Title: Association of depression and anxiety with clinical, sociodemographic, lifestyle and environmental factors in South Asians and white Europeans.

Short title: Association of depression and anxiety in South Asians and white Europeans.

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Word count – main text: 3063

Word count – abstract: 245

Number of tables: 3

Number of figures: 2

Electronic supplementary material: Tables S1–2

What's new?

What is already known?

Depression is associated with Type 2 diabetes where the direction of causation has been suggested to be bidirectional in nature.

What this study has found?

South Asian individuals at high-risk of Type 2 diabetes reported higher depressive symptoms compared to white Europeans. This was irrespective of a number of clinical, sociodemographic, lifestyle or environmental factors.

What are the clinical implications of the study?

Developing and evaluating culturally appropriate methods for treating depression need to be integrated into diabetes prevention services in the future. Integrating depression screening and treatment into these services, with particular focus on minority populations, may improve engagement and retention.

Abstract:

Aim: To investigate prevalence and correlates of depressive and anxiety symptoms within South Asians and white Europeans at high-risk of developing Type 2 diabetes.

Method: Data were collected at baseline, 12, 24 and 36 months from 1429 white Europeans (age=64±7; 35.8% female) and 160 South Asians (age=59±9; 30.6% female) who were at high-risk of Type 2 diabetes from two Type 2 diabetes prevention trials in Leicestershire, UK. The Hospital Anxiety and Depression Scale was administered during each study visit. Clinical, sociodemographic, lifestyle and environmental data were collected.

Results: At baseline, the burden of depressive symptoms varied by ethnic group and gender, with 9.9% of white European men, 14.9% of white European women, 23.6% of South Asian men and 29.2% of South Asian women exceeding the cut-off score for mild-to-severe depression. During the course of the study and after adjustment for clinical, sociodemographic, lifestyle and environmental factors, depressive symptoms remained higher in South Asians compared to white Europeans [1.5 higher score; 95% CI=0.9, 2.1]. Levels of anxiety were also higher in South Asians, although associations were attenuated after adjustment. Social deprivation, body mass index, proximity to fast-food outlets and physical activity acted as correlates for depression in South Asians and white Europeans.

Conclusions: A higher burden of depressive symptoms were consistently evident among South Asians, even after adjustment for multiple covariates. It is important to understand the reasons why these differences are present to help reduce health inequalities and whether higher levels of depressive symptoms affect the uptake and retention to diabetes prevention programmes in South Asian communities.

Key words: Diabetes, ethnicity, depression, anxiety, South Asians

Introduction

Depression is one of the leading causes of disability worldwide, affecting around 350 million people (1). Prevalence estimates across continents range from 2.6 to 5.9% (2). It is one of the most prevalent and debilitating forms of mental health disorder, characterised by either a major depressive disorder (MDD) or a collection of mental and physical depressive symptoms that persist for a minimum of two weeks. Depression is a common co-morbidity of Type 2 diabetes, where the relationship is said to be bidirectional in nature (3).

Although levels of depression within the general and Type 2 diabetes populations have been well researched (2, 4), the generalisability of the findings to minority populations is less well understood. South Asian populations form a large proportion of the global population, standing at just under two billion people (1 in 4). It has been established that South Asian individuals, especially those living in high-income countries, are at elevated risk of developing Type 2 diabetes and cardiovascular disease (CVD) (5). As a result, South Asians may be at increased risk of depression due to the postulated bidirectional relationship between diabetes and depression (6). There is some evidence suggesting migrant South Asian populations have worse mental health than white Europeans (7, 8). For depression specifically however, there is paucity of consistent evidence. The extent to which the associations between South Asian populations and higher levels of depression are confounded or explained by metabolic health, socioeconomic status, lifestyle behaviours or related environmental factors has not been investigated.

This study aims to investigate whether South Asians have higher levels of depressive and anxiety symptoms compared to white Europeans in a sample that was recruited from primary care for diabetes prevention programmes, and whether this difference is independent of clinical, sociodemographic, lifestyle and environmental factors. A further aim was to quantify the clinical, sociodemographic, lifestyle and environmental correlates of depressive and anxiety symptoms and whether these are modified by ethnicity.

Participants and Method

Participants

This study included participants from two Type 2 diabetes prevention trials that were undertaken in Leicestershire, UK using the same standard operating procedures: Let's Prevent Diabetes ('Let's Prevent', ClinicalTrials.gov registration number NCT00677937), and Walking Away from Diabetes ('Walking Away', NCT00941954). Data were collected at baseline, 12, 24 and 36 months. Neither study reported a difference between control and intervention group in depressive symptoms during follow-up. Full study descriptions are available elsewhere (9, 10).

Walking Away: 808 adults were recruited from 10 general practices, 2010–2011. Individuals aged between 18-74 years were included on the basis of having a high risk of impaired glucose regulation (IGR) (composite of impaired glucose tolerance and/or impaired fasting glycaemia) or undiagnosed Type 2 diabetes identified using a modified version of the automated Leicester Risk Score, specifically designed to be administered in primary care. Participants were excluded if they had an existing diagnosis of Type 2 diabetes or were diagnosed with Type 2 diabetes at baseline, were taking steroids or were unable to speak English (10). An automated platform using medical records was used to rank individuals for diabetes risk using predefined weighted variables (age, sex, ethnicity, body mass index (BMI), family history of Type 2 diabetes and use of antihypertensive medication). Those scoring above the 90th centile in each practice were invited to attend a screening visit and to

take part in the study. All those who were screened and did not have diabetes were included in a randomised controlled trial testing the effectiveness of a structured education programme designed to promote increased walking activity (10).

Let's Prevent Diabetes: 880 adults were recruited from 44 general practices, 2010–2011. The inclusion criteria for screening were ages between 40-75 years (if white European) or 25-75 years (if South Asian). As with Walking Away, individuals were recruited on the basis of scoring within the 90th centile of the automated Leicester Risk Score. Participants were excluded if they were unable to give informed consent, pregnant or lactating, had established diabetes or a terminal illness, or if they required an interpreter for a language other than one of the locally used South Asian languages accommodated within this study (9). Those confirmed to have IGR were invited to continue into a randomised controlled trial testing the effectiveness of a structured education programme designed to promote increased walking activity, a healthy diet and weight loss.

Individuals were only eligible if they were at high-risk of developing Type 2 diabetes, and were excluded if they had a previous diagnosis of Type 2 diabetes.

Depression and anxiety

The Hospital Anxiety and Depression Scale (HADS) was administered to all participants in English at baseline, 12, 24 and 36 months. HADS is a valid scale of depression and anxiety when used in a primary care and community setting (11). It gives a score of between 0-21 for both depression and anxiety, with a score of 8-10 demonstrating mild depression/anxiety risk, 11-14 moderate depression/anxiety risk and 15-21 severe depression/anxiety risk (12).

Depression and anxiety scores assessing the number and severity of depressive symptoms were used as a continuous outcome for the main analysis. In addition, for descriptive purposes, we categorised into those without depression or anxiety risk (score of 0-7) and those with mild-severe depression or anxiety risk (a score of ≥8) (12).

Classification of ethnicity

Those defining themselves as white (British, Irish or other) or Asian or Asian British (Indian, Pakistani, Bangladeshi or other) were included. Other ethnicities were excluded due to low numbers.

Variables/covariates

Sociodemographic and health data such as ethnicity, age, sex, smoking status and statin and antihypertensive medication status were collected via interview-administered questionnaire. Body weight and height were measured to the nearest 0.1kg and 0.5cm, respectively. Glycaemic status was determined by HbA1c. Deprivation level was determined by assigning an Index of Multiple Deprivation (IMD) score to participant postcodes.

Objective physical activity (average number of steps per day) was measured in Let's Prevent (sealed piezoelectric pedometer, NL-800, New Lifestyles, USA) and Walking Away (waist-worn GT3X, ActiGraph, Pensacola, FL, USA). At least three and four valid days of data were required in Let's Prevent and Walking Away, respectively. Participants wore the devices for a minimum of three (Let's Prevent) or four (Walking Away) days during waking hours with a minimum wear period of 10 hours per valid day. A commercially available data analysis tool (KineSoft version 3.3.76, Kinesoft, Loughborough, UK; www.kinesoft.org) was used to process the accelerometer data. As both monitors have high levels of accuracy for detecting steps taken, data were pooled as described previously (13).

Environmental factors

Data on participants' environmental factors were included as covariates and included: neighbourhood greenspace (14), proximity to fast-food outlets (15) and air pollutions levels (16). All environmental factors were based on the home postcodes of participants. Data were added because of previous work stating social determinants of health including environmental factors may influence mental health (17).

Neighbourhood greenspace was defined using the geographical information system software ArcGIS 9.3 (18) as previous described (14). A circle with a radius of 3km was used to measure percentage of greenspace in participants' neighbourhood.

Proximity to fast-food ('fast food', 'fish and chips' and 'take away') outlets near homes was defined as the number within a circle with a radius of 500m of a participant's home using methods described previously (15).

Air pollution data were derived from the DEFRA Pollution Climate Mapping (PCM) model, which is described elsewhere (19). Exposure to air pollution was defined as the three-year average, including the year in which the participant entered the study and the preceding two years. Prevailing estimates of outdoor nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$ and PM_{10}) concentrations in a 1×1 km area that the participant's home postcode fell in were used (16).

Statistical analysis

Data from the Walking Away and Let's Prevent studies were pooled. Participants were excluded from this analyses if they did not have a valid score for depression and anxiety. Data across all time points (baseline, 12, 24 and 36 month) was used. A generalised estimating equations (GEE) model with an exchangeable correlation structure was used to allow for analysis of repeated measurements and clustering by GP practice. Continuous depressive and anxiety symptoms data displayed a positive skewed distribution and were therefore analysed using a gamma distribution with an identify link. Zero values were included in the model as 0.001. Resulting beta-coefficients represent the difference in depressive or anxiety symptom scores between ethnic groups. Categorical data were analysed using a binary response and reported as an odds ratio (OR) representing the odds of depression or anxiety risk in South Asians vs white Europeans. Model 1 was unadjusted, model 2 included age, sex, treatment group and deprivation level. Model 3 was additionally adjusted for BMI and A1c. The fully adjusted model (model 4) also included air pollution, number of fast-food outlets, neighbourhood greenspace, physical activity levels, smoking status and medication status (statins and antihypertensives).

Interaction terms for ethnicity × sex were added to the fully adjusted model to investigate whether sex modified associations between ethnicity and depressive symptoms (continuous score). Data were analysed on a complete case basis for each model, therefore a sensitivity analysis using multiple imputation using the AUTO IMPUTATIONS command was undertaken to assess whether replacing missing data affected results for the main associations or interactions by sex. $P<0.05$ was considered significant for main effects and $p<0.1$ for interactions. Data is reported as mean (95% CI) (for continuous data) or OR (95% CI) (for categorical data) unless specified otherwise. Data were analysed in SPSS version 24.

In order to investigate correlates of depressive and anxiety symptoms, post-hoc GEE models were used to analyse the association between individual covariates and depressive symptoms. Models were mutually adjusted to determine which factors were independent correlates of depressive symptoms. Social deprivation, greenspace and air pollution were found to be strongly correlated ($r >0.4$) therefore, these factors were not mutually added to

the model; greenspace was used as the preferred covariate as it had the least missing data, apart from in models investigating social deprivation and air pollution.

Results

Descriptive statistics stratified by ethnicity and gender are summarised in Table 1. Overall, 1429 [89.9%] white European and 160 [10.1%] South Asian individuals were included; the vast majority of the South Asian sample (n = 156) classified themselves as Indian. White Europeans contributed 3408 observations to the analysis and South Asians 370 observations. South Asians had substantially higher levels of social deprivation (IMD score 23.4 vs. 16.7). Compared to their white European counterparts, South Asians were younger (59 [±9] vs. 64 [±7]), with higher HbA1c (6.2 [±0.5] (44 [±5]) vs. 6.0% [±0.4] (42mmol/mol [±4])), greater exposure to air pollution (22.6 [±2.4] vs. 18.7 NO_2, $PM_{2.5}$ and PM_{10}/µg·m3 [±4.0]), less access to greenspace (37.5 [±16.7] vs. 61.3% cover in 3km radius [±24.9]) and were surrounded by more fast-food outlets per 500m (3 [±4] vs. 2 [±3]). South Asian women had the highest prevalence of mild-severe depressive symptoms (29.2%), whereas white European men had the lowest (9.9%). South Asian women had the highest prevalence of mild-severe anxiety symptoms (35.4%), with white European men reporting the lowest (19.6%).

Depression

An association was found between South Asians and white Europeans in depressive symptom scores and depression risk. Unadjusted depression scores were 1.5 [0.9, 2.1] units higher in South Asians compared to white Europeans (Figure 1; Table S1). Results were not affected after adjusting for clinical, sociodemographic, lifestyle or environmental factors (Figure 1, Table S1). Sex was not found to modify results (p=0.380 for interaction) so stratified analyses was not undertaken.

The OR for mild-severe depression risk were also higher in South Asians compared to white Europeans. Unadjusted OR for South Asians compared to white Europeans were 2.81 [2.03, 3.87] (Figure 1; Table S1). Results were not affected after adjusting for clinical, sociodemographic, lifestyle and environmental factors (Figure 1; Table S1).

Anxiety

Unadjusted anxiety symptom scores were 0.6 [0.0, 1.2] units higher in South Asians compared to white Europeans (Figure 2; Table S2). After adjusting for clinical, sociodemographic, lifestyle and environmental factors, anxiety level results were attenuated and there were no differences between ethnicities. Sex was not found to modify results (p=0.195 for interaction).

Unadjusted OR for mild-severe anxiety risk in South Asians compared to white Europeans was 1.52 [1.12, 2.07] (Table S2), although differences were attenuated in the fully adjusted model.

Sensitivity analysis

Using multiple imputation to replace missing data did not change the interpretation of results for depressive or anxiety symptoms. In the fully adjusted model, depressive symptom scores in South Asians were 1.6 [1.1, 2.1] (Table S1) units higher than white Europeans. Sex was not found to modify results (p=0.850 for interaction).

Individual correlates of depression and anxiety

Depression

Post-hoc analysis found social deprivation, BMI, fast-food outlets and physical activity to be associated with depressive symptoms (Table 2). None of these associations were modified by ethnicity (p for ethnicity interaction > 0.10).

Anxiety

Post-hoc anxiety analysis found age, sex, social deprivation, BMI and HbA1c to be associated with anxiety symptoms (Table 3). Ethnicity was found to modify the association between smoking and anxiety symptoms (P for interaction = 0.067), however the association was not significant in either ethnicity when stratified analysis was undertaken ((South Asians = 3.2 [-0.4, 6.7]) (white Europeans = 0.1 [-0.6, 0.8])).

Discussion

This present study found that South Asians display greater depressive symptoms, compared to white Europeans in a population at high-risk of Type 2 diabetes recruited from primary care. This suggests that the higher levels of depressive symptoms in South Asians were not explained by the differences in dysglycaemia (HbA1c), physical activity, social deprivation, air pollution or the physical environment compared to white Europeans. Levels of anxiety symptoms were also higher in South Asians compared to white Europeans, however results were less consistent than for depressive symptoms and were attenuated after adjustment.

These findings contrast with previous work investigating ethnic differences in depression risk which found no association between white Europeans and South Asians who had normal glucose tolerance, impaired glucose tolerance and Type 2 diabetes at baseline (20). Similarly, although Williams et al found higher levels of depressive symptoms in the general South Asian population, the reported differences were largely attenuated after adjusting for differences in physical health (7). However, our results are consistent with a study showing the prevalence of depressive symptoms were higher in British South Asians (21) and with another study showing South Asian men have reported to be more depressed (8), compared to white Europeans.

There are several environmental factors that may explain the observations reported in this study. Given the study population were older and more likely to be first generation migrants, issues surrounding migration may be more applicable to them, compared to second or third-generation migrants. It has been previously stated that increased depressive symptoms and depression risk in minority populations can be typically found in migrants due to environmental, economic, social and psychological factors (22). Whilst this study captured many of these factors, other factors such as lack of opportunity for upward social mobility, discrimination, poor language skills and leaving native homelands may all attribute to increased depressive symptoms (7, 23). These factors may lead to increased stress and social isolation, which in turn could potentially increase depressive symptoms. It has been suggested that lack of control over your future and low status are social determinants that can negatively affect a person's physical and mental health (17). Indeed, evidence has illustrated that South Asians who integrate more with host country culture display less depressive symptoms, compared to those who separate themselves from the host country culture (24).

It has also been suggested that South Asian communities have misconceptions about mental health disorders, which stem from myths, beliefs and perceptions on depression and wider mental health disorders, including their symptoms and behaviours (25). A history of

misconception about mental health disorders within South Asian culture may attribute to increased risk, due to lack of awareness or not seeking help and therefore, not reducing their risk. For example, it is known that those from minority ethnic backgrounds including South Asians access mental health services less than white Europeans (26).

The findings from this study may have important implications for research and diabetes prevention. It is known South Asians are underrepresented in research (27), which may be partially explained by higher rates of depression or depressive symptoms. This may also affect engagement and retention onto diabetes prevention services. Individuals living with depression have been shown to be less likely to use and report more difficulties accessing diabetes healthcare services (28), and are associated with non-adherence for diabetes self-care regimens (29). Integrating depression screening and treatment into diabetes research and prevention services, with particular focus on minority populations, may improve engagement and retention. However, further investigation and evaluation is required.

An important finding from this study was that social deprivation, BMI, fast-food outlets and physical activity were all associated with depressive symptoms, however, none of these factors were modified by ethnicity. Additionally, age, sex, social deprivation, BMI and HbA1c were found to be associated with anxiety symptoms. This extends our analysis by suggesting that while absolute levels may be different across ethnicities, the correlates of depressive and anxiety symptoms are similar between ethnicities. The findings for an association between physical activity and depression score are consistent with previous studies; in particular, interventions to increase physical activity have been shown to result in reductions in depression equivalent to taking anti-depression medication (30). We also report the finding that some environmental and socioeconomic factors are important correlates for depressive symptoms, which extend previous research that has shown that air pollution (31), greenspace (32) and social deprivation (33) are associated with depression, anxiety and mental health. Those who are more deprived may also report lower levels of general health (17), due to reduced income, increased stress and greater social exclusion.

Strengths and limitations

This study has several strengths and limitations. The strengths include the pooling of data from two original studies (Walking Away & Let's Prevent). All participants were also from the same geographical location, with similar risk profiles, and measurements across both studies were performed using identical standard operating procedures. Prospective data measured across four different time points was used. The primary limitation is that HADS may not be culturally relevant to South Asian populations and may need to be tailored and validated to South Asian populations (34). Although all participants could speak English, language barriers may have nevertheless affected the understanding of the HADS. Secondly, the term 'South Asian' covers a wide selection of different cultures, languages and religions. The predominant subgroup nationality from this sample was Indian. Consequently, these results may not apply to all South Asians. Furthermore, the amount of South Asian women recruited was substantially less than South Asian men. Additionally, participants' anti-depressive medication was not recorded in the original studies and therefore, were unavailable for this analyses.

Due to only focusing on high-risk of diabetes individuals, the results are not representative of the wider population. While a diverse range of factors were measured in this study, genetic factors cannot be discounted as potentially attributing to increased South Asian depression and anxiety risk, particularly as depression and diabetes may share environmental and genetic aetiological origins (35). However, it has been argued genetic factors alone are unlikely to explain this increased risk of Type 2 diabetes (36), rather the interaction between environmental and genetic factors may be important (36). The combination of environmental

and genetic factors may influence depression risk in a similar manner (37), however further evidence is required to investigate genetic and biochemical differences in ethnic groups.

Conclusion

Overall, in a population at high-risk of developing Type 2 diabetes South Asian men and women reported a higher burden of depressive symptoms compared to white Europeans. This was irrespective of a number of clinical, sociodemographic, lifestyle or environmental adjustments. Levels of anxiety symptoms were higher in South Asians, but associations were attenuated after adjustment. The implications of these results need further investigation, including whether uptake and retention to diabetes prevention programmes in South Asian communities is affected by levels of depression and whether developing and evaluating culturally appropriate methods for treating depressive symptoms should be integrated into diabetes prevention services in the future.

Funding

This report is independent research funded by the National Institute for Health Research. The research was supported by the NIHR Leicester Biomedical Research Centre which is a partnership between University Hospitals of Leicester NHS Trust, Loughborough University and the University of Leicester; The National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care - Leicestershire, Northamptonshire and Rutland (NIHR CLAHRC – LNR) and East Midlands (NIHR CLAHRC EM) and the University of Leicester Clinical Trials Unit. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research Leicester BRC or the Department of Health.

Conflict of interest

None.

Acknowledgements

CR drafted the manuscript and analysed the data; TY and KK assisted with analysis and interpretation of data; TY, KK, MJD, CE, JH, ND, AC and AJ provided critical revision of the manuscript for important intellectual content; all the authors approved the manuscript for publication.

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Table 1. Baseline demographics for white Europeans and South Asians.

Characteristic	white Europeans Mean (±SD), median (IQR) or count (%)				South Asian Mean (±SD), median (IQR) or count (%)			
	Men		Women		Men		Women	
N	917 (64.2%)		512 (35.8%)		111 (69.4%)		49 (30.6%)	
Age (years)	65 (±7)	n=917	64 (±8)	n=512	60 (±9)	n=111	59 (±8)	n=49
IMD* score	10.6 (7.2, 18.7)	n=886	12.6 (7.6, 21.6)	n=503	21.9 (12.5, 29.3)	n=109	20.3 (15.6, 31.6)	n=49
BMI** (kg/m^2)	31.7 (±4.9)	n=916	34.1 (±6.1)	n=512	29.7 (±4.2)	n=111	32.9 (±4.7)	n=49
HbA1c*** (%)	5.9 (±0.4)	n=904	6.0 (±0.4)	n=498	6.1 (±0.5)	n=109	6.3 (±0.4)	n=49
HbA1c (mmol/mol)	41 (±4)	n=904	42 (±4)	n=498	43 (±5)	n=109	45 (±5)	n=49
Air pollution (NO_2, $PM_{2.5}$ and PM_{10}/µg·m3) ****	18.5 (±4.0)	n=810	19.0 (±4.0)	n=439	22.5 (±2.4)	n=102	22.7 (±2.3)	n=41
Fast-food outlets (per 500m)	2 (±3)	n=914	1 (±3)	n=509	3 (±5)	n=111	2 (±4)	n=49
Greenspace (% cover in 3km radius)	62.3 (±25.0)	n=917	59.5 (±24.7)	n=511	39.0 (±17.4)	n=111	34.2 (±14.5)	n=49
Physical activity (steps per/day)	6779 (±3176)	n=815	5756 (±2724)	n=424	6371 (±2665)	n=88	5624 (±2853)	n=39
Current smoker (y)	83 (9.1%)	n=917	37 (7.2%)	n=512	8 (7.2%)	n=111	1 (2%)	n=49
Prescribed statins (y)	366 (39.9%)	n=917	169 (33%)	n=512	45 (40.5%)	n=111	12 (24.5%)	n=49
Prescribed anti-hypertensives (y)	529 (57.7%)	n=917	287 (56.1%)	n=512	60 (54.1%)	n=111	27 (55.1%)	n=49
Depression score	3 (1, 5)	n=871	3 (1, 6)	n=484	4 (2, 7)	n=106	4 (2, 9)	n=48
Mild-severe depression	86 (9.9%)	n=871	72 (14.9%)	n=484	25 (23.6%)	n=106	14 (29.2%)	n=48
Anxiety score	4 (2, 7)	n=874	6 (3, 9)	n=483	5 (3, 8)	n=106	6 (3, 10)	n=48
Mild-severe anxiety	171 (19.6%)	n=874	152 (31.5%)	n=483	27 (25.5%)	n=106	17 (35.4%)	n=48

* Index of Multiple Deprivation, ** Body Mass Index, *** Glycated Haemoglobin, **** Nitrogen Dioxide and Particulate Matter

Table 2. Association of individual covariates with depression score and category (no depression vs mild-severe depression) and their interactions with ethnicity.

Covariate	B (95% CI)	p value	Interaction with ethnicity p value
Age (years)	0.001 (-0.021, 0.023)	0.913	0.827
Sex (female used as referent group)	0.158 (-0.131, 0.447)	0.285	0.877
IMD* score	0.020 (0.008, 0.032)	0.001	0.706
BMI (kg/m^2)**	0.108 (0.079, 0.136)	0.0001	0.299
HbA1c* (%)**	-0.031 (-0.318, 0.256)	0.834	0.329
Fast-food outlets (per 500m radius)	0.055 (0.001, 0.108)	0.045	0.995
Greenspace (% cover in 3km radius)	-0.005 (-0.011, 0.001)	0.112	0.272
Air pollution (NO_2, $PM_{2.5}$ and PM_{10}/μg·m3) ****	0.023 (-0.016, 0.062)	0.252	0.234
Physical activity (per 2000 steps per/day)	-0.157 (-0.215, -0.099)	0.0001	0.799
Smoking status (y)	0.465 (-0.149, 1.080)	0.138	0.311
Statin medication status (y)	0.015 (-0.267, 0.296)	0.917	0.760
Antihypertensive medication status (y)	0.104 (-0.185, 0.393)	0.482	0.812

* Index of Multiple Deprivation, ** Body Mass Index, *** Glycated Haemoglobin, **** Nitrogen Dioxide and Particulate Matter
(y) = yes. Yes to being a smoker, on statin medication and on antihypertensive medication.
p values represent the association between each individual covariate and depressive symptoms score (beta). Each individual covariate is mutually adjusted for all other covariates unless otherwise stated.

Table 3. Association of individual covariates with anxiety score and category (no anxiety vs mild-severe anxiety) and their interactions with ethnicity.

Covariate	B (95% CI)	p value	Interaction with ethnicity p value
Age (years)	-0.059 (-0.87, -0.031)	0.0001	0.617
Sex (female used as referent group)	1.259 (0.898, 1.620)	0.0001	0.403
IMD* score	0.026 (0.011, 0.041)	0.001	0.294
BMI (kg/m^2)**	0.042 (0.008, 0.076)	0.015	0.672
HbA1c* (%)**	-0.255 (-0.506, -0.004)	0.046	0.406
Fast-food outlets (per 500m radius)	0.032 (-0.032, 0.096)	0.321	0.222
Greenspace (% cover in 3km radius)	-0.002 (-0.010, 0.006)	0.626	0.167
Air pollution (NO_2, $PM_{2.5}$ and PM_{10}/µg·m3) ****	0.016 (-0.034, 0.066)	0.530	0.357
Physical activity (per 2000 steps per/day)	-0.006 (-0.072, 0.060)	0.852	0.710
Smoking status (y)	0.219 (-0.478, 0.916)	0.538	0.067
Statin medication status (y)	0.188 (-0.177, 0.553)	0.312	0.576
Antihypertensive medication status (y)	0.078 (-0.286, 0.442)	0.673	0.768

* Index of Multiple Deprivation, ** Body Mass Index, *** Glycated Haemoglobin, **** Nitrogen Dioxide and Particulate Matter
(y) = yes. Yes to being a smoker, on statin medication and on antihypertensive medication.
p values represent the association between each individual covariate and anxiety symptoms score (beta). Each individual covariate is mutually adjusted for all other covariates unless otherwise stated.

Figure Legends

Figure 1 title

Figure 1. Adjusted beta-coefficients (95% confidence interval) showing the difference in depression score between South Asian and white European ethnicities (panel a) and the odds ratio (95% confidence interval) for the risk of mild-severe depression in South Asians compared to white Europeans (panel b).

Figure 1 caption

White European ethnicity group is referent category.

1 Unadjusted model.

2 Adjusted for age, sex, treatment group and index of multiple deprivation.

3 Same adjustments as model 2 with additional BMI and A1c.

4 Same adjustments as model 3 with air pollution, fast-food restaurants, greenspace, physical activity, smoking status, statin medication status and antihypertensive medication status.

Figure 2 title

Figure 2. Adjusted beta-coefficients (95% confidence interval) showing the difference in anxiety score between South Asian and white European ethnicities (panel a) and the odds ratio (95% confidence interval) for the risk of mild-severe anxiety in South Asians compared to white Europeans (panel b).

Figure 2 caption

White European ethnicity group is referent category.

1 Unadjusted model.

2 Adjusted for age, sex, treatment group and index of multiple deprivation.

3 Same adjustments as model 2 with additional BMI and A1c.

4 Same adjustments as model 3 with air pollution, fast-food restaurants, greenspace, physical activity, smoking status, statin medication status and antihypertensive medication status.