focused mainly on UK evidence but considered studies from other high-income countries. Studies that did not apply appropriate statistical analysis (such as adjusting for history of mental illness and other perinatal risk factors) were excluded.

Information retrieved from studies included: effect sizes, service use patterns, costs, health utilities, prevalence and natural course of conditions. For studies measuring the effect of perinatal anxiety or depression on child outcomes, we removed those not using quantifiable, standardised measures or measuring only intermediate outcomes without evidence of economic consequences; the latter could only be decided based on our knowledge about economic studies of outcomes, so this process was iterative with the search for economic studies.

2.2. Path/decision modelling

Based on the evidence on adverse effects of perinatal anxiety and depression we developed four models reflecting impacts of the two conditions on mothers and their offspring.

First, from published prevalence figures at different stages during pregnancy and after birth we derived mean probabilities for mothers developing antenatal and postnatal anxiety or depression. From general remission rates for depression and anxiety we estimated annual probabilities for mothers continuing to have the condition after the first year. We assumed (conservatively) that all mothers had recovered from their initial episode within ten years.

To avoid double-counting the impact of co-occurring perinatal depression and anxiety on mothers, we derived a probability of developing antenatal anxiety without co-morbid depression based on prevalence for ante- and postnatal anxiety and the scale of co-existence between perinatal anxiety and depression. This meant that some costs which related to comorbid perinatal anxiety and depression were captured under the costs of perinatal depression. This step was not necessary for the impact on children because studies were available that measured the impact of each of the two conditions separately from each other.

Since our aim was to estimate the present value of lifetime costs, we discounted costs and HRQoL after the first year postpartum to the time of birth at an annual rate of 3.5% measured in real terms. Earnings were assumed to increase at 2% a year over and above the general rate of inflation. Cost data were adjusted

where necessary to 2012/13 prices.

2.2.1. Measuring the impact on mothers

We measured impacts on mothers based on data on derived additional (annual) risk of developing ante- or postnatal depression or anxiety and continuing to have symptoms after the perinatal period, multiplied by public sector costs, HRQoL impairments and productivity losses. We distinguished between costs during the perinatal period and in subsequent years. Based on data from longitudinal studies identified during the searches and national averages we assumed mean age for women at childbirth of 32 years, mean remaining life expectancy of 44 years and retirement from employment at 65.

Costs of additional health and social care were taken from studies measuring additional service use and costs for women with perinatal depression or anxiety or individuals with remitted and non-remitted depression or anxiety in the general adult population. For studies which measured service use patterns but not costs, we took unit costs from Curtis (2013) and NHS Reference costs (DH, 2013).

Unless the incremental health disutility values had been already evaluated by controlled trials, HRQoL impairments were calculated by taking the difference between health utility values for individuals with the relevant conditions and mean quality of life in the general female population (Ara and Brazie, 2011). Health disutility was applied to years in ill-health and multiplied by a willingness-to-pay value. We assumed a willingness-to-pay value of £25,000 for a health-related quality-adjusted life year, reflecting the mid-point of the £20,000–£30,000 range used by National Institute of Health and Care Excellence (Appleby et al., 2007). We estimated costs attached to an increased risk of suicide during the subsequent years based on national suicide statistics for depression in the general population and costs of life lost (Harker, 2011; ONS, 2014). For a whole life lost through suicide or infanticide, we applied the 'value of a prevented fatality', estimated at £1,722,000 per case, which is used in UK government policy analysis (DH, 2010).

We calculated productivity losses for mothers based on probabilities that women would be in full- or part-time employment after giving birth, multiplied by reduced working days for someone with concurrent or remitted depression or anxiety (ONS, 2005, 2013a; DWP, 2010; Plaisier et al., 2010). We applied lost work days for concurrent depression or anxiety to the annual probabilities of mothers to have depression or anxiety linked to the initial perinatal condition; we applied lost work days for remitted depression or anxiety to the probabilities of mothers not having any further episodes linked to the perinatal condition. To value annual changes in productivity following a human capital approach we applied mean weekly wage rates to time away from work from national statistics (ONS, 2013b).

2.2.2. Measuring the impact on children

We identified birth and child outcomes for which there was evidence of adverse effects linked to perinatal anxiety or depression such as pre-term birth, infant death, emotional, intellectual and conduct problems. Effects measured at different ages were transformed into annual additional risks measured in percentage points, reflecting an incremental perspective in which only the additional impact associated with a condition was assessed.

For each link between maternal perinatal anxiety or depression and adverse birth or child outcomes we extracted information on effect sizes from studies identified in our search. If there was more than one relevant previous study we used the most conservative effect size. From the relative effect sizes (odds ratios, relative risks) and baseline risks in published studies that measured the negative impact on children we calculated absolute risk reductions as the difference in observed risk for an outcome occurring in the

exposed versus the non-exposed group. Some absolute risk difference estimates were available from our own work (Bauer et al., 2015). We applied prevalence data from the literature.

We assumed that annual additional risks between measured time points were constant; for example, if data for child intellectual problems was available at 6 years and again at 11 years we applied effect sizes found at 6 years to the period 6–11 years. To model the persistence of childhood conditions, including progression from infancy to childhood and childhood to adolescence and adulthood, we took data from surveys and longitudinal studies, assuming that those conditions stopped at age 65.

The next step was to assign costs to adverse birth and child outcomes at different ages, the calculation depending on the nature of the outcome and previous evidence. For some outcomes long-term costs were available from previous studies. For other outcomes, the associated short-term, annual costs of public services were available from the literature so we applied those after adjustment to 2012/13 prices to years for which there was a proven effect, discounted to time of birth. For attaching values to public service use, health-related quality of life impairments and productivity we applied the same approach as when valuing impact on mothers. In addition, we estimated costs of infant death based on risk data of infant mortality in mothers with perinatal depression or anxiety and average infant mortality data in the general UK population (ONS, 2011).

3. Findings

3.1. Impact on mothers

3.1.1. Perinatal depression

Parameters used for estimating the impact of perinatal depression on mothers and details of their derivation are shown in Table 1.

Mean probabilities for developing depression were 10.7%

during pregnancy and 7.4% in the year after childbirth; annual probabilities for persistent depression linked to the original episode were 0.09% from the first to the fifth year, and 0.052% thereafter up to tenth year postpartum.

Present values of lifetime costs per woman with perinatal depression were £1688 for health and social care, £3028 for productivity and £18,158 for health-related quality of life losses. Estimates were based on mean probabilities for developing perinatal depression and for persistence in subsequent years, published costs of health and social care and health disutility (specific to the perinatal period and general adult population ones for subsequent years), work days lost for women with current or remitted depression.

There was insufficient data to estimate costs of suicide linked to the perinatal phase. However, evidence was available that allowed us to derive the additional risk of suicide attributable to depression in the general UK population and we applied this to the additional risk of subsequent episodes of depression linked to the perinatal phase. The present value of lost life was £277 per woman with perinatal depression.

3.1.2. Perinatal anxiety

Present values of lifetime costs per mother with perinatal anxiety were £4320 for health and social care, £5499 for productivity losses, £10,975 for health-related quality of life losses. Estimates were based on mean probabilities of developing perinatal anxiety (without co-existing depression), its persistence in subsequent years, annual costs of health and social care and health disutility for people with anxiety disorder in the general population. Work days lost were calculated distinguishing again between remitted and non-remitted anxiety. Data on costs, health disutility and work days lost all referred to the general adult population with anxiety. Details of the parameters used for estimating the lifetime costs of perinatal anxiety for mothers are shown in Table 2. We did not identify UK-relevant evidence on the link between anxiety disorder, during the perinatal phase or subsequent years, and suicide. Potential life years lost due to anxiety-caused suicide were thus not valued.

Table 1

Parameters for estimating impact of perinatal depression on mothers.

Parameter	Value (costs in 2012/13, £)	Source and comments
<i>Prevalence and course of perinatal depression and risk of suicide</i>		
P depression during pregnancy	10.7%	Heron et al. (2004) and Bennett et al. (2004)
P depression 0–9 months postpartum	7.4%	As above
Cumulative P recovery from depression episode	67% (1st yr); 81% (2nd yr); 88% (5th yr); 93% (10th yr)	Mueller et al. (1996)
P suicide from depression	0.049%	Weighted average for women, 20–44 yr from rates of suicide due to depression and prevalence of depression, suicide and population statistics (ONS, 2013; ONS, 2014)
<i>Incremental annual public sector costs attributable to perinatal depression</i>		
Mean difference in annual public sector costs (health and social care)	£354	Petrou et al. (2002)
Mean difference in annual public sector costs (health and social care)	£1977	McMahon et al. (2012)
<i>Probabilities of part-and full-time employment for women after birth</i>		
P of employment of women before birth	67%	ONS (2013a)
P of return to employment after birth	77%	DWP (2010); measured between 1st and 2nd year after birth
P of full (part)-time employment of women returning to work	Full-time: 13%; part-time: 87%	ONS (2005)
<i>Incremental work weeks lost per year attributable to depression</i>		
Reduced work weeks per year for current (remitted) depression	12(2) wks	Plaisier et al. (2010)
<i>Incremental health utility attributable to perinatal depression and depression</i>		
Health disutility perinatal depression	0.26	Morrell et al. (2009), Ara and Brazie (2011), Burns et al. (2013); health utility for perinatal depression referred to 8–18 wks pregnant and 6 wks postpartum (ICD-10 or EPDS > 11)
Health disutility depression (women)	0.29	Mann et al. (2009) and Ara and Brazie (2011)

Table 2

Parameters for estimating impact of perinatal anxiety on mothers.

Parameter	Value (costs in 2012/13, £)	Source and comments
<i>Prevalence and course of perinatal anxiety</i>		
P anxiety (without co-existing depression) during pregnancy	6.9%	Heron et al. (2004); refers to anxiety measured in second and third trimester and accounts for two third overlap with perinatal depression (Wisner et al., 2013; Lydsdottir et al., 2014; NICE, 2014)
P anxiety (without co-existing depression) after birth	3.0%	As above; refers to anxiety measured 0–9 months postpartum and accounts for two third overlap with perinatal depression (Wisner et al., 2013; Lydsdottir et al., 2014; NICE, 2014)
P non-remitted anxiety linked to perinatal anxiety (without co-existing depression)	1st yr 85.2%; 2nd yr 74.7%; 3rd yr 69.9%; 4th yr 65.6%; 5th yr 64.2%; 6th yr 62.1%; 7th yr 59.5%; 8–10th yr 57.7%	Yonkers et al. (2003); weighted across different anxiety disorders based on prevalence taken from same source: panic disorder (8.5%), panic disorder with agoraphobia (48%), social phobia (19.4%), generalised anxiety disorder (24%)
<i>Incremental health utility attributable to anxiety</i>		
Health disutility anxiety	0.088	Saarni et al. (2007); refers to anxiety disorders across different types compared to population without disorder
<i>Incremental work weeks lost per year attributable to anxiety</i>		
Reduced work wks. due to (remitted) anxiety	9.4(2.8) wks	Plaisier et al. (2010)
<i>Incremental annual public sector costs attributable to perinatal anxiety</i>		
Incremental costs of health and social care	£866	McManus et al. (2009), NICE (2011); p128; refers to generalised anxiety disorder

Table 3

Parameters for estimating the impact of perinatal depression on children.

Parameter	Value (costs in 2012/13, £)	Source and comments
<i>Prevalence and course of perinatal depression (Table 1)</i>		
<i>Parameters to calculate incremental costs of PTB</i>		
RR PTB	1.34	Grote et al. (2010); weighted RR combined for middle/upper and lower socio-economic group (ONS, 2011)
P (extremely) PTB	7.7% (of those 3.9% extremely pre-term)	Mangham et al. (2009)
RD pre-term	2.64pp	Derived from RR of PTB and p of extremely PTB
RD extremely pre-term	0.1pp	Derived from RD of PTB and p of extremely PTB
RD pre-term but not extremely	2.54pp	Derived from RD of PTB and 1-p of extremely PTB
Incremental lifetime costs of extremely PTB	HSC £105,022; ED £4874; OOP £ 2363; PL £3845	Petrou and Khan (2012); 95% HSC during neonatal phase; OOP and PL referred to parents
Incremental lifetime costs of (non-extreme) PTB	HSC £34,131; ED £584; OOP £439; PL £693	As above
Health disutility for extremely pre-term children	0.167	Petrou et al. (2009); measured at 11 yr
Health disutility for (non-extreme) pre-term children	0.073	Petrou et al. (2010); refers to moderate cognitive impairment, term population
<i>Parameters to calculate incremental costs of infant death</i>		
RD infant death	1.3pp	Sanderson et al. (2002), Howard et al. (2007); derived from RR and p infant death (ONS, 2011)
<i>Parameters to calculate incremental costs of child emotional problems</i>		
RD child emotional problems	2.4pp (5–10 yr); 5pp (11–16 yr)	Bauer et al., 2015; RD measured at 11 yr adjustment of 0.48 to derive RD 5–11 yr (Green et al., 2005)
P postnatal depression and subsequent depression	6.2%	Halligan et al., 2007
RD child emotional problems (linked to perinatal depression with subsequent depression)	7.7pp (5–10 yr); 16pp (11–16 yr)	Halligan et al., 2007; OR measured at 13 yr (3.86); adjustment of 0.48 to derive RD 5–11 yr (Green et al., 2005)
Incremental cost of child emotional disorder p.a.	HSC £132; ED £1305	Snell et al. (2013)
Incremental cost of adult depression per year	HSC £1977	McMahon et al. (2012)
<i>Parameters to calculate incremental costs of child conduct problems</i>		
RD child conduct problems	12pp	Bauer et al. (2015); measured at 11 yr
P conduct problems with severity of disorder	25%	Colman et al. (2009)
Incremental lifetime costs of conduct problems without severity of a disorder	HSC: £5100; CJ: £10,000; PL: £10,500; VC: £37,900; HRQoL: £21,500	Parsonage et al. (2014); refers to conduct problems without severity of a disorder; costs to health and social care were those to the NHS
Incremental lifetime costs of conduct disorder	HSC: £12,600; CJ: £35,800; PL £28,400; VC: £134,500; HRQoL £48,700	Parsonage et al. (2014); refers to conduct problems with severity of disorder; costs to health and social care were those to the NHS
<i>Parameters used to calculate special educational needs and leaving school without qualification</i>		
Incremental cost for special education	£3166	Bauer et al. (2015)
Incremental lifetime costs for lost productivity	£1463	Bauer et al. (2015)

Table 4

Parameters for estimating impact of perinatal anxiety on children.

Parameter	Value (costs in 2012/13, £)	Source and comments
Prevalence and course of perinatal anxiety (Table 2)		
<i>Parameters to calculate incremental costs of PTB</i>		
P anxiety during pregnancy	10% (anxiety score 5); 1.8% (anxiety score 6)	Orr et al. (2007); measured anxiety on a scale from 0 to 6; significant associations were only found for scores 5 and 6
RD PTB (PTB)	5.4pp (anxiety score 5); 13.3pp (anxiety score 6)	As above
Incremental lifetime costs PTB	HSC £36,896; ED £190; PL £816; OOP £514	Derived from Petrou and Khan (2012) (see Table 2)
<i>Parameters to calculate incremental costs of child emotional and conduct problems</i>		
P of anxiety during pregnancy	15.3%	O'Donnell et al. (2014)
P of child emotional or conduct problems	7.3%	O'Connor et al. (2002)
RD (RD) child emotional or conduct problems	5.1pp	O'Connor et al. (2002), O'Donnell et al. (2014); mean RD measured at 4 yr and 13 yr
RD child emotional problems	1.7pp	As above
RD child conduct problems	3.4pp	As above
<i>Parameters to calculate incremental costs of child abdominal pain</i>		
P postnatal anxiety	14.7%	Ramchandani et al. (2006)
RD chronic abdominal pain	3.9pp	As above
Costs of child chronic pain p.a.	HSC £9028; ED £433; OOP £1071; UC: £5850; PL £1827	Sleed et al. (2005); education costs referred to those of home tutoring

3.2. Impact on children

3.2.1. Perinatal depression

There was strong evidence – including from meta-analysis and two UK longitudinal studies – on links between ante- or postnatal depression and the following birth and child or adolescent outcomes until age 16: pre-term birth, infant death, teacher-reported special educational needs and leaving school without qualifications, emotional problems and conduct problems (Sanderson et al., 2002; Howard et al., 2007; Halligan et al., 2007; Grote et al., 2010; Murray et al., 2010; Bauer et al., 2015). Studies controlled for a wide range of covariates such as previous maternal depression, co-existing perinatal anxiety and socio-demographic characteristics. Details of parameters applied in the analysis of lifetime costs for the impact of perinatal depression on children are presented in Tables 3 and 4.

3.2.1.1. Pre-term birth. The present value of costs of pre-term birth – based on proportions of extremely (< 28 weeks) versus otherwise pre-term birth (28–36 weeks) – were £974 per child exposed to antenatal depression for health and social care, £20 for education, £418 for health-related quality of life losses, £22 for productivity losses and £14 for costs of parents' out-of-pocket expenditure. These estimates were based on additional risks for a child exposed to antenatal depression being born extremely pre-term of 0.1pp and otherwise pre-term of 2.54pp. While costs of health and social care, education, out-of-pocket expenditure and productivity losses could be taken from existing UK long-term estimates, health-related quality of life losses between ages 5 and 18 required additional calculations. Health disutility data were available from the literature for children born extremely pre-term. For children born otherwise pre-term we used health disutility experienced by children with moderate cognitive impairment. All values and details of parameters are shown in Table 3.

3.2.1.2. Infant death. Costs for lost life at the time of birth were £22,157 per woman with depression. This was based on the mean probability of postnatal depression and additional risk to sudden death for infants of mothers who suffered from postnatal

depression (Table 3).

3.2.1.3. Emotional problems. Lifetime costs of child emotional problems per woman with perinatal depression were: £1020 for health and social care, £558 for education, £4936 for health-related quality of life losses and £2379 for productivity losses. This was based on mean probabilities of child exposure to perinatal depression and additional risks of development and persistence of emotional problems, published annual public sector costs and health disutility data for children with emotional problems (5–16 yr) and adults with depression (17–65 yr). For the calculation of adulthood costs we applied a mean duration of persistent emotional depression of 16 years and assumed an equal distribution of costs over the lifetime. Details of parameters used in the calculations are in Table 3.

The risk of a child developing emotional problems differed depending on whether or not the mother experienced subsequent episodes of depression linked to the original postnatal episode. The additional risk for children exposed to perinatal maternal depression but not to subsequent episodes of developing emotional problems was 5pp whilst the additional risk linked to perinatal depression occurring with subsequent episodes was as high as 16pp (age 11). We used those figures for the years 11–16; for the years 5–11 we applied an adjusted, reduced risk reflecting the course of child emotional problems.

3.2.1.4. Conduct problems. Costs of child conduct problems per woman with perinatal depression were £837 for health and social care, £1974 for criminal justice, £1797 for productivity losses, £3396 for health-related quality of life losses, and £7446 for crime victim costs. Estimates were based on probabilities of exposure to perinatal depression and an additional risk to develop conduct problems, proportions of children with conduct problems with and without the severity of a disorder (Colman et al., 2009) and existing lifetime costs of conduct problems with and without the severity of a disorder (Table 3).

3.2.1.5. Special educational needs and leaving school without qualifications. The present value of costs for additional education was £3166, linked to the additional risk of requiring special education.

The present value of productivity losses was £1463, because of lower earnings from leaving school without qualification, taken from previous work in this area (Bauer et al., 2015). Similar figures had been found by Murray et al. (2010).

3.2.2. Perinatal anxiety

Although less strong than for perinatal depression, there was evidence of a link between perinatal anxiety and adverse birth and child outcomes. The majority of papers analysed the link between ante- or postnatal anxiety and adverse child outcomes based on data from the Avon Longitudinal Study of Parents and Children (ALSPAC). Outcomes that were affected included pre-term birth, emotional and conduct problems and chronic abdominal pain (O'Connor et al., 2002; Ramchandani et al., 2006; Orr et al., 2007; O'Donnell et al., 2014). Studies controlled for a wide range of variables such as history of mental illness, co-existing perinatal depression and various socio-demographic characteristics.

3.2.2.1. Pre-term birth. The costs of pre-term birth per woman with perinatal anxiety were £2435 for health and social care, £13 for education, £54 for productivity losses, £1044 for health-related quality of life and £34 for parental out-of-pocket expenditure. These were based on an additional risk of pre-term birth which varied from 5.5pp to 13.3pp depending on the severity of the mother's anxiety. The proportions of pre-term births defined as extremely or otherwise pre-term and their associated costs were the same as used in relation to perinatal depression.

3.2.2.2. Emotional problems. Costs of child emotional problems per woman with antenatal anxiety were £273 for health and social care, £176 or education, £440 for productivity losses, £535 for health-related quality of life losses. These estimates were based on an additional risk of child emotional problems of 1.7pp and on the same parameters as used to estimate the costs of emotional problems attributable to perinatal depression during childhood (age 5–16) and adulthood (age 17–65).

3.2.2.3. Conduct problems. For child conduct problems, the costs at present value per woman with antenatal anxiety were £236 for health and social care, £558 for criminal justice, £508 for productivity losses, £960 for health-related quality of life losses, and £2105 for crime victim costs. These were based on an additional risk of conduct problems of 3.4pp and the same parameters as used to measure the lifetime costs of conduct problems attributable to perinatal depression.

3.2.2.4. Chronic abdominal pain. The costs of chronic abdominal pain in children per woman with perinatal anxiety were £1531 for health and social care, £140 for education, £736 for productivity losses, £347 for out-of-pocket expenditure and £1892 for unpaid care. These estimates were based on the additional risk that children exposed to perinatal anxiety would develop chronic abdominal pain of 4pp (5–16 years). Annual cost data were available from the literature for children in treatment for chronic abdominal pain. Conservatively, we reduced costs of health and social care by half, assuming that only 50% with chronic abdominal pain accessed such treatment.

3.3. Total impact on mothers and children

Findings on costs are summarised in Table 5. Aggregated present values of lifetime costs per woman with condition were £75,728 for perinatal depression and £34,811 for perinatal anxiety. If mean prevalence estimates were applied, the respective aggregated cost of perinatal anxiety and depression was about £8500 per woman giving birth. For 778,805 live births in UK in

Table 5

Costs per woman with condition (in 2012/13, £).

	Perinatal depression		Perinatal anxiety	
	Mother	Child	Mother	Child
<i>Public sector</i>				
Health and social care	1688	2831	4320	4475
Education	–	3744	–	329
Criminal justice	–	1974	–	558
<i>Wider societal perspective</i>				
Productivity losses	3028	5661	5499	1738
Health-related quality of life losses	18,158	8750	10,975	2539
Lost life	277	22,157	–	–
Out-of-pocket expenditure	–	14	–	381
Unpaid care	–	–	–	1892
Victim cost of crime	–	7446	–	2105
Total cost	23,151	52,577	20,794	14,017
Total public sector cost (in % of total cost)	1688 (7)	8549 (16)	4320 (21)	5362 (38)

2013, the costs amounted to £6.6 billion. Sixty percent of the costs related to the adverse impact on children. Almost a fifth of the total costs were borne by the public sector, with the bulk of these falling to NHS and social care.

4. Discussion

4.1. Summary of main findings

The lifetime impact of perinatal anxiety and depression was substantial and the majority of the costs related to the impact on offspring. The findings showed that those adverse birth and child development outcomes project negative long-lasting consequences in terms of the individual's morbidity (physical and mental ill health), quality of life and career prospects over a lifetime, and possibly even carried over to another, third generation. Although the majority of costs were those to individuals and society, there are still substantial costs carried by the public sector, in particular the NHS and social care.

4.2. Comparison with the literature

Our study took a lifetime perspective, which allowed us to capture a comprehensive set of consequences as they happen at different life stages from birth to infancy, childhood, adolescence and adulthood. As it is the case for cost-of-illness studies generally, the few studies which have been carried out in the maternal and child health field measure the yearly direct costs based on prevalence and health care expenditure or resource use data (Saha and Gerdtham, 2013). It is thus not appropriate to compare the costs we identified with estimates from other studies.

4.3. Implications

Our study shows the overall impact of perinatal depression and anxiety but does not explore the economic case for intervention. A number of evaluations have shown interventions in this area to be cost-effective; they focus on measuring the short-term outcomes of mothers (Morrell et al., 2009; Bauer et al., 2011; Dukhovny et al., 2013; Sockol et al., 2013). The (cost-) effectiveness of interventions in reducing the long-term impacts of perinatal mental illness on children and mothers are largely unknown. Research is needed to

investigate which types of interventions during the perinatal period can improve long-term child development outcomes and their cost implications (Howard et al., 2014; Thornicroft and Patel, 2014). However, studies of this type are expensive and, of course, attribution becomes a bigger issue the longer the time period.

Therefore – in the absence of this knowledge – analysis of existing longitudinal data on long-term outcomes and costs for different individuals affected by perinatal mental illness can be helpful. This includes further analysis of the role of other perinatal risk factors and mediating variables such as breastfeeding and infant attachment (Hahn-Holbrook et al., 2013; Borra et al., 2014). Research should address a limitation of current studies which only analyse the association between a single perinatal condition and one or two child development outcomes; studies need to take adequate account of comorbidities and accumulating effects on children. Further research should also consider the impact of father's depression which correlates with maternal perinatal mental illness and – as suggested by recent studies – has its own effect on adverse child development (Paulson et al., 2006; Ramchandani et al., 2008; Goodman, 2008; Edoka et al., 2011).

4.4. Limitations

The exploratory nature of our method has a number of limitations that need to be considered when interpreting our findings. To capture a broad set of economic consequences we worked with a range of literature but still faced data gaps. To address data shortages we took additional steps that could not be planned in advance, including pragmatic literature searches. For example, whilst some studies established incremental data, this was not always the case and we thus had to look for comparison data (usually national averages). A standardised and consistent approach to estimate cost impact was handicapped by different types of data sources and study designs. Due to the large number of studies and evolving evidence base we were not able to carry out detailed quality assessments and instead applied pragmatic selection criteria. Because papers did not always provide full statistical details (such as means and confidence intervals), we were unable to carry out substantive sensitivity analysis. Instead, in order to increase the robustness of the results, our approach and the assumptions were generally conservative.

A lack of data required certain assumptions. For example, data was not always available for the specific condition and we used approximate values. A lack of data also meant that not all adverse outcomes could be included in the analysis; this included suicide linked to anxiety (without co-existing depression) and HRQoL loss linked to chronic abdominal pain. Whilst it is possible and likely that childhood conditions and their economic consequences overlap, we did not have the data to account for this in our analysis.

Finally, the analysis was concerned with averages across different groups and thus did not shed light on subgroups that should be targeted when considering how to best use available resources.

5. Conclusion

This is the first study that investigates the costs of perinatal depression and anxiety from a lifetime perspective, taking into account the impact of these conditions on both mothers and their children. The analysis shows that the overall cost of perinatal mental illness is very large, suggesting the importance of this area as a major (public) health priority, and requiring much greater attention than it has been given to date. Further research is required to understand which interventions can reduce the long-term effects on mothers and children.

References

- Appleby, J., Devlin, N., Parkin, D., 2007. NICE's cost-effectiveness threshold. *Br. Med. J.* 335, 358–359.
- Ara, R., Brazier, J.E., 2011. Using health state utility values from the general population to approximate baselines in decision analytic models when condition specific data are not available. *Value Health* 14, 539–545.
- Bauer, A., Knapp, M., McDaid, D., 2011. Health visiting and reducing post-natal depression. In: Knapp, M., McDaid, D., Parsonage, M. (Eds.), *Mental Health Promotion and Mental Illness Prevention: The Economic Case*. Department of Health, London, pp. 4–5.
- Bauer, A., Pawlby, S., Dominic, T.P., King, D., Pariente, C.M., Knapp, M., 2015. Perinatal depression and child development: exploring the economic consequences from a South London cohort. *Psychol. Med.* 45, 51–61.
- Bennett, H.A., Einarson, A., Taddio, A., Koren, G., Einarson, T.R., 2004. Prevalence of depression during pregnancy: systematic review. *Obstet. Gynecol.* 103, 698–709.
- Borra, C., Iacovou, M., Sevilla, A., 2014. New evidence on breastfeeding and postpartum depression: the importance of understanding women's intentions. *Matern. Child Health J.* 19, 897–907.
- Burns, A., O'Mahen, H., Baxter, H., Bennert, K., Wiles, N., Ramchandani, P., 2013. A pilot randomised controlled trial of cognitive behavioural therapy for antenatal depression. *BMC Psychiatry* 13, 33.
- Colman, I., Murray, J., Abbott, R.A., Maughan, B., Kuh, D., Croudace, T.J., Jones, P.B., 2009. Outcomes of conduct problems in adolescence: 40 year follow-up of national cohort. *Br. Med. J.* 338, a2981.
- Conroy, S., Pariente, C.M., Marks, M.N., Davies, H.A., Farrelly, S., Schacht, R., Moran, P., 2012. Maternal psychopathology and infant development at 18 months: the impact of maternal personality disorder and depression. *J. Am. Acad. Child Adolesc. Psychiatry* 51, 51–61.
- Curtis, L., 2013. Unit Costs of Health and Social Care 2013. Personal Social Services Research Unit. University of Kent, Kent.
- DH, 2010. Quantifying Health Impacts of Government Policies. Department of Health, London.
- DH, 2013. Reference Cost 2012–13. Department of Health, London (Available from <www.gov.uk/government/publications/nhs-reference-costs-2012-to-2013> (last accessed 04.09.15)).
- Dukhovny, D., Dennis, C.L., Hodnett, E., Weston, J., Stewart, D.E., Mao, W., Zupancic, J.A., 2013. Prospective economic evaluation of a peer support intervention for prevention of postpartum depression among high-risk women in Ontario, Canada. *Am. J. Perinatol.* 30, 631–642.
- DWP, 2010. Maternity and Paternity Rights and Women Returners Survey 2009/10. Department for Work and Pensions and BIS, London, p. 70.
- Edoka, I.P., Petrou, S., Ramchandani, P.G., 2011. Healthcare costs of paternal depression in the postnatal period. *J. Affect. Disord.* 133, 356–360.
- Gavin, N.I., Meltzer-Brody, S., Glover, V., Gaynes, B.N., 2015. Is population-based identification of perinatal depression and anxiety desirable? A public health perspective on the perinatal depression care continuum. In: Milgrom, J., Gemmill, A.K. (Eds.), *Identifying Perinatal Depression and Anxiety: Evidence-based Practice in Screening, Psychosocial Assessment and Management*. Wiley-Blackwell, ISBN: 978-1-118-50965-4.
- Goodman, J.H., Tyr-Viola, L., 2010. Detection, treatment, and referral of perinatal depression and anxiety by obstetrical providers. *J. Womens Health* 19, 447–490.
- Goodman, J.H., 2008. Influences of maternal postpartum depression on fathers and on father–infant interaction. *Infant Mental Health J.* 29, 624–643.
- Green, H., McGinnity, A., Meltzer, H., Ford, T., Goodman, R., 2005. *Mental Health Of Children And Young People in Great Britain 2004*, Summary Report, Office for National Statistics, Her Majesty's Stationary Office, London.
- Grote, N.K., Bridge, J.A., Gavin, A.R., Melville, J.L., Iyengar, S., Katon, W.J., 2010. A meta-analysis of depression during pregnancy and the risk of pre-term birth, low birth weight, and intrauterine growth restriction. *Arch. Gen. Psychiatry* 67, 1012–1024.
- Hahn-Holbrook, J., Haselton, M.G., Dunkel Schetter, C., Glynn, L.M., 2013. Does breastfeeding offer protection against maternal depressive symptomatology?: a prospective study from pregnancy to 2 years after birth. *Arch. Womens Mental Health* 16, 411–422.
- Halligan, S.L., Murray, L., Martins, C., Cooper, P.J., 2007. Maternal depression and psychiatric outcomes in adolescent offspring: a 13-year longitudinal study. *J. Affect. Disord.* 97, 145–154.
- Hay, D.F., Pawlby, S., Waters, C.S., Perra, O., Sharp, D., 2010. Mothers' antenatal depression and their children's antisocial outcomes. *Child Dev.* 81, 149–165.
- Harker, R., 2011. Cost of depression in England. Social and General Statistics Section. House of Commons Library. Ref 2011/08/200-SGS. Available at <<https://wellbeingeconomics.files.wordpress.com/2012/02/costofdepressionstats2010.pdf>> (last accessed 14.08.14).
- Heron, J., O'Connor, T.G., Evans, J., Golding, J., Glover, V., ALSPAC Study Team, 2004. The 21 course of anxiety and depression through pregnancy and the postpartum in a 22 community sample. *J. Affect. Disord.* 80, 65–73.
- Howard, L.M., Kirkwood, G., Latinovic, R., 2007. Sudden infant death syndrome and maternal depression. *J. Clin. Psychiatry* 68, 1279–1283.
- Howard, L.M., Piot, P., Stein, A., 2014. No health without mental health. *Lancet* 384, 1723–1724.
- Kingston, D., Tough, S., 2014. Prenatal and postnatal maternal mental health and school-age child development: a systematic review. *Matern. Child Health J.* 18, 1728–1741.

- Ko, J.Y., Farr, S.L., Dietz, P.M., Robbins, C.L., 2012. Depression and treatment among U.S. pregnant and nonpregnant women of reproductive age, 2005–2009. *J. Womens Health* 21, 830–836.
- Lydsdottir, L.B., Howard, L.M., Olafsdottir, H., Thome, M., Tyrifingsson, P., Sigurdsson, J.F., 2014. The Mental health characteristics of pregnant women with depressive symptoms identified by the Edinburgh Postnatal Depression Scale. *J. Clin. Psychiatry* 75, 393–398.
- Mangham, L., Petrou, S., Doyle, L.W., Draper, E.S., Marlow, N., 2009. The cost of pre-term birth throughout childhood in England and Wales. *Pediatrics* 123, 312–327.
- Mann, R., Gilbody, S., Richards, D., 2009. Putting the 'Q' in depression QALYs: a comparison of utility measurement using EQ-5D and SF-6D health related quality of life measures. *Soc. Psychiatry Psychiatr. Epidemiol.* 44, 569–578.
- McMahon, E.M., Buszewicz, M., Griffin, M., Beecham, J., Bonin, E.M., Rost, F., Walters, K., King, M., 2012. Chronic and recurrent depression in primary care: socio-demographic features, morbidity, and costs. *Int. J. Fam. Med.*, 7.
- Morrell, C.J., Warner, S., Slade, P., Dixon, S., Walters, S., Paley, G., Brugha, T., 2009. Psychological interventions for postnatal depression: cluster randomised trial and economic evaluation: the PoNDER trial. *Health Technol. Assess.* 13, 1–153.
- McManus, S., Meltzer, H., Brugha, T., Bebbington, P., Jenkins, R., 2009. Adult Psychiatric Morbidity in England, 2007: Results of a Household Survey. The NHS Information Centre for Health and Social Care, Leeds.
- Mueller, T.I., Keller, M.B., Leon, A., Solomon, D.A., Shea, D.A., Coryell, W., Endicott, J., 1996. Recovery after five years of unremitting major depressive disorder. *Arch. Gen. Psychiatry* 53, 794–799.
- Murray, L., Arteche, A., Fearon, P., Halligan, S., Croudace, T., Cooper, P., 2010. The effects of maternal postnatal depression and child sex on academic performance at age 16 years: a developmental approach. *J. Child. Psychol. Psychiatry* 51, 1150–1159.
- NICE, 2011. Generalised Anxiety Disorder in Adults, the NICE Guideline on Management in Primary, Secondary and Community Care. National Collaborating Centre for Mental Health and National Institute for Health and Clinical Excellence, British Psychological Society and Royal College of Psychiatrists.
- NICE, 2014. Antenatal and Postnatal Mental Health, Clinical Management and Service Guidance, Draft for Consultation. National Collaborating Centre for Mental Health commissioned by the National Institute for Health and Care Excellence, London. Available at <http://www.nice.org.uk/guidance/gid-cgwave0598/resources/antenatal-and-postnatal-mental-health-update-full-version2> (last accessed 31.07.14).
- O'Connor, T.G., Heron, J., Glover, V., 2002. Antenatal anxiety predicts child behavioral/emotional problems independent of postnatal depression. *J. Am. Acad. Child Adolesc. Psychiatry*, 1470–1477.
- O'Donnell, K.J., Glover, V., Barker, E.D., O'Connor, T.G., 2014. The persisting effect of maternal mood in pregnancy on childhood psychopathology. *Dev. Psychopathol.* (Epub 2014, March 12).
- ONS 2013 ONS, Population estimates for England and Wales, mid 2012, Released 26 June 2013, Office for National Statistics, London, 2013. (Available from <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-england-and-wales/mid-2012/index.html> (last accessed 17.12.15)).
- ONS, 2005. Families and Work ONS 2005 (for Return to Employment Data After Giving Birth). Office for National Statistics, London.
- ONS, 2011. Childhood, Infant and Perinatal Mortality in England and Wales 2011. Office for National Statistics, London.
- ONS, 2013a. Full Report-Women in the Labour Market. Office for National Statistics, London, p. 2014 (Available from http://www.ons.gov.uk/ons/dcp171776_328352.pdf (last accessed 27.06.14)).
- ONS, 2013b. Annual Survey of Hours and Earnings, 2013 Provisional Results. Office for National Statistics, London (Available from <http://www.ons.gov.uk/ons/rel/ashe/annual-survey-of-hours-and-earnings/2013-provisionalresults/index.html> (last accessed 19.07.14)).
- ONS, 2014. Suicides in the United Kingdom, 2012 Registrations. Office for National Statistics, London, p. 2014 (Available at http://www.ons.gov.uk/ons/dcp171778_351100.pdf (last accessed 05.09.14)).
- Orr, S.T., Reiter, J.P., Blazer, D.G., James, S.A., 2007. Maternal prenatal pregnancy-related anxiety and spontaneous pre-term birth in Baltimore, Maryland. *Psychosom. Med.* 69, 566–570.
- Parsonage, M., Khan, L., Saunders, A., 2014. Building a Better Future: the Lifetime Costs of Childhood Behavioural Problems and the Benefits of Early Intervention. Centre for Mental Health, London.
- Paulson, J.F., Dauber, S., Leifermann, J.A., 2006. Individual and combined effects of postpartum depression in mothers and fathers on parenting behaviour. *Pediatrics* 118, 659–668.
- Pearson, R.M., Evans, J., Kounali, D., Lewis, D., Heron, J., Ramchandani, P.G., O'Connor, T.G., Stein, A., 2013a. Maternal depression during pregnancy and the postnatal period: risks and possible mechanisms for offspring depression at age 18 years. *JAMA Psychiatry* 70, 1312–1319.
- Pearson, R.M., Fernyhough, C., Bentall, R., Evans, J., Heron, J., Joinson, C., Stein, A.L., Lewis, G., 2013b. Association between maternal depressogenic cognitive style during pregnancy and offspring cognitive style 18 years later. *Am. J. Psychiatry* 170, 434–441.
- Petrou, S., Cooper, P., Murray, L., Davidson, L.L., 2002. Economic costs of post-natal depression in a high-risk British cohort. *Br. J. Psychiatry* 181, 505–512.
- Petrou, S., Abangma, G., Johnson, S., Wolke, D., 2009. Costs and health utilities associated with extremely pre-term birth: evidence from the EPICure study. *Value Health* 12, 1124–1134.
- Petrou, S., Johnson, S., Wolke, D., Hollis, C., Kochhar, P., Marlow, N., 2010. Economic costs and preference-based health-related quality of life outcomes associated with childhood psychiatric disorders. *Br. J. Psychiatry* 197, 395–404.
- Petrou, S., Khan, K., 2012. Economic costs associated with moderate and late pre-term birth: primary and secondary evidence. *Sem. Fetal Neonatal Med.* 17, 170–178.
- Plaisier, I., Beekman, A.T., de Graaf, R., Smith, J.H., van Dyck, R., Penninx, B.W., 2010. Work functioning in persons with depressive and anxiety disorders: the role of specific psychopathological characteristics. *J. Affect. Disord.* 125, 198–206.
- Ramchandani, P.G., Stein, A., Hotopf, M., Wiles, N.J., 2006. Early parental and child predictors of recurrent abdominal pain at school age: results of a large population-based study. *J. Am. Acad. Child Adolesc. Psychiatry* 45, 729–736.
- Ramchandani, P.G., O'Connor, T.G., Evans, J., Heron, J., Murray, L., Stein, A., 2008. The effects of pre- and postnatal depression in fathers: a natural experiment comparing the effects of exposure to depression on offspring. *J. Child Psychol. Psychiatry* 49, 1069–1078.
- Saarni, S.I., Suvisaari, J., Sintonen, H., Pirkola, S., Koskinen, S., Aromaa, A., Lönnqvist, J., 2007. Impact of psychiatric disorders on health-related quality of life: general population survey. *Br. J. Psychiatry* 190, 326–332.
- Saha, S., Gerdtham, U.G., 2013. Cost of illness studies on reproductive, maternal, newborn, and child health: a systematic review. *Health Econ. Rev.* 3, 24.
- Sanderson, C.A., Cowden, B., Hall, D.M., Taylor, E.M., Carpenter, R.G., Cox, J.L., 2002. Is postnatal depression a risk factor for sudden infant death? *Br. J. Gen. Pract.* 52, 636–640.
- Snell, T., Knapp, M., Healey, A., Guglani, S., Evans-Lacko, S., Fernandez, J.L., Meltzer, H., Ford, T., 2013. Economic impact of childhood psychiatric disorder on public sector services in Britain: estimates from national survey data. *J. Child Psychol. Psychiatry* 54, 977–985.
- Sokol, L.E., Epperson, C.N., Barber, J.P., 2013. Preventing postpartum depression: a meta-analytic review. *Clin. Psychol. Rev.* 33, 1205–1217.
- Sleed, M., Eccleston, C., Beecham, J., Knapp, M., Jordan, A., 2005. The economic impact of chronic pain in adolescence: methodological considerations and a preliminary cost-of-illness study. *Pain* 119, 183–190.
- Surkan, P.J., Kennedy, C.E., Hurley, K.M., Black, M.M., 2011. Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bull. World Health Organ.* 89, 608–615.
- Thornicroft, G., Patel, V., 2014. Including mental health among the new sustainable development goals. *Br. Med. J.* 349, g5189.
- Vesga-López, O., Blanco, C., Keyes, K., Olfson, M., Grant, B.F., Hasin, D.S., 2008. Psychiatric disorders in pregnant and postpartum women in the United States. *Arch. Gen. Psychiatry* 65, 805–815.
- Wisner, K.L., Sit, D.K., McShea, M.C., Rizzo, D.M., Zoretich, R.A., Hughes, C.L., Eng, H. F., Luther, J.F., et al., 2013. Onset timing, thoughts of self-harm, and diagnoses in postpartum women with screen-positive depression findings. *JAMA Psychiatry* 70, 490–498.
- WHO, 2014. Social Determinants of Mental Health. World Health Organization and Calouste Gulbenkian Foundation, Geneva.
- WHO, 2008. Millennium Development Goal 5: Improving Maternal Mental Health. World Health Organization, Geneva.
- Woolhouse, H., Brown, S., Krastev, A., Perlen, S., Gunn, J., 2009. Seeking help for anxiety and depression after childbirth: results of the Maternal Health Study. *Arch. Womens Mental Health* 12, 75–83.