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Consumption of takeaway and delivery meals is associated with increased BMI and percent fat among UK Biobank participants

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ABSTRACT

Background: Consumption of meals bought from out-of-home sources is a suggested risk factor for obesity, but the supporting evidence is mixed.

Objectives: To investigate the association between consumption of different types of meals and BMI or percent body fat.

Methods: Data were from the UK Biobank in response to a "Type of Meals Eaten" survey, which specified the sources of the meals consumed over the previous 24 h. Because direction of causality is unknown, the data were analyzed with meal choice as the dependent variable first and then BMI as the dependent variable second.

Results: The total number of participants was 5197 (2841 women and 2356 men). Participants with higher BMI and percent body fat were more likely to report consuming takeaway and/or delivery meals, with prevalence ORs (95% CIs) of 2.12 (95% CI: 1.40, 3.22; Bonferroni $P < 0.0001$) for women's adjusted BMI, 1.95 (95% CI: 1.30, 2.93; Bonferroni $P < 0.0001$) for women's adjusted percent body fat, 1.65 (95% CI: 1.05, 2.59; Bonferroni $P < 0.002$) for men's adjusted BMI, and 1.41 (95% CI: 0.70, 2.84; Bonferroni $P < 0.01$) for men's adjusted percent body fat. As BMI and percent body fat increased, both men and women were increasingly less likely to report having consumed a home-cooked and prepared meal during the previous 24 h. Analyzing the data with BMI and percent body fat as the dependent variable showed that both unadjusted and adjusted BMI and percent body fat were higher in individuals reporting consumption of takeaway and delivery foods the previous day and lower in those consuming homecooked meals. The probability of having consumed a meal that was prepared and eaten at a restaurant and/or café was also associated with BMI and percent fat among men but not women.

Conclusions: Homecooked meals were more often consumed by those with low BMI and percent body fat, whereas delivery and takeaway meals were more often eaten by individuals with higher BMI. Consumption of fast-food/café meals was not consistently associated with BMI or percent body fat. The direction of causality in these associations cannot be inferred from this cross-sectional study. *Am J Clin Nutr* 2022;116:173–188.

Keywords: type of meals, obesity, fast food, homemade meals, takeaways, ready meals

Introduction

Globally, obesity is a major cost burden, with the proportion of medical care expenditure on obesity treatment or care particularly high in countries reporting a high prevalence (1). In the United Kingdom, it was reported in 2015–2016 that 33% of adults were living with obesity, and it was recorded as a primary or secondary diagnosis in >600,000 National Health Service (NHS) hospital admissions (2). In 2020, the prevalence of overweight and obesity was 67% among men and 60% in women, and the admissions to the hospital that were related to obesity or obesity complications increased by 11,117 (3). It is speculated that in

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Abbreviations used: CSE, General Certificate of Secondary Education; GLM, general linear model; HI, household income; HNC, Higher National Certificate; NHD, National Higher Diploma; NHS, National Health Service; NVQ, National Vocational Qualification.

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2025, the prevalence of obesity will rise to ∼35%, which will likely further increase the burden on the NHS (4, 5).

Meals consumed out of home are considered less healthy than homemade meals as they are often higher in fat, salt, and sugar and low in vitamins and minerals (6–8). Therefore, eating out has often been suggested to be one of the factors significantly contributing to the obesity epidemic (9). During the past 10 y, the United Kingdom has experienced an increase in consumption of food away from home that has reached 26% of total household financial spending (6, 10). At the same time, the number of fast-food outlets has increased dramatically (11, 12). However, the association between meals consumed from such food outlets and obesity is inconclusive (13). Some studies reported a positive relation between consumption of out-of-home meals and BMI or weight gain, whereas others have not found such associations or found associations that were sex specific (9, 14). In the United States, the density of fast-food and full-service restaurants was not associated with obesity prevalence (15). In contrast, in the United Kingdom, 1 study suggested there was an association between obesity levels and the distance between home and the nearest restaurant (16). However, there was no association between the density of fast-food or full-service restaurants per head of population and obesity prevalence, with the exception of fish and chip shops (16, 17).

The results of these studies could be conflicting because of the different approaches to analysis and the methods used for accounting for confounding factors (16). This may be exacerbated by different definitions of food outlets or failure to account for the type of meals that have been served at different outlets. Moreover, in some studies, levels of obesity were inferred from self-reported BMI. The aim of this study was to investigate the association between objectively measured BMI derived from physician-measured height and weight and percent body fat by bioimpedance and self-declared consumption of meals bought from different sources, including homemade meals over the previous 24 h, using data from the UK Biobank.

Method

Population

Data were obtained from UK Biobank (project number 41324). Participants who took part in the "Type of Meals Eaten" surveys at UK Biobank centers between 2009 and 2010 and had their BMI and percent body fat and socioeconomic status recorded were included. Participants with missing BMI, percent body fat, or any variable in their socioeconomic status were excluded (**Figure 1**). The total number of individuals included in this analysis was 5197 (2841 women and 2356 men) with an age range between 40 and 69 y.

Outcome variables

This study focused on results from the survey about the type of meals eaten in or out of home. The "Type of Meals Eaten" survey consisted of 5 questions expecting yes/no answers. Participants were asked to choose with yes or no if they ate any of the types of the listed meals during the previous 24 h. The types of meals were as follows:

- A takeaway and/or delivery meal
- A meal prepared and cooked at home
- A meal prepared and cooked at a restaurant/café or a fast-food café
- A ready meal bought from a supermarket
- A sandwich bought from a shop/café or a canteen

We related the choices of meals to body composition measures (BMI and percent body fat) that were collected and recorded during the visits by health professionals. The recorded BMI was based on the equation in which the body weight was calculated in kilograms and divided by squared height in meters (kg/m^2). The percentage of fat was measured by bioimpedance using the Tanita BC418MA body composition analyzer.

Adjustment variables (possible confounding factors)

The BMI and percent body fat were adjusted for several possible confounding factors (deprivation level per household, employment, income, education, ethnicity, age, and household size). For ethnicity, participants were divided into 6 groups: white, black, Chinese, Indian, mixed, and other. The highest level of education was categorized into 5 groups: O levels/General Certificate of Secondary Education, which is referred to as early secondary school; A levels/AS levels or equivalent, which represents participants with later secondary school; Higher National Diploma (HND) or Higher National Certificate (HNC) or National Vocational Qualification (NVQ); Certificate of Secondary Education (CSEs) or equivalent; and university or college degree. Income per household was divided into 5 categories (<£18,000, £18,000–£30,999, £31,000–£51,999, £52,000–£100,000, and >£100,000). Employment status was also included as a possible confounding factor and divided into 3 categories (employed, unemployed, and students).

Statistical analysis

Because we did not know the directionality of any relations involved, we performed the analysis in 2 different ways. In the first analysis (approach 1A), the meals consumed the previous day were treated as the binary dependent variable in a logistic regression analysis. The unadjusted BMI and percent body fat were the predictor variables. Because participants were not restricted in the number of "yes" answers they could give, each meal type was considered in an independent analysis. We then used general linear models (GLMs) to adjust the BMI and percent body fat values for potential confounding factors (approach 1B). BMI and percent body fat were adjusted for any significant confounding factors by deriving the residuals from GLMs and adding them back to the mean BMI and percent body fat, as we have used previously (15, 16, 18–20). These adjusted values were then used in the logistic regression models as the predictor variables. The data were segregated into men and women to see if there was any association between the type of meals and body composition based on sex.

We then converted the BMI and percent body fat into binary predictor variables. Men and women who had BMI ≥30 were classified as "participants with obesity," and those who had BMI <30 were classified as participants without obesity (21). When using percent body fat as the criterion, men with percent body fat ≥25% were categorized as living with obesity,

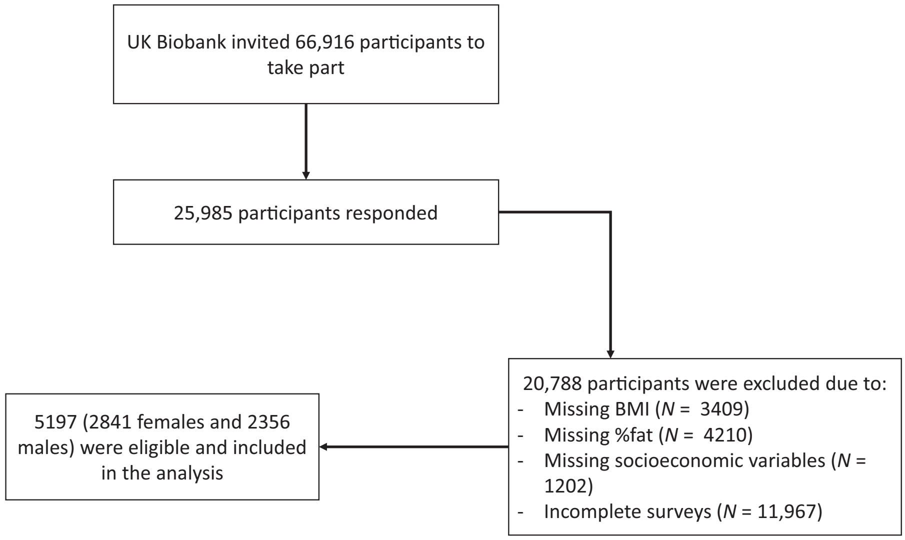

FIGURE 1 Flowchart of inclusion and exclusion of participants.

and women with percent body fat ≥35% were categorized as living with obesity (22, 23). In approach 1C, we compared the probabilities of consuming different meal types the previous day for the individuals with and without obesity based on the unadjusted BMI and percent body fat and in approach 1D based on the adjusted BMI and percent body fat.

In addition, the mean BMI and percent body fat of individuals who consumed >1 type of meal over the previous 24 h were compared with individuals who reported consuming only 1 of the various types. This latter comparison was segregated by sex and 2-sample *t* test was used. To evaluate if there were significant biases in the data, a negative control test was included, whereby height was used as the predictor and meal types as the responses. Due to multiple testing for logistic regressions, the family-wise error rate was high [$\alpha_{fw} = 1 - (0.95)^4 \times 100 = 18.5\%$], and to reduce that and to maintain the confidence in our data set (24), the Bonferroni-corrected *P* value criterion was used (25) for significance, which was 0.01.

In the second analysis approach, we treated body composition as the dependent variable. This was done in 2 ways. First, the unadjusted BMI or percent body fat was used as continuous variables and entered into a GLM with categories of meal types as predictor variables (approach 2A). Then, the latter model was repeated, but this time potential confounding covariates were included (approach 2B). Second, the individuals were categorized into those with and without obesity (approaches 2C and 2D). Then, presence or absence of obesity was used as the binary dependent variable, and the prevalence odds ratios were calculated between participants with obesity and without obesity, with (approach 2D) and without (approach 2C) adjusting for all the significant covariates. SPSS version 24 (IBM Corp) was used for the analysis.

Results

Characteristics of participants

UK Biobank invited 66,916 participants between 2009 and 2010 who were previously registered in the Biobank assessment centers to complete "Type of Meals Eaten" surveys. In total, 25,985 participants responded, and 20,788 were excluded due to missing BMI, percent body fat, and incomplete surveys. The total number of participants who completed the surveys and were included was 5197 (Figure 1).

The general descriptive statistics of socioeconomic and demographic variables of the participants are shown in **Table 1**. The mean ± SD age of the included participants was 55.6 ± 8.1 y. The mean ± SD BMI was 26.4 ± 4.9 in women and 27.4 ± 4.08 in men. Women had higher percent body fat (36.05% ± 6.8%) than men (24.78% ± 5.5%). Women represented 54.7% (2841) of the population included in this analysis. The mean ± SD number of people per household was 2.4 ± 1.2. Participants with household income (HI) between £31,000 and £51,999 a year represented 29.1% (1512) of the sample. Those with HI <£18,000 a year were 13.7% (711), whereas 24.8% (1287) reported that their HI was between £18,000 and £30,999 a year. Those who reported that their HI was between £52,000 and £100,000 represented 25.1% (1303), and only 7.4% (384) reported that their yearly HI was >£100,000.

Regarding employment, 66.6% (3460) were employed, 33.2% (1725) were unemployed, and 12 (0.2%) participants were students. Most of the study population were white (94.6%), whereas black people represented 1.8%. Other minority groups that included Chinese, Indians, mixed, and other ethnicities represented 3.7% altogether.

Analysis approach 1A: using meal types as the dependent variables compared with unadjusted body composition as a continuous predictor

There was a significant association between consumption of takeaway and/or delivery meals over the previous 24 h and unadjusted BMI and unadjusted percent body fat in women (logistic regression: unadjusted BMI: $\beta = 0.08$, $\chi^2 = 25.36$, Bonferroni $P < 0.0001$; unadjusted percent body fat: $\beta = 0.05$, $\chi^2 = 14.28$, Bonferroni $P < 0.0001$). In men, takeaway and/or delivery meal consumption was significantly associated only

TABLE 1 Descriptive statistics: sociodemographic characteristics of the study participants ($N = 5197$)[1]

Type of meals	Number of participants	Any meals away from home	Home meals	Bought sandwiches	Ready meals	Restaurant/café or a fast-food café	Takeaway and/or delivery meal
Age, mean (SD), y							
Women	55 (8)						
Men	56 (8)						
Sex, *n* (%)							
Women	2841 (54.7)	955 (33.6)	1886 (66.3)	222 (7.8)	187 (6.5)	446 (15.6)	100 (3.5)
Men	2356 (45.3)	878 (37.2)	1478 (62.7)	222 (9.4)	172 (7.3)	385 (16.3)	99 (4.2)
BMI, mean (SD), kg/m^2							
Women	26.4 (4.9)	26.89 (5.2)	26.28 (4.8)	26.96 (5.4)	26.32 (4.9)	26.62 (5.04)	28.99 (6.1)
Men	27.4 (4.08)	27.84 (4.1)	27.19 (4.02)	27.87 (3.9)	27.25 (4.2)	27.84 (3.9)	28.78 (5.2)
% Body fat, mean (SD)							
Women	36.05 (6.8)	36.41 (7)	35.88 (6.7)	36.37 (7.3)	35.75 (7.2)	36.21 (6.6)	38.63 (7.2)
Men	24.78 (5.5)	25.11 (5.6)	24.58 (5.4)	24.68 (5.8)	24.83 (5.8)	25.25 (5.4)	26.03 (5.8)
Household size, mean (SD)	2.4 (1.2)						
Income, *n* (%)							
<£18,000	711 (13.7)						
£18,000 to £30,999	1287 (24.8)						
£31,000 to £51,999	1512 (29.1)						
£52,000 to £100,000	1303 (25.1)						
>£100,000	384 (7.4)						
Employment, *n* (%)							
Employed	3460 (66.6)						
Unemployed	1725 (33.2)						
Student	12 (0.2)						
Years of education, *n* (%)							
A levels/AS levels or equivalent	751 (14.5)						
CSE or equivalent	287 (5.5)						
NVQ, NHD, HNC, or equivalent	310 (6.0)						
O levels/GCSE or equivalent	1209 (23.2)						
University or college degree	2640 (50.8)						
Deprivation level, mean (decile scale)	–1.3 (6)						
Ethnicity, *n* (%)							
White	4916 (94.6)						
Black	91 (1.8)						
Chinese	13 (0.3)						
Indian	69 (1.3)						
Mixed	32 (0.6)						
Others	76 (1.5)						

[1]CSE, Grade Certificate of Secondary Education; GCSE, General Certificate of Secondary Education; HNC, Higher National Certificate; NHD, National Higher Diploma; NVQ, National Vocational Qualification.

with unadjusted BMI and not unadjusted percent body fat (logistic regression: unadjusted BMI: $\beta = 0.07$, $\chi^2 = 11.21$, Bonferroni $P < 0.001$; unadjusted percent body fat: $\beta = 0.04$, $\chi^2 = 5.12$, Bonferroni $P = 0.02$). No associations were found in either sex between consumption of "ready meals bought from a supermarket," "sandwiches bought from a shop/café or a canteen," and "meals prepared and cooked at a restaurant/café or a fast-food café" and unadjusted BMI or unadjusted percent body fat. Consuming homemade meals in the previous 24 h was significantly inversely associated with unadjusted BMI but not with unadjusted percent body fat in both women and men (logistic regression; $\beta = -0.02$, $\chi^2 = 9.48$, Bonferroni $P < 0.002$ in women; $\beta = -0.03$, $\chi^2 = 13.71$, Bonferroni $P < 0.0001$ in men), as well as unadjusted percent body fat ($\beta = -0.01$, $\chi^2 = 3.83$, Bonferroni $P = 0.05$ in women; $\beta = -0.01$, $\chi^2 = 4.92$, Bonferroni $P = 0.02$ in men).

Analysis approach 1B: using meal types as the dependent variables compared with adjusted body composition as a continuous predictor

Associations between BMI (and percent body fat) and several possible confounding factors that may distort the relations between the different types of meals and the body composition measures were investigated using GLM (**Supplemental Table 1**). There was no significant difference in the mean BMI or mean percent body fat among unemployed, employed, and students ($P = 0.91$). Income variables were also significantly linked to the obesity measures. Participants who earned <£18,000 a year had the highest mean BMI in comparison with the rest of the income categories, whereas those who earned >£100,000 a year had the lowest mean BMI ($P < 0.0001$). Also, participants with a wage <£18,000 a year had the highest percent body fat, whereas those with >£100,000 had the lowest percent body fat ($P < 0.0001$; **Supplemental Table 2**).

The mean BMI and percent body fat were associated with education status. Participants with CSEs or equivalent had the highest mean BMI and percent body fat, whereas those who had a university or college degree had the lowest mean BMI ($P < 0.0001$; Supplemental Table 1), and participants with NVQ or HND or HNC or equivalent had the lowest percent body fat ($P < 0.0001$; Supplemental Table 2). Regarding ethnicity and BMI and percent body fat, it was found that black participants had the highest mean BMI and percent body fat in comparison with other ethnicities in the sample, whereas Chinese had the lowest mean BMI and percent body fat (mean BMI: $P < 0.0001$; mean percent body fat: $P < 0.0001$; Supplemental Tables 1 and 2).

There was a significant positive association between age and BMI and percent body fat (BMI: $\beta = 0.02$, $P < 0.0001$; percent body fat: $\beta = 0.05$, $P < 0.0001$). Moreover, there was a positive significant association between deprivation level and BMI and percent body fat (BMI: $\beta = 0.12$, $P < 0.0001$; percent body fat: $\beta = 0.09$, $P < 0.0001$). Both body composition measures were significantly inversely associated with household size (BMI: $\beta = -0.11$, $P < 0.0001$; percent body fat: $\beta = -0.59$, $P < 0.0001$). The BMI and percent body fat were adjusted by using stepwise regressions and included all the significant variables mentioned above in the models. The variation explained by the GLM was 4.2% for BMI (Supplemental Table 1) and 4.6% for percent body fat (Supplemental Table 2).

Takeaway and/or delivery meal consumption was significantly related to adjusted BMI and adjusted percent body fat in both sexes. As adjusted BMI and adjusted percent body fat increased, women and men were more likely to consume takeaway and/or delivery meals (logistic regression—women, adjusted BMI: $\beta = 0.08$, $\chi^2 = 22.35$, Bonferroni $P < 0.0001$; men, adjusted BMI: $\beta = 0.06$, $\chi^2 = 9.59$, Bonferroni $P < 0.002$; women, adjusted percent body fat: $\beta = 0.06$, $\chi^2 = 16.67$, Bonferroni $P < 0.0001$; men, adjusted percent body fat: $\beta = 0.04$, $\chi^2 = 9.18$, Bonferroni $P < 0.002$). There were no associations between eating "ready meals bought from a supermarket" and "sandwiches bought from a shop/café or a canteen" and adjusted BMI and adjusted percent body fat in both women and men. "Eating meals prepared and cooked at a restaurant/café or a fast-food café" was positively associated with adjusted BMI and adjusted percent body fat in men but not women (women, adjusted BMI: $\beta = 0.009$, $\chi^2 = 0.79$, Bonferroni $P = 0.37$; men, adjusted BMI: $\beta = 0.03$, $\chi^2 = 6.63$, Bonferroni $P < 0.01$; women, adjusted percent body fat: $\beta = 0.007$, $\chi^2 = 0.91$, Bonferroni $P = 0.34$; men, adjusted percent body fat: $\beta = 0.02$, $\chi^2 = 6.32$, Bonferroni $P < 0.01$). "Meals that were prepared and eaten at home" were significantly negatively associated with adjusted BMI and adjusted percent body fat in women and men. Men and women who reported consuming homemade meals the previous day were less likely to have increased adjusted BMI (women, adjusted BMI: $\beta = -0.02$, $\chi^2 = 10.89$, Bonferroni $P < 0.001$; men, adjusted BMI: $\beta = -0.04$, $\chi^2 = 14.74$, Bonferroni $P < 0.0001$) or increased adjusted percent body fat (women, adjusted percent body fat: $\beta = -0.01$, $\chi^2 = 10.64$, Bonferroni $P < 0.001$; men, adjusted percent body fat: $\beta = -0.02$, $\chi^2 = 13.52$, Bonferroni $P < 0.0001$).

Analysis approach 1C: using meal types as the dependent variables compared with unadjusted BMI and percent body fat recoded as binary predictors

When participants with obesity were compared with those without obesity, it was found that women with unadjusted BMI (≥30) were 136% more likely to have consumed takeaway and/or delivery meals than women without obesity in the previous 24 h, and men with obesity were 72% more likely to report that they had takeaway and/or delivery meals in the previous 24 h, with a prevalence OR of 2.36 (95% CI: 1.55, 3.60; Bonferroni $P < 0.0001$) for women and 1.72 (95% CI: 1.12, 2.66; Bonferroni $P < 0.001$) for men (**Figures 2** and **3**). Also, women with unadjusted percent body fat ≥35% were 58% more likely to have had takeaway and/or delivery meals in the previous 24 h than women with adjusted percent body fat <35% (prevalence OR: 1.58; 95% CI: 1.02, 2.42; Bonferroni $P < 0.0001$) (**Table 2**; Figure 2).

Men with obesity (adjusted BMI ≥30) were 27% less likely to have consumed meals that were prepared and cooked at home in the previous 24 h, and women with obesity (adjusted BMI ≥30) were 24% less likely to have eaten homemade meals in comparison with women with no obesity: for adjusted BMI, prevalence OR was 0.73 (95% CI: 0.59, 0.89; Bonferroni $P < 0.0001$) for men and 0.76 (95% CI: 0.63, 0.91; Bonferroni $P < 0.001$) for women (**Figures 4** and **5**). Women with obesity

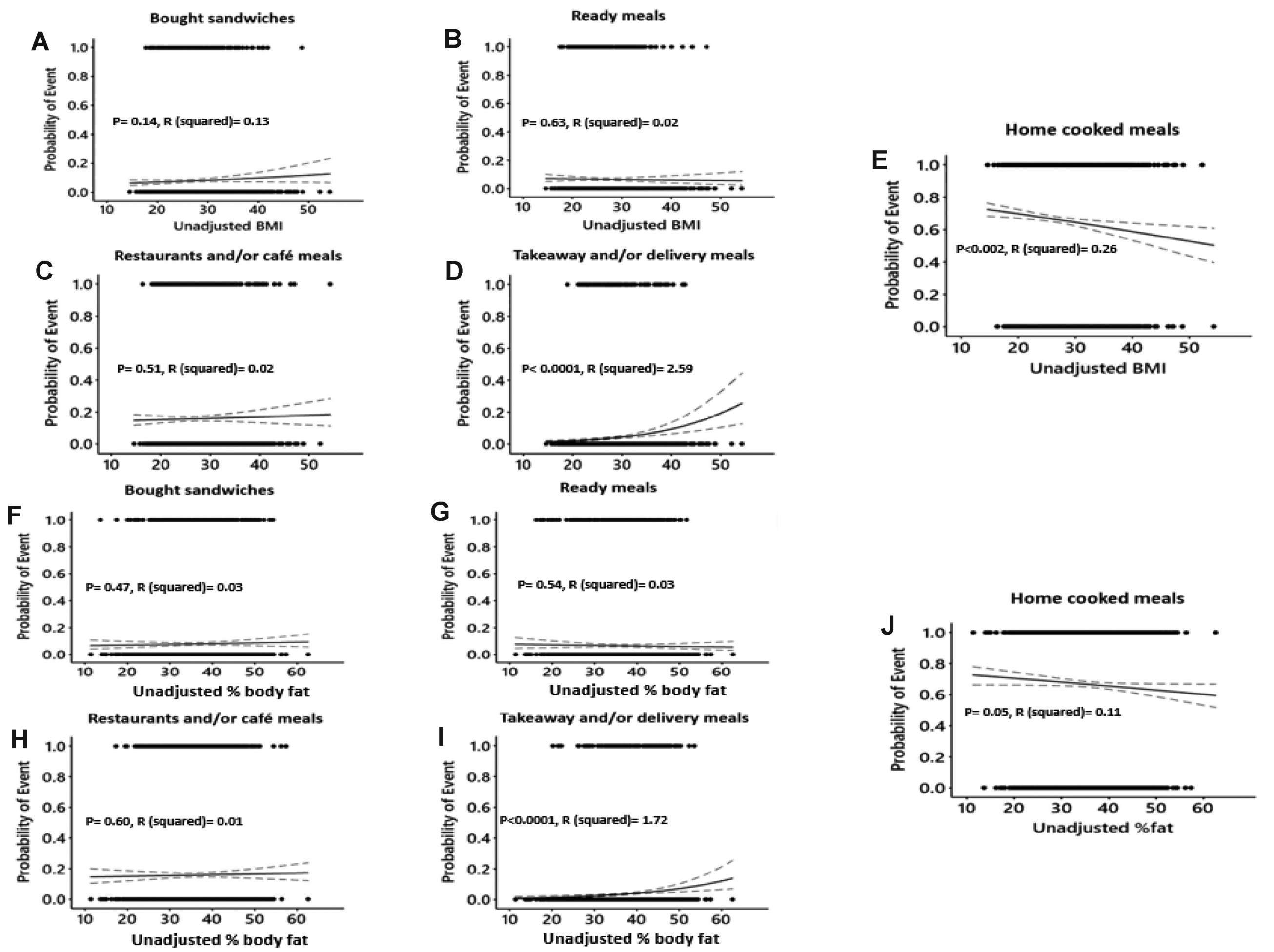

FIGURE 2 Binary logistic regression analyses of the association between different types of meals and unadjusted body composition measures for women. (A–E) Unadjusted BMI. (F–J) Unadjusted percent body fat. $N = 5197$.

(adjusted percent fat ≥35%) were 26% less likely to have consumed home-prepared and homecooked meals than women without obesity (prevalence OR: 0.74; 95% CI: 0.62, 0.87; Bonferroni $P < 0.006$) (**Table 3**; Figure 4). Men with adjusted percent fat of ≥25% were 7% less likely to have consumed home-prepared and homecooked meals than men with adjusted percent fat of <25% (prevalence OR: 0.93; 95% CI: 0.72, 1.20; Bonferroni $P < 0.001$) (Table 3; Figure 5). Men who were classified as living with obesity on the unadjusted BMI scale were 33% less likely to have consumed homecooked and home-prepared meals in the previous 24 h than men without obesity, and women with obesity were 25% less likely to have a meal that was prepared and cooked at home in the previous 24 h than women without obesity. There was no significant association between homecooked and home-prepared meals and unadjusted percent body fat in men or women (Table 2; Figures 2 and 3).

Analysis approach 1D: using meal types as the dependent variables compared with adjusted BMI and percent fat recoded as binary predictors

There were still significant positive associations after adjusting BMI and percent body fat in men and women and recoding these data as a binary variable with the probability of consuming takeaways and/or delivery meals over the past (Table 3; Figures 4 and 5). Women who were classified as women with obesity with adjusted BMI ≥30 were 112% more likely to have consumed a takeaway and/or delivery meal in the previous 24 h than women with adjusted BMI <30 (prevalence OR: 2.12; 95% CI: 1.40, 3.22; Bonferroni $P < 0.0001$) (Table 3; Figure 4). Moreover, women with adjusted percent fat ≥35% were 95% more likely to have had takeaway and/or delivery meals in the previous 24 h than women with adjusted percent body fat <35% (prevalence OR: 1.95; 95% CI: 1.30, 2.93; Bonferroni $P < 0.0001$) (Table 3; Figure 4). Men who were classified as men with obesity based on an adjusted BMI ≥30 scale were 65% more likely to have consumed a takeaway and/or delivery meal in the previous 24 h than men with adjusted BMI <30 (prevalence OR: 1.65; 95% CI: 1.05, 2.59; Bonferroni $P < 0.002$) (Figure 5). Also, men with adjusted percent fat ≥25% were 41% more likely to have had takeaway and/or delivery meals in the previous 24 h than men with adjusted percent fat <25% (prevalence OR: 1.41; 95% CI: 0.70, 2.84; Bonferroni $P < 0.01$) (Table 3; Figure 5). Moreover, men with obesity (adjusted BMI ≥30) were 31% more likely to have consumed restaurant/café or fast-food café meals than men without obesity (prevalence OR: 1.31; 95% CI: 1.009,

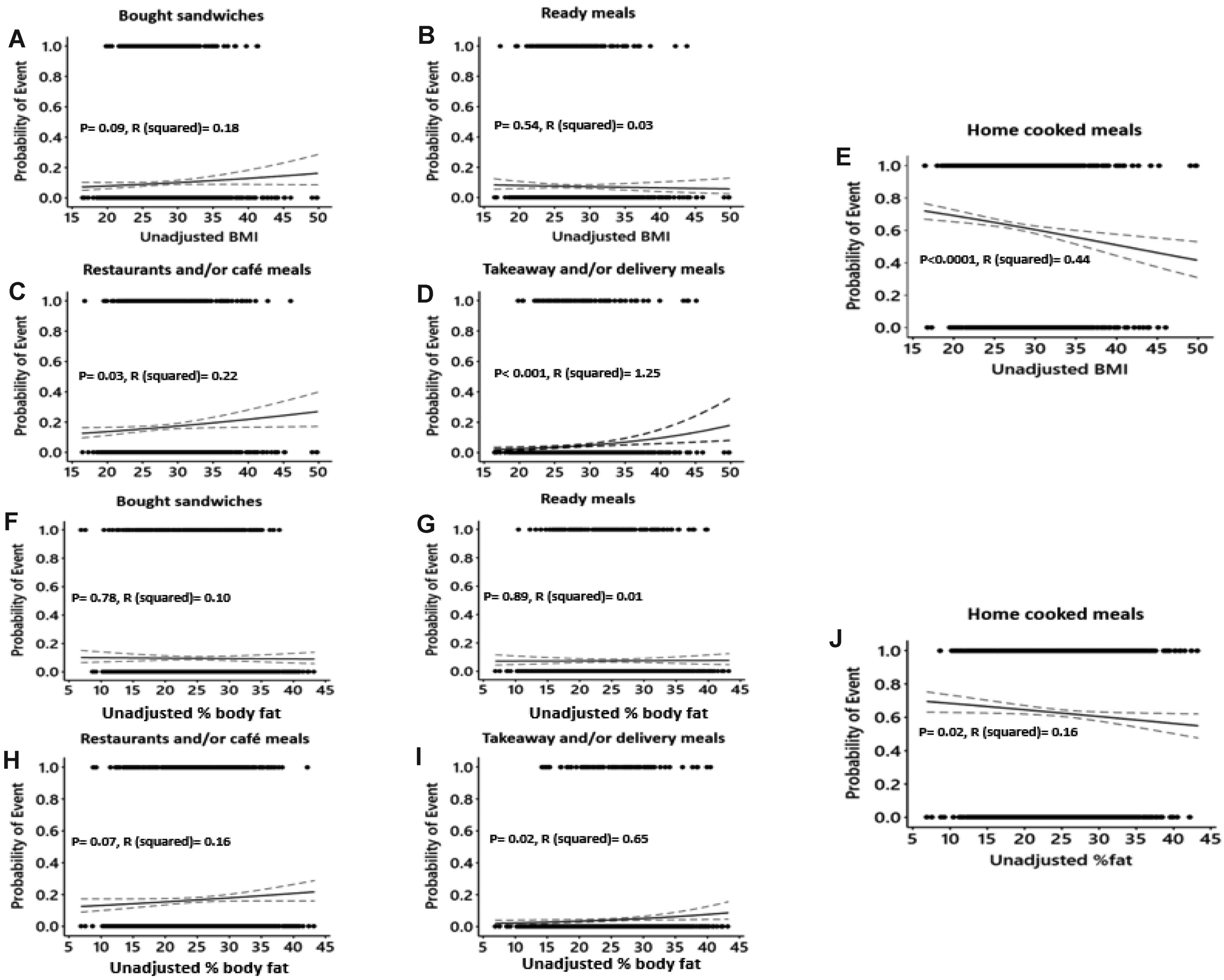

FIGURE 3 Binary logistic regression analyses of the association between different types of meals and unadjusted body composition measures for men. (A–E) Unadjusted BMI. (F–J) Unadjusted percent body fat. $N = 5197$.

1.70; Bonferroni $P < 0.01$) (Table 3; Figure 5). Also, men with obesity with adjusted percent body fat ≥25% were 20% more likely to report having consumed such meals than men without obesity (adjusted percent body fat <25%) (prevalence OR: 1.20; 95% CI: 0.84, 1.69; Bonferroni $P < 0.01$) (Table 3; Figure 5).

Analysis approach 2A: unadjusted BMI and percent body fat as the dependent variables using the GLM model

No significant association was noted between unadjusted BMI and reported consumption of takeaways, bought sandwiches, and ready meals in men (**Table 4**). Unadjusted BMI in men was significantly negatively associated with reporting consumption of homecooked and home-prepared meals (GLM analysis for men; unadjusted BMI: $\beta = -0.32$, Bonferroni $P < 0.005$, $R^2 = 0.80$). However, none of the included types of meals were related to unadjusted percent body fat in men (Table 4).

Only takeaway meal type was significantly positively associated with unadjusted BMI and unadjusted percent body fat in women, whereas none of the reported types of meals were related to the unadjusted obesity measures (GLM analysis for women; unadjusted BMI: $\beta = 1.18$, Bonferroni $P < 0.0001$, $R^2 = 0.95$; unadjusted percent body fat: $\beta = 1.2$, Bonferroni $P < 0.0001$, $R^2 = 0.44$) (Table 4).

Analysis approach 2B: adjusted BMI and percent body fat as the dependent variables using the GLM model

The adjusted BMI and adjusted percent body fat were significantly associated with consuming takeaway meal type in both sexes (adjusted BMI: $\beta = 1.2$, Bonferroni $P < 0.0001$, $R^2 = 4.7$ in women; adjusted BMI: $\beta = 0.60$, Bonferroni $P < 0.004$, $R^2 = 2.05$ in men; adjusted percent body fat: $\beta = 1.3$, Bonferroni $P < 0.0001$, $R^2 = 5.10$ in women; adjusted percent body fat: $\beta = 0.75$, Bonferroni $P < 0.009$, $R^2 = 3.58$ in men) (**Table 5**). No association was found between adjusted BMI and adjusted percent body fat and consuming bought sandwiches and ready meals in both sexes (Table 5). There was a significant association between adjusted BMI but not adjusted percent body fat and consumption of meals prepared at a restaurant/café or a fast-food café in men (adjusted BMI: $\beta = 0.26$, Bonferroni $P < 0.01$, $R^2 = 2.69$; adjusted percent body

TABLE 2 Binary logistic regression analysis of the association between the probability of consuming different types of meals over the previous 24 h and unadjusted body composition measures separated by women and men ($N = 5197$)[1]

Body composition measure	Type of meal	n		SE	DF	Prevalence OR	95% CI	Bonferroni P value	R^2	Figures
Women										
Unadjusted BMI	Bought sandwiches	222	0.19	0.013	1	1.019	0.99, 1.04	0.14	0.13	A1
	Ready meals	187	–0.007	0.015	1	0.99	0.96, 1.02	0.63	0.02	B1
	Restaurant and/or café meals	446	0.006	0.01	1	1.006	0.98, 1.02	0.51	0.02	C1
	Takeaway and/or delivery meals	100	0.86	0.21	1	2.36	1.55, 3.60	<0.0001	2.59	D1
	Home-prepared meals	1886	–0.28	0.09	1	0.75	0.62, 0.91	<0.002	0.26	E1
Unadjusted percent body fat	Bought sandwiches	222	0.007	0.01	1	1.007	0.98, 1.02	0.47	0.03	A2
	Ready meals	187	–0.006	0.01	1	0.99	0.97, 1.01	0.54	0.03	B2
	Restaurant and/or café meals	446	0.003	0.007	1	1.003	0.98, 1.01	0.60	0.01	C2
	Takeaway and/or delivery meals	100	0.45	0.21	1	1.58	1.02, 2.42	<0.0001	1.72	D2
	Home-prepared meals	1886	–0.01	0.005	1	0.98	0.97, 1.0	0.05	0.11	E2
Men										
Unadjusted BMI	Bought sandwiches	222	0.02	0.016	1	1.02	0.99, 1.06	0.09	0.18	A3
	Ready meals	172	–0.01	0.01	1	0.98	0.95, 1.02	0.54	0.03	B3
	Restaurant and/or café meals	385	0.02	0.01	1	1.02	1.002, 1.05	0.03	0.22	C3
	Takeaway and/or delivery meals	99	0.54	0.22	1	1.72	1.12, 2.66	<0.001	1.25	D3
	Home-prepared meals	1478	–0.40	0.10	1	0.67	0.54, 0.81	<0.0001	0.44	E3
Unadjusted percent body fat	Bought sandwiches	222	–0.003	0.01	1	0.99	0.97, 1.02	0.78	0.1	A4
	Ready meals	172	0.001	0.01	1	1.001	0.97, 1.03	0.89	0.01	B4
	Restaurant and/or café meals	385	0.01	0.01	1	1.01	0.99, 1.03	0.07	0.16	C4
	Takeaway and/or delivery meals	99	0.04	0.01	1	1.04	1.005, 1.08	0.02	0.65	D4
	Home-prepared meals	1478	–0.01	0.007	1	0.98	0.96, 0.99	0.02	0.16	E4

[1]Significance is where $P < 0.01$ (after Bonferroni correction). DF, degree of freedom.

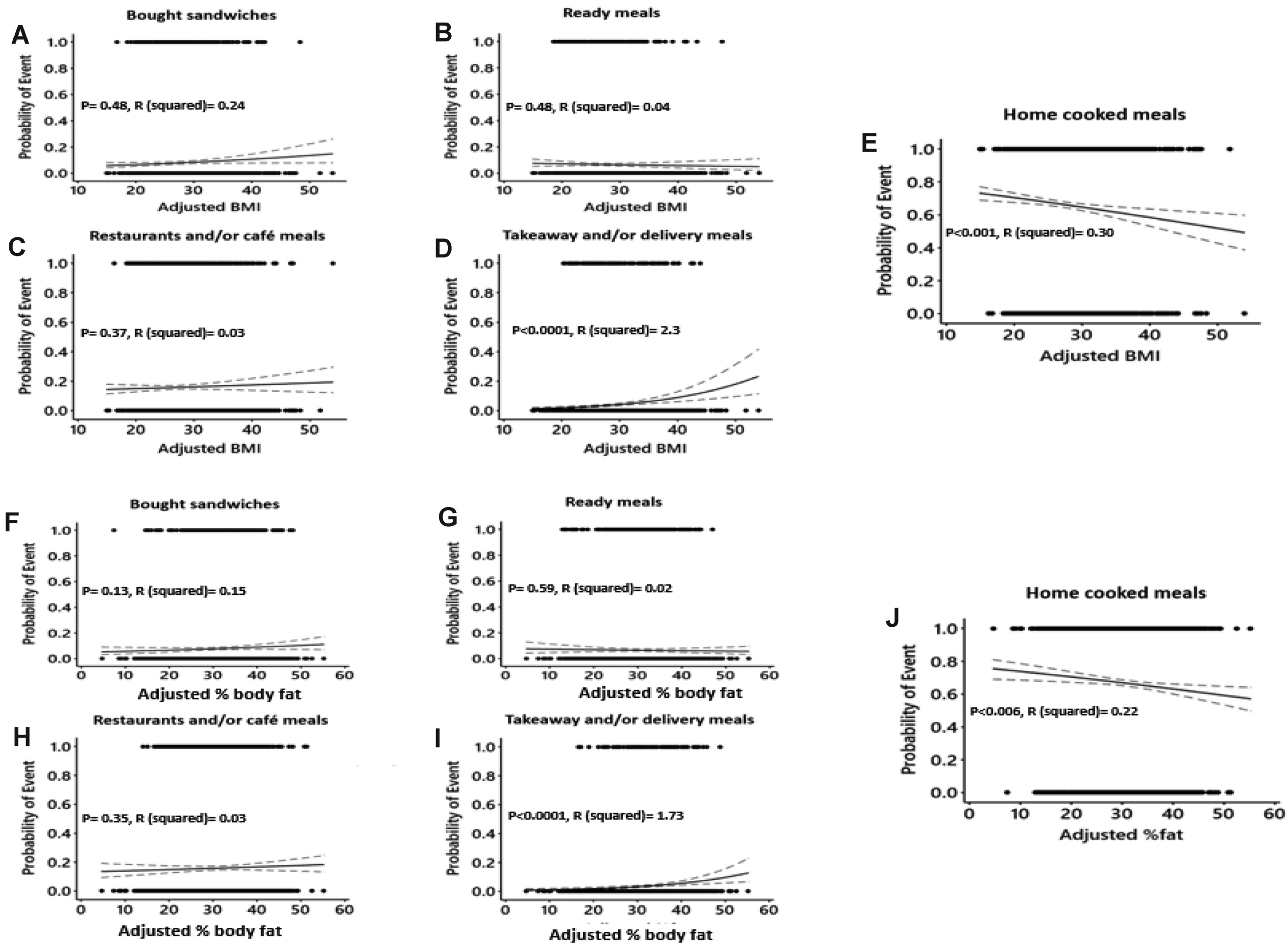

FIGURE 4 Binary logistic regression analyses of the association between different types of meals and adjusted body composition measures for women. (A–E) Adjusted BMI. (F–J) Adjusted percent body fat. $N = 5197$.

fat: $\beta = 0.35$, Bonferroni $P = 0.02$, $R^2 = 3.52$). No association was found between adjusted BMI and adjusted percent body fat and consumption of restaurant/café or fast-food café meals in women (Table 5).

Adjusted BMI and adjusted percent body fat in both sexes were associated significantly negatively with consuming meals prepared and cooked at home (adjusted BMI: $\beta = -0.36$, Bonferroni $P < 0.0001$, $R^2 = 4.3$ in women; adjusted BMI: $\beta = -0.31$, Bonferroni $P < 0.0001$, $R^2 = 2.2$ in men; adjusted percent body fat: $\beta = -0.45$, Bonferroni $P < 0.0001$, $R^2 = 4.94$ in women; adjusted percent body fat: $\beta = -0.38$, Bonferroni $P < 0.001$, $R^2 = 3.72$ in men) (Table 5).

Analysis approach 2C: BMI and percent body fat recoded as binary dependent variables based on unadjusted data

For this analysis, the χ^2 test was performed to examine the association between type of meals and obesity measures. The relation between takeaways and "obesity status" based on unadjusted BMI and based on unadjusted percent body fat was significant among men [unadjusted BMI: $\chi^2(1, N = 99) = 6.2$, Bonferroni $P < 0.01$; unadjusted percent body fat: $\chi^2(1, N = 99) = 6.9$, Bonferroni $P < 0.008$]. In women, takeaway meal type was associated with obesity status from unadjusted BMI but not when it was based on unadjusted percent body fat [unadjusted BMI: $\chi^2(1, N = 100) = 17.1$, Bonferroni $P < 0.0001$; unadjusted percent body fat: $\chi^2(1, N = 98) = 4.4$, Bonferroni $P = 0.03$]. Homecooked and home-prepared meals were associated inversely with obesity status based on unadjusted BMI in women and men [unadjusted BMI: $\chi^2(1, N = 1886) = 8.4$, Bonferroni $P < 0.004$ in women; unadjusted BMI: $\chi^2(1, N = 1478) = 15.9$, Bonferroni $P < 0.0001$ in men]. In both sexes, individuals with unadjusted BMI <25 were more likely to choose homemade meals. There was a significant inverse association also between obesity status based on unadjusted percent body fat and homemade meals in men but not in women [unadjusted percent body fat: $\chi^2(1, N = 1478) = 6.1$, Bonferroni $P < 0.01$]. No association between the latter type of meals and obesity status based on unadjusted percent body fat was observed in women [unadjusted percent body fat: $\chi^2(1, N = 1863) = 1.21$, Bonferroni $P = 0.27$]. Obesity status based on unadjusted BMI in both men and women was inversely associated with bought sandwiches from a shop, café, or canteen [unadjusted BMI: $\chi^2(1, N = 222) = 7.007$, Bonferroni $P < 0.008$ in women; unadjusted BMI: $\chi^2(1, N = 222) = 5.5$, Bonferroni $P < 0.01$ in men]. However, there were no significant associations between the latter

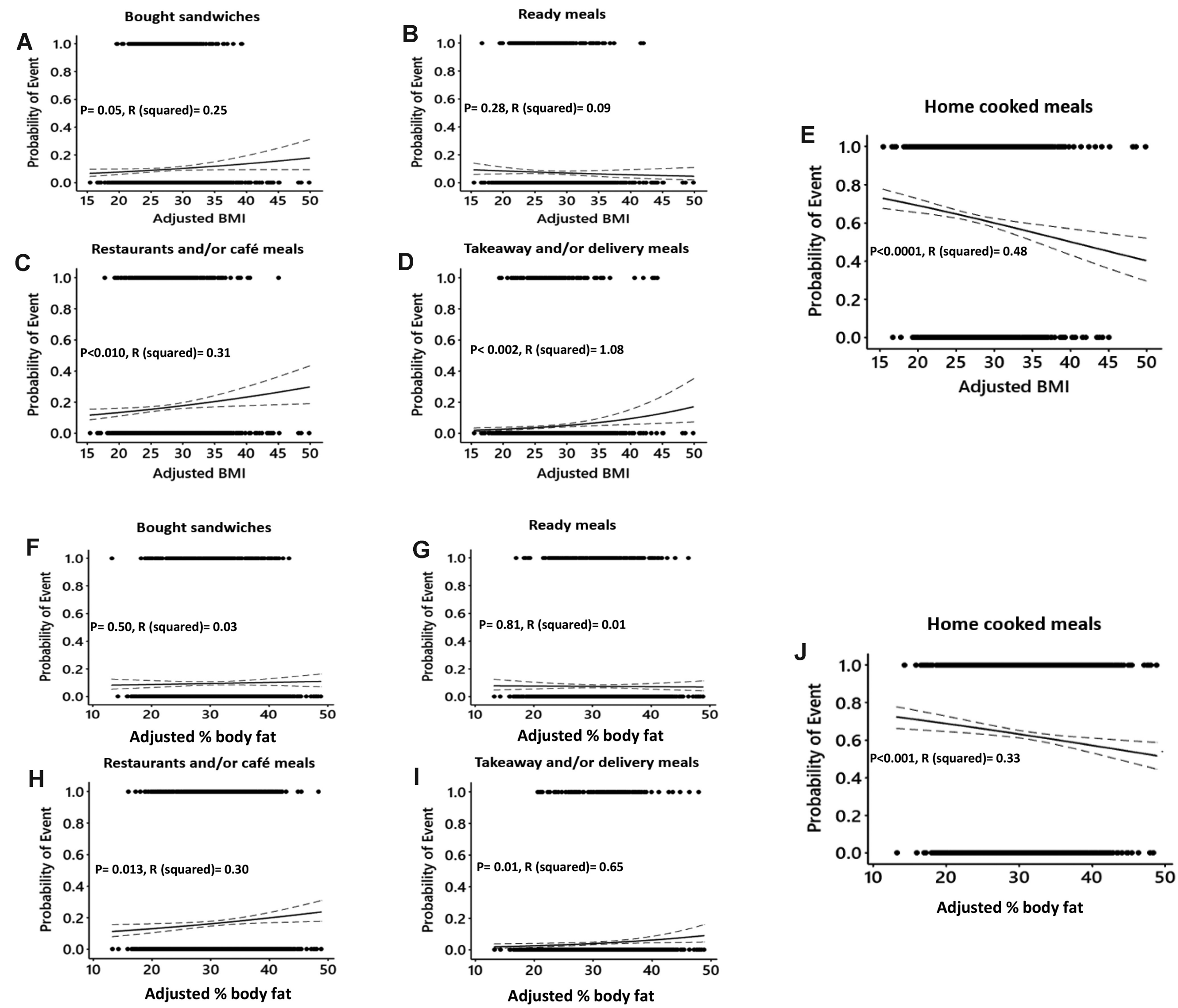

FIGURE 5 Binary logistic regression analyses of the association between different types of meals and adjusted body composition measures for men. (A–E) Adjusted BMI. (F–J) Adjusted percent body fat. $N = 5197$.

type of meals and obesity status calculated from unadjusted percent body fat in both sexes [unadjusted percent body fat: $\chi^2(1,\ N = 218) = 0.002$, Bonferroni $P = 0.96$ in women; unadjusted percent body fat: $\chi^2(1, N = 218) = 0.02$, Bonferroni $P = 0.86$ in men]. Consumption of ready meals in the previous 24 h also had no significant association with obesity status based on either unadjusted BMI and unadjusted percent body fat in men and women [unadjusted BMI: $\chi^2(1,\ N = 187) = 0.145$, Bonferroni $P = 0.70$ in women; unadjusted BMI: $\chi^2(1, N = 172) = 0.33$, Bonferroni $P = 0.56$ in men; unadjusted percent body fat: $\chi^2(1,\ N = 187) = 0.14$, Bonferroni $P = 0.70$ in women; unadjusted percent body fat: $\chi^2(1, N = 172) = 0.03$, Bonferroni $P = 0.85$ in men]. Obesity status, based on unadjusted BMI, was related to meals prepared and cooked at a restaurant/café in men [unadjusted BMI: $\chi^2(1,\ N = 385) = 5.75$, Bonferroni $P < 0.01$] but not in women [obesity status based on unadjusted BMI: $\chi^2(1, N = 446) = 0.29$, Bonferroni $P = 0.58$] and in neither sex when based on unadjusted percent body fat [$\chi^2(1, N = 446) = 0.005$, Bonferroni $P = 0.94$ in women; $\chi^2(1, N = 381) = 3.25$, Bonferroni $P = 0.07$ in men].

Analysis approach 2D: BMI and percent body fat recoded as binary dependent variables based on adjusted data

When defining obesity status using the adjusted BMI and percent body fat, obesity status of men was not significantly related to consumption of delivery or takeaways over the previous 24 h [adjusted BMI: $\chi^2(1, N = 99) = 4.93$, Bonferroni $P = 0.02$; adjusted percent body fat: $\chi^2(1,\ N = 99) = 0.96$, Bonferroni $P = 0.32$]. However, there was a significant association in women [adjusted BMI: $\chi^2(1, N = 100) = 13.19$, Bonferroni $P < 0.0001$; adjusted percent body fat: $\chi^2(1,\ N = 100) = 10.83$, Bonferroni $P < 0.001$]. Women living with obesity were more likely to have eaten takeaway/delivery food in the previous 24 h than women without obesity. Homemade meals were inversely related to obesity status based on adjusted BMI in both sexes [adjusted

TABLE 3 Binary logistic regression analysis of the association between different types of meals and adjusted body composition measures in women and men ($N = 5197$)[1]

Obesity measure	Type of the meal	*n*		SE	DF	Prevalence OR	95% CI	Bonferroni *P* value	R^2, %	Figures
Women										
Adjusted BMI	Bought sandwiches	222	0.02	0.013	1	1.02	1.0003, 1.05	0.48	0.24	A1
	Ready meals	187	–0.01	0.016	1	0.98	0.95, 1.02	0.48	0.04	B1
	Restaurant and/or café meals	446	0.009	0.01	1	1.009	0.98, 1.03	0.37	0.03	C1
	Takeaway and/or delivery meals	100	0.75	0.21	1	2.12	1.40, 3.22	<0.0001	2.30	D1
	Home-prepared meals	1886	–0.27	0.09	1	0.76	0.63, 0.91	<0.001	0.30	E1
Adjusted percent body fat	Bought sandwiches	222	0.016	0.01	1	1.016	0.99, 1.03	0.13	0.15	A2
	Ready meals	187	–0.006	0.01	1	0.99	0.97, 1.01	0.59	0.02	B2
	Restaurant and/or café meals	446	0.007	0.0077	1	1.007	0.99, 1.02	0.35	0.03	C2
	Takeaway and/or delivery meals	100	0.67	0.20	1	1.95	1.30, 2.93	<0.0001	1.73	D2
	Home-prepared meals	1886	–0.29	0.08	1	0.74	0.62, 0.87	<0.006	0.22	E2
Men										
Adjusted BMI	Bought sandwiches	222	0.03	0.016	1	1.03	0.99, 1.06	0.05	0.25	A3
	Ready meals	172	–0.02	0.02	1	0.97	0.94, 1.01	0.28	0.09	B3
	Restaurant and/or café meals	385	0.27	0.13	1	1.31	1.009, 1.70	<0.01	0.31	C3
	Takeaway and/or delivery meals	99	0.50	0.22	1	1.65	1.05, 2.59	<0.002	1.08	D3
	Home-prepared meals	1478	–0.31	0.10	1	0.73	0.59, 0.89	<0.0001	0.48	E3
Adjusted percent body fat	Bought sandwiches	222	0.008	0.01	1	1.008	0.98, 1.03	0.50	0.03	A4
	Ready meals	172	–0.003	0.01	1	0.99	0.96, 1.02	0.81	0.01	B4
	Restaurant and/or café meals	385	0.18	0.17	1	1.20	0.84, 1.69	<0.01	0.30	C4
	Takeaway and/or delivery meals	99	0.34	0.35	1	1.41	0.70, 2.84	<0.01	0.65	D4
	Home-prepared meals	1478	–0.07	0.13	1	0.93	0.72, 1.20	<0.001	0.33	E4

[1] Significance is where $P < 0.01$ (after Bonferroni correction). DF, degree of freedom.

TABLE 4 General linear model analysis: unadjusted obesity measures compared with type of meals consumed ($N = 5197$)[1]

Type of meals	Women	Men	Bonferroni P Women	Bonferroni P Men	R^2 Women	R^2 Men
BMI						
Bought sandwiches	0.16	0.01	0.41	0.93	0.95	0.80
Ready meals	0.15	0.29	0.48	0.11		
Restaurant and/or café meals	0.08	0.24	0.51	0.03		
Takeaway and/or delivery meals	1.18	0.47	<0.0001	0.04		
Home-prepared meals	–0.17	–0.32	0.18	<0.005		
% Body fat						
Bought sandwiches	0.08	–0.28	0.77	0.23	0.44	0.24
Ready meals	0.22	0.20	0.45	0.42		
Restaurant and/or café meals	0.09	0.27	0.60	0.07		
Takeaway and/or delivery meals	1.21	0.39	<0.002	0.21		
Home-prepared meals	–0.16	–0.33	0.35	0.03		

[1]Significance is where $P < 0.01$ (after Bonferroni correction).

BMI: $\chi^2(1, N = 1478) = 8.91$, Bonferroni $P < 0.003$ in men; adjusted BMI: $\chi^2(1, N = 1886) = 8.35$, Bonferroni $P < 0.004$ in women], but when based on adjusted percent body fat, it was only significant in women [adjusted percent body fat: $\chi^2(1, N = 1886) = 12.10$, Bonferroni $P < 0.001$ in women; adjusted percent body fat: $\chi^2(1, N = 1478) = 0.29$, Bonferroni $P = 0.59$ in men]. Individuals with adjusted BMI <25 were more likely to have consumed meals cooked and prepared at home. No association was found between obesity status based on adjusted BMI and adjusted percent body fat in men and consuming sandwiches bought from a shop, café, or a canteen [adjusted BMI: $\chi^2(1, N = 222) = 1.75$, Bonferroni $P = 0.18$; adjusted percent body fat: $\chi^2(1, N = 222) = 0.27$, Bonferroni $P = 0.59$], but there was a significant inverse association in women [adjusted BMI: $\chi^2(1, N = 222) = 9.97$, Bonferroni $P < 0.002$; adjusted percent body fat: $\chi^2(1, N = 222) = 6.12$, Bonferroni $P < 0.01$]. No links between obesity status based on adjusted BMI or adjusted percent body fat and consumption of ready meals and restaurant/café meals were found in both sexes [ready meals: adjusted BMI: $\chi^2(1, N = 187) = 0.20$, Bonferroni $P = 0.65$ in women; adjusted BMI: $\chi^2(1, N = 172) = 0.29$, Bonferroni $P = 0.58$ in men; adjusted percent body fat: $\chi^2(1, N = 187) = 0.02$, Bonferroni $P = 0.88$ in women; adjusted percent body fat: $\chi^2(1, N = 172) = 0.40$, Bonferroni $P = 0.52$ in men; restaurants and/or fast-food café meals: adjusted BMI: $\chi^2(1, N = 446) = 0.01$, Bonferroni $P = 0.91$ in women; adjusted BMI: $\chi^2(1, N = 385) = 4.14$, Bonferroni $P = 0.04$ in men; adjusted percent body fat: $\chi^2(1, N = 446) = 1.27$, Bonferroni $P = 0.25$ in women; adjusted percent body fat: $\chi^2(1, N = 381) = 1.07$, Bonferroni $P = 0.30$ in men].

Analysis of individuals reporting consumption of multiple food types

The BMI and percent body fat (as dependent variables) were compared in both sexes between participants who reported that they consumed a combination of meal types in the previous 24 h and those who reported that they had only eaten homemade meals. Unadjusted and adjusted BMI in women who consumed meals from a variety of sources over the previous 24 h had higher BMI than women who ate only homemade meals (women: unadjusted BMI, $t = 3.00$, $P < 0.003$; adjusted BMI, $t = 3.21$, $P < 0.001$) (**Figure 6**). Also, the adjusted percent body fat was significantly higher among women who reported that they had meals from multiple different sources in comparison with women who only had homemade meals in the previous 24 h (adjusted percent body fat, $t = 3.23$, $P < 0.001$), but there was no significant

TABLE 5 General linear model: obesity measures adjusted for age, deprivation, household size, employment, income, education, and ethnicity ($N = 5197$)[1]

Type of meals	Women	Men	Bonferroni P Women	Bonferroni P Men	R^2 Women	R^2 Men
BMI						
Bought sandwiches	0.40	0.23	0.02	0.10	4.1	1.7
Ready meals	0.13	0.13	0.46	0.39	3.9	1.6
Restaurant and/or café meals	0.13	0.26	0.30	<0.01	3.9	1.94
Takeaway and/or delivery meals	1.2	0.60	<0.0001	<0.004	4.7	2.05
Home-prepared meals	–0.36	–0.31	<0.0001	–0.31	4.3	2.2
% Fat						
Bought sandwiches	0.50	0.10	0.03	0.59	4.7	3.3
Ready meals	0.10	0.009	0.70	0.96	4.5	3.3
Restaurant and/or café meals	0.18	0.35	0.27	0.02	4.6	3.5
Takeaway and/or delivery meals	1.35	0.75	<0.0001	<0.0001	5.1	3.5
Home-prepared meals	–0.45	–0.38	<0.0001	<0.001	4.9	3.7

[1]Significance is where $P < 0.01$ (after Bonferroni correction).

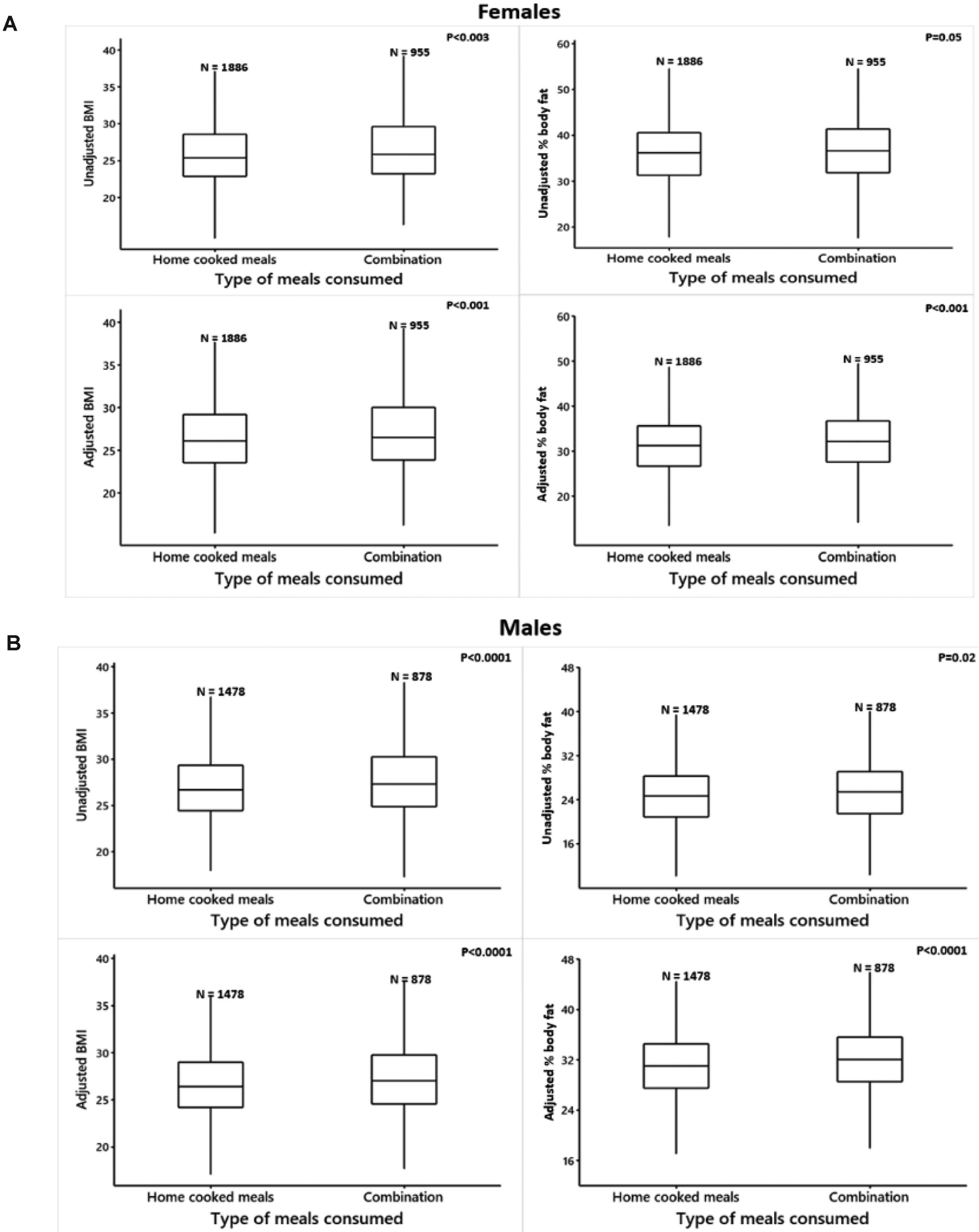

FIGURE 6 Two-sample *t* test: unadjusted and adjusted BMI and percent body fat differences between participants who consumed a combination of meal types over 24 h compared with participants who only ate homecooked meals. $N = 5197$.

difference in the unadjusted percent body fat (unadjusted percent body fat, $t = 1.94$, $P = 0.05$) (Figure 6).

There was a significant difference in the unadjusted and adjusted BMI among men who ate a combination of meal types compared with those who only ate homemade meals (men: unadjusted BMI, $t = 3.70$, $P < 0.0001$; adjusted BMI, $t = 3.84$, $P < 0.0001$; adjusted percent body fat, $t = 2.15$, $P = 0.03$) (Figure 6). Unadjusted percent body fat among men who consumed a combination of different types of meals was not significantly different from the unadjusted percent body fat in men who had only homemade meals, but after adjustment, the percent body fat was significantly higher in men who ate a combination of meals over the previous 24 h in comparison with their counterparts who had only homemade meals (unadjusted percent body fat, $t = 2.20$, $P = 0.02$; adjusted percent body fat, $t = 3.64$, $P < 0.0001$) (Figure 6).

Negative control analysis

Height was used as a negative control to investigate if there was any bias that may distort the data. That is, height is a variable that was expected not to be related to consumption of different meal types over the previous 24 h, and so if it was found to be significant, that might indicate there were some issues with the data. We repeated all the above analyses, replacing BMI or percent body fat with height. No associations were found between individuals' heights and the types of meals consumed over the previous 24 h among both men and women.

Discussion

Studies of the association between food intake and body composition are generally hampered by the inaccuracy of self-reported food intake measurement methods that rely to a large extent on memory and may require recall of precise measures of intake over substantial periods (26–28). The present study minimized these effects by asking a simple question that concerned whether the participant had consumed 1 (or more) of several different types of meals over the previous 24 h. Because of the simplicity of the task and short duration of the recall, it is unlikely that this measure involves significant issues in terms of recall fidelity. The weakness of this approach, however, is that by taking the recall of intake over only a single day prior to completing the survey, the answers are prone to issues of the day in question being unrepresentative for the person completing the survey. Moreover, there is also likely a strong day of week effect. Unfortunately, the day on which the survey was answered was not available from the UK Biobank records to correct for such possible effects. By accumulating more than 5000 records across a large population, however, the association signals can be discerned from the stochastic variation of individual responses.

We sought associations between BMI and percent body fat of the participants and their responses to this survey. Because the directionality of the relations is unknown, the analysis was performed first assuming the survey responses were the dependent variable and, second, by assuming the BMI and percent body fat were the dependent variables. Treating the survey outcome as the dependent variable, after adjusting BMI and percent body fat for several possible confounding factors, this study shows that as BMI and percent body fat increased, individuals were increasingly likely to report that they had consumed a takeaway and/or delivery meal over the previous 24 h. The probability of having consumed a meal that was prepared and eaten at a restaurant and/or café was also associated with BMI and percent body fat among men but not women. As BMI and percent body fat increased, both men and women were increasingly less likely to report having consumed homecooked and home-prepared meals during the previous 24 h. Analyzing the data with the BMI and percent body fat as the dependent variable showed that both unadjusted and adjusted BMI and percent body fat were higher in individuals reporting consumption of takeaway and delivery foods the previous day.

These data support previous work showing that individuals in the United Kingdom who consumed takeaway meals had on average higher daily energy intake in comparison with people who rarely consume this type of meals and were more likely to have obesity or be overweight (6). This was also consistent with previous studies that noted consumption of takeaway meals was positively associated with obesity among UK adults (17, 29, 30). The study revealed that the association between eating out at fast-food and other restaurants and higher BMI and percent body fat was different between the sexes, with a positive association in men but not women. This is consistent with previous studies that found men with high BMI were more likely to eat at restaurants (31) and consume more energy (32). In addition, it was also found previously that people who consumed meals at dine-in restaurants were more likely to be overweight or obese (33). A study from 2016 that included 18,098 adults concluded that men consume more meals that were prepared out of home and have higher energy intake than women (8). These associations, however, contradict population-level surveys that suggest no association between obesity prevalence and the densities of fast-food and full-service restaurants, in both the United States (25) and United Kingdom (15).

The negative association between obesity and homecooked and home-prepared meals is supported by many studies that found meals prepared and consumed at home are negatively related with obesity status. The connection here is consistent with previous work suggesting more frequent consumption of homecooked meals was associated with increased likelihood of having normal BMI and normal percent body fat (34). Moreover, it was noticed that people who consume homecooked meals >5 times a week were 28% less likely to be overweight and 24% less likely to have excess percent body fat (34). Our study supports this and shows that participants who reported that they only had homecooked and home-prepared meals in the previous 24 h have lower BMI and percent body fat than those who reported they had a combination of homecooked meals with other meal types. However, these associations are not always found. For example, a large study of 12,842 adults found that homecooked meals were not associated with reduced risk of obesity (35). The causes of the heterogenous results remain unclear.

Strengths and limitations

A strength of our study is that the measures of BMI and percent body fat were carried out by health professionals at

UK Biobank centers and were not self-reported, and we also used a negative control (height) in all the analyses. The survey of meal choice, however, was self-reported, which could be susceptible to memory error (36). Nevertheless, the question in the survey was about what participants had in the past 24 h, and relatively simple options were provided that may minimize that error. Individuals were not, for example, asked to report meals consumed or portion sizes, making the recall task much easier. One weakness of this study is that it could be representative for middle-aged adults (aged 40–65 y) but not for those who are younger than 40 y or older than 65 y as they may have different dietary habits (37). The age range of the participants was between 40 and 69 y, and consequently, these trends may differ for younger or older adults. Also, this sample from UK Biobank might not be representative of the whole population in the United Kingdom, as the Biobank population is biased demographically in comparison with the general population in the United Kingdom (38). Moreover, there were 22 recruiting centers working with UK Biobank, but unfortunately, no information was found regarding which recruiting centers invited participants to take this survey. Hence, we were unable to explore the data with respect to the geographic spread of the data or to investigate if the survey was disseminated evenly. The study survey did not allow us to analyze the potential impact of day of the week on meal consumption, and there was no information on the type of food eaten at the given establishments. Because dining out is potentially more common at the weekend, any factor increasing the probability that a participant would complete the questionnaire at the weekend would increase their odds of reporting having consumed such a meal. There is, however, no reason to suspect this propensity would be biased with respect to participant BMI or percent body fat. Finally, as the design was cross-sectional, it was unable to define exposure–outcome temporal relations.

In conclusion, this study examined the association between different types of meals and body composition in 5197 participants (extracted from UK Biobank) living in the United Kingdom. Consumption of takeaway and/or delivery meals over the previous 24 h was positively associated with higher BMI and percent body fat in both sexes. Consumption of restaurant/café food was also significant in men but not women. Our investigation supports the widespread suggestion that eating homecooked and prepared meals was less likely to be linked with obesity. If the associations are causal, then delivery and takeaway foods may present a suitable target for intervention studies to reduce obesity.

We thank UK Biobank for their help in providing the data.

The authors' responsibilities were as follows—AAA, JRS, and CH: designed and conducted the research; AAA and JRS: analyzed data; AAA: wrote the paper; JRS and CH: critically revised the manuscript; and all authors: have read and approved the final version. The authors report no conflicts of interest.

Data Availability

The data described in this manuscript are publicly available upon request to UK Biobank.

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