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Association of depression and anxiety with clinical, sociodemographic, lifestyle and environmental factors in South Asian and white European people at high risk of diabetes

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What's new?

- Depression is associated with Type 2 diabetes with a direction of causation that has been suggested to be bidirectional in nature.
- 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.
- The development and evaluation of 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 the prevalence and correlates of depressive and anxiety symptoms within South Asian and white European populations at high risk of developing Type 2 diabetes.

Methods Data were collected at baseline, and at 12, 24 and 36 months from 1429 white European people (age 64±7 years, 35.8% women) and 160 South Asian people (age 59±9 years, 30.6% women) who were at high risk of Type 2 diabetes and who took part in 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 the South Asian compared to the white European participants [score higher by 1.5, 95% CI 0.9–2.1]. Levels of anxiety were also higher in the South Asian participants, although associations were attenuated after adjustment. Social deprivation, BMI, proximity to fast-food outlets and physical activity were correlates for depression in both the South Asian and white European participants.

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

Introduction

Depression is one of the leading causes of disability worldwide, affecting approximately 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, characterized by either a major depressive disorder or a collection of mental and physical depressive symptoms that persist for a minimum of 2 weeks. Depression is a common comorbidity of Type 2 diabetes, with the relationship 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 generalizability 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 (one in four). 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 [5]. As a result, South Asian people may be at increased risk of depression because of 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 a paucity of consistent evidence. The extent to which the associations between South Asian ethnicity and higher levels of depression are confounded or explained by metabolic health, socio-economic status, lifestyle behaviours or related environmental factors has not been investigated.

The aim of the present study was to investigate whether South Asian people 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 methods

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'; 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 the control and intervention groups in depressive symptoms during follow-up. Full study descriptions are available elsewhere [9,10].

Walking Away trial

For the Walking Away trial, 808 adults were recruited from 10 general practices, 2010–2011. Individuals aged 18–74 years were included on the basis of having a high risk of impaired glucose regulation (a 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, BMI, family history of Type 2 diabetes and use of anti-hypertensive 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 randomized controlled trial testing the effectiveness of a structured education programme designed to promote increased walking activity [10].

Let's Prevent Diabetes trial

A total of 880 adults were recruited from 44 general practices for the Let's Prevent trial, in 2010–2011. The inclusion criteria for screening were age 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, were 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 impaired glucose regulation were invited to continue into a randomized 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 in English to all participants at baseline, and at 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 and 21 for both depression and anxiety, with scores 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 categorized participants into those without depression or anxiety risk (score of 0–7) and those with mild-to-severe depression or anxiety risk (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 because of low numbers.

Variables/covariates

Sociodemographic and health data, such as ethnicity, age, sex, smoking status and statin and anti-hypertensive medication status were collected via interview-administered questionnaire. Body weight and height were measured to the nearest 0.1 kg and 0.5 cm, respectively. Glycaemic status was determined according to HbA_{1c}. Deprivation level was determined by assigning the Index of Multiple Deprivation 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 3 and 4 valid days of data were required in Let's Prevent and Walking Away, respectively. Participants wore the devices for a minimum of 3 days (Let's Prevent) or 4 days (Walking Away) during waking hours, with a minimum wear period of 10 h 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 environmental factors for participants were included as covariates and comprised: neighbourhood greenspace [14]; proximity to fast-food outlets [15]; and air pollution levels [16]. All environmental factors were based on the home postcodes of participants. Data were added because of previous work stating that 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 3 km was used to measure percentage of greenspace in participants' neighbourhoods.

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 500 m of a participant's home using methods described previously [15].

Air pollution data were derived from the Department for Environment Food and Rural Affairs (DEFRA) Pollution Climate Mapping model, which is described elsewhere [19]. Exposure to air pollution was defined as the 3-year average, including the year in which the participant entered the study and the preceding 2 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 within which the participant's home postcode fell were used [16].

Statistical analysis

Data from the Walking Away and Let's Prevent studies were pooled. Participants were excluded from this analysis if they did not have a valid score for depression and anxiety. Data across all time points (baseline, 12, 24 and 36 months) were used. A generalized estimating equation model with an exchangeable correlation structure was used to allow analysis of repeated measurements and clustering by general 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. The resulting β coefficients represent the difference in depressive or anxiety symptom scores between ethnic groups. Categorical data were analysed using a binary response and reported as odds ratios, representing the odds of depression or anxiety risk in the South Asian vs white European cohort. Model 1 was unadjusted. Model 2 included age, sex, treatment group and deprivation level. Model 3 was additionally adjusted for BMI and HbA_{1c}. 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 anti-hypertensives).

Interaction terms for ethnicity × sex were added to the fully adjusted model to investigate whether sex modified the 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 with the AUTO IMPUTATIONS command was undertaken to assess whether replacing missing data affected results for the main associations or interactions by sex. *P* values <0.05 were taken to indicate statistical significance for main effects and *P*<0.1 for interactions. Data are reported as mean (95% CI; for continuous data) or odds ratio (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* generalized estimating equation 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.

Ethics

Results

Descriptive statistics stratified by ethnicity and gender are summarized 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 European participants contributed 3408 observations to the analysis and South Asian participants 370 observations. South Asian participants had substantially higher levels of social deprivation (Index of Multiple Deprivation score 23.4 vs 16.7). Compared with their white European counterparts, South Asian participants were younger [age 59 (±9) vs 64 (±7) years], had higher HbA_{1c} levels [44 (±5) vs 42 (±4) mmol/mol or 6.2 (±0.5)% vs 6.0 (±0.4)%], had greater exposure to air pollution [22.6 (±2.4) vs 18.7 (±4.0) NO_2 $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$], had less access to greenspace [37.5 (±16.7)% vs 61.3 (±24.9)% cover in 3-km radius] and were surrounded by more fast-food outlets per 500 m [3 (±4) vs 2 (±3)]. South Asian women had the highest prevalence of mild-to-severe depressive symptoms (29.2%), whereas white European men had the lowest (9.9%). South Asian women had the highest prevalence of mild-to-severe anxiety symptoms (35.4%), with white European men reporting the lowest (19.6%).

Depression

An association was found between South Asian and white European ethnicities in depressive symptom scores and depression risk. Unadjusted depression scores were 1.5 (95% CI 0.9–2.1) units higher in South Asian compared to white European participants (Fig. 1 and Table S1). The results were not affected after adjusting for clinical, sociodemographic, lifestyle or environmental factors (Fig. 1 and Table S1). Sex was not found to modify results (P=0.380 for interaction) so stratified analyses were not undertaken.

The odds ratios for mild-to-severe depression risk were also higher in South Asian compared to white European participants. The unadjusted odds ratios for South Asian compared to white European participants were 2.81 (95% CI 2.03–3.87; Fig. 1 and Table S1). Results were not affected after adjusting for clinical, sociodemographic, lifestyle and environmental factors (Fig. 1 and Table S1).

Anxiety

Unadjusted anxiety symptom scores were 0.6 (95% CI 0.0–1.2] units higher in South Asian compared to white European participants (Fig. 2 and 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).

The unadjusted odds ratio for mild-to-severe anxiety risk in South Asian compared to white European participants was 1.52 (95% CI 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 Asian participants were 1.6 (95% CI 1.1–2.1; Table S1) units higher than white European participants. 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 HbA_{1c} 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 Asian participants: 3.2 (95% CI –0.4, 6.7); white European participants: 0.1 (95% CI –0.6, 0.8)].

Discussion

This present study found that South Asian people have higher levels of depressive symptoms than white European people 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 Asian participants were not

explained by the differences in dysglycaemia (HbA_{1c}), physical activity, social deprivation, air pollution or the physical environment compared to white European participants. Levels of anxiety symptoms were also higher in South Asian compared to white European participants; 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 European and South Asian people who had normal glucose tolerance, impaired glucose tolerance and Type 2 diabetes at baseline [20]. Similarly, although Williams *et al*. [7] 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. The present results are consistent, however, with a study showing that the prevalence of depressive symptoms was higher in British South Asian people [21] and with another study showing South Asian men reported being more depressed compared with white Europeans [8].

There are several environmental factors that may explain the observations reported in the present study. Given the study population was older and more likely to comprise first-generation migrants, issues surrounding migration may be more applicable to it than to populations comprising second- or third-generation migrants. It has been previously stated that elevated depressive symptoms and depression risk in minority populations can be found typically in migrants as a result of environmental, economic, social and psychological factors [22]. Whilst the present 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 contribute to higher levels of 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 one's future and low status are social determinants that can negatively affect a person’s physical and mental health [17]. Indeed, evidence has shown that South Asian people who integrate more with host country culture have fewer 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 about 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 contribute to increased risk via a lack of awareness or not seeking help to reduce the risk. For example, it is known that those from minority ethnic backgrounds, including those of South Asian ethnicity, access mental health services less than white European people [26].

The findings from the present study may have important implications for research and diabetes prevention. It is known that South Asian people are underrepresented in research [27], which may be partially explained by higher rates of depression or depressive symptoms. This may also affect engagement with and retention rates in 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 depression is associated with non-adherence to 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 in this area.

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 HbA_{1c} 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 of 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 socio-economic factors are important correlates

of 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] as a result of reduced income, increased stress and greater social exclusion.

The present study has several strengths and limitations. Its strengths include the pooling of data from two original studies (Walking Away and 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 were used.

The study's primary limitation is that the HADS may not be culturally relevant to South Asian populations and this questionnaire may need to be tailored to and validated in South Asian people [34]. Although all participants could speak English, language barriers may have nevertheless affected the participants' understanding of the HADS. Secondly, the term 'South Asian' covers a wide range of different cultures, languages and religions. The predominant subgroup nationality in the present sample was Indian. Consequently, our results may not apply to all South Asian populations. Furthermore, the number of South Asian women recruited was substantially lower than South Asian men. Additionally, participants' anti-depressive medication was not recorded in the original studies and, therefore, was unavailable for the present analyses.

As the present study only focused on individuals at high risk of diabetes, the results are not representative of the wider population. While a diverse range of factors was measured in this study, genetic factors cannot be discounted as potentially contributing to increased depression and anxiety risk among South Asian people, particularly as depression and diabetes may share environmental and genetic aetiological origins [35]; however, it has been argued that genetic factors alone are unlikely to

explain this increased risk of Type 2 diabetes [36], and rather that 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 between ethnic groups.

In 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 than their white European counterparts. This was irrespective of a number of clinical, sociodemographic, lifestyle or environmental adjustments. Levels of anxiety symptoms were higher in South Asian participants, but associations were attenuated after adjustment. The implications of these results need further investigation, including whether uptake of and retention in diabetes prevention programmes by 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.

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Competing interests

None declared.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. β coefficient of South Asian depressive symptom scores using GEE analysis with adjusted effect (panel a), South Asian mild-to-severe depression risk using GEE analysis with adjusted effect (panel b) and β coefficient of South Asian depressive symptom scores using multiple imputation GEE analysis with adjusted effect (panel c).

Table S2. β coefficient of South Asian anxiety symptom scores using GEE analysis with adjusted effect (panel a), South Asian mild-to-severe anxiety risk using GEE analysis with adjusted effect (panel b) and β coefficient of South Asian anxiety symptom scores using multiple imputation GEE analysis with adjusted effect (panel c).

FIGURE 1 Adjusted β coefficients (95% CI) showing (a) the difference in depression score between South Asian and white European ethnicities and (b) the odds ratios (95% CI) for the risk of mild-to-severe depression in South Asian compared to white European participants. White European ethnicity group is the referent category. Model 1: unadjusted; Model 2: adjusted for age, sex, treatment group and index of multiple deprivation; Model 3: same adjustments as model 2 with additional adjustment for BMI and HbA_{1c}; Model 4: same adjustments as model 3 with additional adjustment for air pollution, fast-food restaurants, greenspace, physical activity, smoking status, statin medication status and anti-hypertensive medication status.

FIGURE 2 Adjusted β coefficients (95% CI) showing (a) the difference in anxiety score between South Asian and white European ethnicities and the (b) the odds ratios (95% CI) for the risk of mild-to-severe anxiety in South Asian compared to white European participants. White European ethnicity group is the referent category. Model 1: unadjusted; Model 2: adjusted for age, sex, treatment group and index of multiple deprivation; Model 3: same adjustments as model 2 with additional adjustment for BMI and HbA_{1c}; Model 4: same adjustments as model 3 with additional adjustment for air pollution, fast-food restaurants, greenspace, physical activity, smoking status, statin medication status and anti-hypertensive medication status.

Table 1 Baseline demographics for white European and South Asian study participants

Characteristic	**White European cohort**				**South Asian cohort**			
	Men		**Women**		**Men**		**Women**	
Participants, *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
Median (IQR) 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
HbA_{1c}, mmol/mol	41 (±4)	*n*=904	42 (±4)	*n*=498	43 (±5)	*n*=109	45 (±5)	*n*=49
HbA_{1c}, %	5.9 (±0.4)	*n*=904	6.0 (±0.4)	*n*=498	6.1 (±0.5)	*n*=109	6.3 (±0.4)	*n*=49
Air pollution, NO_2, $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$	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 500 m	2 (±3)	*n*=914	1 (±3)	*n*=509	3 (±5)	*n*=111	2 (±4)	*n*=49
Greenspace: % cover in 3-km 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/day	6779 (±3176)	*n*=815	5756 (±2724)	*n*=424	6371 (±2665)	*n*=88	5624 (±2853)	*n*=39
Current smoker, *n* (%)	83 (9.1)	*n*=917	37 (7.2)	*n*=512	8 (7.2)	*n*=111	1 (2)	*n*=49
Prescribed statins, *n* (%)	366 (39.9)	*n*=917	169 (33)	*n*=512	45 (40.5)	*n*=111	12 (24.5)	*n*=49

Prescribed anti-hypertensives, *n* (%)	529 (57.7)	*n*=917	287 (56.1)	*n*=512	60 (54.1)	*n*=111	27 (55.1)	*n*=49
Median (IQR) depression score	3 (1–5)	*n*=871	3 (1–6)	*n*=484	4 (2–7)	*n*=106	4 (2–9)	*n*=48
Mild-to-severe depression, *n* (%)	86 (9.9)	*n*=871	72 (14.9)	*n*=484	25 (23.6)	*n*=106	14 (29.2)	*n*=48
Median (IQR) anxiety score	4 (2–7)	*n*=874	6 (3–9)	*n*=483	5 (3–8)	*n*=106	6 (3–10)	*n*=48
Mild-to-severe anxiety, *n* (%)	171 (19.6)	*n*=874	152 (31.5)	*n*=483	27 (25.5)	*n*=106	17 (35.4)	*n*=48

IMD, Index of Multiple Deprivation; IQR, interquartile range; NO_2, $PM_{2.5}$ and PM_{10}/$\mu g \cdot m^3$, nitrogen dioxide and particulate matter.

Data are mean (±SD) unless otherwise indicated.

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

Covariate	β coefficient (95% CI)	*P*	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
HbA_{1c} (%)	–0.031 (–0.318, 0.256)	0.834	0.329
Fast-food outlets (per 500-m radius)	0.055 (0.001, 0.108)	0.045	0.995
Greenspace (% cover in 3-km radius)	–0.005 (–0.011, 0.001)	0.112	0.272
Air pollution (NO_2, $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$)	0.023 (–0.016, 0.062)	0.252	0.234
Physical activity (per 2000 steps/day)	–0.157 (–0.215, -0.099)	0.0001	0.799
Smoking status (yes)	0.465 (–0.149, 1.080)	0.138	0.311
Statin medication status (yes)	0.015 (–0.267, 0.296)	0.917	0.760
Anti-hypertensive medication status (yes)	0.104 (–0.185, 0.393)	0.482	0.812

IMD, Index of Multiple Deprivation; NO_2, $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$, nitrogen dioxide and particulate matter.

P values represent the association between each individual covariate and depressive symptoms score (β). 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-to-severe anxiety) and their interactions with ethnicity

Covariate	β coefficient (95% CI)	*P*	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
HbA_{1c} (%)	–0.255 (–0.506, –0.004)	0.046	0.406
Fast-food outlets (per 500-m radius)	0.032 (–0.032, 0.096)	0.321	0.222
Greenspace (% cover in 3-km radius)	–0.002 (–0.010, 0.006)	0.626	0.167
Air pollution (NO_2, $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$)	0.016 (–0.034, 0.066)	0.530	0.357
Physical activity (per 2000 steps/day)	–0.006 (–0.072, 0.060)	0.852	0.710
Smoking status (yes)	0.219 (–0.478, 0.916)	0.538	0.067
Statin medication status (yes)	0.188 (–0.177, 0.553)	0.312	0.576
Anti-hypertensive medication status (yes)	0.078 (–0.286, 0.442)	0.673	0.768

IMD, Index of Multiple Deprivation; NO_2, $PM_{2.5}$ and $PM_{10}/\mu g \cdot m^3$, nitrogen dioxide and particulate matter.

P values represent the association between each individual covariate and anxiety symptoms score (β). Each individual covariate is mutually adjusted for all other covariates unless otherwise stated.

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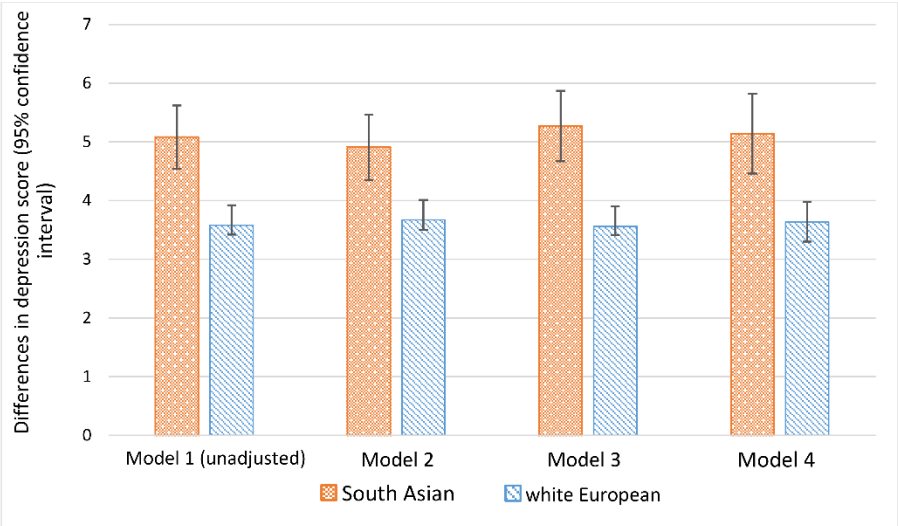

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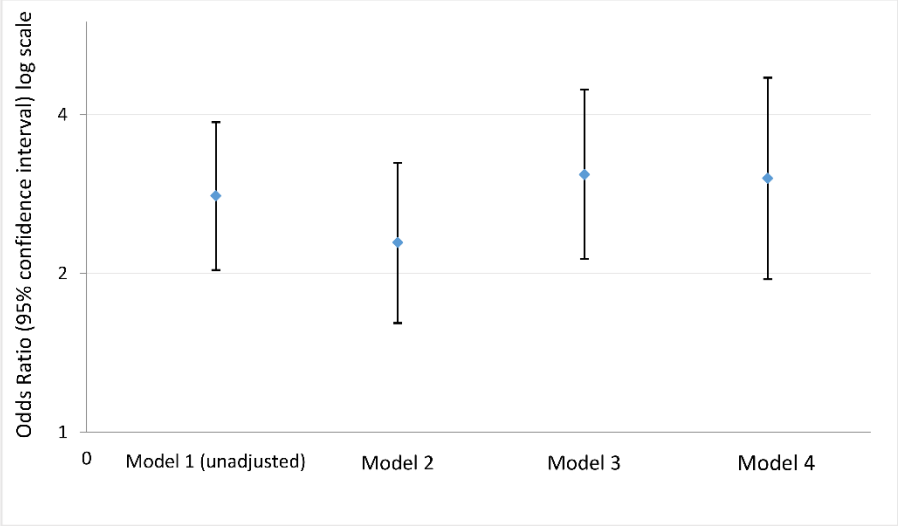

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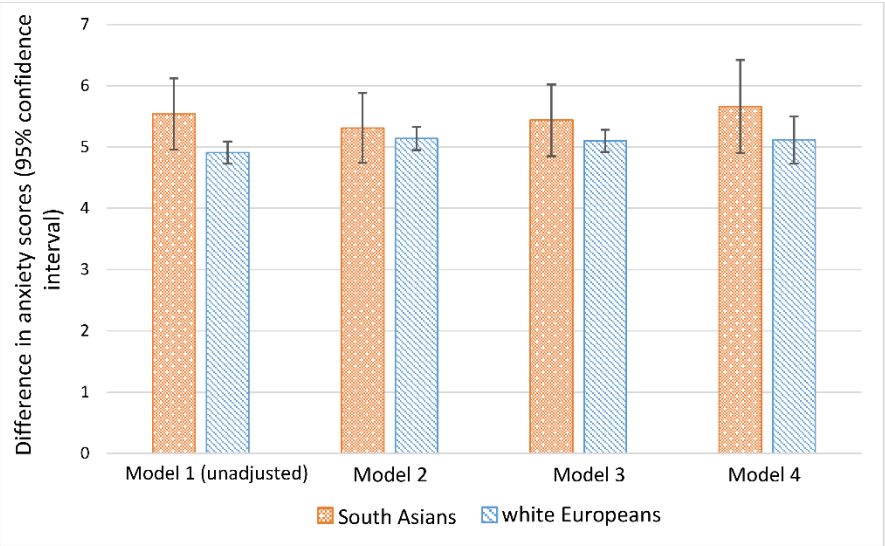

B.