AKADÉMIAI KIADÓ

Journal of Behavioral Addictions

11 (2022) 2, 588–599

DOI:
10.1556/2006.2022.00009

FULL-LENGTH REPORT

Ultra-processed food intake and eating disorders: Cross-sectional associations among French adults

NATASHA FIGUEIREDO[1,2†], JUNKO KOSE[1†], BERNARD SROUR[1,3], CHANTAL JULIA[1,4], EMMANUELLE KESSE-GUYOT[1,3], SANDRINE PÉNEAU[1], BENJAMIN ALLÈS[1], INDIRA PAZ GRANIEL[5], ELOI CHAZELAS[1,3], MÉLANIE DESCHASAUX-TANGUY[1,3], CHARLOTTE DEBRAS[1,3], SERGE HERCBERG[1,3,4], PILAR GALAN[1,3], CARLOS A. MONTEIRO[6], MATHILDE TOUVIER[1,3] and VALENTINA A. ANDREEVA[1*]

[1] Nutritional Epidemiology Research Group (EREN), Sorbonne Paris Nord University, INSERM U1153/INRAE U1125/CNAM, Epidemiology and Statistics Research Center (CRESS) – University of Paris, Bobigny, France

[2] Health Services Research Group (RESHAPE), INSERM U1290, Claude Bernard University - Lyon 1, Lyon, France

[3] National Nutrition and Cancer Research Network (NACRE), Jouy-en-Josas, France

[4] Department of Public Health, AP-HP Paris Seine-Saint-Denis Hospital System, Bobigny, France

[5] Human Nutrition Research Group, Department of Biochemistry and Biotechnology, Rovira i Virgili University, Tarragona, Spain

[6] Department of Nutrition, School of Public Health, University of São Paulo, São Paulo, Brazil

Received: September 9, 2021 • Revised manuscript received: February 13, 2022 • Accepted: March 8, 2022
Published online: April 4, 2022

ABSTRACT

Background and aims: Data regarding the association between ultra-processed food (UPF) consumption and eating disorders (ED) are scarce. Our aim was to investigate whether UPF intake was associated with different ED types in a large population-based study. *Methods:* 43,993 participants (mean age = 51.0 years; 76.1% women) of the French NutriNet-Santé web-cohort who were screened for ED in 2014 via the Sick-Control-One stone-Fat-Food (SCOFF) questionnaire, were included in the analysis. The clinical algorithm *Expali*^{TM} tool was used to identify four ED types: restrictive, bulimic, binge eating, and other (not otherwise specified). Mean dietary intake was evaluated from at least 2 self-administered 24-h dietary records (2013–2015); categorization of food as ultra-processed or not relied on the NOVA classification. The associations between UPF intake (as percent and reflecting mean daily UPF quantity (g/d) within the dietary intake, %UPF) and ED types were evaluated using polytomous logistic regression models. *Results:* 5,967 participants (13.6%) were categorized as likely ED (restrictive $n = 444$; bulimic $n = 1,575$; binge eating $n = 3,124$; other ED $n = 824$). The fully-adjusted analyses revealed a positive association between UPF intake and bulimic, binge eating, and other ED: ED risk (odds ratio, OR) for an absolute 10-percentage point incremental increase in %UPF intake were 1.08 (1.01–1.14; $P = 0.02$), 1.21 (1.16–1.26; $P < 0.0001$), and 1.11 (1.02–1.20; $P = 0.02$), respectively. No significant association was detected for restrictive ED. *Discussion and Conclusion:* This study revealed an association of UPF intake with different ED types among French adults. Future research is needed to elucidate the direction of the observed associations.

KEYWORDS

eating disorders, anorexia nervosa, bulimia nervosa, binge eating disorder, ultra-processed food, epidemiological study

†Natasha Figueiredo and Junko Kose contributed equally to this work and should be considered joint first authors.

*Corresponding author. Tel.: +33 1 48 38 89 30.
E-mail: v.andreeva@eren.smbh.univ-paris13.fr

INTRODUCTION

Feeding and eating disorders (ED) refer to a persistent disturbance of eating behavior, substantially altering physical health and psychosocial functioning (American Psychiatric Association, 2013). Nearly a dozen different ED have been identified; among them, anorexia nervosa (AN), bulimia nervosa (BN), and binge eating (BED) are regarded as typical and have been studied extensively. Individuals with ED often present with comorbid mental conditions, such as anxiety and depressive disorders (Keski-Rahkonen & Mustelin, 2016) and are at increased premature mortality risk (Chesney, Goodwin, & Fazel, 2014). Moreover, it has been suggested - despite the present lack of consensus - that BN and BED display substance dependence characteristics consistent with food addiction, given evidence of impaired control, repeated intake, importance of situational cues, and the associated activation of dopamine reward systems in the brain (Hauck, Cook, & Ellrott, 2020; Paterson, Lacroix, & von Ranson, 2019; Schulte, Avena, & Gearhardt, 2015).

A systematic review of ED prevalence worldwide revealed that 8.4% (range: 3.3–18.6%) of women and 2.2% (range: 0.8–6.5%) of men suffered from ED at least once in their lifetime (Galmiche, Déchelotte, Lambert, & Tavolacci, 2019). It was also suggested that ED point prevalence had doubled, going from 3.5% during 2000–2006 to 7.8% during 2013–2018 (Galmiche et al., 2019). Although young women are regarded as being the most affected (and represent the most studied population subgroup), a recent study among middle-aged adults reported that nearly 15% of women and 8% of men were identified as likely ED cases (Andreeva et al., 2019).

Like many other mental disorders, ED have a multifactorial etiology, including past and present socio-economic status, psychosocial and genetic vulnerability, and family history (Mulders-Jones, Mitchison, Girosi, & Hay, 2017; Weissman & Bulik, 2007). In addition, given that ED are by definition directly related to eating behaviors (American Psychiatric Association, 2013), investigating dietary habits and food preferences among affected individuals is essential. Thus far, cross-sectional and case-control studies have reported positive associations of BED with soda intake (Bragg & White, 2013) and sweet-tasting food preference (Goodman et al., 2018), and an inverse association between AN and fat intake/preference (Schebendach et al., 2019); a prospective study suggested a possible protective effect of the Mediterranean diet on AN and BN risk in women (Leone et al., 2018). In addition, a study with 48 women with non-purge BED reported that the most common food items consumed during episodes of binge eating included breads, pasta, sweets, high-fat meats and salty snacks (Allison & Timmerman, 2007).

In that context, a relatively novel concept has emerged – that of ultra-processed food (UPF) and its potentially detrimental impact on health. UPF refers to industrial formulations of fat, salt, sugar and other food substances that have undergone extensive physical and chemical modifications; UPF often contains flavorings, colorants and other additives (Monteiro et al., 2019). The potential health risks associated with UPF intake were first evoked in 2009 (Monteiro, 2009); a four-level classification with UPF as the fourth group, known as NOVA, was introduced in 2016 (Monteiro et al., 2016). Distinguishing features of the NOVA food classification are the focus on the degree of industrial processing and the presence of food additives. Typically, UPF is attractively packaged, palatable, relatively affordable, and ready to eat, all of which explain its substantial and growing consumption around the world (Baker et al., 2020; Monteiro et al., 2019; Vandevijvere et al., 2019). Recent data suggested that in France UPF intake accounted for approximately 30% of the mean daily energy intake (Calixto Andrade et al., 2021).

UPF intake has been consistently associated with various physical health outcomes (Pagliai et al., 2021), whereas only a handful of studies have explored the link with mental health (Adjibade et al., 2019; Gómez-Donoso et al., 2020; Zheng, Sun, Yu, & Zhang, 2020) and none has investigated the link with ED in the general population. One small, clinical study (n = 74 ED patients) reported that 55% of the average daily intake of AN patients consisted of UPF (NOVA-4 group), whereas the corresponding percentages for patients with BN and BED were 72% and 69%, respectively (non-significant differences) (Ayton, Ibrahim, Dugan, Galvin, & Wright, 2021). It was also highlighted that foods that were consumed during binging episodes were 100% ultra-processed.

At present, research in the UPF-ED domain is scarce and primarily derived from small clinical samples (Allison & Timmerman, 2007; Ayton et al., 2021) of adolescent or young adult (often female) participants (Harshman et al., 2019; Pereira et al., 2021; Werneck, Hoare, & Silva, 2021). Therefore, we assessed the cross-sectional association between UPF intake and ED type in a large adult sample, hypothesizing that UPF intake would be positively associated with non-restrictive ED types. To the best of our knowledge, this is the first epidemiological study in this domain specifically focused on NOVA-derived UPF intake and using a large and heterogeneous sample of men and women recruited from the French general population.

METHODS

The NutriNet-Santé web cohort

NutriNet-Santé is an ongoing prospective web-cohort launched in France in May 2009. Details about the design, protocol and principal objectives are available elsewhere (Hercberg et al., 2010). Briefly, adults aged 18 years and older are recruited from the general population via announcements in the media (e.g., television, radio, Internet, printed press). Apart from age, the inclusion criteria pertain to comprehension of written French and ability to self-

report information using an Internet platform (https://etude-nutrinet-sante.fr/). NutriNet-Santé was approved by the Institutional Review Board of the French Institute for Health and Medical Research and by the National Commission on Informatics and Liberty. The cohort is registered (# NCT03335644) at https://www.ClinicalTrials.gov. Each interested individual is presented with a description of the study and is required to provide informed consent prior to enrollment.

At inclusion and yearly thereafter, participants are asked to complete a five-instrument battery covering socio-demographic and lifestyle profiles, anthropometrics, physical activity, diet, and health status. Apart from these assessments, all participants are asked to complete about one nutrition- or health-related questionnaire per month, as part of the follow-up.

Measures

Dietary data and assessment of ultra-processed food consumption. UPF Intake was the main independent variable in this analysis. In NutriNet-Santé, dietary intake is evaluated at inclusion and every six months thereafter, each time using three non-consecutive 24-h dietary records. The dietary data collection tool has been validated against dietitian interviews and against nutritional status biomarkers (Lassale et al., 2016; Touvier et al., 2011). For each diet assessment day, participants were asked to report all individual food, beverages, and composite dishes consumed, including the portion size/quantity, preparation method, and meal setting (place, time, company, etc.). Portion sizes, for example, were recorded with the help of validated photographs (Le Moullec et al., 1996), standard serving containers or directly in *g* or *ml*. Next, NutriNet-Santé has its own food composition table that includes >3,500 items; it was used to estimate individual mean daily energy and nutrient intake (Etude NutriNet-Santé, 2013). All reported dietary data were weighted in order to respect the 5:7 and 2:7 ratios of week days and weekend days. Aberrant energy intake values were identified via Black's method (Black, 2000). For this analysis, each participant's dietary intake was averaged across a minimum of two 24-h dietary records completed between January 2013 and December 2015 (i.e., three-year window around the ED assessment date, described below). Individuals with aberrant daily energy intake values or with fewer than two 24-h records were excluded from the analysis. Finally, the four-level NOVA classification (i.e., 1- unprocessed/minimally processed food; 2- processed culinary ingredients; 3- processed food; and 4- UPF) (Monteiro et al., 2016) was applied to all reported food/beverage items. A team of researchers and trained dietitians had assigned each item in the NutriNet-Santé food composition table to one of the four NOVA groups, as previously reported (Julia et al., 2018).

Eating disorders assessment. The main outcome in this analysis was ED presence and type. As part of the NutriNet-Santé follow-up, the validated five-item Sick-Control-One stone-Fat-Food (SCOFF) questionnaire (Garcia et al., 2011; Morgan, Reid, & Lacey, 1999) was administrated between June and December 2014 in order to screen for ED. Each of the five items is dichotomous (Yes/No); a minimum of two affirmative responses indicates likely ED; the score has been shown to approximate actual ED point prevalence (Botella, Sepúlveda, Huang, & Gambara, 2013). In total, 125,279 NutriNet-Santé enrollees received the SCOFF, of whom 51,073 returned a completed questionnaire. Next, the clinical algorithm *Expali*^{TM} which relies on the SCOFF score and the Body mass index (BMI, kg/m^2) was used to identify four ED types: restrictive (including AN, atypical AN, and restrictive food intake disorder), bulimic (including BN and low-frequency/short-duration BN), binge eating (including BED and low-frequency/short-duration BED), and other (not otherwise specified) ED (Tavolacci, Gillibert, Zhu Soubise, Grigioni, & Déchelotte, 2019). In general, the atypical/low-frequency/short duration ED were those ED that fall below the DSM-5 established cutoffs as regards the recurrence of ED in terms of frequency (≥1 episode/week) and duration (≥3 months) (American Psychiatric Association, 2013).

Covariate data. Self-reported data on age, sex, educational level, socio-professional category, marital status, alcohol consumption, and smoking status were collected by a validated socio-demographic questionnaire (Vergnaud et al., 2011). Physical activity was assessed by the International Physical Activity Questionnaire-Short Form and scoring followed an established protocol (Craig et al., 2003). Height and weight were self-reported using a validated anthropometric questionnaire (Lassale et al., 2013); it permitted the calculation of BMI and its main categories (underweight: <18.5, normal weight: 18.5–24.9, overweight: 25.0–29.9, and obese: ≥30.0). Self-reported information about prescription medication use for the treatment of anxiety and/or depression was collected using the health status questionnaire. As all of these questionnaires are administered at baseline and annually thereafter, we relied on covariate data provided ≤12 months before the completion of the SCOFF.

Statistical analysis

Descriptive characteristics across ED types reflect number (percent) from chi-squared tests (categorical variables) and mean (±SD) from ANOVA (continuous variables). Next, a continuous measure of UPF intake was calculated; it represented the mean proportion (in %) of UPF in the diet. The associations between the independent variable (per 10-percentage point incremental increase in %UPF intake in the diet) and ED presence/type were assessed using polytomous logistic regression models (no ED = reference), providing odds ratios (OR) and 95% confidence intervals (CI). The first set of analyses (Model 1) was adjusted for age (*years*, continuous scale) and sex, whereas the second set of analyses (Model 2) was adjusted for age (*years*, continuous scale), sex, mean total energy intake (*Kcal/d*, continuous scale), alcohol consumption (*g* ethanol/*d*, continuous scale), smoking status (never, former, current smoker), physical activity level (low, moderate, high), educational level (less than high school, high school diploma or equivalent, college/undergraduate

degree, graduate degree), socio-professional category (homemaker/disabled/unemployed, student, manual/blue collar worker, office work/administrative staff, professional/executive staff, retired), marital status (living alone or married/cohabiting), and number of 24-h dietary records (continuous scale). Given strong evidence for differences in the presence and type of ED by sex; (Andreeva et al., 2019; Galmiche et al., 2019), we performed interaction tests with the latter variable. The choice of covariates for the multivariable model was guided by evidence of statistical significance at the bivariate level and also by empirical evidence from prior hypothesis-driven studies regarding the association of UPF consumption with mental health outcomes (Adjibade et al., 2019; Gómez-Donoso et al., 2020; Zheng et al., 2020). Next, two sets of sensitivity analyses were carried out in order to assess the robustness of the main findings: the first set addressed the comorbidity of ED with anxiety/depressive disorders (Keski-Rahkonen & Mustelin, 2016) and included only participants who did not report anxiety and/or depression medication use prior to January 1, 2016; the second set of sensitivity analyses included only participants with six or more 24-h dietary records in order to augment the independent variable assessment. Finally, one supplementary analysis was performed in order to investigate the association between non-UPF intake (NOVA groups 1–3) and ED presence/type. The main tests were two-sided and $P < 0.05$ was considered as evidence for statistical significance. SAS version 9.4 (SAS Institute, Inc., Cary NC, USA) was used for all statistical analyses.

Ethics

The NutriNet-Santé study is conducted according to the Declaration of Helsinki guidelines. It was approved by the Institutional Review Board of the French Institute for Health and Medical Research (INSERM # 00000388FWA00005831) and by the National Commission on Informatics and Liberty (CNIL # 908450 and # 909216). NutriNet-Santé is registered (# NCT03335644) at https://www.ClinicalTrials.gov. Electronic Informed consent was obtained from all individuals prior to inclusion in the study.

RESULTS

Description of sample

NutriNet-Santé participants who returned a completed SCOFF questionnaire ($n = 51{,}073$) were generally older, more likely to be former/never smokers, to have post-secondary education and to be married/cohabiting compared to their counterparts who did not complete the questionnaire (all $P < 0.0001$) (Andreeva et al., 2019). From the present analyses, we excluded those lacking anthropometric ($n = 296$), socio-demographic ($n = 153$), and/or physical activity ($n = 1{,}145$) data. Next, those with fewer than two 24-h dietary record and/or with aberrant energy intake values ($n = 5{,}486$) were also excluded. Thus, we arrived at a final sample of 43,993 participants (Fig. 1) (76.1% women; mean age = 51.0 ± 14.6 years; mean %UPF = 16.0% ± 8.0%). A total of 5,967 participants (13.6%) were categorized as likely ED cases, as follows: restrictive ED, $n = 444$; bulimic ED, $n = 1{,}575$; binge eating ED, $n = 3{,}124$; other ED, $n = 824$.

Descriptive characteristics across ED types are presented in Table 1. Individuals in the restrictive and bulimic ED categories were more likely to be women, younger, homemaker/disabled/unemployed, students, current smokers, to live alone, and to consume less alcohol compared to those in the other ED categories (all $P < 0.0001$). In the full simple, the mean number of 24-h dietary records was 9.4 ± 4.6.

Association between UPF intake and ED presence/type

Given that the interaction test of %UPF by sex was not statistically significant ($P = 0.19$), the main analysis was carried out in the full sample. Table 2 shows OR and 95% CI for the partially (Model 1) and fully-adjusted (Model 2) association between UPF intake and ED presence/type obtained from polytomous logistic regression. In Model 2, a significantly higher OR for an absolute 10-percentage point incremental increase in %UPF in the diet was seen for all ED types except for restrictive disorders. ORs for bulimic, binge eating and other ED were 1.08 (1.01–1.14; $P = 0.02$), 1.21 (1.16–1.26; $P < 0.0001$), and 1.11 (1.02–1.20; $P = 0.02$), respectively. The supplementary analysis, focused on the association between non-UPF intake (i.e., NOVA groups 1–3) and ED presence/type revealed a significantly lower OR for an absolute 10-percentage point incremental increase in non-UPF intake (%) only for BED (0.89; 0.86–0.93; $P < 0.0001$).

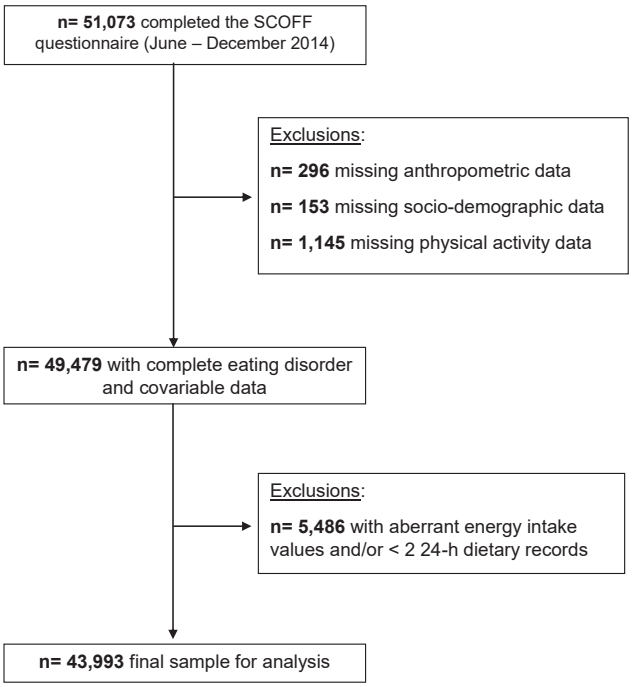

Fig. 1. Participants flowchart

Table 1. Descriptive characteristics of the sample according eating disorder presence and type, NutriNet-Santé Study, France (N = 43,933)

	Full sample		No eating disorder		Restrictive disorders		Bulimic disorders		Binge eating disorders		Other eating disorders		P-value[1]
	n = 43,993		n = 38,026		n = 444		n = 1,575		n = 3,124		n = 824		
Sex													
Women	33,457	(76.1)	28,325	(74.5)	422	(95.0)	1,458	(92.6)	2,602	(83.3)	650	(78.9)	<0.0001
Men	10,536	(23.9)	9,701	(25.5)	22	(5.0)	117	(7.4)	522	(16.7)	174	(21.1)	
Age, years, mean (SD)	51.0	(14.6)	51.4	(14.5)	38.3	(13.5)	43.3	(14.4)	51.2	(13.6)	51.1	(14.9)	<0.0001
Age category													
18–39 y	11,180	(25.4)	9,340	(24.6)	264	(59.5)	694	(44.1)	682	(21.8)	200	(24.3)	<0.0001
40–59 y	17,697	(40.2)	15,197	(40.0)	142	(32.0)	630	(40.0)	1,400	(44.8)	328	(39.8)	
≥60 y	15,116	(34.4)	13,489	(35.5)	38	(8.6)	251	(15.9)	1,042	(33.4)	296	(35.9)	
Educational level													
Less than high school	6,503	(14.8)	5,451	(14.3)	38	(8.6)	195	(12.4)	643	(20.6)	176	(21.4)	<0.0001
High school diploma or equivalent	7,755	(17.6)	6,542	(17.2)	86	(19.4)	303	(19.2)	633	(20.3)	191	(23.2)	
College, undergraduate degree	13,585	(30.9)	11,721	(30.8)	143	(32.2)	513	(32.6)	955	(30.6)	253	(30.7)	
Graduate degree	16,150	(36.7)	14,312	(37.6)	177	(39.9)	564	(35.8)	893	(28.6)	204	(24.8)	
Socio-professional category													
Homemaker/disabled/unemployed	381	(0.9)	319	(0.8)	14	(3.2)	20	(1.3)	20	(0.6)	8	(1.0)	<0.0001
Student	1,201	(2.7)	933	(2.5)	60	(13.5)	108	(6.9)	75	(2.4)	25	(3.0)	
Manual/blue collar	8,445	(19.2)	6,851	(18.0)	128	(28.8)	440	(27.9)	808	(25.9)	218	(26.5)	
Office work/administrative staff	8,728	(19.8)	7,514	(19.8)	99	(22.3)	368	(23.4)	595	(19.0)	152	(18.4)	
Professional/executive staff	11,127	(25.3)	9,830	(25.9)	108	(24.3)	394	(25.0)	646	(20.7)	149	(18.1)	
Retired	14,111	(32.1)	12,579	(33.1)	35	(7.9)	245	(15.6)	980	(31.4)	272	(33.0)	
Marital status													
Living alone (single, divorced, widowed)	11,450	(26.0)	9,630	(25.3)	199	(44.8)	516	(32.8)	890	(28.5)	215	(26.1)	<0.0001
Married/cohabiting	32,543	(74.0)	28,396	(74.7)	245	(55.2)	1,059	(67.2)	2,234	(71.5)	609	(73.9)	
Physical activity level[2]													
Low	9,738	(22.1)	8,205	(21.6)	81	(18.2)	339	(21.5)	904	(28.9)	209	(25.4)	<0.0001
Moderate	18,549	(42.2)	16,126	(42.4)	185	(41.7)	674	(42.8)	1,247	(39.9)	317	(38.5)	
High	15,706	(35.7)	13,695	(36.0)	178	(40.1)	562	(35.7)	973	(31.2)	298	(36.2)	
BMI (kg/m^2), mean (SD)	23.9	(4.4)	23.6	(4.1)	18.3	(2.6)	22.8	(3.5)	28.0	(5.7)	26.2	(5.3)	<0.0001
BMI category													
Underweight (<18.5)	2,215	(5.0)	1,874	(4.9)	341	(76.8)	0	(0.0)	0	(0.0)	0	(0.0)	<0.0001
Normal weight (18.5–24.9)	27,846	(63.3)	25,014	(65.8)	103	(23.2)	1,412	(89.7)	908	(29.1)	409	(49.6)	
Overweight (25.0–29.9)	10,027	(22.8)	8,439	(22.2)	0	(0.0)	95	(6.0)	1,255	(40.2)	238	(28.9)	
Obese (≥30.0)	3,905	(8.9)	2,699	(7.1)	0	(0.0)	68	(4.3)	961	(30.8)	177	(21.5)	
Smoking status													
Never smoker	22,021	(50.1)	19,272	(50.7)	234	(52.7)	757	(48.1)	1,388	(44.4)	370	(44.9)	<0.0001
Former smoker	17,106	(38.9)	14,662	(38.6)	127	(28.6)	584	(37.1)	1,376	(44.1)	357	(43.3)	
Current smoker	4,866	(11.1)	4,092	(10.8)	83	(18.7)	234	(14.9)	360	(11.5)	97	(11.8)	
Alcohol use, g ethanol/d, mean (SD)	7.5	(10.7)	7.7	(10.8)	4.5	(7.7)	5.6	(8.5)	6.4	(9.8)	6.8	(10.8)	<0.0001

(continued)

Table 1. Continued

	Full sample		No eating disorder		Restrictive disorders		Bulimic disorders		Binge eating disorders		Other eating disorders		*P*-value[1]
	n = 43,993		*n* = 38,026		*n* = 444		*n* = 1,575		*n* = 3,124		*n* = 824		
Total energy intake, Kcal/d, mean (SD)	1,782.3	(480.0)	1,797.9	(476.0)	1,505.7	(490.6)	1,661.6	(469.1)	1,724.0	(502.9)	1,664.1	(480.0)	<0.0001
UPF consumption[3], % of total amount of food consumed, mean (% g/d)	16.0	(8.0)	15.8	(7.8)	17.7	(11.0)	17.3	(9.3)	17.4	(9.0)	16.7	(8.9)	<0.0001
Number of 24-h dietary records, mean (SD)	9.4	(4.6)	9.5	(4.6)	8.8	(4.8)	8.5	(4.5)	8.9	(4.6)	8.6	(4.6)	<0.0001

Values refer to number (%) except when noted otherwise. [1] *P*-values obtained from chi-squared tests or ANOVA, as appropriate. [2] Assessed with the International Physical Activity Questionnaire-Short Form according to established scoring criteria. [3] Categorized as ultra-processed based on the NOVA-4 classification. Values are rounded off to one decimal place.
BMI: Body Mass Index; SD: Standard deviation; UPF: Ultra-processed food.

No other significant associations were observed (Supplementary Table 1).

Sensitivity analyses

The results of the sensitivity analyses are summarized in Table 3. For the first sensitivity analysis, we retained only participants who did not report medication use for the treatment of anxiety and/or depression (n = 39,383). The main results were replicated except for bulimic and other ED; the latter associations were attenuated and became statistically non-significant. For the second sensitivity analysis, we retained only participants with a minimum of six 24-h dietary records (n = 33,832). No substantial change in the main results was observed.

DISCUSSION AND CONCLUSION

To our knowledge, this large cross-sectional study was the first to investigate the association between UPF intake and ED presence and type among adults recruited from the general population. Largely supporting our main hypothesis, we found that an increase in UPF intake was significantly associated with higher odds for bulimic, binge eating, and other ED. The largest effect size was observed for BED (21% higher risk compared to those without ED), followed by the "other" ED category (11% higher risk) and bulimic ED (8% higher risk). Only one other study among adults – conducted in a clinical setting with a small sample of patients with ED – has investigated an association between UPF intake and ED (Ayton et al., 2021). That descriptive study used retrospectively-assessed UPF intake and showed that the average daily intake among patients with BN and BED consisted of about 70% UPF (NOVA-4 group), whereas the corresponding percentage among patients with AN was 55%. The differences, however, were not statistically significant. The authors further estimated that foods consumed during binging episodes were 100% UPF (Ayton et al., 2021). In turn, a small case-control study using four-day food records reported higher intakes of refined-carbohydrate processed foods, added sugars, and total carbohydrates and lower intakes of fruit, vegetables and protein among children and adolescents with avoidant/restrictive ED compared to healthy controls (Harshman et al., 2019). Given that restrictive ED in the present study include AN, atypical AN, and avoidant/restrictive food intake disorder, the nature of UPF – often high in both added/free sugars and saturated fat (Monteiro et al., 2019) – may partly explain our null findings as regards the relationship with UPF intake. A handful of studies have explored UPF in relation to other mental health outcomes. For example, one cross-sectional and two prospective analyses among adults showed an increased risk of depression or depressive symptoms associated with NOVA-categorized UPF consumption (Adjibade et al., 2019; Gómez-Donoso et al., 2020; Zheng et al., 2020), and one cross-sectional study reported a positive association between UPF intake and

Table 2. Association between ultra-processed food intake and eating disorder presence and type, NutriNet-Santé Study, France (N = 43,993)

	Model 1			Model 2		
	Per 10-percentage point increase in proportion of UPF in diet, OR (95% CI)		*P*-value	Per 10-percentage point increase in proportion of UPF in diet, OR (95% CI)		*P*-value
Restrictive disorders						
n = 444	1.06	(0.95–1.18)	0.29	1.09	(0.98–1.21)	0.12
Bulimic disorders						
n = 1,575	1.09	(1.03–1.16)	0.003	1.08	(1.01–1.14)	0.02
Binge eating disorders						
n = 3,124	1.28	(1.23–1.33)	<0.0001	1.21	(1.16–1.26)	<0.0001
Other eating disorders						
n = 824	1.16	(1.07–1.26)	0.0004	1.11	(1.02–1.20)	0.02

No eating disorder = reference.
Model 1 is a multivariable polytomous logistic regression adjusted for age and sex.
Model 2 is a multivariable polytomous logistic regression adjusted for age, sex, marital status, educational level, socio-professional category, smoking status, physical activity level, dietary energy intake, alcohol intake, and number of 24-h dietary records.
Values are rounded off to two decimal places.
CI: Confidence interval; OR: Odds ratio.

Table 3. Sensitivity analyses of the association between ultra-processed food intake and eating disorders presence and type, NutriNet-Santé Study, France

	Sensitivity analysis 1 (n = 39,383) excluding participants with reported medication use for anxiety and/or depression			Sensitivity analysis 2 (n = 33,832) excluding participants with <6 24-h dietary records		
	Per 10-percentage point increase in proportion of UPF in diet; OR (95% CI)		*P*-value	Per 10-percentage point increase in proportion of UPF in diet; OR (95% CI)		*P*-value
Restrictive disorders						
No. of cases	338			316		
	1.04	(0.92–1.18)	0.49	1.13	(0.99–1.29)	0.08
Bulimic disorders						
No. of cases	1,281			1,109		
	1.05	(0.98–1.13)	0.14	1.09	(1.00–1.18)	0.04
Binge eating disorders						
No. of cases	2,527			2,258		
	1.21	(1.15–1.26)	<0.0001	1.26	(1.20–1.33)	<0.0001
Other eating disorders						
No. of cases	699			586		
	1.08	(0.99–1.18)	0.10	1.25	(1.13–1.38)	<0.0001

Results from a multivariable polytomous logistic regression (no eating disorder = reference) adjusted for age, sex, marital status, educational level, socio-professional category, smoking status, physical activity level, dietary energy intake, alcohol intake, and number of 24-h dietary records.
Values are rounded off to two decimal places.
CI: Confidence Interval; OR: Odds Ratio.

anxiety-induced sleep disturbance among adolescents (Werneck et al., 2021).

The substantial sugar/salt/fat content and various additives (i.e., colors, flavors, emulsifiers) - all of which render UPF highly palatable (Monteiro et al., 2019) – can help explain the significant findings observed with bulimic, binge eating and other ED. It has been suggested - despite the lack of consensus at present - that BN and BED present substance dependence characteristics consistent with food addiction, given evidence of impaired control, repeated intake and the associated activation of dopamine reward systems in the brain (Hauck et al., 2020). Findings from neuroimaging, neurocognitive, genetic, and animal studies suggest that similar to other impulsive/compulsive disorders, BED might be associated with maladaptation of the corticothalamic circuitry that controls motivation and impulse control (Kessler, Hutson, Herman, & Potenza, 2016). In turn, the combination of sugar and fat is reported to enhance reward signaling mechanisms causing addictive-like behaviors (Schulte et al., 2015). Moreover, the reduced fiber volume found in UPF compared to that in raw food could lead to faster eating, increased intake, and decreased satiety

(de Graaf & Kok, 2010). In light of these mechanisms, the observed positive association between UPF consumption and binge eating ED (BED and low-frequency/short-duration BED) could be due to the high palatability and reduced satiation potential of UPF. Future studies could provide further evidence by investigating associations of ED with intake of individual nutrients, foods and food groups.

Another important characteristic of UPF pertains to food additives, such as colors, emulsifiers, flavor enhancers, sugar substitutes, etc. The expanding UPF consumption worldwide has been linked to deleterious metabolic outcomes via various endocrine, neurobiological and microbiome pathways (Ayton & Ibrahim, 2020). Artificial non-nutritive sweeteners, for example, were initially marketed as healthy sweetener alternatives yet have been implicated in overeating owing to potentiation of sugar-cravings and potential sugar dependence (Onaolapo & Onaolapo, 2018). Moreover, studies have highlighted higher use of artificial sweeteners by individuals suffering from ED compared to healthy controls (Klein, Boudreau, Devlin, & Walsh, 2006; Schebendach et al., 2017). An enhanced reward value of sweet taste among those with AN binge/purge type was reported, suggesting that typical food avoidance seen in AN could be accounted for by decreased reward value of all taste-related stimuli (Schebendach et al., 2017). Next, a review of animal and in vitro trials reported that emulsifiers found in UPF could alter microbiome compositions, elevate fasting blood glucose, provoke overeating, promote weight gain, and induce hepatic steatosis (Laster & Frame, 2019).

Some limitations of this study should be noted. First, the cross-sectional set-up precludes any inference of causality; it could be speculated that a bidirectional association might exist between UPF intake and ED, given the nature of the latter (American Psychiatric Association, 2013). In addition, null findings emerged regarding bulimic and other ED in the sensitivity analysis, which excluded individuals reporting medication use for anxiety and/or depression. Therefore, future prospective as well as mediation analyses are needed to shed light on temporal aspects and causal factors involved in the UPF-ED link. Second, despite adjustment for a large number of covariables, residual confounding by unmeasured constructs (e.g., ethnoracial status, family ED history) might be present. As regards the independent variable assessment, in spite of efforts to avoid systematic bias (Julia et al., 2018), potential NOVA misclassification of some food items cannot be entirely ruled out. Next, some NutriNet-Santé participants were excluded from the analysis due to having <2 24-h dietary records or due to having aberrant dietary energy intake values. The latter might have included individuals with very low caloric intake, thus leading to a potential under-estimation of the associations with restrictive ED. Moreover, despite validation against interviews with a dietitian and against various biomarkers of nutritional status (Lassale et al., 2016; Touvier et al., 2011), the self-reported 24-dietary record - as any dietary data collection method - has weaknesses stemming from respondent burden and social desirability (Shim, Oh, & Kim, 2014). As regards the main outcome, our assessment of ED relied on a validated screening tool, yet it does not correspond to any clinical ED diagnosis. In our sample, 13.6% of the participants were categorized as presenting likely ED cases, which is somewhat higher than the mean rates in Western countries, reported in a systematic review (Galmiche et al., 2019). It should be noted, however, that ED are insufficiently recognized and under-diagnosed (Keski-Rahkonen & Mustelin, 2016). In our study, in addition to SCOFF (which does not distinguish among the various types of ED), we employed the validated clinical algorithm *Expali*^{TM} (Tavolacci et al., 2019) which allowed us to obtain four distinct ED categories. Finally, caution is advised when generalizing the present findings. NutriNet-Santé includes a higher proportion of women and individuals of high socio-economic status compared to the general French population (Andreeva et al., 2015), which bears on the external validity of the study. However, UPF intake in NutriNet-Santé was similar to that found in a nationally-representative sample (Calixto Andrade et al., 2021).

Despite these limitations, the study contributes new knowledge to the growing body of evidence supporting a deleterious impact of UPF intake on physical and mental health outcomes. To our knowledge, this is the first large epidemiological study to report significant associations between UPF consumption and different ED types. Data were collected by validated instruments in a socio-demographically diverse sample of adults. Moreover, dietary intake was estimated on the basis of a mean of nine 24-h dietary records. Finally, the association between UPF intake and ED was assessed in main and sensitivity analyses while controlling for a large number of pertinent covariates.

In conclusion, these findings revealed significant positive associations between UPF intake and different ED types, especially BN and BED, across sex. Upon replication, the results could inform the development of primary and secondary prevention programs and could nudge public policy-makers towards the adoption of dietary guidelines that specifically stress the need to limit UPF consumption; this is currently the case in some Latin American countries (Monteiro et al., 2019). In the future, prospective epidemiological as well as clinical and experimental research could advance knowledge about causality and mediation pathways. The accumulation of evidence regarding the deleterious health impact of UPF could help bring to the forefront the need for public health policies – nationally and internationally – aiming to improve availability and affordability of raw and minimally processed foods on the population level.

Funding source: The NutriNet-Santé study is supported by the French Ministry of Solidarity and Health, the National Agency for Public Health (Santé Publique France), the National Institute for Health and Medical Research (INSERM), the National Research Institute for Agriculture, Food and Environment (INRAE), the National Conservatory of Arts and Crafts (CNAM), the Center for Epidemiological Research and Statistics (CRESS) and Sorbonne Paris Nord

University. Junko Kose and Eloi Chazelas are funded by doctoral fellowships provided by the French Ministry of Education via Sorbonne Paris Nord University. Charlotte Debras is supported by a doctoral fellowship provided by the French National Cancer Institute (INCA). Indira Paz Graniel is supported by a doctoral grant from the Spanish Ministry of Universities (#EST19/00261). The funders had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Author's contributions: EKG, SH, PG, and MT designed and implemented the NutriNet-Santé cohort study; SP and VAA implemented the SCOFF questionnaire and coordinated eating disorder data collection; CAM developed the NOVA classification; CJ, EKG, SH, and MT developed the ultra-processed food intake assessment in NutriNet-Santé based on the NOVA classification; VAA conceptualized the study, designed the analytic strategy, and provided theoretical and empirical guidance; NF and JK performed the literature review, statistical analyses and jointly led the writing; MT and BS provided methodological guidance; all authors assisted with interpretation of the data, critically revised the manuscript for important intellectual content. All authors approved the final version of the manuscript and its submission.

Conflict of interest: The authors declare that they have no conflict of interest.

Acknowledgements: The authors thank Pr. Pierre Déchelotte for his involvement in the assessment of eating disorders in the NutriNet-Santé cohort and Dr. Marie-Pierre Tavolacci for providing the *Expali*^{TM} clinical algorithmic tool. The authors also thank Cédric Agaesse (dietary data manager), Alexandre De-Sa and Rebecca Lutchia (dietitians); Thi Hong Van Duong, Younes Esseddik (IT manager), Régis Gatibelza, Jagatjit Mohinder and Aladi Timera (computer scientists); Julien Allegre, Nathalie Arnault, Laurent Bourhis, Nicolas Dechamp, and Fabien Szabo de Edelenyi, Ph.D. (biostatistics team manager); Maria Gomes (NutriNet-Santé participant support) and Nathalie Druesne-Pecollo, Ph.D. (operational coordinator) for their technical contribution to the cohort. Finally, the authors thank all the volunteers of the NutriNet-Santé cohort.

ABBREVIATIONS

AN	anorexia nervosa
ANOVA	Analysis of variance
BED	Binge eating disorders
BMI	Body mass index
BN	Bulimia nervosa
CI	confidence interval
ED	Eating disorders
OR	odds ratio
SCOFF	Sick-Control-One stone-Fat-Food questionnaire
UPF	Ultra-processed food

REFERENCES

Adjibade, M., Julia, C., Allès, B., Touvier, M., Lemogne, C., Srour, B., ... Kesse-Guyot, E. (2019). Prospective association between ultra-processed food consumption and incident depressive symptoms in the French NutriNet-Santé cohort. *BMC Medicine*, *17*(1), 78. https://doi.org/10.1186/s12916-019-1312-y.

Allison, S., & Timmerman, G. M. (2007). Anatomy of a binge: Food environment and characteristics of nonpurge binge episodes. *Eating Behaviors*, *8*, 31–38. https://doi.org/10.1016/j.eatbeh.2005.01.004.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed.). Washington: American Psychiatric Association Publishing.

Andreeva, V. A., Salanave, B., Castetbon, K., Deschamps, V., Vernay, M., Kesse-Guyot, E., & Hercberg, S. (2015). Comparison of the sociodemographic characteristics of the large NutriNet-Santé e-cohort with French Census data: The issue of volunteer bias revisited. *Journal of Epidemiology and Community Health*, *69*(9), 893–898. https://doi.org/10.1136/jech-2014-205263.

Andreeva, V. A., Tavolacci, M.-P., Galan, P., Ladner, J., Buscail, C., Péneau, S., ... Julia, C. (2019). Sociodemographic correlates of eating disorder subtypes among men and women in France, with a focus on age. *Journal of Epidemiology and Community Health*, *73*(1), 56–64. https://doi.org/10.1136/jech-2018-210745.

Ayton, A., & Ibrahim, A. (2020). The Western diet: A blind spot of eating disorder research?—a narrative review and recommendations for treatment and research. *Nutrition Reviews*, *78*(7), 579–596. https://doi.org/10.1093/nutrit/nuz089.

Ayton, A., Ibrahim, A., Dugan, J., Galvin, E., & Wright, O. W. (2021). Ultra-processed foods and binge eating: A retrospective observational study. *Nutrition*, *84*, 111023. https://doi.org/10.1016/j.nut.2020.111023.

Baker, P., Machado, P., Santos, T., Sievert, K., Backholer, K., Hadjikakou, M., ... Lawrence, M. (2020). Ultra-processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers. *Obesity Reviews*, *21*(12), e13126. https://doi.org/10.1111/obr.13126.

Black, A. E. (2000). Critical evaluation of energy intake using the Goldberg cut-off for energy intake:basal metabolic rate. A practical guide to its calculation, use and limitations. *International Journal of Obesity and Related Metabolic Disorders*, *24*(9), 1119–1130. https://doi.org/10.1038/sj.ijo.0801376.

Botella, J., Sepúlveda, A. R., Huang, H., & Gambara, H. (2013). A meta-analysis of the diagnostic accuracy of the SCOFF. *The Spanish Journal of Psychology*, *16*, E92. https://doi.org/10.1017/sjp.2013.92.

Bragg, M. A., & White, M. A. (2013). Examining the relationship between soda consumption and eating disorder pathology. *Advances in Eating Disorders*, *1*(2), 141–147. https://doi.org/10.1080/21662630.2013.742317.

Calixto Andrade, G., Julia, C., Deschamps, V., Srour, B., Hercberg, S., Kesse-Guyot, E., ... Bertazzi Levy, R. (2021). Consumption of ultra-processed food and its association with sociodemographic characteristics and diet quality in a representative

sample of French adults. *Nutrients*, *13*(2), 682. https://doi.org/10.3390/nu13020682.

Chesney, E., Goodwin, G. M., & Fazel, S. (2014). Risks of all-cause and suicide mortality in mental disorders: A meta-review. *World Psychiatry*, *13*(2), 153–160. https://doi.org/10.1002/wps.20128.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB.

Etude NutriNet-Santé (2013). *Table de composition des aliments*. Paris: Économica.

Galmiche, M., Déchelotte, P., Lambert, G., & Tavolacci, M. P. (2019). Prevalence of eating disorders over the 2000–2018 period: A systematic literature review. *The American Journal of Clinical Nutrition*, *109*(5), 1402–1413. https://doi.org/10.1093/ajcn/nqy342.

Garcia, F. D., Grigioni, S., Allais, E., Houy-Durand, E., Thibaut, F., & Déchelotte, P. (2011). Detection of eating disorders in patients: Validity and reliability of the French version of the SCOFF questionnaire. *Clinical Nutrition*, *30*(2), 178–181. https://doi.org/10.1016/j.clnu.2010.09.007.

Gómez-Donoso, C., Sánchez-Villegas, A., Martínez-González, M. A., Gea, A., Mendonça, R. de D., Lahortiga-Ramos, F., & Bes-Rastrollo, M. (2020). Ultra-processed food consumption and the incidence of depression in a Mediterranean cohort: The SUN Project. *European Journal of Nutrition*, *59*(3), 1093–1103. https://doi.org/10.1007/s00394-019-01970-1.

Goodman, E. L., Breithaupt, L., Watson, H. J., Peat, C. M., Baker, J. H., Bulik, C. M., & Brownley, K. A. (2018). Sweet taste preference in binge-eating disorder: A preliminary investigation. *Eating Behaviors*, *28*, 8–15. https://doi.org/10.1016/j.eatbeh.2017.11.005.

de Graaf, C., & Kok, F. J. (2010). Slow food, fast food and the control of food intake. *Nature Reviews Endocrinology*, *6*(5), 290–293. https://doi.org/10.1038/nrendo.2010.41.

Harshman, S. G., Wons, O., Rogers, M. S., Izquierdo, A. M., Holmes, T. M., Pulumo, R. L., … Thomas, J. J. (2019). A diet high in processed foods, total carbohydrates and added sugars, and low in vegetables and protein is characteristic of youth with avoidant/restrictive food intake disorder. *Nutrients*, *11*(9), 2013. https://doi.org/10.3390/nu11092013.

Hauck, C., Cook, B., & Ellrott, T. (2020). Food addiction, eating addiction and eating disorders. *The Proceedings of the Nutrition Society*, *79*(1), 103–112. https://doi.org/10.1017/S0029665119001162.

Hercberg, S., Castetbon, K., Czernichow, S., Malon, A., Mejean, C., Kesse, E., … Galan, P. (2010). The Nutrinet-Santé study: A web-based prospective study on the relationship between nutrition and health and determinants of dietary patterns and nutritional status. *BMC Public Health*, *10*(1), 242. https://doi.org/10.1186/1471-2458-10-242.

Julia, C., Martinez, L., Allès, B., Touvier, M., Hercberg, S., Méjean, C., & Kesse-Guyot, E. (2018). Contribution of ultra-processed foods in the diet of adults from the French NutriNet-Santé study. *Public Health Nutrition*, *21*(1), 27–37. https://doi.org/10.1017/S1368980017001367.

Keski-Rahkonen, A., & Mustelin, L. (2016). Epidemiology of eating disorders in Europe: Prevalence, incidence, comorbidity, course, consequences, and risk factors. *Current Opinion in Psychiatry*, *29*(6), 340–345. https://doi.org/10.1097/YCO.0000000000000278.

Kessler, R. M., Hutson, P. H., Herman, B. K., & Potenza, M. N. (2016). The neurobiological basis of binge-eating disorder. *Neuroscience & Biobehavioral Reviews*, *63*, 223–238. https://doi.org/10.1016/j.neubiorev.2016.01.013.

Klein, D. A., Boudreau, G. S., Devlin, M. J., & Walsh, B. T. (2006). Artificial sweetener use among individuals with eating disorders. *The International Journal of Eating Disorders*, *39*(4), 341–345. https://doi.org/10.1002/eat.20260.

Lassale, C., Castetbon, K., Laporte, F., Deschamps, V., Vernay, M., Camilleri, G. M., … Kesse-Guyot, E. (2016). Correlations between fruit, vegetables, fish, vitamins, and fatty acids estimated by web-based nonconsecutive dietary records and respective biomarkers of nutritional status. *Journal of the Academy of Nutrition and Dietetics*, *116*(3), 427–438.e5. https://doi.org/10.1016/j.jand.2015.09.017.

Lassale, C., Péneau, S., Touvier, M., Julia, C., Galan, P., Hercberg, S., & Kesse-Guyot, E. (2013). Validity of web-based self-reported weight and height: Results of the Nutrinet-Santé study. *Journal of Medical Internet Research*, *15*(8), e152. https://doi.org/10.2196/jmir.2575.

Laster, J., & Frame, L. A. (2019). Beyond the calories-is the problem in the processing? *Current Treatment Options in Gastroenterology*, *17*(4), 577–586. https://doi.org/10.1007/s11938-019-00246-1.

Le Moullec, N. L., Deheeger, M., Preziosi, P., Monteiro, P., Valeix, P., Rolland-Cachera, M. F., … Hercberg, S. (1996). Validation du manuel-photos utilisé pour l'enquête alimentaire de l'étude SU.VI.MAX. *Cahiers de Nutrition et de Diététique*, *31*(3), 158–164.

Leone, A., Martínez-González, M. Á., Lahortiga-Ramos, F., Molero Santos, P., Bertoli, S., Battezzati, A., & Bes-Rastrollo, M. (2018). Adherence to the Mediterranean dietary pattern and incidence of anorexia and bulimia nervosa in women: The SUN cohort. *Nutrition*, *54*, 19–25. https://doi.org/10.1016/j.nut.2018.02.008.

Monteiro, C. A. (2009). Nutrition and health. The issue is not food, nor nutrients, so much as processing. *Public Health Nutrition*, *12*(5), 729–731. https://doi.org/10.1017/S1368980009005291.

Monteiro, C. A., Cannon, G., Levy, R., Moubarac, J.-C., Jaime, P., Martins, A. P., … Parra, D. (2016). NOVA. The star shines bright. *World Nutrition*, *7*(1–3), 28–38.

Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J.-C., Louzada, M. L., Rauber, F., … Jaime, P. C. (2019). Ultra-processed foods: What they are and how to identify them. *Public Health Nutrition*, *22*(5), 936–941. https://doi.org/10.1017/S1368980018003762.

Morgan, J. F., Reid, F., & Lacey, J. H. (1999). The SCOFF questionnaire: Assessment of a new screening tool for eating disorders. *BMJ*, *319*(7223), 1467–1468. https://doi.org/10.1136/bmj.319.7223.1467.

Mulders-Jones, B., Mitchison, D., Girosi, F., & Hay, P. (2017). Socioeconomic correlates of eating disorder symptoms in an Australian population-based sample. *PloS One*, *12*(1), e0170603. https://doi.org/10.1371/journal.pone.0170603.

Onaolapo, A. Y., & Onaolapo, O. J. (2018). Food additives, food and the concept of 'food addiction': Is stimulation of the brain reward circuit by food sufficient to trigger addiction? *Pathophysiology*, *25*(4), 263–276. https://doi.org/10.1016/j.pathophys.2018.04.002.

Pagliai, G., Dinu, M., Madarena, M. P., Bonaccio, M., Iacoviello, L., & Sofi, F. (2021). Consumption of ultra-processed foods and health status: A systematic review and meta-analysis. *The British Journal of Nutrition*, *125*(3), 308–318. https://doi.org/10.1017/S0007114520002688.

Paterson, C., Lacroix, E., & von Ranson, K. M. (2019). Conceptualizing addictive-like eating: A qualitative analysis. *Appetite*, *141*, 104326. https://doi.org/10.1016/j.appet.2019.104326.

Pereira, E. M., da Silva, K. B. B., Costa, P. R. F., da Silva, L. E. M., Nepomuceno, C. M. M., da Silva, H. B. M., . . . de Santana, M. L. P. (2021). Restrained eating behavior, anorexia nervosa and food consumption between children and adolescents: A scoping review. *British Journal of Nutrition*, *18*, 1–68. https://doi.org/10.1017/S0007114521004219.

Schebendach, J., Klein, D. A., Mayer, L. E. S., Attia, E., Devlin, M. J., Foltin, R. W., & Walsh, B. T. (2017). Assessment of the motivation to use artificial sweetener among individuals with an eating disorder. *Appetite*, *109*, 131–136. https://doi.org/10.1016/j.appet.2016.11.026.

Schebendach, J. E., Uniacke, B., Walsh, B. T., Mayer, L. E. S., Attia, E., & Steinglass, J. (2019). Fat preference and fat intake in individuals with and without anorexia nervosa. *Appetite*, *139*, 35–41. https://doi.org/10.1016/j.appet.2019.04.008.

Schulte, E. M., Avena, N. M., & Gearhardt, A. N. (2015). Which foods may be addictive? The roles of processing, fat content, and glycemic load. *Plos One*, *10*(2), e0117959. https://doi.org/10.1371/journal.pone.0117959.

Shim, J.-S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health*, *36*, e2014009. https://doi.org/10.4178/epih/e2014009.

Tavolacci, M.-P., Gillibert, A., Zhu Soubise, A., Grigioni, S., & Déchelotte, P. (2019). Screening four broad categories of eating disorders: Suitability of a clinical algorithm adapted from the SCOFF questionnaire. *BMC Psychiatry*, *19*, 366. https://doi.org/10.1186/s12888-019-2338-6.

Touvier, M., Kesse-Guyot, E., Méjean, C., Pollet, C., Malon, A., Castetbon, K., & Hercberg, S. (2011). Comparison between an interactive web-based self-administered 24-h dietary record and an interview by a dietitian for large-scale epidemiological studies. *British Journal of Nutrition*, *105*(7), 1055–1064. https://doi.org/10.1017/S0007114510004617.

Vandevijvere, S., Jaacks, L. M., Monteiro, C. A., Moubarac, J.-C., Girling-Butcher, M., Lee, A. C., . . . Swinburn, B. (2019). Global trends in ultraprocessed food and drink product sales and their association with adult body mass index trajectories. *Obesity Reviews*, *20*(Suppl 2), 10–19. https://doi.org/10.1111/obr.12860.

Vergnaud, A.-C., Touvier, M., Méjean, C., Kesse-Guyot, E., Pollet, C., Malon, A., . . . Hercberg, S. (2011). Agreement between web-based and paper versions of a socio-demographic questionnaire in the NutriNet-Santé study. *International Journal of Public Health*, *56*(4), 407–417. https://doi.org/10.1007/s00038-011-0257-5.

Weissman, R., & Bulik, C. (2007). Risk factors for eating disorders. *The American Psychologist*, *62*, 181–198. https://doi.org/10.1037/0003-066X.62.3.181.

Werneck, A. O., Hoare, E., & Silva, D. R. (2021). Do TV-viewing and frequency of ultra-processed food consumption share mediators in relation to adolescent anxiety-induced sleep disturbance? *Public Health Nutrition*, *24*(16), 5491–5497. https://doi.org/10.1017/S1368980021000379.

Zheng, L., Sun, J., Yu, X., & Zhang, D. (2020). Ultra-processed food is positively associated with depressive symptoms among United States adults. *Frontiers in Nutrition*, *7*, 600449. https://doi.org/10.3389/fnut.2020.600449.

Supplementary Table 1. Association between non-ultra-processed food[1] intake and eating disorder presence and type, NutriNet-Santé Study, France (N = 43,993)

	Model 1			Model 2		
	Per 10-percentage point increase in proportion of non-UPF in diet, OR (95% CI)		*P*-value	Per 10-percentage point increase in proportion of non-UPF in diet, OR (95% CI)		*P*-value
Restrictive disorders						
n = 444	1.03	(0.93–1.13)	0.61	0.92	(0.84–1.01)	0.09
Bulimic disorders						
n = 1,575	0.98	(0.93–1.04)	0.53	0.97	(0.92–1.03)	0.32
Binge eating disorders						
n = 3,124	0.89	(0.86–0.92)	<0.0001	0.89	(0.86–0.93)	<0.0001
Other eating disorders						
n = 824	0.97	(0.90–1.05)	0.47	0.97	(0.90–1.05)	0.46

[1]Non-ultra-processed food: food and beverage products categorized in Group 1 (unprocessed/minimally processed), Group 2 (processed culinary ingredients) or Group 3 (processed) by the NOVA classification.
No eating disorder = reference.
Model 1 is a multivariable polytomous logistic regression adjusted for age and sex.
Model 2 is a multivariable polytomous logistic regression adjusted for age, sex, marital status, educational level, socio-professional category, smoking status, physical activity level, dietary energy intake, alcohol intake, and number of 24-h dietary records.
Values are rounded off to two decimal places.
CI: Confidence interval; OR: Odds ratio.