Maternal depression and infant growth and development in British Pakistani women: A Cohort study

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Maternal depression and infant growth and development in British Pakistani women: A Cohort study

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ABSTRACT

Introduction: Perinatal depression has been found to be a strong and independent risk factor for poor child growth and development in low-income South Asian populations. We aimed to study if there was a similar association in first and second generation British women of Pakistani origin.

Methods: We conducted a prospective cohort study in the North-West of England in areas with high density of Pakistani-origin population. Seven hundred and four physically healthy women were assessed in two phases (screening and detailed assessment of high scorers and a proportion of low scorers) during their third trimester of pregnancy to obtain at birth a cohort of 63 infants of depressed mothers and 173 infants of psychologically well mothers. All infants were weighed and measured at birth and 6 months, and their development was assessed using the Bayley's Scales of Infant Development (BSID-III).

Results : There was no difference in the birthweight or weight and height at 6 months of infants of depressed mothers vs. infants of psychologically well mothers. The only significant difference between the two groups was in the infants' adaptive behaviour; infants of depressed mothers scored significantly lower than infants of psychologically well mothers (mean difference 4.6; t= 2.81, df 195; p=0.006). The association remained significant after adjustment for sociodemographic factors by multivariate analyses.

Conclusions: Prenatal depression is not associated with impaired growth in this sample of British Pakistani women. There is however an association of prenatal depression with parent-reported problems in the infants' adaptive behaviour. Further research is needed to understand various pathways through which maternal depression affects infant outcomes in low- and high-income settings.

Article Summary

Article Focus:

- In South Asian countries, maternal depression has been identified as a strong risk factor for undernutrition and stunted growth in infants.
- Maternal depression has also been associated with insecure attachment styles and deficiencies in cognitive development.
- In a longitudinal cohort design, this article examines the potential association between prenatal maternal depression and infant development, in a sample of British women of Pakistani origin.

Key Messages:

- The present sample of British Pakistani women shows lower rates of depression as compared to the women living in Pakistan.
- Prenatal depression was not found to be associated with infant undernutrition or stunted growth. On the other hand, there was a significant association between prenatal depression and the infant's adaptive behaviour, as measured by BSID-III.

Strengths and Limitations of this study

- The longitudinal prospective cohort design employed in this study was well suited to address the research question. Engaging the prospective sample through culturally appropriate channels and informants helped to achieve high follow-up rates.
- Due to resource and time limitations, the required sample size for the group of depressed women could not be achieved.

INTRODUCTION

Recent meta-analyses show that maternal depression is a risk factor for low birth weight and early childhood underweight and stunting in low and middle income countries.[1;2] Maternal depression appears to be a particularly strong and independent risk factor for infant under nutrition in South Asian countries,[3] where 30-40% of all children under 5 are underweight or stunted.[4] Our longitudinal cohort study in rural Pakistan[5] found that the relative risks at 6 months for infants of mothers who were depressed during pregnancy being underweight or stunted (weight- or length- for-age z-score < -2SD) were 4.0 (95%CI 2.1-7.7), and 4.4 (95%CI 1.7-11.4) respectively. These associations remained significant after adjustment for confounders. The population attributable risk (PAR) estimate indicated that if the Pakistani infant population was unexposed to maternal depression, 30% (95% CI 19%-41%) fewer children would be stunted. Furthermore, studies show that infants of depressed mothers are less likely to be securely attached and more likely to have behavioural problems and poor cognitive development.[6] Globally, maternal depression has been called a major threat to optimal child development and calls have been made to address it at a public health level.[6;7]

Evidence from high income countries is less equivocal.[8] However, most studies have been conducted in the general population. Considering that the rates of maternal depression in British Pakistani women are also higher – a recent population-based study in the North-West of England [9] found depression prevalence in British Pakistani women was 31% compared to 18% in white European women – and given such strong and independent associations with infant under nutrition in South Asia, it would be important to explore its association with poor infant growth and development in this population.

The aim of this study was to systematically investigate the association of antenatal maternal depression and infant growth and other development parameters in a representative community-based sample in the North-West of England, using a longitudinal prospective cohort design.

METHODS

Participants

The study was conducted in North-West England. Subjects were recruited from two maternity hospitals in areas with high density of Pakistani-origin population – Central Manchester Hospital in the City of Manchester and East Lancashire Hospital, in Lancashire. Furthermore, over 80% of the Pakistani-origin women in the study area migrated from the Potohar and Mirpur region of Pakistan, the same area where we conducted our Pakistan studies[10,11,12], allowing a direct comparison between populations that are ethnically similar. From March 2006 to August 2008 all British women of Pakistani origin presenting to these maternity hospitals for their antenatal check-ups, and who consented to take part in the research, were invited to participate. Our definition of ethnicity required a strict 3 from 4 grandparents to share the same ethnic group, and was also self-defined using Census categories. Exclusions were women with multiple pregnancies, diagnosed physical or learning disability, post-partum or other psychosis, and following delivery, infants born prematurely, with congenital deformity, physical or mental handicap.

Measurements

Assessment of maternal depression

Informed written consent was obtained from all participants. A two-phase procedure was used to diagnose depression in the women who consented and met the inclusion criteria. In the first phase, all participating women were administered the Edinburgh Postnatal Depression Scale (EPDS).[13] This is the most widely used tool to screen for probable cases of perinatal depression and has been found to have excellent psychometric properties cross-culturally and in the Pakistani population.[14] All Women scoring over 12 and a 1 in 7 random sample of low scoring women were invited for further assessment of their mental state with a diagnostic interview using the Schedules for Assessment in Neuropsychiatry (SCAN).[15] SCAN is an internationally validated semistructured interview generating International Classification of Diseases, 10th Revision (ICD-10) diagnoses of depressive disorder. All interviews were carried out by trained and experienced clinicians.

Assessment of infant growth and development

Infant growth measurements were carried out using standard anthropometric techniques and equipment.[16] Measurements were carried out at birth, and 6 months postnatal. Growth data were converted into standard deviations (z scores) for weight and length using Epi Info 2002 software (Centers for Disease Control, Atlanta, Ga). Infants were classified as underweight or stunted if their weight-for-age z scores or length-for-age z scores were less than −2, on the basis of National Centre for Health Statistics/World Health Organization reference data.

Bayley Scales of Infant Development -Third Edition (BSID-III) were used to assess infant development .[17] The BSID-III yield composite scores reflecting infants' Cognitive, Language, Motor, Socio-Emotional, and Adaptive Behavioral development. Three of these content domains—Cognitive, Language, and Motor—are assessed by items administered to the child, whereas the Social-Emotional and Adaptive Behavior domains are based on information supplied by the primary caregiver to items contained in a separate questionnaire. A standard score is derived for each scale, with a mean of 100 and a SD of 15. This instrument has excellent psychometric properties, and has been validated on over 1700 children. The BSID-III was administered by a single trained research assistant.

All instruments have been previously adapted for use in the Pakistani population and the researcher doing the assessments was trained by an expert experienced in their use in Pakistani infants.

Assessment of sociodemographic and other factors

Data on selected sociodemographic factors of interest were collected through a specially developed Personal Information Questionnaire (PIQ). The factors included age, marital status, education, any self-reported health problem, whether 1st or 2nd generation immigrant, pregnancy planned or unplanned and number of children.

Sample Size and Statistical Analysis

Assuming the SD of birth weight is 500 grams, a sample of 100 depressed and 100 non-depressed women would give the study 80% power to detect a difference in the mean birth weight between groups of 200 grams at the 5% significance level. Assuming, from previous South Asian data,[18] a correlation coefficient between EPDS score and change in weight of 0.15, an SD of weight change of 400grams and an SD of 5 for EPDS scores, 100 women in each group will allow the study to detect a difference in growth of 20 grams for each 1-unit increase in EPDS score.

Mean differences in birthweight weight-for-age *z* scores and height-for-age *z* scores at 6 months between the exposed group (infants of prenatally depressed mothers) and the nonexposed group (infants of prenatally nondepressed mothers) were analysed using growth indices as continuous measures. Similar analyses were carried out for the Bayley's composite scores in the cognitive, language, motor, socioemotional and adaptive behaviour domains. For each outcome, multiple regression analysis was used to control for the confounding effects of all the variables under study. Pearson correlation was used to examine the association between the EPDS score and the anthropometric outcomes at 6 months for each gender separately.

RESULTS

Fig 1 shows the flow of participants in this study. Altogether 714 women meeting the study criteria were interviewed with the EPDS, of whom 261 (36.6%) scored 12 or more. Of these, 191 (73.2%) went into the main study. Reasons why 70 did not are as follows: the baby was delivered before an interview took place for 30, 2 babies died, 11 mothers refused, 11 were unavailable, 11 could not be contacted and 5 were not asked. A random selection of 67 (14.8%) of the low EPDS scorers were asked for the main interview, and 46 of these (69%) completed interviews. Of the 21 who did not, 3 babies were delivered before the interview, 2 mothers refused, 15 were unavailable, and 1 could not be contacted. Out of the 191 high EPDS scorers, 59 (30.9%) were found to be depressed on the SCAN interview, and 4 out of the 46 low scorers were depressed (8.7%). The weighted prevalence of depression in this group of pregnant Pakistani women was 16.8% (95% confidence interval 14.1% to 19.6%).

Table 1 compares the socio-demographic characteristics between the depressed and non-depressed groups. Women in the depressed group were less likely to be 1st generation Pakistani and more likely to have more than 2 children; they were similar to the non-depressed women in other factors measured.

Table 1: Comparison of socio-demographic factors between depressed and non-depressed women

Socio-demographic factors	**Depressed (n=63) % (n)**	**Not depressed (n=174) % (n)**
1st generation Pakistani	77.8% (49)	81.6% (142)
Educated to A-level or more	54.0% (34)	54. 0% (94)
Married	95.2% (60)	97.7% (170)
Planned pregnancy	42.6% (26)	45.7% (69)
Primagravida	28.2% (19)	28.2% (49)
≥ 2 children	49.2% (31)	41.4% (72)
Marked health difficulty	1.6% (1)	0% (0)
Age	28.5 (5.0)*	28.6 (5.1)*

*Mean (SD)

Only 19 (8 %) of the infants had low birth weight (≤ 2500 grams). Only 4 (2%) of the infants' were below -2SD weight-for-age and 2 (1%) were below -2SD length-for-age at 6 months, indicating that the prevalence of underweight or stunting in our sample was very low.

Table 2 shows differences in birth weight and mean weight-for-age z scores (WAZ) and height-for-age z scores (HAZ) of infants at 6 months in the two groups. None of the differences is significant.

Table 2: Comparison of depressed and non-depressed groups in infant anthropometric status

Variable	Depression Mean (SD) n	No Depression Mean (SD) n	Difference Mean (95% CI)	P-value
Birth weight (in grams)	3204 (539) 60	3179 (559) 169	25 (-140,189)	0.77
WAZ at 6 months	0.19 (1.05) 49	0.13 (1.35) 140	0.06 (-0.36, 0.48)	0.77
HAZ at 6 months	0.78 (0.82) 48	0.74 (1.06) 138	0.03 (-0.30, 0.37)	0.85

WAZ: Weight-for-age z score
HAZ: Height-for-age z score

We analysed the data using EPDS scores as a continuous measure, and after stratifying for gender of the infant. The correlation coefficient for the female infants for WAZ was -0.16 (p=0.11) and for HAZ was -0.15 (p=0.15). The corresponding statistics for male infants were -0.08 (p=0.5) and -0.11 (p=0.37), indicating that there was no association between the EPDS scores and growth of the infants.

Table 3 shows the difference between the infants of depressed and non-depressed mothers in the composite scores on the cognitive, language, motor, and behavioural dimensions of the Bayley's Scales of Infant Development at 6 months. The only score where there was a significant difference between the two groups was adaptive behaviour, with the infants of depressed mothers scoring lower than the infants of non-depressed mothers (mean difference 4.6; t= 2.81, df 195; p=0.006).

Table 3: Comparison of depressed and non-depressed groups on Bayley's Scales of Infant development scores

Birth measurements and scores of baby	**Depressed (n=51) Mean (SD)**	**Non-depressed (n=146) Mean (SD)**	**T**	**df**	**p-value (t-test)**
Cognitive composite score	93.8 (10.4)	96.2 (9.6)	1.51	195	0.13
Language composite score	89.7 (8.7)	90.0 (8.7)	0.16	195	0.88
Motor composite score	91.1 (14.2)	93.1 (13.5)	0.88	195	0.38
Social emotional composite score	107 3 (17.9)	108.4 (16.7)	0.42	195	0.67
Adaptive behavior composite score	95.2 (9.2)	99.8 (10.5)	2.81	195	0.006

Multiple regression for each of the Bayley's scores, and for weight and height for age at baseline adjusting for all variables listed in table 1 showed that the effects of mother's depression remained unchanged. The unstandardised regression coefficient for non-depressed vs. depressed for the adaptive behaviour composite score was 5.35, standard error 1.73, p=0.002. There were no

significant effects of mother's depression on any of the other Bayley's scores, or birthweight, or WAZ or HAZ at 6 months, after adjusting for these covariates.

DISCUSSION

This study was conducted on a sample of British women of Pakistani origin, the great majority of whom had migrated from the same geographical region where we conducted a similar study in Pakistan[5], allowing us to make direct comparisons between the two samples. The prevalence of prenatal depression in this sample of British Pakistani women is about 17%, which is slightly higher than the 10-15% reported in the general population[19] but lower than the 28% reported in the Pakistani sample.[20] The infant growth parameters were strikingly different between the two populations – low birthweight in the British Pakistani sample was 8%, compared to 25% in the Pakistani sample;[21] underweight at 6 months was 2% compared to 18% in the Pakistani sample; stunting was 1% compared to 10% in the Pakistani sample[5]. Unlike the Pakistani sample where the relative risk of undernutrition at 6 months with prenatal depression was 5.9 (95% CI 2.7 – 12.8), we found no association between prenatal depression and undernutrition or stunting in the British Pakistani infants. The only infant development domain to show a significant association with prenatal depression was parent-reported adaptive behaviour (communication, play, self-direction, and social skills etc).

The strengths of the study are that it used a longitudinal cohort design, most appropriate for such an investigation, and we were able to achieve high follow-up rates. Studies on ethnic minority populations suffer from problems of access and recruitment, but we did not encounter such problems because we engaged the communities through key informants and user friendly, culturally appropriate information leaflets. Our research team consisted wholly of bilingual Pakistani-origin researchers. However, we were not able to meet our required sample-size in the depressed group because of time and resource constraints, and this is a limitation that should be kept in mind when interpreting the results. However, the strikingly low levels of undernutrition in our sample and the absence of even a trend towards an association of poorer growth with prenatal depression is sufficient to derive reasonable conclusions from this data. Maternal depression, which is a strong and independent

predictor of infant growth in Pakistani women, is not associated with infant growth in British Pakistani women.

The results are not wholly unexpected. In an earlier paper, we had argued that maternal competence in child care, which is likely to be negatively affected by depression, probably plays a greater role in the child's physical well-being and development in impoverished settings, as the environment is frequently more hostile than in the more resourced settings.[22] Overcrowding, poor sanitation and food insecurity are common, with suboptimal maternal care potentially resulting in a greater risk to the physical health of a child in such settings.

One could hypothesize that, in an environment where basic hygiene and food-security is assured, the manifestations of maternal depression are different. A secondary analysis of the Millenium Cohort study provides some preliminary evidence – we have found severe psychological distress in mothers of toddlers to be associated with obesity in their children.[23] The association of maternal depression with poorer scores on adaptive behaviour might indicate a similar trend. Further studies are required to investigate the impact of maternal depression on infant development domains in well-resourced settings.

There seems to be a paucity of research, especially in the area of mental health, in ethnic minorities living in the developed world.[24] Because it is difficult to include non-English speaking mothers and children, studies that examine maternal health and child outcomes generally report results from predominantly literate English speaking white European population.[25;26;27] Consequently little is known about the impact of poor mental health in ethnic minorities living in the UK. Furthermore, trans-cultural studies and comparative studies between immigrants and their populations of origin, could yield important epidemiological information that helps our understanding of such disorders of public health importance.

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ETHICS APPROVAL

This study received a favourable ethical opinion from the Central Manchester Local Research Ethics Committee. REC Reference No: 06/Q1407/15.

COMPETING INTERESTS

None declared.

AUTHORS CONTRIBUTIONS

NH, AR and KC designed the study. SK coordinated the study and helped with ethical approval and data collection. BT did the statistical analysis. AR wrote the first draft. NH was involved throughout the project and finalised the manuscript. All authors helped to prepare the final report. NH is the guarantor.

REFERENCES

1. Grote NK, Bridge JA, Gavin AR, Melville JL, Iyengar S, Katon WJ. A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. *Arch Gen Psychiatry* 2010;**67**(10):1012-1024.

2. Surkan PJ, Kennedy CE, Hurley KM, Black MM. Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bull World Health Organ* 2011;**89**(8):608-615.

3. Patel V, Rahman A, Jacob KS, Hughes M. Effect of maternal mental health on infant growth in low income countries: new evidence from South Asia. *BMJ* 2004;**328**(7443):820-823.

4. UNICEF. Progress for children: a report card on nutrition. 2006. New York, UNICEF. Ref Type: Report

5. Rahman A, Iqbal Z, Bunn J, Lovel H, Harrington R. Impact of maternal depression on infant nutritional status and illness: a cohort study. *Arch Gen Psychiatry* 2004;**61**(9):946-952.

6. Wachs TD, Black MM, Engle PL. Maternal Depression: A Global Threat to Children's Health, Development, and Behavior and to Human Rights. *Child Development Perspectives* 2009;**3**:51-59.

7. Engle PL. Maternal mental health: program and policy implications. *Am J Clin Nutr* 2009; **89**(3):963S-966S.

8. Stewart RC. Maternal depression and infant growth: a review of recent evidence. *Maternal & Child Nutrition* 2009;**3**(2):94-107.

9. Gater R, Tomenson B, Percival C, Chaudhry N, Waheed W, Dunn G et al. Persistent depressive disorders and social stress in people of Pakistani origin and white Europeans in UK. *Soc Psychiatry Psychiatr Epidemiol* 2009;**44**(3):198-207.

10. Husain N, Creed F, Tomenson B. Depression and social stress in Pakistan.*Psychol Med* 2000; **30**(2):395-402.

11. Rahman A, Iqbal Z, Harrington R. Life events, social support and depression in childbirth: perspectives from a rural community in the developing world. *Psychol Med* 2003;**33**(7):1161-1167.

12. Husain N, Bevc I, Husain M, Chaudhry IB, Atif N, Rahman A. Prevalence and social correlates of postnatal depression in a low income country. *Arch Womens Ment Health* 2006; **9**(4):197-202.

13. Cox J, Holden L. Perinatal Psychiatry: Use and Misuse of the Edinburgh Postnatal Depression Scale. London: Gaskell; 1994.

14. Rahman A, Iqbal Z, Lovel H, Shah MA. Screening for postnatal depression in the developing world: a comparison of the WHO Self-Reporting Questionnaire (SRQ-20) and the Edinburgh Postnatal Depression Screen (EPDS). *Journal of Pakistan Psychiatric Society* 2005;**2**:69-72.

15. World Health Organization. International Classification of Mental and Behavioural Disorders. Diagnostic Criteria for Research. 10 ed. Geneva: World Health Organization; 1993.

16. World Health Organization. Physical status: the use and interpretation of anthropometry. Technical report series No. 854. 1995. Geneva, World Health Organization.
Ref Type: Report

17. Bayley N. Bayley Scales of Infant and Toddler Development: Technical Manual. 3rd ed. San Antonio, TX: Harcourt Assessment; 2006.

18. Patel V, DeSouza N, Rodrigues M. Postnatal depression and infant growth and development in low income countries: a cohort study from Goa, India. *Arch Dis Child* 2003;**88**(1):34-37.

19. O'Hara MW, Swain AM. Rates and risk of postpartum depression: a meta-analysis. *International Review of Psychiatry* 1996;**8**:37-54.

20. Rahman A, Iqbal Z, Harrington R. Life events, social support and depression in childbirth: perspectives from a rural community in the developing world. *Psychol Med* 2003; **33**(7):1161-1167.

21. Rahman A, Bunn J, Lovel H, Creed F. Association between antenatal depression and low birthweight in a developing country. *Acta Psychiatr Scand* 2007;**115**(6):481-486.

22. Rahman A, Harrington R, Bunn J. Can maternal depression increase infant risk of illness and growth impairment in developing countries? *Child Care Health Dev* 2002;**28**(1):51-56.

23. Ramasubramanian L, Rahman A. The association between maternal serious psychological distress and child obesity at 3 years: a cross-sectional analysis of the UK millenium cohort data. *Child Care Health Dev* in press.

24. Gavin NI, Gaynes BN, Lohr KN, Meltzer-Brody S, Gartlehner G, Swinson T. Perinatal depression: a systematic review of prevalence and incidence. *Obstet Gynecol* 2005;**106**(5 Pt 1):1071-1083.

25. Murray L, Cooper P. Effects of postnatal depression on infant development. *Arch Dis Child*. 1997;**77**(2):99-101.

26. Chronicity of maternal depressive symptoms, maternal sensitivity, and child functioning at 36 months. NICHD Early Child Care Research Network. *Dev Psychol*. 1999;**35**(5):1297-1310.

27. Brennan PA, Hammen C, Andersen MJ, et al. Chronicity, severity and timing of maternal depressive symptoms: relationships with child outcomes at age 5. *Dev Psychol*. 2000;**36**(6):759-766.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

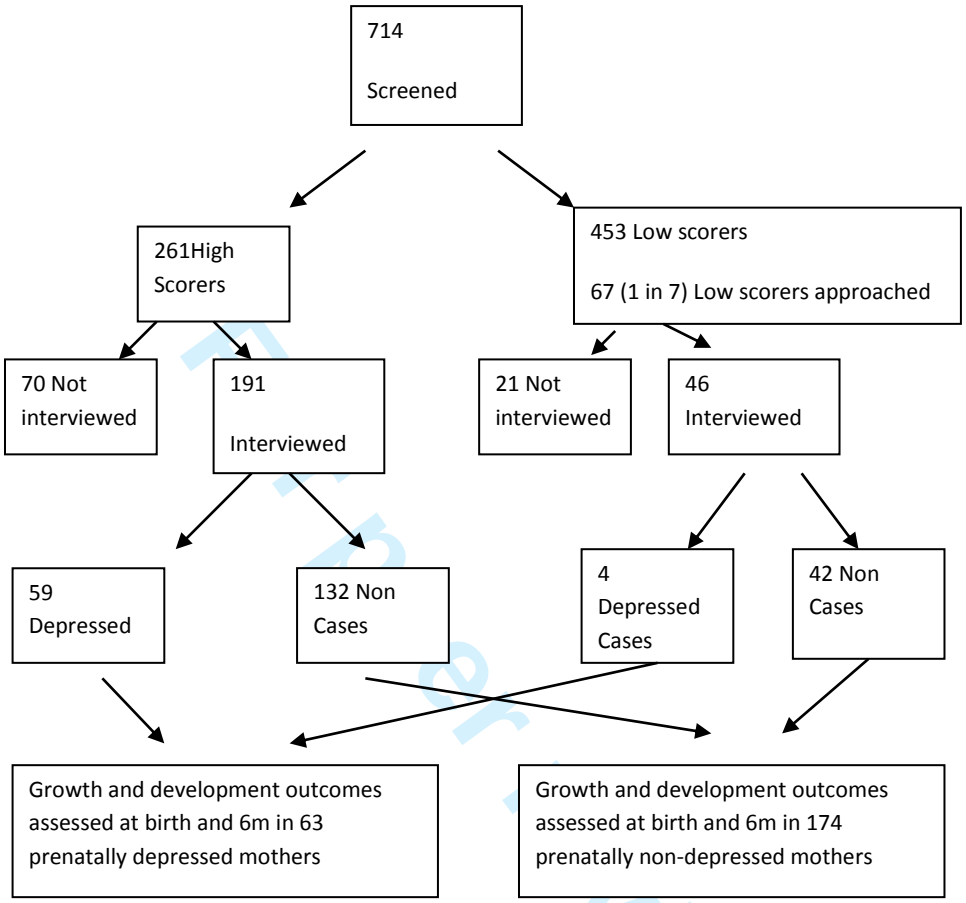
Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11, 12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Figure 1:



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ABSTRACT

Introduction: Perinatal depression has been found to be a strong and independent risk factor for poor child growth and development in low-income South Asian populations. We aimed to study if there was a similar association in first and second generation British women of Pakistani origin.

Methods: We conducted a prospective cohort study in the North West of England in areas with high density of Pakistani origin population. Seven hundred and four physically healthy women were assessed in two phases (screening and detailed assessment of high scorers and a proportion of low scorers) during their third trimester of pregnancy to obtain at birth a cohort of 63 infants of depressed mothers and 173 infants of psychologically well mothers. All infants were weighed and measured at birth and 6 months, and their development was assessed using the Bayley's Scales of Infant Development (BSID-III).

Results : There was no difference in the birth weight or weight and height at 6 months of infants of depressed mothers vs. infants of psychologically well mothers. The only significant difference between the two groups was in the infants' adaptive behaviour; infants of depressed mothers scored significantly lower than infants of psychologically well mothers (mean difference 4.6; t= 2.81, df 195; p=0.006). The associations remained significant after adjustment for socio-demographic factors by multivariate analyses.

Conclusions: Prenatal depression is not associated with impaired growth in this sample of British Pakistani women. There is however an association of prenatal depression with parent reported problems in the infants' adaptive behaviour. Further research is needed to understand various pathways through which maternal depression affects infant outcomes in low and high income settings.

Article Summary

Article Focus:

- In South Asian countries, maternal depression has been identified as a strong risk factor for under nutrition and stunted growth in infants.
- Maternal depression has also been associated with insecure attachment styles and deficiencies in cognitive development.
- In a longitudinal cohort design, this article examines the potential association between prenatal maternal depression and infant development, in a sample of British women of Pakistani origin.

Key Messages:

- The present sample of British Pakistani women show lower rates of depression as compared to the women living in Pakistan.
- Prenatal depression was not found to be associated with infant under nutrition or stunted growth. On the other hand, there was a significant association between prenatal depression and the infant's adaptive behaviour, as measured by the BSID-III.

Strengths and Limitations of this study

- The longitudinal prospective cohort design employed in this study was well suited to address the research question. Engaging the prospective sample through culturally appropriate channels and informants helped to achieve high follow up rates.
- Due to resource and time limitations, the required sample size for the group of depressed women could not be achieved.

INTRODUCTION

Recent meta-analyses show that maternal depression is a risk factor for low birth weight and early childhood underweight and stunting in low and middle income countries.[1;2] Maternal depression appears to be a particularly strong and independent risk factor for infant under nutrition in South Asian countries,[3] where 30-40% of all children under 5 are underweight or stunted.[4] Our longitudinal cohort study in rural Pakistan[5] found that the relative risks at 6 months for infants of mothers who were depressed during pregnancy being underweight or stunted (weight- or length- for-age z-score < -2SD) were 4.0 (95%CI 2.1-7.7), and 4.4 (95%CI 1.7-11.4) respectively. These associations remained significant after adjustment for confounders. The population attributable risk (PAR) estimate indicated that if the Pakistani infant population was unexposed to maternal depression, 30% (95% CI 19%-41%) fewer children would be stunted. Furthermore, studies show that infants of depressed mothers are less likely to be securely attached and more likely to have behavioural problems and poor cognitive development.[6] Globally, maternal depression has been called a major threat to optimal child development and calls have been made to address it at a public health level.[6;7]

Evidence from high income countries is less equivocal.[8] However, most studies have been conducted in the general population. Considering that the rates of maternal depression in Pakistani women are also higher – a recent population-based study in the North West of England [9] found depression prevalence in British Pakistani women was 31% compared to 18% in white European women – and given such strong and independent associations with infant under nutrition in South Asia, it would be important to explore its association with poor infant growth and development in this population.

The aim of this study was to systematically investigate the association of antenatal maternal depression and infant growth and other development parameters in a representative community-based sample in the North West of England, using a longitudinal prospective cohort design.

METHODS

Participants

The study was conducted in North West England. Subjects were recruited from maternity hospitals in areas with high density of Pakistani-origin population – Central Manchester Hospital in the City of Manchester and East Lancashire Hospital, in Lancashire. Furthermore, over 80% of the Pakistani-origin women in the study area migrated from the Potohar and Mirpur region of Pakistan, the same area where we conducted our Pakistan studies[10;11;12], allowing a direct comparison between populations that are ethnically similar. From August 2006 to July 2008 all British women of Pakistani origin presenting to these maternity hospitals for their antenatal check-ups, and who consented to take part in the research, were invited to participate. Our definition of ethnicity required a strict 3 from 4 grandparents to share the same ethnic group and was also self-defined using Census categories. Exclusions were women with multiple pregnancies, diagnosed physical or learning disability, post-partum or other psychosis, and following delivery, infants born prematurely, with congenital deformity, physical or mental handicap.

Measurements

Assessment of maternal depression

Informed written consent was obtained from all participants. A two-phase procedure was used to diagnose depression in the women who consented and met the inclusion criteria. In the first phase, all participating women were administered the Edinburgh Postnatal Depression Scale (EPDS).[13] This is the most widely used tool to screen for probable cases of perinatal depression and has been found to have excellent psychometric properties cross-culturally and in the Pakistani population.[14] The EPDS was initially developed and validated for postnatal depression but it has been reported to be useful for the detection of depression during pregnancy[15;16;17] with good psychometric properties. We have used the EPDS during pregnancy in our studies in Pakistan[14, 18].The women were approached in an antenatal clinic and all those in the third trimester of their pregnancy, who gave consent, were screened using the EPDS. A commonly used cut-off score of 12 or more was used to identify

possibly depressed women (phase 1). All Women scoring 12 or more and a 1 in 7 random sample of low scoring women were invited for further assessment of their mental state with a diagnostic interview (phase 2) using the Schedules for Assessment in Neuropsychiatry (SCAN).[19] SCAN is an internationally validated semi structured interview generating International Classification of Diseases, 10th Revision (ICD-10) diagnoses of depressive disorder. All interviews were carried out by trained and experienced clinicians.

Assessment of infant growth and development

Infant growth measurements were carried out using standard anthropometric techniques and equipment.[20] Measurements were carried out at birth and 6 months postnatal. Growth data were converted into standard deviations (z scores) for weight and length using Epi Info 2002 software (Centers for Disease Control, Atlanta, Ga). Infants were classified as underweight or stunted if their weight-for-age z scores or length-for-age z scores were less than - 2, on the basis of National Center for Health Statistics/World Health Organization reference data.[21]

Bayley Scales of Infant Development -Third Edition (BSID-III) were used to assess infant development .[22] The BSID-III yield composite scores reflecting infants' Cognitive, Language, Motor, Socio-Emotional, and Adaptive Behavioral development. Three of these content domains - Cognitive, Language, and Motor - are assessed by items administered to the child, whereas the Social-Emotional and Adaptive Behavior domains are based on information supplied by the primary caregiver to items contained in a separate questionnaire. A standard score is derived for each scale, with a mean of 100 and a SD of 15. This instrument has excellent psychometric properties, and has been validated on over 1700 children. The BSID-III was administered by a single trained research assistant.

All instruments have been previously adapted for use in the Pakistani population and the researcher doing the assessments was trained by an expert experienced in their use in Pakistani infants.

Assessment of socio-demographic and other factors

Data on selected socio-demographic factors of interest were collected through a specially developed Personal Information Questionnaire (PIQ). The factors included age, marital status, education, any self-reported health problem, whether 1st or 2nd generation immigrant, pregnancy planned or unplanned and number of children.

Statistical Analysis

In this study, the EPDS was used as a screening instrument at antenatal phase 1 to identify 'possible' cases of depression. Then, in accordance with the methods of two-phase studies, all the high scorers and a random sample of low scorers were invited for antenatal phase 2 interviews, which used the SCAN. The prevalence of depression was carried out using inverse sampling weights, which are the reciprocal of the sampling fraction, whereby the data from the sample of low scorers is 'scaled up' to its full original sample size.[24] In our study, 191 out of the 261 high EPDS scorers and 46 out of the 453 EPDS low scorers were interviewed using the SCAN. Thus the sampling weights are 261/191 for the high scorers and 453/46 for the low scorers.

Mean differences in birth weight weight-for-age *z* scores and height-for-age *z* scores at 6 months between the exposed group (infants of prenatally depressed mothers) and the non exposed group (infants of prenatally non depressed mothers) were analyzed using growth indices as continuous measures. Similar analyses were carried out for the Bayley's composite scores in the cognitive, language, motor, socio-emotional and adaptive behaviour domains. For each outcome, multiple regression analysis was used to simultaneously control for the confounding effects of all the variables under study. Pearson correlation was used to examine the association between the EPDS score and the anthropometric outcomes at 6 months for each gender separately.

Sample Size

Assuming the SD of birth weight is 500 grams, a sample of 100 depressed and 100 non-depressed women would give the study 80% power to detect a difference in the mean birth weight between groups of 200 grams at the 5% significance level. Assuming, from previous South Asian data,[23] a correlation coefficient between EPDS score and change in weight of 0.15, an SD of weight change of

400grams and an SD of 5 for EPDS scores, 100 women in each group will allow the study to detect a difference in growth of 20 grams for each 1-unit increase in EPDS score.

Socio-demographic factors	Depressed (n=63) % (n)	Not depressed (n=174) % (n)

RESULTS

Fig 1 shows the flow of participants in this study. Altogether 714 women meeting the study criteria were interviewed with the EPDS, of whom 261 (36.6%) scored 12 or more. Of these, 191 (73.2%) completed phase 2 interviews. Reasons why 70 did not are as follows: the baby was delivered before an interview took place for 30, 2 babies died, 11 mothers refused, 11 were unavailable, 11 could not be contacted and 5 were not asked. A random selection of 67 (14.8%) of the low EPDS scorers were invited for phase 2 interviews, and 46 of these (69%) completed interviews. Of the 21 who did not, 3 babies were delivered before the interview, 2 mothers refused, 15 were unavailable, and 1 could not be contacted. The response rate for phase 2 interviews was 80.1% (237 completed interviews out of 296 mothers invited and eligible for phase 2). Out of the 191 high EPDS scorers, 59 (30.9%) were found to be depressed on the SCAN interview, and 4 out of the 46 low scorers were depressed (8.7%), making a total of 63 depressed mothers. The 132 high EPDS scorers and the 42 low scorers who were not depressed on the SCAN interview were combined to form the group of 174 non-depressed mothers. The weighted prevalence of depression in this group of pregnant Pakistani women was 16.8% (95% confidence interval 14.1% to 19.6%). The response rate for birthweight was 96.6%, and for the 6 month cognitive assessments was 86.0%.

Table 1 compares the socio-demographic characteristics between the depressed and non-depressed groups. Women in the depressed group were less likely to be 1st generation Pakistani and more likely to have more than 2 children; they were similar to the non-depressed women in the other factors measured.

Table 1. Comparison of socio-demographic factors between depressed and non-depressed women

1st generation Pakistani[1]	77.8% (49)	81.6% (142)
Educated to A-level or more	54.0% (34)	54. 0% (94)
Married	95.2% (60)	97.7% (170)
Planned pregnancy	42.6% (26)	45.7% (69)
Primagravida	28.2% (19)	28.2% (49)
≥ 2 children	49.2% (31)	41.4% (72)
Marked health difficulty[2]	1.6% (1)	0% (0)
Age	28.5 (5.0)*	28.6 (5.1)*

*Mean (SD)

Only 19 (8 %) of the infants had low birth weight (≤ 2500 grams). Only 4 (2%) of the infants' were below -2SD weight-for-age and 2 (1%) were below -2SD length-for-age at 6 months, indicating that the prevalence of underweight or stunting in our sample was very low.

Table 2 shows differences in birth weight and mean weight-for-age z scores (WAZ) and height-for-age z scores (HAZ) of infants at 6 months in the two groups. None of the differences is significant.

We analysed the data using EPDS scores as a continuous measure, and after stratifying for gender of the infant. The correlation coefficient for the female infants for WAZ was -0.16 (p=0.11) and for HAZ was -0.15 (p=0.15). The corresponding statistics for male infants were -0.08 (p=0.5) and -0.11 (p=0.37), indicating that there was no association between the EPDS scores and growth of the infants.

Table 2: Unadjusted Comparison of depressed and non-depressed groups in infant anthropometric status

Variable	Depression Mean (SD) n	No Depression Mean (SD) n	Difference Mean (95% CI)	P-value

[1] 1st generation Pakistani: Women born outside the UK; 2nd generation Pakistani: Women born in the UK.

[2] The Life Events & Difficulties Schedule (LEDS) was used in the original study by Brown and Harris[25] and is known for its reliability. The LEDS has been used in the Pakistani population in the UK[26] and in Pakistan.[27] Classification of difficulties is according to the type of difficulty, the relationship of other persons involved in the difficulty and whether there is a health aspect of the difficulty. A difficulty is rated only if the situation lasts for four weeks. The rating is on a 6-point contextual severity scale ranging from 1-3 for marked difficulties. For low moderate it is 4 and 5-6 for minor difficulties. There are two LEDS manuals, one for rating events and the other for rating difficulties. The guidelines are given to decide whether an event or difficulty is to be included.

Birth weight (in grams)	3204 (539) 60	3179 (559) 169	25 (-140,189)	0.77
WAZ at 6 months	0.19 (1.05) 49	0.13 (1.35) 140	0.06 (-0.36, 0.48)	0.77
HAZ at 6 months	0.78 (0.82) 48	0.74 (1.06) 138	0.03 (-0.30, 0.37)	0.85

WAZ: Weight-for-age z score
HAZ: Height-for-age z score

Table 3 shows the difference between the infants of depressed and non-depressed mothers in the composite scores on the cognitive, language, motor, and behavioural dimensions of the Bayley's Scales of Infant Development at 6 months. The only score where there was a significant difference between the two groups was adaptive behaviour, with the infants of depressed mothers scoring lower than the infants of non-depressed mothers (mean difference 4.6; t= 2.81, df 195; p=0.006).

Table 3: Comparison of depressed and non-depressed groups on Bayley's Scales of Infant development scores

Multiple regression for each of the Bayley's scores, and for weight and height for age at baseline adjusting for all variables listed in table 1 showed that the effects of mother's depression

Birth measurements and scores of baby	**Depressed (n=51) Mean (SD)**	**Non-depressed (n=146) Mean (SD)**	**T**	**df**	**p-value (t-test)**
Cognitive composite score	93.8 (10.4)	96.2 (9.6)	1.51	195	0.13
Language composite score	89.7 (8.7)	90.0 (8.7)	0.16	195	0.88
Motor composite score	91.1 (14.2)	93.1 (13.5)	0.88	195	0.38
Social emotional composite score	107 3 (17.9)	108.4 (16.7)	0.42	195	0.67
Adaptive behavior composite score	95.2 (9.2)	99.8 (10.5)	2.81	195	0.006

remained unchanged. The unstandardised regression coefficient for non-depressed vs depressed for the adaptive behaviour composite score was 5.35, standard error 1.73, p=0.002. There were no significant effects of mother's depression on any of the other Bayley's scores, or birthweight, orWAZ or HAZ at 6 months, after adjusting for these covariates.

DISCUSSION

This study was conducted on a sample of British women of Pakistani origin, the great majority of whom had migrated from the same geographical region where we conducted a similar study in Pakistan[5], allowing us to make direct comparisons between the two samples. The prevalence of prenatal depression in this sample of British Pakistani women is about 17%, which is slightly higher than the 10-15% reported in the general population[28] but lower than the 28% reported in the Pakistani sample.[29] The infant growth parameters were strikingly different between the two populations – low birth weight in the British Pakistani sample was 8%, compared to 25% in the Pakistani sample;[30] underweight at 6 months was 2% compared to 18% in the Pakistani sample; stunting was 1% compared to 10% in the Pakistani sample[5]. Unlike the Pakistani sample where the relative risk of under nutrition at 6 months with prenatal depression was 5.9 (95% CI 2.7 – 12.8), we found no association between prenatal depression and under nutrition or stunting in the British Pakistani infants. The only infant development domain to show a significant association with prenatal depression was parent-reported adaptive behaviour (communication, play, self-direction, and social skills etc).

The strengths of the study are that it used a longitudinal cohort design, most appropriate for such an investigation, and able to achieve high follow-up rates. This is the only longitudinal study to our knowledge looking at the association of depression during pregnancy and child outcomes in British Pakistani women. The strength of this study is that the sample is not affected by treatment seeking. Studies on ethnic minority populations suffer from problems of access and recruitment but we did not encounter such problems because we engaged the communities through key informants and user friendly, culturally appropriate information leaflets. Our research team consisted wholly of

bilingual Pakistani-origin researchers. However, we were not able to meet our required sample-size in the depressed group because of time and resource constraints, and this is a limitation that should be kept in mind when interpreting the results. However, the strikingly low levels of under nutrition in our sample and the absence of even a trend towards an association of poorer growth with prenatal depression is sufficient to derive reasonable conclusions from this data. Maternal depression, which is a strong and independent predictor of infant growth in Pakistani women, is not associated with infant growth or development in British Pakistani women.

The results are not wholly unexpected. In an earlier paper, we had argued that maternal competence in child care, which is likely to be negatively affected by depression, probably plays a greater role in the child's physical well-being and development in impoverished settings, as the environment is frequently more hostile than in the more resourced settings.[31] Overcrowding, poor sanitation and food insecurity are common, with suboptimal maternal care potentially resulting in a greater risk to the physical health of a child in such settings.

One could hypothesize that, in an environment where basic hygiene and food-security is assured, the manifestations of maternal depression are different. A secondary analysis of the Millenium Cohort study provides some preliminary evidence – we have found severe psychological distress in mothers of toddlers to be associated with obesity in their children.[32] The association of maternal depression with poorer scores on adaptive behaviour might indicate a similar trend. Further studies are required to investigate the impact of maternal depression on infant development domains in well-resourced settings.

The BSID has been used to measure child development not only in a variety of U.S. populations including Hispanic and Mexican Americans but also in a variety of international populations. The transcultural research has involved populations as diverse as in Bangladesh [33;34], Taiwan[35], Nigeria[36] and Brazil[37], etc. These studies did not report any major difficulties in the use of BSID with diverse non-English-speaking cultures. Although BSID has been used in Pakistani population in Pakistan and people of Pakistani origin in the UK however it is based on western norms.

It has been debated whether or not instruments designed in one system are applicable to other cultures.

In a review in Lancet series on Global mental health [38] and a more recent systematic review and meta-analysis[39] include studies from South Asia which suggest that depression during pregnancy increases the risk of low birth weight and the postnatal depression is associated with infant likely to be underweight and stunted. However there are conflicting reports from some other developing countries. In the developed world such an association is reported only in the low socioeconomic groups[8] and there are reports on the significant adverse effects of postnatal depression on the cognitive development and behaviour[40;41;42] particularly among the boys. The adverse effects on the male infants persist long term.[43] A recent review by Walker[44] suggests that now there is sufficient evidence linking maternal depression to adverse child development outcomes in the developing world also. Therefore early intervention is recommended as reducing or preventing maternal depression may also be a major preventive strategy for the children.

There seems to be a paucity of research, especially in the area of mental health, in ethnic minorities living in the developed world.[28] Because it is difficult to include non-English speaking mothers and children, studies that examine maternal health and child outcomes generally report results from predominantly literate English speaking white European population.[28;45;46] Consequently little is known about the impact of poor mental health in ethnic minorities living in the UK. Furthermore, trans-cultural studies and comparative studies between immigrants and their populations of origin, could yield important epidemiological information that helps our understanding of such disorders of public health importance.

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ETHICS APPROVAL

This study received a favourable ethical opinion from the Central Manchester Local Research Ethics Committee. REC Reference No: 06/Q1407/15.

COMPETING INTERESTS

None declared.

AUTHORS CONTRIBUTIONS

NH, AR and KC designed the study. SK coordinated the study and helped with ethical approval and data collection. BT did the statistical analysis. AR wrote the first draft. NH was involved throughout the project and finalised the manuscript. All authors helped to prepare the final report. NH is the guarantor.

DATA SHARING

Technical appendix, statistical code, and dataset available from the corresponding author at nusrat.husain@manchester.ac.uk

REFERENCES

1. Grote NK, Bridge JA, Gavin AR, Melville JL, Iyengar S, Katon WJ. A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. *Arch Gen Psychiatry* 2010; **67**(10):1012-1024.

2. Surkan PJ, Kennedy CE, Hurley KM, Black MM. Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bull World Health Organ* 2011; **89**(8):608-615.

3. Patel V, Rahman A, Jacob KS, Hughes M. Effect of maternal mental health on infant growth in low income countries: new evidence from South Asia. *BMJ* 2004; **328**(7443):820-823.

4. UNICEF. Progress for children: a report card on nutrition. 2006. New York, UNICEF. Ref Type: Report

5. Rahman A, Iqbal Z, Bunn J, Lovel H, Harrington R. Impact of maternal depression on infant nutritional status and illness: a cohort study. *Arch Gen Psychiatry* 2004; **61**(9):946-952.

6. Wachs TD, Black MM, Engle PL. Maternal Depression: A Global Threat to Children's Health, Development, and Behavior and to Human Rights. *Child Development Perspectives* 2009; **3**:51-59.

7. Engle PL. Maternal mental health: program and policy implications. *Am J Clin Nutr* 2009; **89**(3):963S-966S.

8. Stewart RC. Maternal depression and infant growth: a review of recent evidence. *Maternal & Child Nutrition* 2009; **3**(2):94-107.

9. Gater R, Tomenson B, Percival C, Chaudhry N, Waheed W, Dunn G et al. Persistent depressive disorders and social stress in people of Pakistani origin and white Europeans in UK. *Soc Psychiatry Psychiatr Epidemiol* 2009; **44**(3):198-207.

10. Husain N, Creed F, Tomenson B. Depression and social stress in Pakistan.*Psychol Med* 2000; **30**(2):395-402.

11. Rahman A, Iqbal Z, Harrington R. Life events, social support and depression in childbirth: perspectives from a rural community in the developing world. *Psychol Med* 2003; **33**(7):1161-1167.

12. Husain N, Bevc I, Husain M, Chaudhry IB, Atif N, Rahman A. Prevalence and social correlates of postnatal depression in a low income country. *Arch Womens Ment Health* 2006; **9**(4):197-202.

13. Cox J, Holden L. Perinatal Psychiatry: Use and Misuse of the Edinburgh Postnatal Depression Scale. London: Gaskell; 1994.

14. Rahman A, Iqbal Z, Lovel H, Shah MA. Screening for postnatal depression in the developing world: a comparison of the WHO Self-Reporting Questionnaire (SRQ-20) and the Edinburgh Postnatal Depression Screen (EPDS). *Journal of Pakistan Psychiatric Society* 2005; **2**:69-72.

15. Evans J, Heron J, Francomb H, Oke S, Golding J. Cohort study of depressed mood during pregnancy and after childbirth. *BMJ*. 2001;**323**(7307):257-60.

16. Felice E, Saliba J, Grech V, Cox J. Validation of the Maltese version of the Edinburgh Postnatal Depression Scale. *Arch Womens Ment Health.* 2006;**9**(2):75-80.

17. Rubertsson C, Börjesson K, Berglund A, Josefsson A, Sydsjö G. The Swedish validation of Edinburgh Postnatal Depression Scale (EPDS) during pregnancy. *Nord J Psychiatry*. 2011;**65**(6):414-8.

18. Husain N, Parveen A, Husain M, Saeed Q, Jafri F, Rahman R, Tomenson B, Chaudhry IB. Prevalence and psychosocial correlates of perinatal depression: a cohort study from urban Pakistan. *Arch Womens Ment Health*. 2011;**14**(5):395-403.

19. World Health Organization. International Classification of Mental and Behavioural Disorders. Diagnostic Criteria for Research. 10 ed. Geneva: World Health Organization; 1993.

20. World Health Organization. Physical status: the use and interpretation of anthropometry. Technical report series No. 854. 1995. Geneva, World Health Organization.
Ref Type: Report

21. de Onis M, Onyango AW, Borghi E, Garza C, Yang H. Comparison for the World Health Organisation (WHO) Child Growth Standards and the National Centre for Health Statistics/WHO international health growth reference: implications for child health programmes. *Public Health Nutrition* 2006;**9**(7):942-947.

22. Bayley N. Bayley Scales of Infant and Toddler Development: Technical Manual. 3rd ed. San Antonio, TX: Harcourt Assessment; 2006.

23. Patel V, DeSouza N, Rodrigues M. Postnatal depression and infant growth and development in low income countries: a cohort study from Goa, India. *Arch Dis Child* 2003; **88**(1):34-37.

24. Dunn G (2000) Statistics in Psychiatry. Arnold

25. Brown GW, Harris T. Social origins of depression: a study of psychiatric disorder in women. London, Tavistock 1978.

26. Husain N, Creed F, Tomenson B. Adverse social circumstances and depression in people of Pakistani origin in the UK: *Br J Psychiatry*.1997;**171**:434-438.

27. Husain N, Creed F, Tomenson B. Depression and social stress in Pakistan. *Psycholo Med.* 2000;**30**:395-402.

28. Gavin NI, Gaynes BN, Lohr KN, Meltzer-Brody S, Gartlehner G, Swinson T. Perinatal depression: A systematic review of prevalence and incidence. Obstet Gynecol 2005;**106**(5 Pt 1):1071.

29. Rahman A, Iqbal Z, Harrington R. Life events, social support and depression in childbirth: perspectives from a rural community in the developing world. *Psychol Med* 2003; **33**(7):1161-1167.

30. Rahman A, Bunn J, Lovel H, Creed F. Association between antenatal depression and low birthweight in a developing country. *Acta Psychiatr Scand* 2007; **115**(6):481-486.

31. Rahman A, Harrington R, Bunn J. Can maternal depression increase infant risk of illness and growth impairment in developing countries? *Child Care Health Dev* 2002; **28**(1):51-56.

32. Ramasubramanian L, Rahman A. The association between maternal serious psychological distress and child obesity at 3 years: a cross-sectional analysis of the UK millenium cohort data. *Child Care Health Dev* .2011[Epub ahead of print]

33. Nahar B, Hamadani JD, Ahmed T, Tofail F, Rahman A, Huda SN, Grantham-McGregor SM. Effects of psychosocial stimulation on growth and development of severely malnourished children in a nutrition unit in Bangladesh. *Eur J Clin Nutr*. 2009;**63**(6):725-31.

34. Hamadani JD, Baker-Henningham H, Tofail F, Mehrin F, Huda SN, Grantham-McGregor SM. Validity and reliability of mothers' reports of language development in 1-year-old children in a large-scale survey in Bangladesh. *Food Nutr Bull*. 2010 Jun;31(2 Suppl):S198-206.

35. Wu YT, Tsou KI, Hsu CH, Fang LJ, Yao G, Jeng SF; Taiwan Infant Developmental Collaborative Study Group. Brief report: Taiwanese infants' mental and motor development--6-24 months. *J Pediatr Psychol*. 2008 Jan-Feb;33(1):102-8.

36. Aina OF, Morakinyo O. The validation of Developmental Screening Inventory (DSI) on Nigerian children. *J Trop Pediatr*. 2001;**47**(6):323-8.

37. Quevedo LA, Silva RA, Godoy R, Jansen K, Matos MB, Tavares Pinheiro KA, Pinheiro RT. The impact of maternal post-partum depression on the language development of children at 12 months. *Child Care Health Dev*. 2011 Jun 8.

38. Prince M, Patel V, Saxena S, Maj M, Maselko J, Phillips MR, Rahman A. No health without mental health. *Lancet*. 2007;**370**(9590):859-77.

39. Surkan PJ, Kennedy CE, Hurley KM, Black MM. Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bull World Health Organ*. 2011;**89**(8):608-15.

40. Goodman SH, Gotlib IH. Risk for psychopathology in the children of depressed mothers: a developmental model for understanding mechanisms of transmission. *Psychol Rev*. 1999;**106**(3):458-90.

41. Grace SL, Evindar A, Stewart DE. The effect of postpartum depression on child cognitive development and behavior: a review and critical analysis of the literature. *Arch Womens Ment Health*. 2003;**6**(4):263-74.

42. Sohr-Preston SL, Scaramella LV. Implications of timing of maternal depressive symptoms for early cognitive and language development. *Clin Child Fam Psychol Rev*. 2006;**9**(1):65-83.

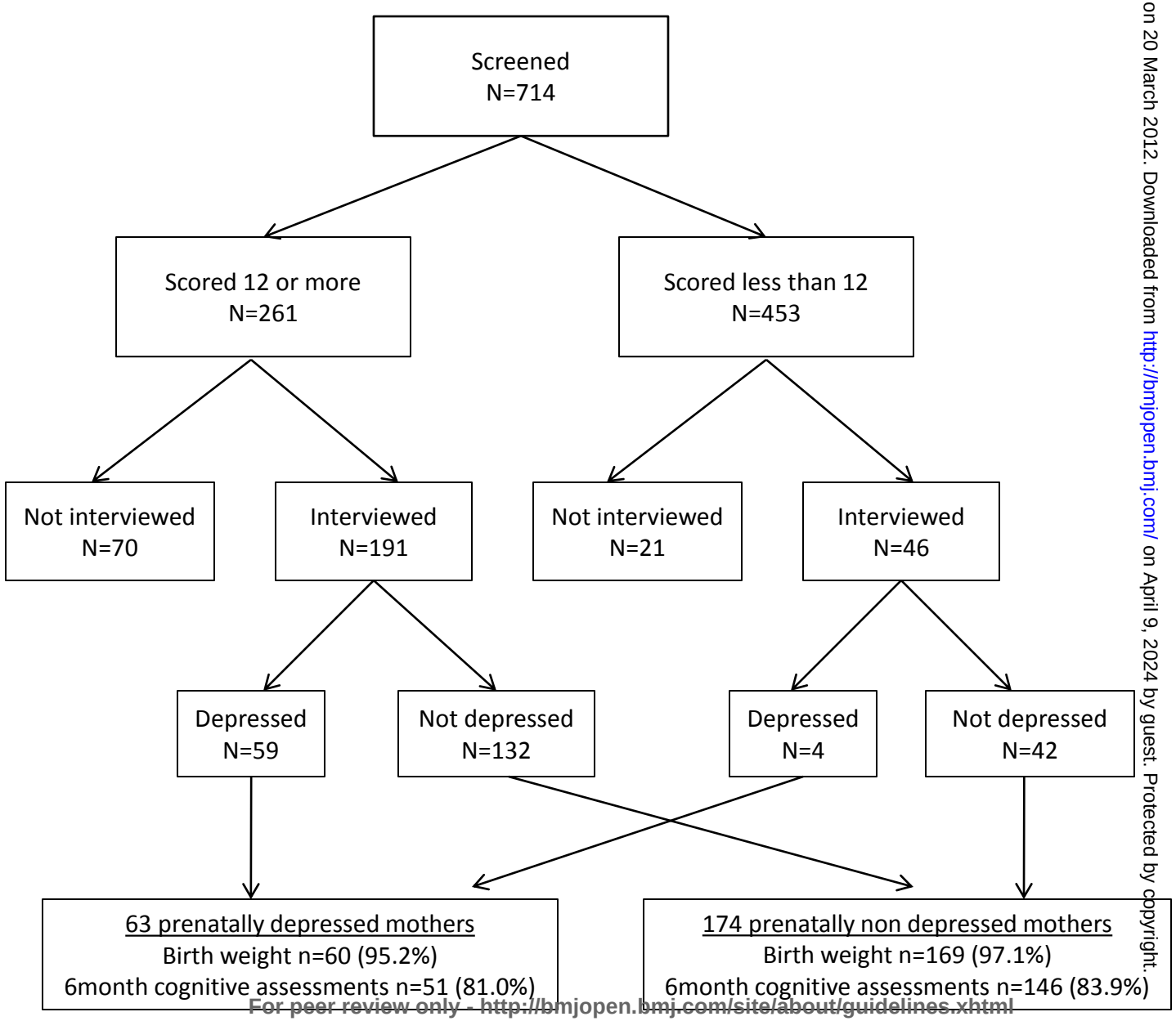
43. Murray L., Halligan S.L., Cooper P.J. Effects of postnatal depression on mother–infant interactions, and child development. In: Wachs T., Bremner G., editors. Vol. 192–220. Wiley-Blackwell; 2010. (Handbook of Infant Development).

44. Walker SP, Wachs TD, Grantham-McGregor S, Black MM, Nelson CA, Huffman SL et al. Inequality in early childhood: risk and protective factors for early child development. *Lancet.* 2011;**378**(9799):1325-1328.

45. Murray L, Cooper P. Effects of postnatal depression on infant development. *Arch Dis Child*. 1997;77(2):99-101.

46. Chronicity of maternal depressive symptoms, maternal sensitivity and child functioning at 36 months. NICHD Early Child Care Research Network. *Dev Psychol.* 1999;**35**(5):1297-1310.

Figure 1. Flow of participant through two-phase antenatal screen and interviews.



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11, 12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.