High-sugar, high-saturated fat dietary patterns do not associate with depressive symptoms in mid-life men and women: prospective study

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ABSTRACT

Background: Evidence is contradictory for the relationship between unhealthy 'Western' dietary patterns and depressive symptoms.

Aims: We examined whether high-sugar and high-saturated fat dietary patterns are associated with depressive symptoms over 5 years in a British cohort of men and women.

Methods: We used data from the Whitehall II study for 5,044 individuals (aged 35-55 years). Diet was assessed at phase 7 (2003-2004) using a validated food frequency questionnaire. Dietary patterns were derived using reduced rank regression with sugar, saturated fat and total fat as response variables. The Centre for Epidemiological Studies Depression (CES-D) was used to assess depressive symptoms (CES-D sum score ≥16 and/or use of antidepressant medication) at phase 7 and at phase 9 (2008-2009).

Results: In total, 398 cases of recurrent and 295 cases of incident depressive symptoms were observed. We identified two dietary patterns: a combined high-sugar/high-saturated fat (HSHF) and a high-sugar (HS). No association was observed between the dietary patterns and either incidence or recurrent depressive symptoms. For example, higher consumption of the HSHF dietary pattern was not associated with recurrent depressive symptoms in men (model 3, Q4: OR=0.67, 95% CI: 0.36, 1.23, p for trend= 0.130) nor in women (model 3, Q4: OR=1.26, 95% CI: 0.58, 2.77, p for trend= 0.973).

Conclusions: Among middle-aged men and women living in the UK, dietary patterns containing high amounts of sugar and saturated fat do not appear to be associated with new onset or recurrence of depressive symptoms.

Key words: dietary patterns, depressive symptoms, sugar, fat, reduced rank regression

INTRODUCTION

‘Western’ dietary patterns are presumed to contribute to depression risk. Amongst others, inflammation has been postulated as potential biological pathway (1). A suggested underlying mechanism for this pathway is that pro-inflammatory markers modulate the synthesis, release and re-uptake of mood-related neurotransmitters (e.g. serotonin and dopamine) (2). However, evidence is still inconsistent for this relationship as two previous prospective studies observed that ‘Western’ dietary patterns are associated with higher prevalence of depressive symptoms (3, 4), whereas three other prospective studies failed to find a significant association with new cases of clinically defined depression (5) and depressive symptoms (6, 7). These inconsistencies may be due to the heterogeneity between studies such as differences in the measurement of the outcome (incidence versus prevalence, with the majority of studies assessing depressive symptoms using self-reported scales), dietary data and food group classification (8).

‘Western’ dietary patterns are characterized by high intakes of unhealthy snacks, fast foods, sugar-sweetened beverages, red and processed meat which generally contain high levels of sugar and saturated fat. Previous prospective studies of the relationship between the independent contribution of sugar and saturated fat to depression, found that sugar intake (by studying sweet foods and beverages (9) and the glycemic index (10)) and saturated fat (11) were associated with higher depressive symptoms. However, it is difficult to determine the effect of single nutrients in examining diet-disease relationships (12) since people consume dietary patterns that consist of complex combinations of nutrients that are highly correlated and interact with each other (13). Moreover, it is difficult to distinguish between a sugar and a saturated fat dietary pattern because many foods contain both macronutrients and restriction of one macronutrient implies the increase of another macronutrient to maintain energy balance (14).

Reduced rank regression (RRR) is a statistical method that is used to derive overall dietary patterns and is able to additionally investigate the independent contributions of specific nutrients in these dietary patterns (15). As the obtained dietary factor scores are independent of each other, a sugar and a saturated fat dietary pattern can be identified in isolation as well as in combination. By using this method, a previous study showed that a ‘combined high-sugar and saturated-fat’ dietary pattern was associated with higher depressive symptoms and depressed mood in a multi-ethnic population (12). However, due to the cross-sectional nature of this study, reverse causation may have been present. In order to gain insight into this issue, the objective of the current study is to examine whether high-sugar and high-saturated fat dietary patterns are associated with depressive symptoms over 5 years in a British cohort of men and women. Based on findings from the aforementioned cross-sectional study and a previous study that observed a positive association between a ‘Western’ diet and depressive symptoms in the same population (3), we hypothesize that a ‘combined high-sugar and saturated-fat’ dietary pattern yielded from RRR will be associated with higher incidence and recurrence of depressive symptoms.

METHODS

Subjects and study design

The Whitehall II study is an ongoing cohort study performed in London, the United Kingdom among 10,308 British civil servants aged 35-55 years. Baseline data collection (phase 1) took place in 1985-1988 and follow-up data on diet was collected in intervals of 5 years from 1991-1993 (phase 3) until 2016 (phase 12) and depressive symptoms from 2003-2004 (phase 7) onwards. Participants completed a self-administered health questionnaire every 2-3 years and attended a health screening clinic for a clinical examination every 5 years. More detailed information concerning the study protocol can be found elsewhere (16). Complete data on diet, depressive symptoms and demographics were available on 5,044 participants at phase 7 and on 4,515 participants for depressive symptoms at phase 9. The University College London ethics committee approved the study protocol and written informed consent was obtained from all included participants after thorough explanation of the study. A flowchart of how the study sample was reached is given in **Supplemental Figure 1**.

Depressive symptoms assessment at phase 7 and 9

The CES-D scale is a widely used self-report scale that measures depressive symptoms in the general population over the past week (17) and has been validated previously against an interviewer-administered instrument in an older population (18). CES-D data was administered at phase 7 (2003-2004) and five years later, at phase 9 (2008-2009). Depressive symptoms were defined by a CES-D score ≥16, self-reported use of anti-depressant medication, or both. In this study we defined two categories of depressive symptoms.

1. ‘recurrent depressive symptoms’: having depressive symptoms at both phase 7 and phase 9; participants with no recurrent depressive symptoms were described as not having depressive symptoms at phases 7 and 9 or when depressive symptoms occurred in only one of the 2 phases.
2. ‘incident depressive symptoms’: participants with depressive symptoms at phase 9, after exclusion of participants who were classified as having baseline depressive symptoms (CES-D score ≥16, self-reported use of anti-depressant medication, or both at phase 7) (19).

Dietary pattern assessment at phase 7

A machine-readable food frequency questionnaire (FFQ), which originates from the one used in the US Nurses’ Health Study (20), was used to collect habitual dietary data and contained 127 food items. The FFQ was anglicized and foods commonly eaten in the UK were added (21). A common unit or portion size for each food, e.g. one egg or one slice of bread was specified, and participants were asked how often, on average, they had consumed that amount of the item during the previous year. The nine responses ranged from 'never or less than once per month' to 'six or more times per day'. To derive nutrient intakes, the consumption frequency was multiplied for each food by its nutrient content and then summed across all foods. The FFQ has been previously validated in terms of nutrient and food consumption (21, 22).

We applied RRR to identify dietary patterns at phase 7. RRR derives dietary patterns in an exploratory way and is based on a priori knowledge in the selection of intermediate markers (response variables) that are thought to link dietary patterns to disease risk (15). As we aimed to derive high-sugar and high-saturated fat dietary patterns, we included the nutrients sugar (g/d), saturated fatty acids (g/d) and total fatty acids (g/d) from the FFQ as response variables. All response variables were log-transformed because they were not normally distributed. In total, 34 food groups were created, based on nutrient profile and previous studies on dietary patterns and depression (**Supplemental Table 1**)(3, 12). All 34 food groups received a factor loading, but for simplicity we reported only the food groups that loaded highly (≥0.20) and which we considered as being characteristic for the respective dietary pattern. We operationalized dietary pattern scores as quartiles with increasing quartiles representing higher intakes of the nutrients that are highly correlated to the dietary patterns and higher consumption of the foods that are characteristic for the dietary patterns. More detailed information on RRR is described previously (23).

Covariates at phase 7

Models were adjusted for the following confounding factors in separate models at phase 7 which were determined a priori. Age (in years), energy intake (kcal/d), ethnicity (white, non-white), educational level (low, middle, high), marital status (married or cohabiting, single, divorced or widowed), socioeconomic status (SES) based on occupational position, categorized into three groups: high (administrative), intermediate (professional or executive), and low (clerical or support). This measure is a comprehensive marker of socioeconomic circumstances in the Whitehall II study being related to education, salary, social status, and level of responsibility at work (16). We further adjusted for physical activity level over the last year (active (>2.5 hours per week of moderate physical activity or >1 hour per week of vigorous physical activity), inactive (<1 hour per week of moderate physical activity and <1 hour per week of vigorous physical activity), or moderately active (if neither active nor inactive), smoking status (never smoker, former smoker, current smoker), coronary heart disease (CHD) (denoted by clinically verified nonfatal myocardial infarction or definite angina), type 2 diabetes (defined by diagnosis of the World Health Organization) and body mass index (BMI). Since alcohol consumption was included as one of the food components in our dietary patterns, we did not include alcohol as covariate.

Statistical analysis

Baseline characteristics according to quartiles of the combined high-sugar and high-saturated fat dietary pattern, were explored by using the chi-square test for categorical variables and the ANOVA test for continuous variables. Logistic regression models were applied to estimate the prospective association between quartiles of dietary patterns (with the first quartile being used as reference category) at phase 7 with incident depressive symptoms at phase 9 and recurrent depressive symptoms. Additionally, tests for trend across the quartiles were calculated. We examined effect modification by testing interactions between diet and the main covariates regarding depressive symptoms in the fully adjusted models. We observed statistically significant sex differences in the association between the HSHF dietary pattern and depressive symptoms incidence and recurrence (P<0.20) and therefore presented all models stratified by sex. In the first model we adjusted for demographic variables age, ethnicity, marital status, educational level, SES and energy intake. In model 2 we additionally adjusted for lifestyle variables smoking status and physical activity. Finally, we additionally adjusted for co-morbidity (diabetes, CHD and BMI) in model 3.

Sensitivity analyses

To examine whether the diet-depression relationship was robust, we performed sensitivity analyses. First, we excluded participants with extreme energy intakes, under-reporters were participants with an energy intake <(basal metabolic rate (BMR) x physical activity level (PAL)) with PAL at a value of ≤0.87 and over-reporters were defined as energy intake > BMR x PAL, with PAL >2.75 (24, 25). Second, we included energy-adjusted food groups as predictor variables and repeated the dietary pattern analyses. Third, besides excluding participants with depressive symptoms at baseline, we additionally excluded participants with anti-depressant medication at phase 9 (n=73) and repeated the analyses to distinguish between the questionnaire-based depressive symptoms and a physician diagnosis. Finally, we repeated the analyses with severe depressive symptoms, defined as CES-D score ≥23, self-reported use of anti-depressant medication or both to examine whether depressive symptoms severity influences the association under study.

RESULTS

Study population

Baseline characteristics according to quartiles of the HSHF dietary pattern are presented in **Table 1**. Participants in the highest quartile of the HSHF dietary pattern were mainly men, of white ethnicity and had a higher SES. Furthermore, participants in the highest quartile were physically more active, smoked less and had a higher energy intake. Finally, participants in the fourth quartile had more depressive symptoms and consumed more sugar, total fat and saturated fat (Table 1).

Dietary pattern analysis

The food groups that were associated with the identified dietary patterns and their corresponding factor loadings are shown in **Table 2**. We identified two dietary patterns. The first dietary pattern was characterized by high intakes of sweet snacks, high-fat dairy products, fast foods, added sugar, butter, other fat, creamy sauces, processed meat, whole grains and potatoes and was labelled as ‘combined high-sugar and high-saturated-fat’ (HSHF) dietary pattern. The pattern was highly correlated with all three response variables (Spearman correlation coefficient: 0.74, 0.88 and 0.87 for sugar, total fat and saturated fat, respectively). The second identified dietary pattern was characterized by fruit, natural fruit juices, low-fat dairy products and to a lesser extent by added sugar and sugar sweetened beverages and was low in fatty foods; butter, red and processed meat, eggs and fast foods and was labelled as ‘high-sugar’ (HS) dietary pattern. Even though the food items added sugar and sugar-sweetened beverages were below the cut-off point of 0.20, they contributed to an important extent to this dietary pattern and are therefore presented. The HS dietary pattern was highly correlated to sugar (Spearman correlation coefficient: 0.59) and negatively correlated to fat and saturated fat (Spearmen correlation coefficient: -0.27 and -0.24 for total fat and saturated fat, respectively). The explained variation in the response variables was 67% for the HSHF dietary pattern and 15% for the HS dietary pattern (15%) (Table 2).

Baseline dietary patterns in relation to recurrence of depressive symptoms over 5 years

Recurrent episode of depressive symptoms was identified in 247 (7%) men and 151 (11%) women. The prospective association between quartiles of dietary patterns and recurrence of depressive symptoms is presented in **Table 3**. No association was observed between higher consumption of the HSHF dietary pattern and recurrent depressive symptoms in men (model

1: Q4: OR=0.63, 95% CI: 0.34, 1.16, p for trend= 0.087) nor in women (model 1: Q4: OR=1.26, 95% CI: 0.58, 2.73, p for trend= 0.988). The association did not change after additionally adjusting for lifestyle- and co-morbidity variables (men: model 3, Q4: OR=0.67, 95% CI: 0.36, 1.23, p for trend= 0.130)(women: model 3, Q4: OR=1.26, 95% CI: 0.58, 2.77, p for trend= 0.973). Similarly, increasing quartiles of the HS dietary pattern did not associate with recurrent episode of depressive symptoms in any of the models and this was similar in both sexes (fully adjusted model, men: p for trend= 0.069, women: p for trend= 0.579)(Table 3).

Dietary patterns and 5-year onset of depressive symptoms

We excluded participants with missing data on depressive symptoms at phase 9 (n=529) and prevalent depressive symptoms at baseline (n=673). This left us with 3,842 participants for examining incidence of depressive symptoms. In **Table 4**, we present the prospective association between quartiles of dietary patterns at phase 7 and incidence of depressive symptoms at phase 9. We observed 184 cases (6%) in men and 111 cases (10%) in women of incident depressive symptoms at phase 9. We did not find an association between increasing quartiles of the HSHF or the HS dietary patterns and incidence of depressive symptoms 5 years later in any of the models. For both men and women, in the fully adjusted model, being in the highest quartile of the HSHF dietary pattern was not associated with incident depressive symptoms 5 years later, OR=1.43 (95% CI: 0.71, 2.87, p for trend= 0.277) and OR=0.73 (95% CI: 0.26, 2.06, p for trend= 0.590) respectively. Likewise, no association was found for higher consumption of the HS dietary pattern and incident depressive symptoms 5 years later in any of the models (model 3, men: p for trend= 0.687, women: p for trend= 0.907) (Taeble 4).

Sensitivity analyses

When excluding participants with extreme energy intakes (n=479), no differences were observed for the association between the HSHF dietary pattern nor in the HS dietary pattern and any depressive symptoms category in either men or women. In a second sensitivity analysis, we repeated RRR with energy-adjusted food groups by using the residual method. We identified a HSHF dietary pattern with only butter, chocolates and sweets, high-fat dairy products and added sugar as characteristic food groups. Consequently, this pattern was not associated with any depressive symptom category. Finally, we repeated analyses with severe depressive symptoms (CES-D score ≥23, self-reported use of anti-depressant medication or both) where we observed no differences between any of the dietary patterns and any severe depressive symptoms category as compared to the main analyses in either man or women (data not shown).

DISCUSSION

In this study, we identified two dietary patterns; a HSHF dietary pattern and a HS dietary pattern and sought to examine their associations with the recurrence of depressive symptoms and new onset over 5-y follow-up period separately in men and women. Higher consumption of dietary patterns high in sugar and or saturated fat are not associated with the recurrence or incidence of depressive symptoms in men nor in women living in the UK.

Contrary to our findings, two previous studies observed an association between unhealthy 'Western' dietary patterns and depressive symptoms (3, 4). Differences with the current study may be due to methodological differences in deriving dietary patterns. These studies used principal component analysis to identify patterns which is purely data driven (3, 4). So while we identified a similar dietary pattern to Akbaraly et al. and Le Port et al., the most important food groups (chocolates, sweets and pastries, processed meat, high-fat dairy products, fast foods and creamy sauces) in the current study (factor loadings around 0.25) contributed a lesser extent to the diet compared to the other studies (factor loadings around 0.40). Another potential explanation for the null findings may be due to the influence of energy intake. A previous prospective study observed that energy intake (partly) explained the association between unhealthy 'Western' dietary patterns and depressive symptoms (6). To get further insight into the influence of energy intake in the current study, we performed sensitivity analyses by excluding participants with extreme energy intakes and by repeating RRR with energy-adjusted food groups using the residual method. Both analyses did not show different findings compared to the main analyses. Hereby indicating that energy intake did not explain the null findings in the current study. Furthermore, when investigating the influence of other demographic or lifestyle variables in the current study, none of these variables could explain why we did not observe associations in the diet-depressive symptoms relationship. This is in contrast with two other prospective studies that observed initial positive associations between unhealthy dietary patterns and depressive symptoms attenuated after adjustment for demographic and lifestyle variables (5, 7). A final explanation could be that the severity of depressive symptoms might have influenced the association under study. Therefore, we performed sensitivity analyses where we examined the association between dietary patterns severe depressive symptoms (CES-D score ≥23, self-reported use of anti-depressant medication or both). However, no differences in associations were observed. Thus, the severity did not influence the association between dietary patterns high in sugar and saturated fat and depressive symptoms.

Our results also differ from a previous cross-sectional study performed among a multi-ethnic population residing in the Netherlands (12). The Dutch study observed that unhealthy dietary patterns, containing foods that are rich in sugar and saturated fat, associated with higher depressive symptoms, and persisted after correcting for energy intake. However, as these analyses were cross-sectional, reverse causation may have explained the association. Thus in the current study we excluded participants having depressive symptoms at baseline to examine the incidence of depressive symptoms. Furthermore, we additionally excluded participants with anti-depressant medication at follow-up (phase 9, n=73) and repeated analyses. However, no associations were observed in either dietary pattern. Therefore, it may be that in our previous cross-sectional study, the positive association between HSHF dietary pattern and depressive symptoms was explained by reverse causality.

Our results concerning the HS dietary pattern are in line with our previous study where higher consumption of a HS dietary pattern did not associate with depressive symptoms (12), but are in contrast with a previous study performed in the same population. Knüppel et al. initially found that higher sugar intake from sweet food/beverages was prospectively associated with recurrent depression in men (9). These different findings may be explained by the different method used as Knüppel et al. specifically examined sugar intake, whereas the current study focused on the independent contribution of sugar, as part of an overall dietary pattern. Moreover, the median fruit intake was very high (275g/d) and was consequently characteristic for the HS dietary pattern due to the high amount of sugar in fruit. However, fruit intake has been indicated to lower depressive symptoms due to their anti-oxidant properties (26). Hereby it may be indicated that even though the sugar intake is high in the current population (for an important part from fruit), health benefits from fruit may have attenuated the association between the HS dietary pattern and depressive symptoms.

Strengths and limitations

The major strength of this study is the prospective design since we were able to examine the diet-depression relationship longitudinally. The study was based on a large established cohort study with several points of follow-up which allowed us to examine prevalence, incidence and recurrence. Finally, applying RRR to study overall dietary patterns may be considered as a strength as this method includes both prior knowledge as well as the pattern structure in the dataset. Additionally, using all dietary information takes into account the issue where restriction of one macronutrient implies an increased intake of another macronutrient (14).

The major limitation of our study was the use of a self-report memory-based FFQ to collect dietary data. Data from a FFQ are subject to misreporting, depending on food group and weight status. Another limitation is the fact that people tend to underreport unhealthy foods such as sweet snacks, sugar-sweetened beverages and fast foods and consequently, the observed associations are likely to be underestimates. Consequently, total energy intake is difficult to measure as it is also likely to be underestimated. Additionally, we used a self-administered questionnaire to define depressive symptoms. Even though the CES-D has been validated previously in this population and found to have a high sensitivity (89%) and specificity (86%), it may not be the best tool to examine new onset of depressive symptoms as the CES-D could be less sensitive to men measuring depressive symptoms. Moreover, we did not use a clinical diagnosis (18). We tried to increase accuracy by including antidepressant intake in the definition. Finally, residual confounding may be present due to unknown or unmeasured lifestyle or demographic factors.

Conclusion

We found no evidence for an association of a dietary pattern high in fatty and sugary foods with incident and recurrent episodes of depressive symptoms in either men or women. Based on our results, we conclude that there is no consistent evidence for a relationship between dietary patterns high in sugar and/or saturated fat and depressive symptoms. Further prospective studies are needed to disentangle the complex associations of the components of an unhealthy diet, and the course of depression .

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Table 1. Baseline characteristics according to quartiles of the combined high-sugar and high-saturated fat dietary pattern[1]

Characteristic	**Q1 (*n=1,255*)**	**Q2 (*n=1,269*)**	**Q3 (*n=1,260*)**	**Q4 (*n=1,260*)**	**p-value**
Age (years)	45 (5.7)	44 (5.8)	45 (6.0)	45 (6.1)	0.050
Sex, women	449 (36%)	377 (30.%)	322 (26%)	214 (17%)	<0.001
Ethnicity					<0.001
White	1,094 (87%)	1,196 (94%)	1,210 (96%)	1,222 (97%)	
Non-white	161 (13%)	73 (5.8%)	50 (4.0%)	38 (3%)	
Marital status					
Married or cohabiting	941 (75%)	957 (75%)	990 (79%)	973 (77%)	0.001
Single	142 (11%)	160 (13%)	151 (12%)	175 (14%)	
Divorced, separated or widowed	172 (14%)	152 (12%)	119 (9.4%)	112 (8.9%)	
Social Economic Status					
Low occupation	152 (12%)	105 (8.3%)	104 (8.3%)	88 (7.0%)	<0.001
Middle occupation	591 (47%)	549 (43%)	526 (42%)	505 (40%)	
High occupation	512 (41%)	615 (49%)	630 (50%)	667 (53%)	
Physical activity					
Inactive	374 (30%)	293 (23%)	306 (24%)	262 (21%)	<0.001
Moderately active	237 (19%)	210 (17%)	201 (16%)	216 (17%)	
Vigorous	644 (51%)	766 (60%)	753 (60%)	782 (62%)	
Smoking status					
Never smoker	581 (46%)	591 (47%)	628 (50%)	652 (52%)	0.018
Former smoker	566 (45%)	578 (46%)	557 (44%)	520 (41%)	
Current smoker	108 (8.6%)	100 (7.9%)	75 (6.0%)	88 (7.0%)	
Energy intake (kcal/d)	1,496 (291)	1,941 (234)	2,293 (253)	2,984 (558)	<0.001
Alcohol intake (g/d)	13 (13.8)	13 (14)	12 (13)	12 (13)	0.009
BMI (kg/m^2)	27 (4.7)	27 (4.2)	27 (4.1)	26 (4.0)	0.085
Diabetes	315 (25%)	282 (22%)	324 (26%)	295 (23%)	0.154

CHD	125 (10%)	112 (8.8%)	100 (7.9%)	117 (9.3%)	0.344
Antidepressant use	39 (3.1%)	37 (2.9%)	39 (3.1%)	49 (3.9%)	0.520
CES-D score	8.4 (8.2)	7.8 (7.3)	7.4 (7.2)	8.2 (7.7)	0.002
Depressive symptoms	230 (18%)	182 (14%)	171 (14%)	217 (17%)	0.002
Recurrent depressive symptoms	108 (9%)	89 (7%)	85 (7%)	116 (9%)	0.058
Mono-disaccharide intake (g/d)[2]	91 (29)	118 (29)	143 (34)	184 (51.5)	<0.001
Total fat intake (g/d)[2]	48 (12)	67 (13)	82 (15)	115 (29)	<0.001
Saturated fat intake (g/d)[2]	24 (6.6)	33 (7.3)	41 (8.6)	59 (17)	<0.001

[1] Values are means ± SDs or numbers and percentages. BMI, body mass index; CHD, Coronary heart disease; CES-D, Centre for Epidemiologic Studies Depression

[2] Values are medians ± IQR

Table 2. Food groups with their corresponding factor loadings for the three factors derived by reduced rank regression together with the percentage of variation explained of response variables

Factor 1	**Load**	**Factor 2**	**Load**
HSHF dietary pattern[1]		**HS dietary pattern**[1]	
Positive loadings			
Chocolates, sweets and pastries High-	0.44	Fruit	0.58
fat dairy products	0.26	Natural fruit juices	0.33
Fast foods	0.26	Low-fat dairy products	0.21
Added sugar	0.26	*Added sugar*	*0.17*
Butter	0.25	*Sugar-sweetened beverages*	*0.12*
Other fat	0.21		
Creamy sauces	0.21		
Processed meat	0.20		
Whole grains	0.20		
Potatoes	0.20		
Negative loadings			
		Butter	-0.29
		Red meat	-0.23
		Processed meat	-0.22
		Eggs	-0.22
		Fast foods	-0.22
Explained variation of response variables	67%		15%

[1] The presented food groups with factor loadings of ≥0.20 were interpreted as being characteristic for the dietary patterns. HSHF dietary pattern, combined high-sugar and high-saturated fat; HS, high-sugar

Table 3. The prospective association between quartiles of dietary patterns and recurrent episode of depressive symptoms[1]

	Men (*n=3,344*)		Women (*n=1,171*)	
	HSHF dietary pattern			
Model 1				
Q1	1 (reference)	0.087	1 (reference)	0.988
Q2	0.83 (0.55, 1.25)		0.64 (0.39, 1.06)	
Q3	0.66 (0.41, 1.05)		0.72 (0.40, 1.28)	
Q4	0.63 (0.34, 1.16)		1.26 (0.58, 2.73)	
Model 2				
Q1	1 (reference)	0.094	1 (reference)	0.956
Q2	0.85 (0.56, 1.28)		0.66 (0.40, 1.09)	
Q3	0.67 (0.42, 1.06)		0.71 (0.40, 1.27)	
Q4	0.64 (0.34, 1.18)		1.24 (0.57, 2.71)	
Model 3				
Q1	1 (reference)	0.130	1 (reference)	0.973
Q2	0.86 (0.57, 1.29)		0.66 (0.40, 1.10)	
Q3	0.69 (0.43, 1.10)		0.73 (0.41, 1.31)	
Q4	0.67 (0.36, 1.23)		1.26 (0.58, 2.77)	
	HS dietary pattern			
Model 1				
Q1	1 (reference)	0.156	1 (reference)	0.455
Q2	1.20 (0.83, 1.74)		1.07 (0.65, 1.77)	
Q3	0.90 (0.61, 1.34)		0.87 (0.52, 1.46)	
Q4	1.43 (1.99, 2.04)		0.88 (0.54, 1.43)	
Model 2				
Q1	1 (reference)	0.092	1 (reference)	0.597
Q2	1.21 (0.83, 1.74)		1.11 (0.67, 1.84)	
Q3	0.93 (0.63, 1.38)0.687		0.93 (0.55, 1.55)	
Q4	1.50 91.04, 2.15)		0.93 (0.57, 1.52)	
Model 3				
Q1	1 (reference)	0.069	1 (reference)	0.579
Q2	1.23 (0.85, 1.78)		1.11 (0.67, 1.84)	
Q3	0.95 (0.64, 1.42)		0.91 (0.54, 1.53)	
Q4	1.54 (1.07, 2.11)		0.93 (0.57, 1.51)	

[1]. Values are odds ratios, 95% CI and p for trend. HSHF, combined high-sugar and high-saturated fat; HS, high-sugar

Model 1: adjusted for age, ethnicity, marital status, social economic status, energy intake

Model 2: adjusted for model 1 and for physical activity, smoking status

Model 3: adjusted for model 2 and for cardiovascular disease, diabetes, body mass index

Table 4. The prospective association between quartiles of dietary patterns and incident episode of depressive symptoms[1]

	Men (*n=2,910*)		Women (*n=932*)	
	HSHF dietary pattern			
Model 1				
Q1	1 (reference)	0.344	1 (reference)	0.516
Q2	0.55 (0.33, 0.92)		0.71 (0.40, 1.25)	
Q3	0.78 (0.45, 1.35)		0.81 (0.41, 1.60)	
Q4	1.36 (0.68, 2.73)		0.69 (0.24, 1.93)	
Model 2				
Q1	1 (reference)	0.320	1 (reference)	0.551
Q2	0.55 (0.33, 0.92)		0.71 (0.40, 1.26)	
Q3	0.79 (0.46, 1.36)		0.82 (0.41, 1.61)	
Q4	1.38 (0.69, 2.78)		0.71 (0.25, 2.02)	
Model 3				
Q1	1 (reference)	0.277	1 (reference)	0.590
Q2	0.55 (0.33, 0.92)		0.72 (0.40, 1.28)	
Q3	0.81 (0.47, 1.40)		0.83 (0.42, 1.65)	
Q4	1.43 (0.71, 2.87)		0.73 (0.26, 2.06)	
	HS dietary pattern			
Model 1				
Q1	1 (reference)	0.833	1 (reference)	0.792
Q2	1.43 (0.92, 2.21)		1.20 (0.66, 2.18)	
Q3	1.55 (1.01, 2.38)		1.05 (0.57, 1.92)	
Q4	1.01 (0.64, 1.60)		1.15 (0.64, 2.05)	
Model 2				
Q1	1 (reference)	0.713	1 (reference)	0.918
Q2	1.45 (0.93, 2.25)		1.16 (0.64, 2.12)	
Q3	1.59 (1.04, 2.43)		1.01 (0.55, 1.87)	
Q4	1.04 (0.66, 1.65)		1.09 (0.61, 1.96)	
Model 3				
Q1	1 (reference)	0.687	1 (reference)	0.907
Q2	1.45 (0.94, 2.26)		1.17 (0.64, 2.13)	
Q3	1.61 (1.05, 2.47)		1.01 (0.54, 1.87)	
Q4	1.05 (0.66, 1.67)		1.10 (0.61, 1.98)	

[1] Values are odds ratios, 95% CI and p for trend. HSHF, combined high-sugar and high-saturated fat; HS, high-sugar

Model 1: adjusted for age, ethnicity, marital status, social economic status, energy intake

Model 2: adjusted for model 1 and for physical activity, smoking status

Model 3: adjusted for model 2 and for cardiovascular disease, diabetes, body mass index