

# Antenatal depression and anxiety and early pregnancy BMI among White British and South Asian women: Retrospective analysis of data from the Born in Bradford cohort

Nafisa Insan<sup>1</sup>, Emma Slack<sup>1</sup>, Nicola Heslehurst<sup>1</sup>, and Judith Rankin<sup>1</sup>

<sup>1</sup>Newcastle University

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## Abstract

**Objective** To investigate the association between antenatal depression and anxiety and early pregnancy Body Mass Index (BMI) within and between White British and South Asian women. **Design** Retrospective analysis **Setting** The Born in Bradford cohort, UK Population White British and South Asian pregnant women, 2007-2011 **Methods** Mother's BMI was stratified into six World Health Organisation BMI categories (underweight, recommended, overweight or obese class 1-3). To determine associations with outcomes, univariate and multivariate logistic regression models (adjusting for maternal age, education, deprivation and smoking) were used. **Main outcome measure** Depression and anxiety using the General Health Questionnaire (GHQ); a GHQ score of  $>0$  for the depression subscale and  $>6$  for anxiety. **Results** There were 7824 women included (3514 White British and 4310 South Asian). South Asian women were significantly more likely to have depression than White British (43.3% vs 36.1%  $p<0.0001$ ) and less likely to have anxiety (45.3% vs 48.4%  $p<0.01$ ). There was no significant association between early pregnancy BMI and depression or anxiety in South Asian women. White British women with an overweight BMI had higher odds of anxiety compared with women with a recommended BMI (Adjusted Odds Ratio 1.25, 95% Confidence Interval 1.05-1.47). No significant associations were observed for other BMI categories. **Conclusion** Although South Asian women have a higher prevalence of depression than White women in this cohort, the known associations between maternal obesity and anxiety do not appear to be present. More studies are needed using validated depression tools for South Asian pregnant women.

## Introduction

Depression and anxiety are the most common mental health conditions during pregnancy, with approximately 12% and 13% of women experiencing them, respectively.<sup>1</sup> Antenatal depression and anxiety are associated with increased risk of post-partum depression, and poor cognitive and emotional development in the child.<sup>2</sup> South Asian (Indian, Pakistani and Bangladeshi) women are more susceptible to depression and anxiety compared to White women.<sup>3</sup>

There is evidence of a significant association between mental health conditions during pregnancy and maternal obesity. A meta-analysis published in 2014 found odds of antenatal depression and anxiety increased by 43% and 30%, respectively, in women with obesity compared to women of recommended BMI.<sup>4</sup> The included studies were predominately from high-income countries (53 out of 62 studies), of which two focused on ethnic-minorities (African American and Hispanic);<sup>5,6</sup> none focused on South Asian women. A systematic review<sup>7</sup> investigating the effects of maternal anthropometrics on pregnancy outcomes in South Asians did not identify any studies on mental health conditions, further highlighting the lack of published data in this field.

In addition to the increased risk of mental health conditions among South Asian women, they also carry an increased risk of maternal obesity. In the UK, half of pregnant women enter pregnancy with a BMI in

the overweight or obese range.<sup>8</sup> Evidence suggests that South Asian women have the highest odds of first trimester obesity compared to White British women,<sup>9</sup> and an increased risk of obesity-related complications, e.g. Gestational Diabetes Mellitus (GDM)<sup>7</sup> during pregnancy at a lower BMI than White British women. The World Health Organisation (WHO) reflects this in their BMI criteria, where the categories for overweight and obesity are lower in South Asian groups (23-27.49 kg/m<sup>2</sup> and [?] 27.5 kg/m<sup>2</sup> respectively)<sup>7</sup> compared with the general population criteria (25-29.9 kg/m<sup>2</sup> and [?]30 kg/m<sup>2</sup>).<sup>10</sup> The National Institute of Health and Care Excellence (NICE) guidelines have recommended the use of these lower WHO thresholds to identify and treat South Asian individuals with obesity-related illnesses;<sup>11</sup> however, this is not reflected in pregnancy guidelines.

Given the increased risk for both obesity and mental health conditions in South Asian women, the aim of this study was to address the current research gap by investigating the association between antenatal depression and anxiety and early pregnancy BMI within and between South Asian and White British women, using data from the Born in Bradford (BiB) cohort.

## Methods

### Study population

BiB is a longitudinal multi-ethnic community birth cohort of 12453 women (including 6900 South Asian, 50.1%) established in Bradford in 2007 to understand the reasons behind poor health outcomes within the city.<sup>12</sup> The cohort aimed to examine how environmental, genetic, behavioural and social factors impact on the health of the mother and child, and development from childhood through to adult life.<sup>12</sup> Bradford is the sixth largest city in the UK and is one of the most deprived areas in the UK.<sup>12</sup>

### Study design

This study was a retrospective analysis of data from the BiB cohort. White British and South Asian pregnant women were the populations of interest. Women from other ethnic groups, or where ethnicity data were missing, were excluded from the analysis. The two outcome variables were antenatal depression and anxiety. In the BiB cohort, mental health was assessed using the GHQ. The GHQ is a validated self-report questionnaire with 28 items relating to the respondent's current mental state, ability to carry out functions and daily activities and appearance of new and distressing phenomena.<sup>13</sup> The 28 items are grouped into four categories each used to identify symptoms of certain psychiatric disorders. Since this study focused on depression and anxiety as the most common mental health conditions during pregnancy, the total Likert score of the subscales for depression and anxiety (D, items 22-28; B, items 8-14) were used in the analysis (Appendix S1).<sup>13</sup> There are no agreed thresholds for the subscales to indicate depression or anxiety, but studies suggest that the cut-off score should be based on the mean/median of the sample of interest.<sup>14,15</sup> In this study, the median was used due to the non-normality of distribution. This was 0 for depression and 6 for anxiety. Therefore, a score of >0 was used to indicate depression and >6 indicated anxiety.

The main exposure variable was maternal early pregnancy BMI. Data from the BiB cohort includes information on the mother's booking BMI calculated using measured height and weight between 10-12 weeks of pregnancy.<sup>16</sup> A realistic lower limit of 11 kg/m<sup>2</sup> was set as this has been shown to be the lowest BMI for survival in women.<sup>17</sup> An upper limit of 80 kg/m<sup>2</sup> was based on the frequency distribution in the data from the BiB cohort and a published study.<sup>18</sup> Women with a booking BMI outside this range were excluded from analysis (n=720, 6.5%). BMI was analysed as a categorical variable due to the inclusion of underweight which is also associated with increased depression and anxiety,<sup>19</sup> therefore, a continuous analysis may skew the results. BMI was stratified by the WHO's classification. For White British women, the categories were: underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-24.9 kg/m<sup>2</sup>; overweight, 25-29.9 kg/m<sup>2</sup>; and obese class 1, 30.0-34.9 kg/m<sup>2</sup>; class 2, 35.0-39.9 kg/m<sup>2</sup>; class 3, [?]40.0 kg/m<sup>2</sup>.<sup>2</sup> The categories used for South Asian women were: underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-22.9 kg/m<sup>2</sup>; overweight, 23-27.49 kg/m<sup>2</sup>; and obese class 1, 27.5-32.49 kg/m<sup>2</sup>; class 2, 32.5-37.49 kg/m<sup>2</sup>; class 3, [?]37.5 kg/m<sup>2</sup>.<sup>20</sup> A secondary analysis was performed using the general population BMI criteria (**Table S1**) for South Asian women due to the current lack of guidance in the UK for using Asian-specific criteria in pregnancy.

Additional variables included in the adjusted models were maternal age, maternal education, area of residence deprivation (based on postcode) and maternal smoking. Maternal age (years) was analysed as a continuous variable. Maternal education was defined as mother’s highest educational qualification (equivalised) with the following categories: none, GSCE equivalent, A-level equivalent and higher than A-level (used as reference group). The Index of Multiple Deprivation (IMD) was used to categorise area of residence deprivation. The IMD is a measure of relative deprivation for small areas in England and is the most widely used tool to measure deprivation in health-related research in the UK.<sup>21</sup> Since BiB was carried out in Bradford, the national IMD quintiles would be of limited use for this study because Bradford has a higher level of deprivation compared to most areas of the UK.<sup>12</sup> Therefore, the deprivation data were skewed towards the most deprived quintiles for this population. A binary variable was created with quintiles 2-5 combined to represent lower levels of deprivation (used as the reference group) and quintile 1 represented the highest level of deprivation. Maternal smoking during pregnancy was a binary variable (yes/no).

## Statistical analysis

Univariate independent t-tests were used to test for significant associations for normally distributed continuous variables and the chi-squared and Fishers exact test were used for categorical variables. Statistical hypotheses were tested using two-tailed 95% confidence intervals (95% CI). Regression assumptions were met, and data were analysed using multiple logistic regression modelling with maternal BMI, maternal age, maternal education, deprivation level and smoking during pregnancy as exposure variable, and GHQ depression >0 and GHQ anxiety >6 as the dichotomous outcome variables. Interaction analysis was carried out to determine if there were differences in the regression associations between White British and South Asian women i.e. associations between ethnicity and antenatal depression and anxiety within each BMI category. The analyses were performed using STATA version 16.

## Results

There were 9420 White British and South Asian women who had a BMI between 11 and 80 kg/m<sup>2</sup>. Following exclusions for missing GHQ data (n=1596, 17%), a total sample size of 7824 women was available for analysis. The final sample included 3514 White British and 4310 South Asian women (3780 Pakistani, 343 Indian and 187 Bangladeshi). There was no statistically significant difference between the included and excluded group in terms of age ( $27.3 \pm 0.1$  versus  $27.3 \pm 0.14$ ) or deprivation level (Low deprivation 34.5% vs 31.3%, high deprivation 65.5% vs 68.7%) (**Table S2**). However, the included population had significantly higher education levels than those excluded (>A-level 24.6% vs 21.1%, A-level 15.8% vs 8.9%,  $p < 0.0001$ ) and were more likely to smoke (17.6% vs 10.2%,  $p < 0.0001$ ) (**Table S2**).

**Table 1** shows the summary of characteristics of the included sample of pregnant women, stratified by ethnicity, with tests for association between the ethnic groups. In the included population, South Asian women were significantly older than White British women, had a higher percentage with >A-level education level, were more likely to live in the highest deprivation areas, less likely to smoke, had a higher proportion with depression, but a lower proportion with anxiety, independent of early pregnancy BMI. There was a significant association between BMI and ethnicity, with a higher proportion of South Asian than White British women in the overweight and obese categories(**Table 1**).

Within the White British ethnic group, women with obesity were significantly older, had a lower percentage with >A-level education level, were more deprived and less likely to smoke, compared to women with a recommended BMI (**Table 2**). Overall, 36% of White British women had depression and 48% had anxiety. Within South Asian women, those with obesity were significantly older and had a lower percentage with >A-level education level compared with women with a recommended BMI. There was no significant association between deprivation level, smoking status, depression or anxiety and early pregnancy BMI among South Asian women. In both the South Asian and White British groups, women with an obese BMI had higher proportions with depression and anxiety, compared with women with a recommended BMI, although this was not statistically significant.

There was no significant association between depression and early pregnancy BMI among White British

women (**Table 3**) . Univariate regression found that South Asian women with an overweight BMI had significantly higher odds of depression than South Asian women of recommended BMI (odds ratio (OR) 1.17, 95% confidence interval (CI) 1.00-1.36). After adjusting for age, education level, smoking and deprivation, the adjusted odds ratio (AOR) was no longer significant (AOR 1.16, 95% CI 0.99-1.36). No other associations between BMI and depression were found to be significant. Interaction analysis found no significant association between ethnicity and antenatal depression within any BMI category (**Table 3**).

**Table 4** shows the crude and adjusted ORs for screening positive for anxiety within each ethnic group for each BMI category and AORs for interaction analysis between White British and South Asian women. Univariate analysis showed that White British women with an overweight BMI had significantly higher odds of anxiety compared with White British women of recommended BMI (OR 1.21, 95% CI 1.03-1.42). This remained significant after adjusting for age, ethnicity, education level, smoking and deprivation (AOR 1.25, 95% CI 1.05-1.47). White British women with obesity also had higher odds of anxiety compared with recommended weight (OR 1.18, 95% CI 1.00-1.39). However, after adjustments this result was no longer significant (AOR 1.13, 95% CI 0.95-1.35). There was no significant association between anxiety and early pregnancy BMI among South Asian women. Interaction analysis found no significant association between ethnicity and antenatal anxiety within any BMI category (**Table 4**) .

Other exposure variables were shown to be associated with antenatal depression and anxiety within White British and South Asian women (**Table S3**). For White British women, maternal age (AOR 0.98, 95% CI 0.97-0.99) and education (no education AOR 2.12, 95% CI 1.63-2.76) were significantly associated with depression, and smoking was significantly associated with both depression (AOR 1.32, 95% CI 1.12-1.56) and anxiety (AOR 1.34, 95% CI 1.14-1.57). For South Asian women, maternal age (AOR 1.02, 95% CI 1.01-1.04) and education (no education AOR 0.65, 95% CI 0.55-0.78) were significantly associated with anxiety, and smoking was significantly associated with both depression (AOR 2.08, 95% CI 1.49-2.91) and anxiety (AOR 2.87, 95% CI 2.02-4.07).

## Discussion and conclusion

### Main findings

This study identified little evidence that early pregnancy BMI is a risk factor for antenatal depression or anxiety within South Asian and White British women in this population. There was an association between ethnicity and antenatal depression and anxiety with a significantly higher proportion of South Asian women with depression compared with White British women, but lower proportion with anxiety, independent of early pregnancy BMI.

Analysis of other socio-demographic variables identified smoking during pregnancy was a more important risk factor for both antenatal depression and anxiety in White British and South Asian women than early pregnancy BMI. Lack of education was a risk factor for antenatal depression in White British women but reduced the odds of antenatal anxiety in South Asian women. Older age was a risk factor for antenatal anxiety in South Asian women but reduced the odds of antenatal depression in White British women. However, effect sizes for maternal age were very small compared to smoking and education.

### Strengths and limitations

This study used data from a large prospective birth cohort, which minimises selection bias. However, following exclusions and categorisation of data, sample sizes were reduced. Although this study had a large sample size of 3514 White British women and 4310 South Asian women, the numbers of women with early pregnancy obesity were much smaller (903 and 1312 respectively). This study applied the Asian-specific BMI criteria as well as carrying out a secondary analysis using general population BMI criteria, which adds to the pregnancy evidence-base for South Asian women. We also used mother's booking BMI which is measured in early pregnancy rather than self-reported pre-pregnancy weight and height. This approach reduces self-reporting bias since self-reported BMI tends to be under-estimated and provides a more accurate measure of BMI.<sup>22</sup>

The South Asian ethnic group encompassed Pakistani, Indian and Bangladesh women which may introduce heterogeneity. Pakistani women have higher rates of obesity compared to Indian and Bangladeshi women.<sup>23</sup> Rates of depression are also different between these sub-groups, with Indians showing higher rates (61%) compared with Pakistani and Bangladeshi people (55%).<sup>24</sup> Nevertheless, 88% of the included South Asian group were Pakistani, therefore, inclusion of women from India and Bangladesh may not have resulted in much bias.

The use of the GHQ in a South Asian sample comes with limitations as screening instruments may perform differently in different populations due to cultural and social differences.<sup>25</sup> This is especially important to consider when assessing differences between populations as was the case in this study. In a study examining the psychometric properties of the subscales of the GHQ in a multi-ethnic maternal sample from the BiB cohort,<sup>25</sup> results showed that there was variation in the concepts measured by the GHQ between groups of different language and ethnic heritage. This may be due to the artefacts of translation and administration bias. The meaning of underlying concepts for some of the GHQ items differ according to language of administration.<sup>25</sup> Nevertheless, these issues of subjectivity and translations are found within most measurement tools, hence, more studies should be carried out in South Asian women using measurement tools such as the Edinburgh Postnatal Depression Scale (EPDS) which has validated Urdu<sup>26</sup> and Bengali<sup>27</sup> versions.

### Interpretations

Our results indicate there were no significant associations between antenatal depression and anxiety and early pregnancy BMI within this population. There is limited literature on the association between maternal BMI and depression and anxiety in the UK, with one study also showing no significant association in either mental health condition.<sup>28</sup> However, meta-analysis<sup>4</sup> of studies across international, mainly high-income, settings showed significantly increased odds of depression during pregnancy among women with overweight and obese BMIs, compared with women of recommended BMI. It also found significantly increased odds of anxiety in women with obesity, compared with women of recommended BMI, but no significant association for overweight.<sup>4</sup>

The difference in statistical significance of the results between this study and the meta-analysis<sup>4</sup> could be due to the outcome measurement tool. The GHQ was not used in any of the studies included in the meta-analysis<sup>4</sup> which mostly used either the Centre for Epidemiological Studies Depression Scale (CES-D)<sup>29,30</sup> or EPDS<sup>31,32</sup> for depression and The State-Trait Anxiety Inventory (STAI) for anxiety.<sup>30</sup> This can introduce variation in the classification of depression and anxiety between this study and other literature.

In this study, depression rates are higher in South Asian women compared with White British, whereas, anxiety rates are lower. Gater et al<sup>33</sup> found that depressive disorder was more common in Pakistani women compared with White women. McKenzie et al<sup>34</sup> found higher rates of suicide among older South Asian women, compared to White women. In relation to anxiety, there is a lack of published literature examining rates of anxiety within South Asian women in the UK. However, Weich et al<sup>35</sup> found that rates of common mental disorders (anxiety and depression) were higher in Pakistani women compared to White women of similar age. The contradicting results for anxiety may be partly methodological, since Weich et al<sup>35</sup> used the Revised Clinical Interview Schedule (CIS-R), whereas, this study used the GHQ which is not recommended for epidemiological assessment in South Asian women<sup>23</sup>. It may also be explained by the study settings, this study was set in Bradford which has a high density of South Asian's. These large social networks have been shown to be beneficial for mental health due to feelings of shared identity and provision of support<sup>36</sup>. Therefore, in this study population, general anxiety symptoms may be managed by these large social networks among South Asian women.

Smoking during pregnancy has been associated with increased antenatal depression and anxiety in the literature.<sup>37,38</sup> This may be due to the negative impact of nicotine on psychiatric symptoms<sup>38</sup> but also related to increased guilt for not being able to quit and health concerns for the baby.<sup>38</sup> Although this study found that less South Asian women smoke during pregnancy, the impact of smoking tends to be higher among South Asian women due to cultural and religious stigma attached to it<sup>39</sup>. This could play a role in

higher depression rates found in South Asian women.

Lack of education has been shown to be a risk factor for antenatal depression in many studies.<sup>40,41,42</sup> However, in a study of South Asian women, it reduced antenatal anxiety and depression<sup>43</sup> which is also highlighted in this study. This could be explained by gender roles in South Asian culture in which women are expected to be more involved in taking care of the family than earning money or getting educated<sup>44</sup>. Therefore, South Asian women with less education tend to be more accepted by their in-laws as they fulfil their roles and responsibilities within the family. This may reduce the amount of stress and conflict within the family.

## Conclusion

This study suggests little evidence to support an association between early pregnancy BMI and antenatal depression and anxiety in South Asian or White British women in this population. Smoking was found to be an important risk factor for antenatal depression and anxiety, particularly among South Asian women who have higher rates of antenatal depression. Further research should focus on South Asian women using validated depression and anxiety measurement tools for this population and Asian-specific BMI criteria.

## Disclosure of interests

None declared. Completed disclosure of interest forms are available to view online as supporting information.

## Contribution of authorship

Conception: JR, ES, NH. Planning: NI, JR, ES, NH. Access to data: NI, ES, NH, JR. Data analysis: NI, ES. Review of results: NI, ES, NH, JR. Writing of manuscript: NI, ES, NH, JR.

## Details of ethics approval

BiB have ethics approval from Bradford Research Ethics Committee for the data to be collected and used for research purposes (REC reference number: 07/H1302/112). Approval of data sharing and collaboration from BiB was received on 07/03/19 which was an addendum to a previous application (ID SP48).

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**Table 1** Maternal characteristics of all women stratified by ethnicity

	<b>Total n = 7824</b>	<b>White British n = 3514</b>	<b>South Asian n = 4310</b>	<b>p value<sup>P</sup></b>
<b>BMI categories<sup>+</sup> (n, %)</b>				<b>&lt;0.0001**</b>
Underweight	336 (4.3) 2835 (36.2) 2438 (31.2)	94 (2.7) 1514 (43.1) 1003 (28.5) 903	242 (5.6) 1321 (30.6) 1435 (33.3)	
Recommended	2215 (28.3) 1361 (17.4) 589 (7.5) 265	(25.7) 508 (14.5) 264 (7.5) 131 (3.7)	1312 (30.4) 853 (19.8) 325 (7.5) 134	
Overweight Obese	(3.4)		(3.1)	
Class 1 Class 2				
Class 3				

	<b>Total n = 7824</b>	<b>White British n = 3514</b>	<b>South Asian n = 4310</b>	<b>p value<sup>P</sup></b>
<b>Age (mean, SD)</b>	Mean = 27.3 ± 0.1	26.6 ± 0.1	27.8 ± 0.1	<b>&lt;0.0001**</b>
<b>Education level (n, %)</b>	1685 (21.5) 2475 (31.6)	698 (19.9) 1192 (33.9)	987 (22.9) 1283 (29.8)	<b>&lt;0.0001**</b>
None GCSE	1235 (15.8)	645 (18.3)	590 (13.7)	
A-level Higher than A-Level	1924 (24.6) <i>505 (6.4)</i>	678 (19.3) <i>301 (8.6)</i>	1246 (28.9) <i>204 (4.7)</i>	
<b>IMD level (n, %)</b>	2696 (34.5) 5125 (65.5)	1702 (48.4) 1810 (51.5)	994 (23.1) 3315 (76.9)	<b>&lt;0.0001**</b>
Low deprivation	<i>3 (0.04)</i>	<i>2 (0.1)</i>	<i>1 (0.02)</i>	
High deprivation	<i>Missing</i>			
<b>Smoking status (n, %)</b>	1375 (17.6) 6446 (82.4)	1217 (34.6) 2295 (65.3)	158 (3.7) 4151 (96.3)	<b>&lt;0.0001**</b>
Yes No	<i>3 (0.04)</i>	<i>2 (0.1)</i>	<i>1 (0.02)</i>	
<i>Missing</i>				
<b>Depression (n, %)</b>	3158 (40.4) 4666 (59.6)	1267 (36.1) 2247 (63.9)	1891 (43.9) 2419 (56.1)	<b>&lt;0.0001**</b>
Yes No				
<b>Anxiety (n, %)</b>	3655 (46.7) 4113 (52.6)	1701 (48.4) 1790 (22.9)	1954 (45.3) 2323 (53.9)	<b>0.004**</b>
Yes No	<i>56 (0.7)</i>	<i>23 (0.3)</i>	<i>33 (0.8)</i>	

SD=standard deviation

GCSE= The General Certificate of Secondary Education

IMD=Index of Multiple deprivation

**+White British BMI categories:** Underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-24.9 kg/m<sup>2</sup>; overweight, 25-29.9 kg/m<sup>2</sup>; obese, [?]30 kg/m<sup>2</sup>; obese class 1, 30.0-34.9 kg/m<sup>2</sup>; obese class 2, 35.0-39.9 kg/m<sup>2</sup>; obese class 3, [?]40.0 kg/m<sup>2</sup>  
**South Asian BMI categories:** underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-22.9 kg/m<sup>2</sup>; overweight, 23-27.49 kg/m<sup>2</sup>; obese, [?]27.5 kg/m<sup>2</sup>; obese class 1, 27.5-32.49 kg/m<sup>2</sup>; obese class 2, 32.5-37.49 kg/m<sup>2</sup>; obese class 3, [?]37.5 kg/m<sup>2</sup>

\*\*Significant at 0.01 significance level (two-tailed)

<sup>P</sup>T-test for continuous variable and chi-squared with Fishers exact (where cell count < 5) for categorical variables

*Missing data not included in Chi-squared analysis*

	Underweight	Underweight	Recommended weight	Recommended weight	Overweight	Overweight	Obese class 1	Obese class 2	Obese class 2	Obese class 3	Obese class 3	Obese class 3	p value
	White British	South Asian	White British	South Asian	White British	South Asian	White British	South Asian	White British	South Asian	White British	South Asian	
	N=94	N=242	N=1514	N=1321	N=1003	N=1435	N=508	N=853	N=264	N=325	N=131	N=134	
<b>Age (mean±SD)</b>	21.8±0.5	25.2±0.3	25.7±0.2	26.4±0.1	27.4±0.2	28.2±0.1	27.7±0.2	29.0±0.2	27.6±0.3	29.2±0.3	28.2±0.5	30.8±0.5	0.0001

	Underweight	High weight	Recommended weight	Recommended weight	Overweight	Overweight	Obese class 1	Obese class 2	Obese class 2	Obese class 3	Obese class 3	p value	
<b>Education level (n, %)</b>	50 (29.8)	80 (33.1)	329 (21.7)	255 (19.3)	169 (16.8)	321 (22.4)	88 (17.3)	212 (24.9)	55 (20.8)	100 (30.8)	29 (22.1)	49 (36.6)	<0.001**
None	12 (45.7)	27 (33.1)	247 (33.8)	186 (29.7)	202 (32.7)	202 (28.3)	103 (34.1)	120 (30.7)	58 (34.1)	41 (31.4)	23 (35.1)	14 (31.3)	
GSCE A-level	7 (12.8)	76 (31.4)	316 (20.9)	428 (32.4)	210 (20.9)	439 (30.6)	91 (17.9)	223 (26.1)	32 (12.1)	65 (20.0)	22 (16.8)	15 (11.2)	
Higher than A-Level	24 (7.4)	55 (31.4)	765 (20.9)	330 (32.4)	535 (20.9)	349 (30.6)	234 (17.9)	179 (26.1)	95 (12.1)	60 (20.0)	49 (16.8)	21 (11.2)	<0.001**
<b>IMD level (n, %)</b>	24 (25.5)	55 (22.7)	765 (50.5)	330 (25.0)	535 (53.3)	349 (24.3)	234 (46.1)	179 (21.0)	95 (36.0)	60 (18.5)	49 (37.4)	21 (15.7)	<0.001**
Low deprivation	70 (74.5)	186 (76.9)	748 (49.4)	991 (75.0)	468 (46.7)	1086 (75.7)	273 (53.7)	674 (79.0)	169 (64.0)	265 (81.5)	82 (62.6)	113 (84.3)	
High deprivation	6 (59.6)	236 (97.5)	542 (64.1)	48 (96.4)	322 (67.9)	63 (95.5)	165 (67.5)	21 (97.5)	98 (62.9)	14 (95.7)	34 (74.0)	6 (95.5)	<0.001**
<b>Smoking status (n, %)</b>	38 (40.4)	236 (97.5)	970 (64.1)	1273 (96.4)	681 (67.9)	1371 (95.5)	343 (67.5)	832 (97.5)	166 (62.9)	311 (95.7)	97 (74.0)	128 (95.5)	
Yes	38 (40.4)	236 (97.5)	970 (64.1)	1273 (96.4)	681 (67.9)	1371 (95.5)	343 (67.5)	832 (97.5)	166 (62.9)	311 (95.7)	97 (74.0)	128 (95.5)	
No	97 (39.4)	145 (59.9)	543 (64.1)	555 (58.0)	352 (64.9)	657 (54.2)	179 (64.8)	380 (55.5)	107 (59.5)	137 (57.8)	49 (62.6)	65 (51.5)	0.63
<b>Depression (n, %)</b>	57 (60.6)	145 (59.9)	971 (64.1)	766 (58.0)	651 (64.9)	778 (54.2)	329 (64.8)	473 (55.5)	157 (59.5)	188 (57.8)	82 (62.6)	69 (51.5)	
Yes	57 (60.6)	145 (59.9)	971 (64.1)	766 (58.0)	651 (64.9)	778 (54.2)	329 (64.8)	473 (55.5)	157 (59.5)	188 (57.8)	82 (62.6)	69 (51.5)	
No	38 (40.4)	95 (39.3)	699 (46.2)	581 (44.0)	510 (50.8)	657 (45.8)	250 (49.2)	405 (47.5)	131 (49.6)	153 (47.1)	73 (55.7)	63 (47.0)	0.06
<b>Anxiety (n, %)</b>	55 (58.5)	146 (60.3)	803 (53.0)	726 (55.0)	487 (48.6)	764 (53.2)	257 (50.6)	446 (52.3)	130 (49.2)	171 (52.6)	58 (44.3)	70 (52.2)	
Yes	55 (58.5)	146 (60.3)	803 (53.0)	726 (55.0)	487 (48.6)	764 (53.2)	257 (50.6)	446 (52.3)	130 (49.2)	171 (52.6)	58 (44.3)	70 (52.2)	
No	38 (40.4)	95 (39.3)	699 (46.2)	581 (44.0)	510 (50.8)	657 (45.8)	250 (49.2)	405 (47.5)	131 (49.6)	153 (47.1)	73 (55.7)	63 (47.0)	

**Table 2** Maternal characteristics of White British and South Asian women, stratified by BMI<sup>+</sup>

SD=standard deviation

GCSE= The General Certificate of Secondary Education

IMD=Index of Multiple deprivation

\*Significant at 0.05 significance level (two-tailed)

\*\*significant at 0.01 significance level (two-tailed)

P<sub>T</sub>-test for continuous variable and chi-squared with fishers exact (where cell count <5) for categorical variables

**+White British BMI categories:** Underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-24.9 kg/m<sup>2</sup>; overweight, 25-29.9 kg/m<sup>2</sup>; obese, [?]30 kg/m<sup>2</sup>; obese class 1, 30.0-34.9 kg/m<sup>2</sup>; obese class 2, 35.0-39.9 kg/m<sup>2</sup>; obese class 3, [?]40.0 kg/m<sup>2</sup>**South Asian BMI categories:** underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-22.9 kg/m<sup>2</sup>; overweight, 23-27.49 kg/m<sup>2</sup>; obese, [?]27.5 kg/m<sup>2</sup>; obese class 1, 27.5-32.49 kg/m<sup>2</sup>, obese class 2, 32.5-37.49 kg/m<sup>2</sup>, obese class 3, [?]37.5 kg/m<sup>2</sup>

*Sum of percentages may not add to 100% due to missing/incomplete data, missing data not included in chi-squared analysis*

**Table 3** Multiple logistic regression model of early pregnancy BMI and screening positive for depression stratified by ethnicity with interaction model between White British and South Asian women

Anxiety	White British	White British	South Asian	South Asian	Interaction AOR <sup>a</sup> WB = reference
BMI categories <sup>+</sup>	Unadjusted OR (95% CI)	<b>AOR (95% CI)<sup>a</sup></b>	Unadjusted OR (95% CI)	<b>AOR (95% CI)<sup>a</sup></b>	
<b>Recommended weight</b>	<i>Reference group</i>	Reference group	<i>Reference group</i>	Reference group	<b>1.18 (0.69-2.01)</b>
<b>Underweight</b>	0.80 (0.52-1.22)	<b>0.75 (0.48-1.17)</b>	0.80 (0.52-1.22)	<b>0.82 (0.61-1.09)</b>	<b>1.23 (0.60-2.52)</b>
<b>Overweight</b>	1.21 (1.03-1.42)*	<b>1.25 (1.05-1.47)**</b>	1.09 (0.94-1.27)	<b>1.06 (0.91-1.24)</b>	<b>1.05 (0.0-1.79)</b>
<b>Obese</b>	1.18 (1.00-1.39)*	<b>1.13 (0.95-1.35)</b>	1.13 (0.97-1.31)	<b>1.13 (0.96-1.33)</b>	<b>1.04 (0.85-1.29)</b>
<b>Class 1</b>	1.13 (0.92-1.38)	<b>1.09 (0.88-1.35)</b>	1.13 (0.95-1.34)	<b>1.15 (0.96-1.38)</b>	<b>1.28 (0.73-2.23)</b>
<b>Class 2</b>	1.17 (0.90-1.52)	<b>1.13 (0.85-1.49)</b>	1.13 (0.89-1.44)	<b>1.09 (0.84-1.40)</b>	<b>1.17 (0.63-2.15)</b>
<b>Class 3</b>	1.43 (0.99-2.04)	<b>1.29 (0.89-1.88)</b>	1.11 (0.78-1.58)	<b>1.10 (0.75-1.62)</b>	-

OR= odds ratio

AOR=adjusted odds ratio

CI= Confidence Interval

WB=White British

**+White British BMI categories:** Underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-24.9 kg/m<sup>2</sup>; overweight, 25-29.9 kg/m<sup>2</sup>; obese, [?]30 kg/m<sup>2</sup>; obese class 1, 30.0-34.9 kg/m<sup>2</sup>; obese class 2, 35.0-39.9 kg/m<sup>2</sup>; obese class 3, [?]40.0 kg/m<sup>2</sup>**South Asian BMI categories:** underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-22.9 kg/m<sup>2</sup>; overweight, 23-27.49 kg/m<sup>2</sup>; obese, [?]27.5 kg/m<sup>2</sup>; obese class 1, 27.5-32.49 kg/m<sup>2</sup>, obese class 2, 32.5-37.49 kg/m<sup>2</sup>, obese class 3, [?]37.5 kg/m<sup>2</sup>\*Significant at 0.05 significance level (two-tailed)

-Insufficient data to run the model

<sup>a</sup>Adjusted for Maternal age, maternal education, area of residence deprivation and maternal smoking

**Table 4** Multiple logistic regression model of early pregnancy BMI and screening positive for anxiety stratified by ethnicity with interaction model between White British and South Asian women

<b>Anxiety</b>	<b>White British</b>	<b>White British</b>	<b>South Asian</b>	<b>South Asian</b>	<b>Interaction AOR<sup>a</sup> WB = reference</b>
BMI categories <sup>+</sup>	Unadjusted OR (95% CI)	<b>AOR (95% CI)<sup>a</sup></b>	Unadjusted OR (95% CI)	<b>AOR (95% CI)<sup>a</sup></b>	
<b>Recommended weight</b>	<i>Reference group</i>	Reference group	<i>Reference group</i>	Reference group	<b>1.18 (0.69-2.01)</b>
<b>Underweight</b>	0.80 (0.52-1.22)	<b>0.75 (0.48-1.17)</b>	0.80 (0.52-1.22)	<b>0.82 (0.61-1.09)</b>	<b>1.23 (0.60-2.52)</b>
<b>Overweight</b>	1.21 (1.03-1.42)*	<b>1.25 (1.05-1.47)**</b>	1.09 (0.94-1.27)	<b>1.06 (0.91-1.24)</b>	<b>1.05 (0.0-1.79)</b>
<b>Obese</b>	1.18 (1.00-1.39)*	<b>1.13 (0.95-1.35)</b>	1.13 (0.97-1.31)	<b>1.13 (0.96-1.33)</b>	<b>1.04 (0.85-1.29)</b>
<b>Class 1</b>	1.13 (0.92-1.38)	<b>1.09 (0.88-1.35)</b>	1.13 (0.95-1.34)	<b>1.15 (0.96-1.38)</b>	<b>1.28 (0.73-2.23)</b>
<b>Class 2</b>	1.17 (0.90-1.52)	<b>1.13 (0.85-1.49)</b>	1.13 (0.89-1.44)	<b>1.09 (0.84-1.40)</b>	<b>1.17 (0.63-2.15)</b>
<b>Class 3</b>	1.43 (0.99-2.04)	<b>1.29 (0.89-1.88)</b>	1.11 (0.78-1.58)	<b>1.10 (0.75-1.62)</b>	-

OR= odds ratio

AOR=adjusted odds ratio

CI= Confidence Interval

WB=White British

**+White British BMI categories:** Underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-24.9 kg/m<sup>2</sup>; overweight, 25-29.9 kg/m<sup>2</sup>; obese, [?]30 kg/m<sup>2</sup>; obese class 1, 30.0-34.9 kg/m<sup>2</sup>; obese class 2, 35.0-39.9 kg/m<sup>2</sup>; obese class 3, [?]40.0 kg/m<sup>2</sup>**South Asian BMI categories:** underweight, <18.5 kg/m<sup>2</sup>; recommended weight, 18.5-22.9 kg/m<sup>2</sup>; overweight, 23-27.49 kg/m<sup>2</sup>; obese, [?]27.5 kg/m<sup>2</sup>; obese class 1, 27.5-32.49 kg/m<sup>2</sup>, obese class 2, 32.5-37.49 kg/m<sup>2</sup>, obese class 3, [?]37.5 kg/m<sup>2</sup>\*Significant at 0.05 significance level (two-tailed)

\*\*Significant at 0.01 significance level (two-tailed)

-Insufficient data to run the model

<sup>a</sup>Adjusted for Maternal age, maternal education, area of residence deprivation and maternal smoking