Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis

Pamela J Surkan \textsuperscript{a}, Caitlin E Kennedy \textsuperscript{a}, Kristen M Hurley \textsuperscript{b} & Maureen M Black \textsuperscript{b}

\textsuperscript{a} Department of International Health, Johns Hopkins Bloomberg School of Public Health, 615 N Wolfe Street, Baltimore, MD, 21205, United States of America (USA).
\textsuperscript{b} Department of Pediatrics, University of Maryland School of Medicine, Baltimore, USA.

Correspondence to Pamela J Surkan (e-mail: psurkan@jhsph.edu).

\textit{(Submitted: 14 March 2011 – Revised version received: 14 April 2011 – Accepted: 18 April 2011 – Published online: 26 May 2011.)}


Introduction

Research in developing countries suggests that poor maternal mental health, in particular maternal depression, may be a risk factor for poor growth in young children.\textsuperscript{1} In addition, the risk of depression in women is approximately twofold higher than in men\textsuperscript{2} and women are particularly prone in the postpartum period because of hormonal changes associated with childbirth and stressors associated with parenting.\textsuperscript{3, 4} The combination of women’s vulnerability to depression, their responsibility for childcare and the high prevalence of maternal depression in developing countries\textsuperscript{5} means that maternal mental health in these countries could have a substantial influence on growth during childhood.

Childhood growth is a key indicator of child health and nutritional status. According to recent estimates from developing countries, stunting and underweight have an overall prevalence of 32% and 20%, respectively.\textsuperscript{6} Inadequate growth during childhood can result in reduced adult stature, low educational performance, reduced economic productivity, impaired work capacity and heightened disease risk.\textsuperscript{7–12} Rapid physical growth and development occur in early life when infants are dependent on the primary caregiver for their social and nutritional needs,\textsuperscript{13} which makes young children vulnerable to the effects of their caregivers’ mental health problems.
Recent research on the relationship between maternal depressive symptoms and child stunting or underweight has produced inconsistent results. Two descriptive reviews have provided a summary of research findings but, to the best of our knowledge, no quantitative synthesis of research results has been produced. Our study goals were to review systematically the literature on maternal depression and childhood growth in developing countries and to summarize and compare any associations found across populations using meta-analytical techniques.

Methods

The study used standard methods for systematic reviews and meta-analyses in accordance with PRISMA (Preferred reporting items for systematic reviews and meta-analyses) and MOOSE (Meta-analysis of observational studies in epidemiology) statements.

Study inclusion criteria

A study was included in the meta-analysis if it: (i) quantitatively assessed the relationship between maternal depression or depressive symptoms (or mental disorders in which depression was a major component) and child growth using an odds ratio (OR) or included data that could be used to calculate an OR; (ii) was published in a peer-reviewed journal up until April 2010; and (iii) was not an intervention study. We restricted our search to developing countries but applied no other population or language restrictions.

Maternal depression and childhood growth can both be assessed using several methods. Depression can be diagnosed through standardized diagnostic interviews, such as the Structured Clinical Interview of the Diagnostic and statistical manual of mental disorders, 4th edition or the interview for the Schedules for Clinical Assessment in Neuropsychiatry, while depressive symptoms can be assessed directly using a questionnaire, such as the Edinburgh Postnatal Depression Scale or assessed as a major component of mental disorders using, for example, the World Health Organization (WHO) Self-Reporting Questionnaire.

Childhood growth can be quantified in terms of weight-for-age or height-for-age. Underweight and stunting are commonly defined using WHO criteria: more than two standard deviations (SDs) below the mean weight-for-age and the mean height-for-age, respectively (i.e. a z-score < −2). In this analysis we also included studies with more relaxed or more stringent criteria. Overall, the studies included in the analysis measured maternal depression or depressive symptoms and childhood growth in a variety of ways.

Search strategy and study selection

The following online computer databases were searched for studies on maternal depression and child growth: PubMed, PsycINFO, CINAHL Plus, Web of Science, SCOPUS and EMBASE. Medical Subject Heading (MeSH) terms in PubMed were used to identify a string of search terms that were applied in the six databases: (“mother” OR “maternal”) AND (“depression” OR “depressive disorder” OR “mental health”) AND (“child” OR “infant”) AND (“nutritional disorders” OR “growth disorders” OR “nutritional status” OR “body size”). Where available, full-text searches and explosion-of-terms searches were carried out. In an explosion-of-terms
search, the initial search terms are linked to a web of similar search terms provided by the database. A search of secondary references was conducted by scanning the reference lists of relevant articles and by cross-referencing with previous reviews on the topic. In addition, experts in the field were contacted to identify additional citations.

Studies that were clearly not relevant were excluded by reviewing their titles and abstracts. The remaining studies were then read in full by at least two authors of this study and selected for inclusion in the analysis by consensus. Articles identified as relevant by both authors were invariably included; those considered relevant by only one author were discussed among all authors to assess their suitability for inclusion.

Data extraction

A systematic coding form was used to record each study's objective, location, population, design and sample size; the children's ages; exposure and outcome measures; confounding variables; and the study's method of analysis, results, conclusions and limitations. Discrepancies in coding were resolved by consensus. The rigour of each study was evaluated using an adaptation of the Newcastle–Ottawa Scale for assessing the quality of nonrandomized studies in meta-analyses. Each study was classified by design as either a longitudinal cohort, case–control or cross-sectional study and each was assessed to determine if it satisfied four criteria: (i) the women and children were representative of the community studied; (ii) the response rate (i.e. the percentage of individuals in the selected population sample who agreed to participate in the study and completed follow-up) was 80% or higher; (iii) a diagnostic measure of depression had been used; and (iv) the results had been adjusted for at least two confounding variables.

Meta-analysis

We converted different estimates of effect size to the common metric of an OR since most studies compared two groups and reported dichotomous outcomes. However, three studies reported outcomes as continuous variables. We converted data from the first of these three studies to ORs using Comprehensive Meta-Analysis V2.2 software (Biostat Inc., Englewood, United States of America). For the other two studies, the original authors either re-analysed the primary data to generate ORs or provided data for us to calculate them. We used standard meta-analytical methods to estimate the standardized effect sizes using the inverse variance approach and random effects models. The heterogeneity of the different studies' findings was assessed using the Q-statistic. Publication bias was assessed from funnel plots of the standard error against the log OR using both Begg and Mazumdar's rank correlation test and Egger's test of the intercept to determine statistical significance.

Meta-analysis was conducted for the two outcomes of interest – underweight and stunting – using weight-for-age and height-for-age as variables, respectively. When different follow-up times were used in a given study, we used the longest follow-up time. If a study assessed depression at several time points, we used the assessment closest to delivery. We conducted subanalyses of studies that used strict criteria of underweight and stunting (i.e. a weight-for-age and height-for-age z-score < −2 or a weight-for-age and height-for-age below the fifth percentile given in WHO...
and Centers for Disease Control and Prevention growth charts, studies that used a measure of depression or depressive symptoms but not of mental disorders of which depression was a major component, and longitudinal studies.

The population attributable risk (PAR) for underweight and stunting was calculated on the basis of four studies that were selected because they reported significant findings and a prevalence of maternal depressive symptoms near the lower or higher end of the range. For each study, the overall relative risk (RR) of child underweight was calculated using the adjusted OR obtained in that study and the prevalence of underweight in children with depressed mothers. The RR for stunting was similarly obtained. These RRs were then used to calculate the PARs.

Results

The computer database search yielded 312 citations and two additional records were identified through other sources. After removing duplicates, 210 citations were available for assessment. The initial screening of titles and abstracts identified 51 citations that potentially met the inclusion criteria. After the texts were reviewed in full, 14 articles reporting on 17 separate studies met the inclusion criteria.

The studies came from several regions: four from Africa, six from South America and the Caribbean, six from southern Asia and one from south-eastern Asia. Although the studies covered a mix of urban and rural settings, most were carried out among participants with a low socioeconomic status (Table 1, available from: http://www.who.int/bulletin/volumes/89/8/11-088187).

<table>
<thead>
<tr>
<th>Table 1. Studies included in systematic review of maternal depression and child growth in developing countries, 1996–2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>html, 24kb</td>
</tr>
</tbody>
</table>

Seven studies were cross-sectional, six were case–control studies and four used a longitudinal cohort design. Nine of the 17 studies were based on representative community samples, four used a diagnostic measure of depression and 15 controlled for at least two confounding variables (Table 2, available from: http://www.who.int/bulletin/volumes/89/8/11-088187). In addition, 10 of the 13 studies that reported a response rate had a rate ≥ 80%.

<table>
<thead>
<tr>
<th>Table 2. Quality of studies included in systematic review of maternal depression and child growth in developing countries, 1996–2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>html, 10kb</td>
</tr>
</tbody>
</table>

Most studies used the WHO criterion of a weight-for-age or height-for-age z-score < −2 to identify underweight or stunting, respectively. All 17 studies assessed underweight. They used a variety of measures: nine used a weight-for-age z-score < −2; three used a weight-for-age below the fifth percentile given in WHO and Centers for Disease Control and Prevention growth charts; one used a weight-for-age below the equivalent 10th percentile; one used a weight-for-age below the third percentile; one used a weight-for-age of 50% to 80% of the expected value; one used a weight-for-age < 75% of the expected value and one used the combined measure of a
current weight-for-age z-score < −1.5 plus a history of a weight-for-age z-score < −2. Twelve studies assessed stunting: nine used a height-for-age z-score < −2; two used a height-for-age below the fifth percentile given in WHO and Centers for Disease Control and Prevention growth charts; and one used a height-for-age below the 10th percentile.

Studies used a wide range of indicators of maternal depression. Four used a diagnostic measure of depression based on either the Diagnostic and statistical manual of mental disorders (n = 3) or the International classification of diseases (n = 1); five used a measure of depressive symptoms such as the Edinburgh Postnatal Depression Scale (n = 2) or the Center for Epidemiologic Studies Depression Scale (n = 3); and eight used a measure of mental disorders such as the 20-item WHO Self-Reporting Questionnaire (n = 7) or the Adult Psychiatric Morbidity Questionnaire (n = 1). Some deviations from the standard use of these measures were observed: for example, one study analysed only items related to depression on the Self-Reporting Questionnaire.

Overall, most studies found a null or marginally significant relationship between maternal depression and poor child growth. However, the direction of the association was always the same: the worse the depression, the greater the growth deficit. Only 6 of the 17 studies on underweight and 5 of the 12 on stunting found a statistically significant relationship with maternal depression.

**Underweight meta-analysis**

The meta-analysis of the relationship between maternal depression and child underweight included effect size estimates from 17 studies (Fig. 1), covering a combined study population of 13,923 mother and child pairs. The pooled data showed a moderate, statistically significant relationship between maternal depression and underweight (OR: 1.5; 95% confidence interval, CI: 1.2–1.8). The heterogeneity of the findings was substantial (Q-statistic: 39.94; P = 0.001) across the studies. The funnel plot showed a statistically significant relationship between the standard error and the log OR using both tests of significance, an indication of a publication bias against small studies reporting non-significant findings.

![Fig. 1. Effect of maternal depression on child underweight reported in studies from developing countries included in meta-analysis, 1996–2010](image-url)

Fifteen studies used a strict definition of underweight: a weight-for-age z-score < −2 or a weight-for-age at or below the fifth percentile given in WHO and Centers for Disease Control and Prevention growth charts. Meta-analysis of these studies showed that the relationship between maternal depression and underweight (OR: 1.5; 95% CI: 1.2–1.8) remained similar to that in the meta-analysis of all studies and the heterogeneity persisted (Q = 37.83, P = 0.001). When the meta-analysis was restricted to the nine studies that used measures of depression or depressive symptoms, the relationship between maternal depression and underweight strengthened and remained statistically significant (OR: 1.7; 95% CI: 1.2–2.4), and the findings remained heterogeneous (Q = 18.70; P = 0.017). Finally, when the meta-analysis was restricted to the four longitudinal cohort studies, the relationship strengthened further (OR: 2.2; 95% CI: 7.1–15.3).
WHO | Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis

CI, confidence interval; OR, odds ratio.

Note: The position of the square indicates the OR for the relationship between maternal depression and child underweight for the study and its size is proportional to the weight of that study in the meta-analysis. The length of the line represents the 95% CI for the OR. The diamond shape indicates the pooled OR for all studies included in the meta-analysis.

1.5–3.2) and high homogeneity was noted (Q: 2.47; P = 0.48).

Stunting meta-analysis

The meta-analysis of the relationship between maternal depression and child stunting included effect size estimates from 12 studies (Fig. 2) with a combined study population of 13,214 mother and child pairs. The pooled data showed a moderate, statistically significant relationship between maternal depression and stunting (OR: 1.4; 95% CI: 1.2–1.7). Substantial heterogeneity across studies was noted (Q: 26.85; P = 0.005). The relationship between the standard error and the log OR in the funnel plot was statistically significant using both tests of significance.

Fig. 2. Effect of maternal depression on child stunting reported in studies from developing countries included in meta-analysis, 1996–2010

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>OR and 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adewuya et al. 2008</td>
<td>Nigeria</td>
<td></td>
</tr>
<tr>
<td>Anoop et al. 2004</td>
<td>India</td>
<td></td>
</tr>
<tr>
<td>Baker-Henningsham et al. 2003</td>
<td>Jamaica</td>
<td></td>
</tr>
<tr>
<td>Black et al. 2009</td>
<td>Bangladesh</td>
<td></td>
</tr>
<tr>
<td>Carvalheas et al. 2002</td>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>de Miranda et al. 1996</td>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>Harpham et al. 2005</td>
<td>Ethiopia</td>
<td></td>
</tr>
<tr>
<td>Harpham et al. 2005</td>
<td>India</td>
<td></td>
</tr>
<tr>
<td>Harpham et al. 2005</td>
<td>Peru</td>
<td></td>
</tr>
<tr>
<td>Harpham et al. 2005</td>
<td>Viet Nam</td>
<td></td>
</tr>
<tr>
<td>Patel et al. 2003</td>
<td>India</td>
<td></td>
</tr>
<tr>
<td>Rahman et al. 2004 (urban)</td>
<td>Pakistan</td>
<td></td>
</tr>
<tr>
<td>Rahman et al. 2004 (rural)</td>
<td>Pakistan</td>
<td></td>
</tr>
<tr>
<td>Santos et al. 2010</td>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>Stewart et al. 2008</td>
<td>Malawi</td>
<td></td>
</tr>
<tr>
<td>Surkan et al. 2008</td>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>Tomlinson et al. 2006</td>
<td>South Africa</td>
<td></td>
</tr>
<tr>
<td>Combined estimate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CI, confidence interval; OR, odds ratio.

Note: The position of the square indicates the OR for the relationship between maternal depression and child underweight for the study and its size is proportional to the weight of that study in the meta-analysis. The length of the line represents the 95% CI for the OR. The diamond shape indicates the pooled OR for all studies included in the meta-analysis.

Eleven studies used a strict definition of stunting: a height-for-age z-score ≤ −2 or a height-for-age at or below the fifth percentile given in WHO and Centers for Disease Control and Prevention growth charts. Meta-analysis of these studies showed that the relationship between maternal depression and stunting (OR: 1.4; 95% CI: 1.2–1.7) remained similar to that in the meta-analysis of all studies and the heterogeneity persisted (Q = 25.00; P = 0.005). When the meta-analysis was restricted to the seven studies that used measures of depression or depressive symptoms, the relationship between maternal depression and stunting strengthened (OR: 2.0; 95% CI: 1.4–2.9) and homogeneity was noted (Q: 11.55; P = 0.073). Finally, when the meta-analysis was restricted to the four longitudinal cohort studies, the relationship was strengthened slightly (OR: 2.0; 95% CI: 1.0–3.9) and modest heterogeneity was found (Q: 9.30; P = 0.026).

Population attributable risk

The PAR for underweight was calculated for two studies: the study of Patel et al., which reported a low prevalence of depressive symptoms, and that of Surkan et al., which reported a high prevalence of depressive symptoms and a low prevalence of underweight (Table 3). The PAR in these studies was 22.5% and 29.4%, respectively.

Table 3. Effect of maternal depressive symptoms on child underweight or stunting in selected studies from developing countries, 1996–2010

Similarly, the PAR for stunting was calculated for two studies: the study of Patel et al., which reported a relatively low prevalence of depressive symptoms, and that of Black et al., which reported a high prevalence (Table 3). The PAR was 27.5% and 27.0% for the two studies, respectively.

Discussion

Our analysis revealed a positive and significant association between maternal depression or depressive symptoms and impaired child growth in developing countries. Our meta-analysis of 17 studies, based on adjusted estimates when possible, showed that the children of depressed mothers were at an increased risk of both underweight and stunting: the combined OR was approximately 1.4. This finding emerged after combining the results of studies that had very different designs, came from a wide range of locations and included children of different ages.

Because the findings varied across studies, we conducted subanalyses to explore how they might be altered by applying stricter definitions of maternal depression and of child growth outcomes or by restricting the analysis to longitudinal studies alone. When strict definitions of underweight and stunting were used, the magnitude of the pooled estimate for the relationship between maternal depression and inadequate growth was almost unaffected. When a strict definition of maternal depression was...
used, the OR for poor child growth increased. Finally, when the analysis was restricted to longitudinal studies, the pooled results showed strong associations with maternal depression: the ORs for underweight and stunting were approximately 2.2 and 2.0, respectively. However, because this subanalysis was based on only four longitudinal studies, its findings must be considered preliminary and need to be confirmed by more prospective studies.

Using data from four selected studies, we estimated a PAR for inadequate growth in the range of 23–29%. However, this estimate is imprecise because the four studies used different measures of depressive symptoms and controlled for different confounding variables.

The mechanisms responsible for the association between maternal depression and inadequate child growth are not clear. Nor is it known whether these mechanisms vary between countries and regions. Cultural differences in caregiving and feeding and the degree of food insecurity may all play a role. Previous research suggests that maternal depression is associated with compromised parenting behaviour, nonresponsive caregiving practices and a lower likelihood or shorter duration of breastfeeding. The time at which child growth is measured may also influence the observed association with maternal depression: Stewart et al. hypothesized that, because caregivers other than the mother often become more involved after weaning, the effect of maternal depression may be more pronounced in the immediate postpartum period. Of the articles included in the meta-analysis, only two evaluated the influence of other factors on the relationship between maternal depressive symptoms and child growth. Black et al. found that the effect of maternal depressive symptoms on infant height-for-age was partially mediated by the home environment, whereas maternal perceptions of infant temperament had no effect. Surkan et al. found no evidence that the relationship between maternal depressive symptoms and stunting was mediated by parenting self-efficacy, which reflects the belief parents have in their ability to care for their children. Future research should examine the mechanisms linking maternal depressive symptoms and child growth.

The review was limited by the modest number of studies included: only 17 were available overall and only four were included in the subanalysis of longitudinal studies. Additionally, the studies varied in quality, as reflected in the way they adjusted for potential confounding variables: one study adjusted for covariates individually while another made no adjustments. In some regions, most studies were from the same country; for example, four of the five studies from South America were conducted in Brazil. As in any systematic review, publication bias may have affected our findings; significant findings may have been disproportionately reported in the literature, as suggested by the funnel plots for both underweight and stunting in the meta-analysis. Consequently, our meta-analysis may have overestimated the association between maternal depression and inadequate child growth. However, this is unlikely because most studies reported null results.

Although the definitions of underweight and stunting differed between the studies, height and weight were measured, not self-reported. In contrast, the diagnosis of maternal depression and its severity may have been less precise owing to the use of depression scales that were not validated in the...
study populations, particularly since different cultures have differing concepts of depression. In addition, there may be a reciprocal relationship between maternal mental health and child health given that a child’s poor health could generate depressive symptoms in the mother. Subsequent research should investigate the possibility that poor child growth increases the risk of maternal depression.

Estimates of the incidence of depression in women in developing countries vary widely, from 15–57%. Depression in these women has a complex etiology involving factors as diverse as poverty, marital conflict, domestic violence and lack of control over economic resources. However, recent studies suggest that depression can be affordably treated in developing countries. Varied interventions, such as social support, group therapy or home visits, which are often delivered by lay community workers, have led to a reduction in maternal depressive symptoms in a range of countries, including China, Jamaica, Pakistan, South Africa and Uganda. Interventions aimed at improving parenting and the mother–infant relationship have been effective in reducing depressive symptoms in postpartum women, which suggests that maternal depression is modifiable. Our findings indicate that a reduction in the incidence of maternal depressive symptoms in developing countries would not only have a beneficial effect on mothers, but would also improve child growth substantially, and this could in turn influence the children’s future health, development and socioeconomic status.

Acknowledgements
The authors thank Laurence Magder, Bryan Shaw, Yan Wang and Virginia Tedrow for their assistance with this project.

Competing interests:
None declared.

References:
7. Haas JD, Murdoch S, Rivera J, Martorell R. Early nutrition and later


41. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1977; 1: 385-


