



Research paper

## Economic costs of perinatal depression and anxiety in a lower middle income country: Pakistan

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## ABSTRACT

**Background:** Women's mental health during the perinatal period is a major public health problem in Pakistan. Many challenges and competing priorities prevent progress to address the large treatment gap.

**Aim**

To quantify the long-term impacts of untreated perinatal depression and anxiety in economic terms, thus highlighting its overall burden based on country-specific evidence.

**Methods:** Cost estimates were generated for a hypothetical cohort of women giving birth in 2017, and their children. Women and children experiencing adverse events linked to perinatal mental health problems were modelled over 40 years. Costs assigned to adverse events included were those linked to losses in quantity and quality-of-life, productivity, and healthcare-related expenditure. Present values were derived using a discount rate of 3%. Data were taken from published cohort studies, as well as from sources of population, economic and health indicators.

**Results:** The total costs were \$16.5 billion for the cohort and \$2680 per woman giving birth. The by far largest proportion referred to quality-of-life losses (\$15.8 billion). Productivity losses and out-of-pocket expenditure made up only a small proportion of the costs, due to low wages and market prices. When the costs of maternal suicide were included, total costs increased to \$16.6 billion.

**Limitations:** Important evidence gaps prevented the inclusion of all cost consequences linked to perinatal mental health problems.

**Conclusions:** Total national costs are much higher compared with those in other, higher middle-income countries, reflecting the excessive disease burden. This study is an important first step to inform resource allocations.

### 1. Background

Maternal mental ill-health during pregnancy and after delivery (=perinatal period) is highly prevalent and contributes substantially to the Global Burden of Disease (Gelaye et al., 2016; McNab et al., 2022; WHO, 2008). Maternal mental health problems are more prevalent in low- and middle-income countries (LMICs) and particularly among

women living in poverty and exposed to gender-based violence (Lund et al., 2010). In Pakistan, which is a lower middle income country with major gender inequities and high rates of gender-based violence, perinatal depression affects about 30% of women (Mahendran et al., 2019). Prevalence rates for anxiety disorders are likely to be equally high or higher (Gul et al., 2019; Niaz et al., 2004). About one in ten women has suicidal thoughts during pregnancy and half of those attempt suicide

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(Asad et al., 2010). Since Pakistan has one of the highest childbirth rates globally absolute numbers of women who experience perinatal mental health problems are particularly large (estimated of at least 1.8 million/year, based on 5.9 million births in 2017 and a prevalence rate of 30 %).

Evidence from other LIMCs show that economic costs of perinatal mental health problems, if untreated, are very large, because of the many short-term and long-term adverse impacts on mothers and their children (Bauer et al., 2022a; Bauer et al., 2022b). The increased risks linked to perinatal mental health problems on pregnancy outcomes, children's physical and mental health are well established and greatly exacerbated in those exposed to multiple poverty-related risk factors (Stein et al., 2014). In Pakistan, depression during pregnancy has been linked to an increased risk of infant diarrhoea, stunting and wasting (Rahman et al., 2004), and if it becomes chronic, a greater risk of child socio-emotional development problems (Ali et al., 2013; De Oliveira et al., 2019).

With regards to policy and practice, in certain regions, there have been innovative developments in the perinatal mental health field over the last decades. The most prominent example is the development and implementation of the now World Health Organisation (WHO)-endorsed 'Thinking Healthy Programme' (WHO, 2015), which provides psycho-social treatment to women during the perinatal period, and has been trialled in many different delivery formats in several urban and rural regions nationally and internationally (Fuhr et al., 2019; Rahman et al., 2008; Sikander et al., 2019a). Where the programme is offered – mainly as part of large trials – it is integrated into maternal and child healthcare, and recently also combined with a parenting and child learning intervention, the Learning Through Play (LTP) programme (Husain et al., 2021). The 2019 President's Programme to Promote Mental Health of Pakistanis, which specifically incorporates plans for early years intervention and the roll out of the Thinking Healthy Programme, is a major policy milestone (Mirza and Rahman, 2019). At the same time, recent developments such as inflation and natural disasters have added to the challenges of funding the programme. Country-specific economic evidence, including of the costs of the problem, can address information gaps about best ways of spending perennially restricted budgets. The aim of this study is to estimate the costs of perinatal mental health problems in Pakistan, therefore developing an economic rationale for investing into perinatal mental health that can inform the current policy opportunities.

## 2. Method

As done in an earlier UK study (Bauer et al., 2016), decision-analytic modelling techniques (Briggs et al., 2006) were used to simulate the additional costs because of (untreated) perinatal mental health problems. A hypothetical cohort of women and their children were followed in annual cycles over time (10 years for women, 40 years for children) to cover the period over which most impacts occur considering the chronic course of perinatal mental health problems for some women, and an assumed main earning period for their children of up to 40 years of life.

We assigned costs to adverse impacts on mothers and children including costs borne by society. Societal costs included losses in quantity and quality-of-life, measured in the form of disability-adjusted life years (DALYs), productivity/income losses and healthcare-related expenditure. Following an approach used in global costing studies (Stenberg et al., 2014; Chisholm et al., 2016), both productivity and DALYs were valued separately, making sure (mental) health was valued distinctively for its contribution to labour force participation and its contribution to other intrinsic benefits (e.g., ability to enjoy life or to contribute to society such as performing parenting or caring tasks). As done in those studies, we applied 0.5 per capita gross domestic product (GDP) to a DALY, using World Bank estimates for GDPs. DALYs are a measure of overall disease burden expressed as the number of years lost due to ill-health disability or early death. Income losses were valued reflecting income decrements linked to adverse impacts as assessed in

national studies. Healthcare-related expenditure referred to individuals' payments for healthcare and related expenses (e.g. for travelling to healthcare facilities) as we were unable to identify evidence concerning impacts of perinatal mental health problems on government expenditure for healthcare. Adverse impacts, types of costs and data sources included in the modelling are shown in Table 1.

For the model parameter values, we used data from peer-reviewed publications of results from birth cohort studies examining the impact of perinatal mental health problems on mothers and children, as well as from sources of population, economic and health indicators published by national and international organisations (WHO, World Bank and national government). We used Pakistan-specific data where those were available. Where we used international (rather than national or local Pakistani) evidence or evidence not specific to the perinatal period, we make this explicit. All parameters used for the study, values, data sources, and details of how values were derived are presented in Table 2.

The year 2017 was chosen as present year because this was the latest year for which most statistical data about women and children were available. Since we modelled costs as they occur not only in 2017 but also in the future, we determined the present value of costs (in 2017) using a discount rate of 3 % commonly applied in global health and the Global Burden of Disease study (Lim et al., 2016) and recommended by the International Panel on Cost Effectiveness in Health and Medicine (Haacker et al., 2019; Mandelblatt et al., 1997).

### 2.1. Population cohort: women and children

The cohort included in the model refers to women to have depression or anxiety during the perinatal period, and their children they gave birth to. For an accurate estimation of disease burden, we focus on conditions for which there is good evidence, and we also seek to distinguish between severities of depression and anxiety. However, scarce data on the severity of these conditions in low- and middle-income countries

**Table 1**  
Outcomes, types of costs included in model, details and data sources for unit costs.

Outcome	Types of costs	Details and data sources for unit costs
Maternal mental illness during perinatal period (depression, anxiety + suicide)	Disability adjusted life years (valued in Gross Domestic Product) Employment/income (valued in Gross Domestic Product)	Disability weights from Global Burden of Disease study Data on lost productivity for women during the perinatal period as assessed in evaluation of Thinking Healthy Programme
Maternal mental illness subsequent episodes/ chronic development of depression	Disability adjusted life years (valued in Gross Domestic product) Employment/income (valued in Gross Domestic Product)	Disability weights from Global Burden of Disease study Extrapolated from lost productivity for women during the perinatal period as assessed in evaluation of Thinking Healthy Programme
Child stunting	Employment/income (valued in Gross Domestic Product)	Income decrement-based for childhood stunting from national data (informed by international evidence)
Child wasting	Disability adjusted life years (valued in Gross Domestic Product)	Disability weights from Global Burden of Disease study
Child diarrhoea	Healthcare and healthcare-related expenditure (privately paid)	Data on out-of-pocket expenditure paid for treating diarrhoea in children
Child socio-emotional problems	Disability adjusted life years (valued in Gross Domestic Product)	Disability weights from Global Burden of Disease study

**Table 2**  
Parameters, values, data sources and details for the modelling.

Parameter	Value	Data source and details
<b>Mothers' cohort and impacts</b>		
No. of live births (in 2017)	5,946,118	World data atlas for birth rate in 2017 <sup>1</sup> ; applied to population data in 2017 <sup>2</sup>
Probability of still birth	0.043	Still birth rate of 43.1 per 1000 births (Blencowe et al., 2019; Lawn et al., 2016)
No. of still births	256,278	Derived from above: 5,946,118/1000 * 43.1
Number of women in pregnancy before considering mortality during pregnancy	6,202,396	Derived from above: 5,948,118 + 256,278 = 6,202,396
No. of women dying from maternal death (i.e. pregnancy related)	8325	Derived from maternal mortality of 140 per 100,000 live births (in 2017), <sup>3</sup> and no. of live births: 140/100,000 * 5,946,118
Proportions of women dying from maternal (pregnancy-related) death, ante- vs. postpartum	Ante: 20 % Intra/post: 80 %	Kassebaum et al. (2014), Table 2 Global and regional maternal deaths in 2013 by cause
No. of women dying from maternal (pregnancy-related) death during pregnancy	1665	Derived from above: 8325 * 0.2
Annual probability of death (women aged 15 to 39)	0.002	Institute for Health Metrics and Evaluation, Global Burden of Disease Life Tables 2017 <sup>4</sup>
No. of women dying from other causes during pregnancy	9304	Derived from average mortality probability of women 15–39 years for 9 months period applied to number of live and still births: 0.002 * (9/12) * 6,202,396
No. of women alive during whole pregnancy	6,191,427	6,202,396 – 1665 – 9304
No. of women dying from pregnancy-related causes intra- or postpartum	6666	Derived from above: 8325 * 0.8
No. of women dying from other causes during first year postpartum	11,892	Derived from average mortality probability of women 15–39 years for 12 months period applied to number of live births: 0.002 * 5,946,118
No. women alive during postpartum period	5,927,560	Derived from above: 5,946,118 – 6666 – 11,892
Prop. women with ante- and postnatal depression (major)	30 %	Mahendran et al. (2019); Sikander et al. (2019a)
Prop. women with ante- and postnatal anxiety (without co-existing depression)	25 %	Gul et al. (2019); Niaz et al. (2004)
Prop. cause suicide in relation to all-cause mortality (perinatal period)	0.00003	Suicide mortality rate among women of 3 per 100,000; World Bank <sup>5</sup>
Average duration of perinatal mental health problems (in yrs.)	0.25	Garman et al. (2019)
Proportion of women with ongoing perinatal mental health problems	35 %	De Oliveira et al. (2019)
Disability weight depression (major)	0.658	Global Burden of Disease 2013 <sup>6</sup>
Value of DALY (GDP per capita, in 2017, USD)	1465	National statistics GDP data <sup>7</sup>

**Table 2 (continued)**

Parameter	Value	Data source and details
Lost productivity due to perinatal depression (in 2017, USD)	Antenatal period: 54.3 Postnatal period: 72.4	Sikander et al. (2019b); estimates of Thinking Healthy Programme evaluation; uprated to 2017 values <sup>8</sup>
<b>Children's cohort and impacts</b>		
Annual probability of death	0.05 (<1st year); 0.04 (1 year); 0.002 (2nd and 3rd year); 0.001/2 (4th to 34th year); 0.003/4 (35th to 40th year)	Institute for Health Metrics and Evaluation, Global Burden of Disease Life Tables 2017IHME GBD Life Tables 2017 <sup>9</sup>
Risk difference for child problems in excess due to exposure to antenatal depression	20 %	Rahman et al. (2004); based on relative risk of 2.45 and estimated prevalence in population without risk of 24 %
Stunting (linked to antenatal depression)	21 %	Rahman et al. (2004); based on relative risk of 2.3 and estimated prevalence in population without risk of 29 %
Wasting	29 %	Rahman et al. (2007); based on relative risk of 2.3 and estimated prevalence in population without risk of 42 % (Rahman et al., 2007b)
Diarrhoea	27 %	Ali et al. (2013); based on adjusted odds ratio of 5.9 and estimated prevalence in population without risk of 22.5 % (Ali et al., 2013)
<b>Emotional problems (linked to severe and chronic postnatal depression)</b>		
Disability weights for child wasting and socio-emotional development problems	0.128	Global Burden of Disease study 2013 <sup>10</sup>
Wasting	0.396	Global Burden of Disease study 2013 <sup>11</sup>
Socio-emotional development problems	0.133	
Depression (moderate)		
Anxiety (moderate)		
Annual decrement in earnings due to stunting (in 2017, USD)	108	Pakistan World Food Programme report 2017 <sup>12</sup> ; weighted average women (50 %) vs. men (50 %), manual (65 %) vs. service sector (35 %); based on labour participation rates (women: 22 %; men: 83 %); average income manual labour (women: USD 569; men: USD 1228) vs. service sector (women and men: USD 2464); stunting-related decrement manual labour (6 %) vs. service sector (19 %)
Out-of-pocket expenditure for an episode of diarrhoea (in 2017, USD)	7	Rheingans et al. (2012), Rheingans et al. (2012)

prevents an exact estimation of women with mild, moderate, or severe conditions.

Based on prevalence rates from a large number of national studies in Pakistan summarised in recent meta-analysis (Mahendran et al., 2019), it was assumed that altogether 30 % of women experience a diagnosable major depression perinatally (Husain et al., 2006; Husain et al., 2011;

Mahendran et al., 2019; Sikander et al., 2019b). Whilst most estimates refer to the antenatal period, the few studies which have measured the prevalence of postnatal depressive disorder find similar rates (Ali et al., 2009; Husain et al., 2006) so that we took the same rate for both ante- and postnatal period. Furthermore, it is assumed that additional 25 % of women have anxiety disorder. This is calculated based on a prevalence of diagnosable anxiety disorder of about 35 % (Niaz et al., 2004) and an estimated proportion of women with co-existing depression and anxiety of 10 %. The latter is informed by international evidence suggesting that one third of women with depression have a co-existing anxiety disorder (Falah-Hassani et al., 2017). Because of a lack of data, it is assumed that this proportion of women with anxiety have a moderate illness.

For a proportion of women (35 %), it was assumed that they would continue having perinatal depression and anxiety after the postnatal period. This is based on evidence of a chronic development of the condition for a proportion of women (De Oliveira et al., 2019), which is much higher than the proportion found in middle or high-income countries (Garman et al., 2019; Hagaman et al., 2019). (Even though data refer to women with depression, the same proportion is assumed for women with anxiety.) We assume in the model that, even for those women with persistent problems, there is a recovery from the initial episode. Therefore, we model a yearly reduction of women who have depression or anxiety following an approach used previously (Bauer et al., 2016), which assume a linear remission over the course of ten years.

To derive numbers of mothers in the cohort of women alive each year, the number of women was reduced by a proportion of women who are assumed to die from other causes than maternal mental illness during the perinatal period. For this, we used age- and gender-specific mortality data from national statistics. For the probability of death during the perinatal period we aggregated the additional risk of women dying from pregnancy- and maternity-related causes (Kassebaum et al., 2014) to general mortality data.

For each year after birth, we estimated the number of children who because of perinatal depression will experience adverse events (stunting, wasting, diarrhoea, socio-emotional development problems). Based on data from birth cohort studies in Pakistan (Ali et al., 2013; De Oliveira et al., 2019; Rahman et al., 2007b; Rahman et al., 2004), we established risk differences derived from probabilities that outcomes occur in the group of children exposed, versus probabilities in the group of children not exposed to depression. By applying the additional risk of adverse outcomes (stunting, wasting, diarrhoea, socio-emotional development problems) to the proportion of children exposed to ante- or postnatal depression we derived the excess number of children with adverse outcomes because of their mothers' depression.

As for mothers, annual mortality rates were applied to the cohort of children with adverse outcomes to adjust for the proportion children who die every year from other causes than perinatal mental illness.

## 2.2. Assigning costs to adverse impacts

Economic impacts for *mothers* occurred in the form of losses in quantity and quality-of-life (measured in DALYs) and in productivity during and – for the proportion of women with persistent problems – after the perinatal period. To measure the economic impact linked to quantity and quality-of-life losses, DALYs were calculated by multiplying the number of women with depression or anxiety, disability weights for depression and anxiety and the duration over which the problems are assumed to last. For depression we used a disability weight for major depression and for anxiety we used a disability weight for moderate anxiety; we assume for both depression and anxiety that the duration of the episode is 3 months as found in other LMICs (Garman et al., 2019). DALYs were then converted to monetary values by applying 0.5 of GDP per capita, and present cost values were derived by aggregating discounted values over the whole period (year of pregnancy to 10 years after birth).

To calculate productivity losses, we used data on productivity losses linked to perinatal depression as established for an evaluation of the Thinking Healthy Programme across the trial population (Sikander et al., 2019a). We adjusted the prices to 2017 values. A caveat is that the value was derived by asking women about lost productivity due to mental illness rather than by comparing a group of women with and without perinatal depression. However, we considered this the best available estimate especially as it is related directly to women's depression during the perinatal period. Especially as income is strongly gender dependent in Pakistan this approach seemed appropriate. We applied the estimate for the postnatal period to the subsequent 10 years for the proportion of women with chronic depression. A present value is derived by aggregating discounted values over the whole period (year of pregnancy to 10 years after birth).

Costs were assigned to adverse impacts on *children* linked to an increased risk of diarrhoea, stunting, wasting and socio-emotional development problems due to perinatal mental health problems. All estimates for adverse child outcomes were taken from national studies and referred specifically to the impacts of perinatal depression (Ali et al., 2013; Rahman et al., 2007a, 2007b). First, to establish the additional number of children affected negatively by an outcome due to their exposure to perinatal depression, risk differences were derived from probabilities that outcomes occur in the group of children exposed, versus probabilities in the group of children not exposed to depression during pregnancy or the year after birth. By applying the additional risk of adverse outcomes (diarrhoea, stunting, wasting, socio-emotional development problems) to the proportion of children exposed to perinatal depression we calculated the excess number of children with adverse outcomes linked to mothers' perinatal depression.

Economic impacts linked to infant diarrhoea referred to the costs for healthcare and related expenditure as borne by families in Pakistan (Rheingans et al., 2012), and we multiplied the cost per child with diarrhoea by the additional number of children expected to have diarrhoea linked to depression in the first year postpartum. Since diarrhoea episodes last for a very short while and there is no infant-specific disability weight for diarrhoea, we did not calculate DALYs for this adverse outcome.

Impacts linked to child wasting and socio-emotional development problems, referred to DALYs only since there was no evidence that would have allowed us to attach healthcare-related expenditure or productivity losses to these outcomes. Since the link between perinatal depression and child socio-emotional development problems had been established only for those exposed to persistent maternal depression, we also only applied the disability weights to the estimated proportion of children exposed to persistent maternal depression. To calculate DALYs linked to the two outcomes, disability weights from the Global Burden of Disease study were multiplied by the additional number of children affected by wasting or by socio-emotional development problems. The disability weight for wasting was taken directly as reported in the source whilst for socio-emotional development problems we calculated a weighted average of disability weights for moderate depression and anxiety. As described above a 0.5 GDP value was applied to one DALY. In line with international evidence showing the persistence nature of child mental health problems for this population (Matijasevich et al., 2015; O'Donnell et al., 2014; Pearson et al., 2013; Rajyaguru et al., 2021; Verkuijl et al., 2014), we assumed that socio-emotional development problems last throughout the whole child- and adulthood period. The same assumption was made for wasting.

The economic impacts of stunting attributable to perinatal depression are known to be substantial (Smith Fawzi et al., 2019). This is based on evidence that stunting leads to lower school achievements and losses in income. We estimated income losses linked to stunting based on an annual decrement in earnings linked to stunting, which we applied to the number of children affected by stunting because of perinatal depression. The annual decrement was derived from the 2017 Pakistan World Food Programme report (WFP, 2017) which draws on previous

research (Grantham-McGregor et al., 2007) but we made a distinction between men’s and women’ income and income for manual versus service sector employees. We calculated a weighted average of an income decrement for a child with stunting which consider the much lower labour force participation rate of women as well as their much lower income when employed in a manual job. The income decrement was applied to the additional number of children with stunting due perinatal depression over the child-and adulthood period starting from when the child is 16 years (which is the assumed average age when a person enters the labour market). There is currently no disability weight for stunting so DALYs were not calculated for this outcome. Similarly, there is no evidence on the impact on healthcare-related expenditure, so this cost was not included in the model.

2.3. Sensitivity analysis

In sensitivity analysis, we included additional economic impacts, which are linked to women’s suicide during the perinatal period. This was done to account for depression as important risk factor for suicide (Bachmann, 2018). DALYs were estimated based on a suicide rate of 3.1 per 100,000 in the general population of women in Pakistan (taken from World Bank data) and a weight for years of life lost for someone dying during mid-life (taken from the Global Burden of Disease study). Because of complicated legal and social factors, which are strongly exacerbated in LMICs, identifying accurate suicide rates is notoriously difficult for this population (Fuhr et al., 2019) and this the figure is likely to underestimate true numbers substantially. A lack of data prevented us from including impacts on fathers and wider family and community in the sensitivity analysis.

3. Results

Our findings are shown in Table 3. On left side of the Table 3 the total costs of perinatal depression and anxiety, in the absence of scaled-up treatment, are presented in the form of the average cost per woman giving birth, as well as the total cost across the population of women who were pregnant in 2017. We estimated total costs at USD 6.2 billion, using the method described above. Values reflect present (i.e., discounted) values of the costs as they occurred over the lifetime for the hypothetical 2017 cohort of women and the children, they gave birth to in that year. As described above, this referred to a time horizon of ten years for the women’s cohort and of 40 years for the children’s cohort. DALYs (which are converted into US dollars) only represent years lost due to disability and did not include years of life lost due to death linked to depression or anxiety, such as through suicide. The right side of Table 3 show the results from sensitivity analysis, in which the costs of

**Table 3**  
Costs of perinatal depression and anxiety per woman giving birth and per cohort of women giving birth (based on 2017 data, in USD), findings from base case and sensitivity analysis.

	Findings from base case: costs of perinatal depression and anxiety		Findings from sensitivity analysis: costs of perinatal depression, anxiety & suicide	
	Per woman giving birth	Per cohort in 000's	Per woman giving birth	Per cohort in 000's
<b>Mother</b>				
DALY loss	2312	14,315,719	2342	14,383,706
Income loss	61	360,953	61	360,953
<b>Child</b>				
DALY loss	243	1,442,742	243	1,442,742
Income loss	64	380,936	64	380,936
Out-of-pocket expenditure	0.6	3516	0.6	3516
<b>Total cost (mother + child)</b>	<b>2280</b>	<b>16,503,866</b>	<b>2692</b>	<b>16,571,854</b>

suicide during the perinatal period were added to the costs of perinatal anxiety and depression.

Our findings presented in Table 3 show the high-cost impacts of depression and anxiety during the perinatal period for both mothers and children. The total cost of these conditions was USD 16.5 billion for the cohort of women giving birth in 2017 and USD 2680 per woman giving birth. The largest proportion of costs referred to quality-of-life losses due to disability (USD 15.8 billion). Productivity losses were USD 0.7 billion and out-of-pocket expenditure linked to cost for infant diarrhoea in the year postpartum were USD 3.5 million. Whilst many quality-of-life losses (91 %) referred to mothers, productivity losses referred equally to women and children. When the costs of maternal suicide were included, the total costs increased to USD 16.6 billion.

4. Discussion

Whilst the economic costs of perinatal mental health problems have been established in a few countries now, including (higher) middle-income countries (Bauer et al., 2022a; Bauer et al., 2022b), this is the first study which provides a cost estimate for a lower middle income country. In comparison with findings on costs from Brazil and South Africa, this study shows that the total cost is much higher: The cost in Pakistan is USD 6.2 billion, USD 4.9 billion in Brazil and USD 2.8 billion in South Africa. However, when looking at the cost per woman giving birth, the picture changes: The cost is USD 2680 in Pakistan, which is higher than the cost in Brazil (USD 1700) but lower than the cost in South Africa (USD 2800).

4.1.1. What explains the (high) costs?

Overall, the high cost of perinatal mental health problem is largely due to the health-related quality-of-life losses, measured in monetary terms. The high total cost at a country-level is explained by the very high birth rate and high prevalence of perinatal depression and anxiety in Pakistan. In comparison with country-level costs in Brazil and South Arica, costs linked to health-related quality-of-life losses are higher in Pakistan whereas costs linked to productivity losses and healthcare-related expenditure are lower. Two contextual factors are important to consider when interpreting these costs: (1) the role of *gender inequity* and (2) the *lack of universal health coverage*. Women’s mental health problems are strongly correlated with risk factors related to gender, such as domestic violence, son preference, role restrictions around housework and infant care (Sikander et al., 2019b), which, in combination, exacerbate the negative impact on mother and child (Fisher et al., 2013). Rates of emotional, physical and sexual abuse during pregnancy and after giving birth have been found to affect more than half of women in certain regions (Ali et al., 2011). The low costs linked to productivity losses found in our study reflect a low likelihood that women are employed as well as a low income of women in employment. Thus costs, high in terms of health-related quality-of-life losses and low in terms of productivity losses, reflect the stark gender inequities prevailing in the country. In addition, compared to higher middle-income countries, public sector support in form of healthcare to mitigate any of these health impacts is almost non-existent for most people. Universal health coverage, which has an important role in improving maternal and child health and development, and offers opportunities for addressing mental health as part of an integrated approach towards health, has been only recently introduced in some regions (Farooq et al., 2022). Inflation and natural disasters have presented major challenges for sustaining and scaling a system that provides basic healthcare.

4.1.2. What are the strengths and limitations of the study?

A strength of the study is that the methodology has been employed before in other countries thus increasing comparability of findings

(Bauer et al., 2022a; Bauer et al., 2022b). By taking a societal, long-term and intergenerational perspective including costs as they occur because of adverse impacts on mothers and children, the study follows a methodology recommended by international organisations such as the WHO (Chisholm et al., 2016; WHO, 2003). The main limitations of this study relate to gaps in evidence and subsequent assumptions that needed to be made. Various costs linked to adverse impacts could not be included in the analysis due to a lack of data. This includes the burden of infant and child mortality linked to perinatal depression (Jacques et al., 2019), due to poor infant nutrition and diarrhoea (Rahman et al., 2007b; Rahman et al., 2004), as well as the impact on fathers and siblings (Conde et al., 2022; Howard and Khalifeh, 2020). Other evidence gaps include data on prevalence and impacts of other maternal mental health problems at this time, for example obsessive-compulsive disorder and psychosis, and impacts of perinatal mental health problems on healthcare expenditure, including those linked to attempted suicide by mothers, or infant hospitalisations. We did not include findings regarding the relationship between (chronic) postnatal depression and pre-term or low-birth weight as a predictor of cognitive problems or cognitive problems themselves since findings concerning the nature and strength of this relationship have been inconsistent (Ali et al., 2013; De Oliveira et al., 2019; Husain et al., 2014; Rahman et al., 2007a). The study only considers impacts as they have been identified for two diagnosable mental disorders; it is likely that this underestimates impacts linked all disorders and to stress and symptoms not reaching the threshold of a diagnosis. Thus, the results from this study will inevitably be conservative as many of the likely high costs could not be measured. It is important to note that whilst the evidence used to inform cost impacts of perinatal mental health problems comes from studies that considered confounding factors, it cannot be excluded that some impacts relate to other risk factors.

#### 4.1.3. Why is the study important, and what further research is needed?

Estimating the costs of perinatal mental health problems in a country can be a powerful catalyst for change. We applied a methodology that can be used for costing studies in other countries. Economic evidence is highly context-specific (Knapp and Wong, 2020), and this study provides country-specific estimates of the costs of perinatal mental health problems using national or regional evidence. Since the prevalence and impacts of perinatal mental health problems on mothers and children varies strongly between countries, decision makers might be more readily convinced by national evidence. Therefore, more costs studies are needed for different countries, which would also facilitate global burden estimates and comparisons between countries. Ideally, costs studies are updated on an ongoing basis so that they reflect latest demographic and economic changes, for example as they occur during economic or health crises or emergencies, and growing availability of data. Furthermore, especially for large countries and countries with stark differences in socio-demographic, economic and political factors between regions, it will be useful to develop cost estimates at regional levels.

#### 4.1.4. What should happen next?

Gender-based roles, violence, and stigma are a major contributors in the causation and chronicity of maternal mental health issues as well as major barriers to access to treatment (McNab et al., 2022). Those factors together with a lack of investment in maternal and mental healthcare as well as in poverty alleviation to address social determinants of (mental) health, including women's empowerment and education makes progress in this area difficult (Khan et al., 2009). Evidence from a long-term follow-up study of the Thinking Healthy Programme in Pakistan shows that investing into maternal mental health during the perinatal period can empower women financially (Baranov et al., 2020), highlighting importance of addressing the mental health and poverty cycle (Lund et al., 2010). Since Pakistan has the highest burden of maternal, foetal and child mortality globally with an estimated 30,000 women

dying each year from pregnancy-related causes (Agha, 2018), effective action requires mental health to be incorporated alongside improved physical healthcare in the country's efforts to meet strategic development goals. As numbers of healthcare facilities currently increase, more women receive their recommended health checks and antenatal care and improvements are made with regards to workforce skills and integrated working (e.g., lady health workers supported by community midwives), there are opportunities for embedding mental health into service improvement and workforce development initiatives.

That major positive change is possible has been highlighted by the recent introduction of the President's Programme for Mental Health (Mirza and Rahman, 2019), which was a direct response to the calls made by the Lancet Commission on Global Mental Health and Sustainable Development (Patel et al., 2018), which included world-leading mental health researchers. In line with guidance from the WHO, the new programme focuses on implementing and scaling early-years interventions that promote mental health and prevent mental illness, such as the Thinking Healthy Programme. By utilising technologies in the training and delivery of interventions, the government plans to increase access to mental health in a manner that is potentially cost-effective and affordable. There is an important role for researchers to work collaboratively with government and other stakeholders to generate economic evidence that can inform resource allocations for the integration of perinatal mental health into maternal and child healthcare and promote sustained investment.

<sup>1</sup><https://knoema.com/atlas/Pakistan/Birth-rate>.

<sup>2</sup><https://www.populationpyramid.net/pakistan/2017/>.

<sup>3</sup>[https://data.unicef.org/resources/data\\_explorer/unicef\\_f/?ag=UNICEF&df=GLOBAL\\_DATAFLOW&ver=1.0&dq=.MNCH\\_MMR+MNCH\\_LTR\\_MATERNAL\\_DEATH+MNCH\\_MATERNAL\\_DEATH..&startPeriod=2016&endPeriod=2021](https://data.unicef.org/resources/data_explorer/unicef_f/?ag=UNICEF&df=GLOBAL_DATAFLOW&ver=1.0&dq=.MNCH_MMR+MNCH_LTR_MATERNAL_DEATH+MNCH_MATERNAL_DEATH..&startPeriod=2016&endPeriod=2021).

<sup>4</sup><https://cloud.ihme.washington.edu/index.php/s/2JLHyPXCnZQyd9Q?path=%2FLife%20Tables>.

<sup>5</sup><https://data.worldbank.org/indicator/SH.STA.SUIC.FE.P5?locations=PK>.

<sup>6</sup>Ibid.

<sup>7</sup><https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=PK>.

<sup>8</sup><https://www.usinflationcalculator.com/>.

<sup>9</sup><https://cloud.ihme.washington.edu/index.php/s/2JLHyPXCnZQyd9Q?path=%2FLife%20Tables>.

<sup>10</sup><https://www.thelancet.com/action/showFullTableHTML?isHtml=true&tableId=tbl2&pii=S2214-109X%2815%2900069-8>.

<sup>11</sup><https://www.thelancet.com/action/showFullTableHTML?isHtml=true&tableId=tbl2&pii=S2214-109X%2815%2900069-8>.

<sup>12</sup>[https://www.pc.gov.pk/uploads/report/Economic\\_Consequences.pdf](https://www.pc.gov.pk/uploads/report/Economic_Consequences.pdf).

#### CRedit authorship contribution statement

**Annette Bauer:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Writing – original draft, Writing – review & editing. **Martin Knapp:** Funding acquisition, Methodology, Resources, Supervision, Writing – review & editing. **Mohsin Alvi:** Methodology, Validation, Writing – review & editing. **Nasim Chaudhry:** Methodology, Validation, Writing – review & editing. **Alain Gregoire:** Conceptualization, Funding acquisition, Project administration, Validation, Writing – review & editing. **Abid Malik:** Methodology, Validation, Writing – review & editing. **Siham Sikander:** Methodology, Validation, Writing – review & editing. **Kiran Tayyeba:** Methodology, Validation, Writing – review & editing. **Ahmed Waqas:** Methodology, Validation, Writing – review & editing. **Nusrat Husain:** Methodology, Project administration, Resources, Validation, Writing – review & editing.

## Declaration of competing interest

None.

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