



A 50 year review of hyperpalatable foods consumed in binge-eating episodes

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Abstract

Hyperpalatable foods containing hedonically reinforcing combinations of fat, sugar, carbohydrates, and sodium have increased in prevalence in modern food systems. These foods, containing nutrient combinations rarely found in nature, strongly activate neural reward circuits and may exacerbate vulnerability to binge-eating behaviors. The present review synthesized five decades (1973–2023) of empirical research to characterize the consumption of hyperpalatable foods during binge-eating episodes and identify which hyperpalatable groups (Fat-and-Sugar, Fat-and-Sodium, or Carbohydrate-and-Sodium) predominate. After exclusions, 37 eligible studies were identified that reported foods consumed during binge-eating episodes in sufficient detail for hyperpalatability analyses. Nutritional information for 158 food items was extracted from national food composition databases and analyzed using established hyperpalatability criteria. Study characteristics were also summarized. Results indicated that hyperpalatable foods overwhelmingly dominated binge-eating episodes. Across studies, 100% reported at least one hyperpalatable food, and 88.6% of all analyzed binge foods met hyperpalatability criteria. Among these foods, the most common hyperpalatable groups were Fat-and-Sugar (47.1%) and Fat-and-Sodium (47.1%). Only 11.4% of binge foods were non-hyperpalatable, and 5.1% were minimally processed. Collectively, evidence across five decades indicates hyperpalatable foods are prominent in binge episodes. These findings suggest that binge episodes are characterized not merely by excessive caloric intake but by preferential consumption of industrially engineered foods designed to maximize palatability and reward. Future research should examine causal mechanisms linking exposure to hyperpalatable foods, obesity, and binge-eating behaviors, and test interventions that reduce hyperpalatable food consumption. Understanding the role of hyperpalatable foods may inform novel prevention and treatment strategies for binge-eating and obesity.

Keywords Binge-eating · Hyperpalatable foods · Obesity · Macronutrient · Review

1 Introduction

Hyperpalatable foods, quantitatively defined by Fazzino et al. (2019), contain hedonically rewarding nutrients of fat, sugar, sodium, and/or starchy carbohydrates present in combinations and thresholds that rarely occur in nature [1].

Although palatable foods high in carbohydrates or fat have existed in nature (e.g., nuts, berries), technological advances during World War II fueled a rise in industrialized food production in the mid-twentieth century, allowing for the large-scale manufacturing and marketing of these foods at low cost to consumers [2–4]. Techniques for producing hyperpalatable foods advanced further between the 1980s and 2000s, when major US tobacco companies (e.g., RJ Reynolds, Philip Morris) acquired leading food manufacturers (e.g., Kraft, General Foods) and adapted formulation, sensory-engineering, and marketing strategies used to optimize tobacco products to develop food products [2, 5–7]. Foods developed between 1988–2001 under tobacco-company ownership were significantly more likely to meet criteria for hyperpalatability and thereby played a disproportionate role in the proliferation of such products throughout the U.S.

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food supply [2, 7]. Recent analyses indicate that 69% of foods in the U.S. marketplace now meet criteria for hyperpalatability [2, 8]. The widespread availability of hyperpalatable foods parallels the population-level increases in obesity and binge-eating behaviors observed over recent decades [6, 8–10]. At an individual-level, elevated intake of these foods among young adults has been linked to later weight and body fat gain, increasing the risk of developing obesity [11].

While numerous biological and psychological mechanisms contribute to binge-eating pathology, the sensory and neurochemical properties of hyperpalatable foods may further exacerbate pre-existing individual-level risk factors [7, 12]. Foods rich in fat and sugar activate key neural circuits involved in reward processing, including dopaminergic, opioid, and serotonergic pathways [12, 13]. Repeated exposure to these foods over time may induce tolerance-like neuroadaptations that diminish reward sensitivity and prompt the consumption of larger quantities to achieve comparable pleasure or relief [14, 15]. Concurrently, changes in the reward and executive control regions of the brain may result in hyper-sensitivity to hyperpalatable food cues in the environment and enhanced motivation or drive to seek out and consume hyperpalatable foods, termed sensitization [13, 16]. Collectively, these features render hyperpalatable foods uniquely capable of motivating greater intake and dampening responsiveness to physiological hunger and fullness cues, increasing vulnerability to binge-eating episodes [17].

More recently, the concept of hyperpalatability has gained attention as a potential mechanism amplifying binge-eating risk. Binge-eating disorder, defined by the regular (>1–2 times per week) consumption of objectively large amounts of food within relatively short windows of time and often accompanied by distress and a sense of loss of control, is often associated with adverse health outcomes such as obesity, metabolic syndrome, Type 2 diabetes, and cancer [18, 19]. Emerging evidence suggests that consumption of hyperpalatable foods is significantly higher during clinical binge-eating episodes than during non-binge or restrictive eating episodes, suggesting hyperpalatable foods may be a key target of binge eating occasions [20–22]. In a U.S. sample of 147 adults (83% women) with full- or sub-threshold bulimia nervosa, hyperpalatable foods accounted for a median of 1,846 kcal per binge episode compared with about 280 kcal during restricting episodes, and greater hyperpalatable food intake during binge episodes was significantly associated with more frequent binge-eating occasions [20]. Consistent findings have emerged in population data; in a representative sample of adults from a large city in Brazil ($N=2,297$), hyperpalatable foods comprised 62–76% of calories consumed during binge-eating episodes, substantially higher

than in non-binge meals, highlighting their dominant role in energy intake among individuals with binge-type eating pathology [21]. Additionally, in a U.S. community sample of 296 adults, a stronger preference for immediate hyperpalatable food rewards over delayed monetary rewards was uniquely linked to both greater binge-eating behavior and stronger reward-enhancement motives, suggesting that impulsive choice specific to hyperpalatable foods may heighten vulnerability to binge eating [22]. Collectively, these findings indicate that hyperpalatable foods may play a central role in binge-eating episodes, particularly among individuals with clinically significant eating pathology.

Despite growing recognition that hyperpalatable foods may play a pivotal role in promoting binge-eating behaviors, no large-scale synthesis has characterized the consumption of hyperpalatable foods during binge-eating episodes across the empirical literature spanning the past five decades (1973–2023). Addressing this gap is critical for understanding how engineered combinations of fat, sugar, and sodium may drive loss of control overeating. The present narrative review systematically identifies and analyzes all foods reported in published studies of binge-eating episodes to determine the proportion that met established quantitative criteria for hyperpalatability [1]. Additionally, we examine whether particular hyperpalatable nutrient groups (Fat-and-Sugar, Fat-and-Sodium, and Carbohydrate-and-Sodium) were disproportionately represented in reported foods consumed during binge eating occasions.

2 Method

2.1 Data sources and literature search

Data was initially gathered for a parent study assessing highly processed foods (based on the presence of refined carbohydrates or added fats) in binge eating episodes (Worth et al., under review). Teams of two trained research assistants were each assigned to search one of five time periods (1970s, 1980s, 1990s, 2000s, and 2010–2025). Searches were conducted in PubMed, PsycINFO, and Google Scholar using the following predefined search terms: “binge episode” AND macronutrient, “binge eating” AND macronutrient, “binge episode” AND food, “binge eating” AND food, “bulimic episode” AND food, and “bulimic episode” AND macronutrient. Studies were eligible for inclusion if they: 1) involved human participants and 2) explicitly identified specific foods consumed during binge-eating or “bulimic” episodes. Screening was performed independently by each team based on titles, abstracts, and keywords. Eligible studies were recorded in a shared spreadsheet that included citation details, the database source, the keywords used to

identify the article, the foods listed as consumed during binge episodes, participant characteristics, and a concise summary of the study design.

2.2 Eligibility assessment

The initial search was conducted in 2022 and yielded 148 studies. To ensure comprehensive coverage and account for newly published research, updated searches were repeated in September 2025; however no new studies were identified in the search update. Since calculations of hyperpalatability require more precise nutrition information than highly processed food categorization, studies were further assessed in September 2025 for providing foods in sufficient detail with readily available, country-specific nutrition data to conduct hyper-palatability analysis. The lead author (IAW) reviewed all study full texts to assess for inclusion criteria, with all exclusion decisions independently verified by a second author (ANG). A total of 37 studies met inclusion criteria and were included in this review (see Fig. 1 and Supplementary Table 1 for more details on study exclusions). As per Fig. 1, 111 studies were excluded for the following reasons: (1) foods were not clearly reported as consumed during a binge-eating episode (e.g., foods consumed during over-eating episodes); (2) foods consumed during binge-eating episodes were reported only in broad or nonspecific categories (e.g., “sweets”) and did not include any sufficiently detailed, codable food examples; (3) duplicate studies; (4) foods were cited only in the literature review section; (5) laboratory binge-eating paradigms in which participants were not permitted to choose binge foods; (6) publication type (i.e., dissertation or book chapter); (7) country-specific nutrition databases were not readily available for country of origin, precluding nutrient estimation (8) foods were not listed with sufficient specificity to permit hyperpalatability classification (Theim et al., 2007; snack foods, desserts, grains, cereals).

2.3 Data extraction

For each of the 37 studies, the following information was extracted: 1) country of origin, 2) study aim and outcomes, 3) participant characteristics, 4) operational definition of binge eating, 5) method used to determine foods consumed, 6) description of foods reported during binge episodes, and 7) a list of foods with sufficient detail to enable nutrient analysis (see Table 1). At this stage, certain foods that were reported too generally (e.g., salty snacks, fried foods; $n=51$) to accurately determine nutrition information were excluded from the hyperpalatability analyses as well as beverages, as the hyperpalatability classification does not apply

to liquids (e.g., soda, tea; $n=6$). In total, 87 foods (35.5%) were excluded from an initial sample of 245 foods (see Supplementary Table 2 for further details on food exclusions). A few broad food categories (e.g., fruit, green vegetables) were retained, as none of these foods would meet criteria for hyperpalatability regardless of specific variety. Study characteristics, including the definition of binge eating used, food assessment methodology, and participant composition, were quantified across all included studies.

2.4 Nutritional information

Across the 37 studies, a total of 158 food items were analyzed. Nutrient information for brand-specific foods (e.g., *Zingers*, *Cheerios*; $n=10$) was extracted using manufacturer data (Hostess, Kellogg’s) [60–69]. For non-branded foods reported in U.S. studies ($n=86$; 54.4%), nutrient information was drawn from the Food and Nutrient Database for Dietary Studies (FNDDS) corresponding to the publication year (2001–2023) [70–77]. Foods from studies published prior to 2001 were coded using the FNDDS 2001–2002 dataset, the earliest release available from the USDA. due to the limited reliability. Foods from the United Kingdom (UK) ($n=28$; 17.7%) were identified using McCance and Widdowson’s *The Composition of Foods Integrated Dataset (CoFID) 2021*, which provides nutrition information for commonly consumed foods and recipes in the UK [78]. For items such as bread that appeared in numerous variations, the average of all available entries was used to create an archetype representative of that food. Foods from other countries were similarly identified using their respective national nutrition databases: *Livsmedelsverket* for Sweden ($n=9$; 5.7%), *AUSNUT* for Australia ($n=9$; 5.7%), the *Dutch Food Composition Database* for the Netherlands ($n=8$; 5.1%), and *Table Ciquel* for France ($n=8$; 5.1%) [79–82]. Data processing was conducted in R and Microsoft Excel. Nutrient values (grams, kilocalories, total fat, sodium, carbohydrates, fiber, and sugar) were compiled into a final dataset with all included foods and their respective nutrient characteristics ($n=158$; see Supplementary Table 3).

2.5 Hyperpalatability

Each food was classified for hyperpalatability (yes/no) based on the quantitative criteria developed by Fazzino et al. (2019). Foods meeting one or more of the following nutrient profiles were considered hyperpalatable: 1) fat and sodium ($>25\%$ of kcal from fat and $\geq 0.30\%$ sodium by weight), 2) fat and sugar ($>20\%$ kcal from fat and $>20\%$ kcal from sugar), and 3) carbohydrate and sodium ($>40\%$ kcal from starchy carbohydrates and $\geq 0.20\%$ sodium by weight)

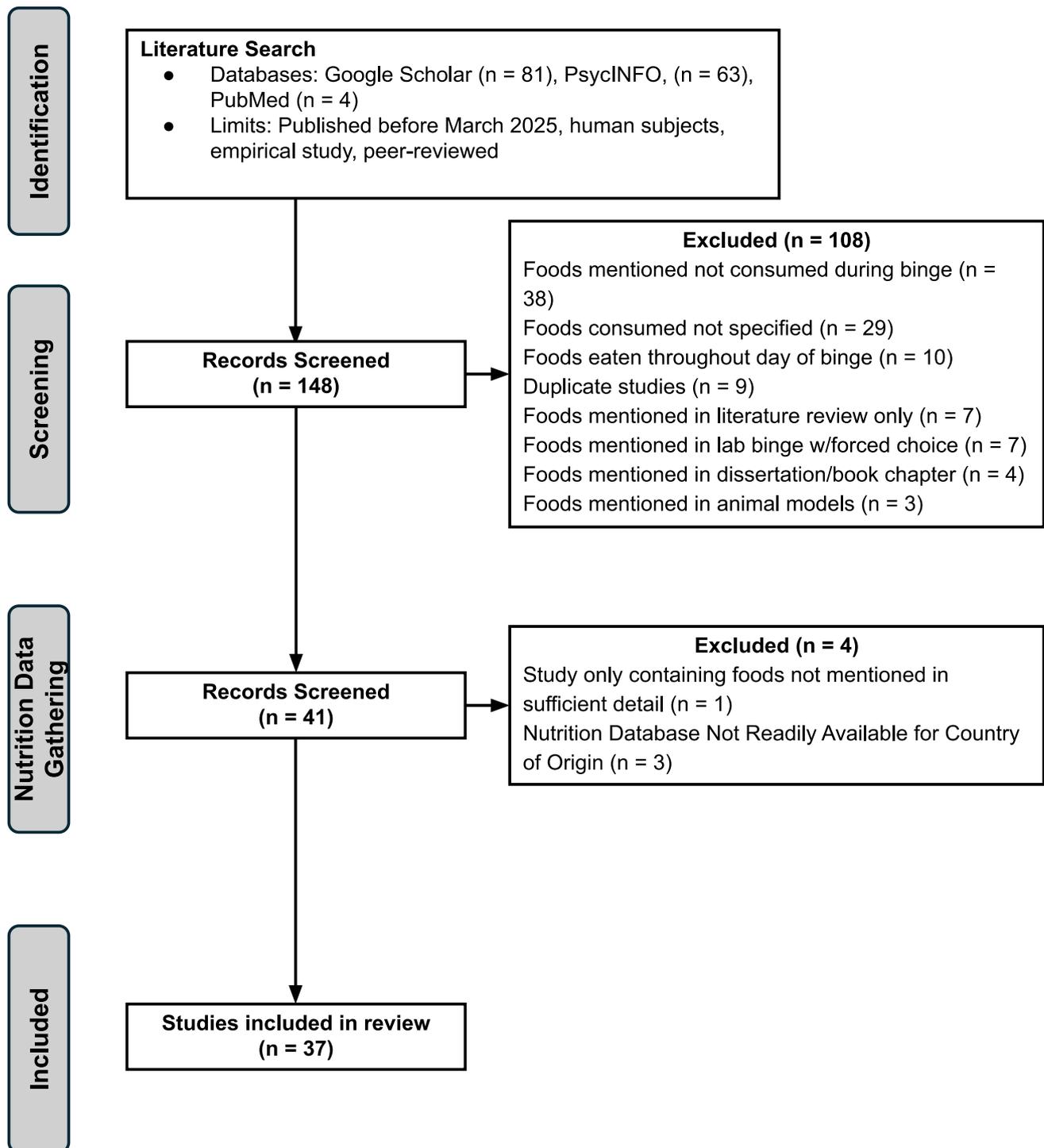


Fig. 1 Study selection flow diagram outlining identification, screening, and inclusion processes, with reasons for exclusions at each stage

(Fazzino et al., 2019; Fig. 2). The overall proportion of hyperpalatable foods listed in each study was calculated as n hyperpalatable food items reported in each study divided by total N food items listed in each study. Similarly, the percent of hyperpalatable foods consumed per hyperpalatable food group were also calculated.

3 Results

3.1 Study characteristics

Definitions of binge eating varied across studies, though all adhered to core criteria from the *Diagnostic and Statistical*

Table 1 Study Sample Characteristics

Study	Country	N	Sex/Gender (% Female/Woman)	Mean Age (M) (years) (Standard Deviation); Range (R)	Race/Ethnicity	Socio-Economic Status (SES)	Eating Disorder Status	BMI Status	Binge Eating Definition
Wijesinghe, 1973 [23]	UK	2	100%	M=28.5 (12.0) R=20–37	NR	NR	NR	NR	CE
Castelnuovo-Tedesco, 1974 [24]	US	2	50%	P1: NR, P2: 30	NR	NR	NR	NR	BE
Rau & Green, 1975 [25]	US	2	50%	M=24.0 (1.4) R=23–25	NR	NR	NR	P1: 14.0; P2: NR	CE
Orbach, 1978 [26]	UK	60	100%	M=NR R=NR	NR	NR	NR	NR	CE
Smith, 1981 [27]	UK	1	100%	36	NR	NR	NR	OW/OB	BE/CE
Abraham & Beumont, 1982 [28]	AUS	32	93.8%	M=24.0 (NR) R=NR	NR	"covered all community groups"	BN	UW; NW; OW/OB	BE
Carter & Duncan, 1984 [29]	US	421	100%	NR ("high school age")	NR	NR	NR	NW	BE
Tarrier, 1984 [30]	UK	1	100%	35	NR	NR	BN	NW	BE
Leon et al., 1985 [31]	US	S1: 213 S2: 37	S1: 66.2% S2: 100%	S1: M=NR; R=14–46 S2: M=NR; R=17–35	NR	"middle class"	S1: NR S2: BN	NW (n=36); OW/OB (n=1)	BE
Robinson et al., 1985 [32]	UK	15	100%	M=25.0 (NR) R=18–36	NR	NR	BN	NR	bulimic episode/binge
Marcus et al., 1988 [33]	US	68	100%	M=38.7 (8.5) R=NR	NR	NR	BED	NR	BEp
Schmidt & Marks, 1988 [34]	UK	4	100%	M=22.5 (4.1) R=17–26	NR	NR	BN	NW (n=3); OW/OB (n=1)	binge
Jansen et al., 1989 [35]	NL	1	100%	22	NR	NR	BN	NW	BEp
Kales, 1990 [36]	US	21	100%	M=23.2 (4.6) R=NR	NR	NR	BN	NR	BEp
Yanovski et al., 1992 [37]	US	19	100%	M=NR R=NR	NR	NR	BED (n=10); NC (n=9)	OW; OB	laboratory BE
Hetherington & MacDiarmid, 1993 [38]	UK	50	92%	M=39.8 (2.2) R=14–83	NR	NR	NR	UW; NW; OW; OB	disinhibited eating; LOC
van der Ster Wallin et al., 1994 [39]	SWE	47	100%	M=28.0 (7.0) R=20–46	NR	NR	BN (n=33); AN/BN (n=14)	UW; NW; OW	binge
Geraciotti et al., 1995 [40]	US	5	100%	M=35.6 (14.3) R=19–58	NR	NR	BN (n=1)	NW; OW; OB	BE

Table 1 (continued)

Study	Country	N	Sex/Gender (% Female/Woman)	Mean Age (M) (years) (Standard Deviation); Range (R)	Race/Ethnicity	Socio-Economic Status (SES)	Eating Disorder Status	BMI Status	Binge Eating Definition
Greeno et al., 1995 [41]	US	79	100%	M=39.3 (NR) R=NR	NR	NR	BED (n=40); NC (n=39)	OW; OB	binge
Telch et al., 1998 [42]	US	60	100%	M=42.7 (9.9) R=NR	White (n=53); Hispanic (n=5); Black (n=1); Asian/Pacific Islander (n=1)	NR	BED	OW; OB	LOC
Allison & Timmerman, 2007 [43]	US	48	100%	M=43.5 (10.9) R=NR	White (n=37); Hispanic (n=5); African American (n=4)	85.5% income ≥ \$30,000	NR	NW; OW; OB	BEp
McIver et al., 2009 [44]	AUS	25	100%	M=42. (NR) R=25–61	NR	NR	BED	OW; OB	BEp
Cameron et al., 2011 [45]	UK	1	100%	24	NR	NR	BED	OW; OB	binge
Reslan & Saules, 2011 [46]	US	969	63.9%	M=NR R=18–40	Caucasian (n=710)	NR	BED (n=90)	NR	binge
Palmborg et al., 2014 [47]	US	19	100%	M=14.5 (1.2) R=13–17	African American (n=11); White (n=6); Hispanic/Latina (n=1); Biracial: Indian/White (n=1)	NR	NR	NR	BE; LOC
Rigaud et al., 2014 [48]	FR	186	100%	M=27.5 (9.1) R=NR	NR	NR	BED (n=59); AN (n=65); BN (n=62)	UW; NW; OW; OB	BEp
Phillips et al., 2016 [49]	US	425	75.1%	M=19.8 (NR) R=18–22	White (n=339); Asian (n=39); Other (n=33); Hispanic (n=16)	NR	NR	NR	BEp
Tester et al., 2016 [50]	US	47	76.6%	M=12 (NR) R=NR	NR	income ≤ \$45,000	NR	OW; OB	BE
Carey et al., 2017 [51]	US	11	0%	M=32.1 (12.7) R=19–52	Caucasian (n=9); Caucasian/Pacific Islander (n=1); Asian (n=1)	NR	BED	OW; OB	LOC
Evans et al., 2019 [52]	US	4	100%	M=45.8 (14.7) R=28–61	White (n=3); Hispanic (n=1)	NR	BED	OW; OB	BE
Lecomte et al., 2019 [53]	FR	5	100%	M=17.2 (0.8) R=16–18	NR	NR	BN	NR; OW; OB	BE
Carmen et al., 2020 [54]	US	3	66.7%	M=50.0 (14.4) R=34–62	White (n=2); African American (n=1)	NR	BED; NC	OB	BE

Table 1 (continued)

Study	Country	N	Sex/Gender (% Female/Woman)	Mean Age (M) (years) (Standard Deviation); Range (R)	Race/Ethnicity	Socio-Economic Status (SES)	Eating Disorder Status	BMI Status	Binge Eating Definition
Brownstone et al., 2021 [55]	US	14	78.6%	M=35.3 (12.0) R=19–65	White (n=12); Latinx (n=1); African American (n=1)	NR	NR	UW; NW; OW; OB	subjective BE
Frayn et al., 2022 [56]	US	14	92.9%	M=44.5 (14.3) R=NR	White (n=9); Black or African American (n=4); Asian (n=1)	<\$50 k (71.3%), \$50–99 k (21.4%), ≥\$200 k (7.1%)	BED	NR	binge; “eating as much as possible”
Bruzas et al., 2022 [57]	US	34	64.7%	M=41.2 (10.1) R=NR	Non-Hispanic White (n=24); Black (n=10)	NR	BED	OW; OB	BEp
Davis et al., 2022 [58]	US	51	100%	M=19 SD=NR R=18–25	White (n=37); Black/African American (n=5); Hispanic (n=4); Asian/Pacific Islander (n=4); Biracial (n=1)	NR	BN (n=21); NC	NR	Lab BE
King et al., 2023 [59]	US	12	100%	M=54.0 (8.4) R=36–64	White (n=10); African American (n=1); Other (n=1)	NR	NR	NW; OW; OB	binge or bulimic episode

Eating disorder status reflects diagnoses or symptom status as reported in original study. Binge eating (BE) was generally defined as consumption of an objectively large amount of food accompanied by a sense of loss of control. Bulimia nervosa (BN) was generally defined as recurrent binge-eating episodes with compensatory behaviors (e.g., self-induced vomiting, laxative misuse, fasting, or excessive exercise) to prevent weight gain. Anorexia nervosa (AN) was generally defined as restriction of energy intake resulting in significantly low body weight (typically BMI ≤ 17.5), accompanied by intense fear of weight gain and/or disturbance in body weight or shape.

AN anorexia nervosa, BE binge eating, BED binge-eating disorder, BEp binge-eating episode or binge episode, BN bulimia nervosa, BMI body mass index, CE compulsive eating, NR not reported, LOC loss of control or loss of control over eating, NC non-clinical sample, NW normal weight (BMI between 18.5–24.9), OB obese (BMI > 30.0), OW overweight (BMI between 25.0–29.9), UW underweight (BMI < 18.5). For full details on studies, see Supplementary Table 4

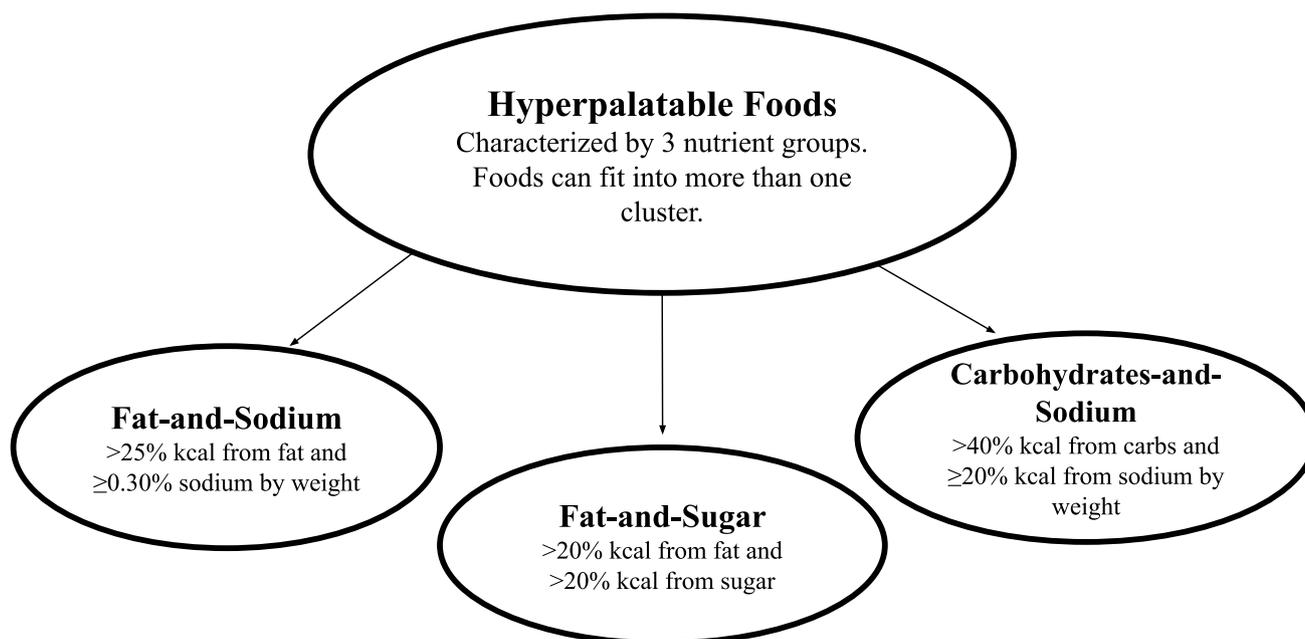


Fig. 2 Hyperpalatable Food Groups

Manual of Mental Disorders (DSM) emphasizing overeating and loss of control (see Table 1). Nearly half ($n=17$; 45.9%) used an author-generated definition grounded in prior literature, whereas 27.0% ($n=10$) relied on participant self-definition, 21.6% ($n=8$) adopted diagnostic criteria from the DSM edition available at the time, and 5.4% ($n=2$) incorporated both DSM and participant definitions. Most studies obtained information about foods consumed during binge-eating episodes through participant self-report in therapeutic or focus-group settings ($n=25$; 67.6%). The remaining studies gathered data via questionnaires ($n=6$; 16.2%), food diaries ($n=4$; 10.8%), or 24-h dietary recalls ($n=2$; 5.4%). Nearly all studies contained a majority (>60%) female/woman sample ($n=34$; 91.9%), with 64.9% ($n=24$) of all studies being comprised of only women/females. Samples comprised of individuals with overweight/obesity were most frequently represented ($n=12$; 32.4%), followed by samples of participants spanning BMI classifications ($n=6$; 16.2%).

3.2 Hyperpalatable food consumption in each study

Across all 37 studies, every study (100%) identified at least one hyperpalatable food consumed during binge-eating episodes (see Table 2). Most studies ($n=29$; 78.4%) reported that all foods consumed during binge episodes were hyperpalatable. Fat-and-sugar hyperpalatable foods were the most frequently reported subtype by study ($n=31$; 83.8%), followed by fat-and-sodium ($n=28$; 75.7%) and

Table 2 Classification of Binge Foods in Each Study

Category	<i>n</i>	Percent of Total Studies (<i>N</i> =37)
Total studies	37	100.0%
Hyperpalatable Food ^a	37	100.0%
Fat-and-Sugar Hyperpalatable Food Group ^a	31	83.8%
Fat-and-Sodium Hyperpalatable Food Group ^a	28	75.7%
Carbohydrate-and-Sodium Hyperpalatable Food Group ^a	16	43.2%
Only Containing Hyperpalatable Foods	29	78.4%
Containing at Least One Non-Hyperpalatable Food	8	21.6%

^aIncludes studies reporting ≥ 1 food meeting criterion

carbohydrate-and-sodium foods ($n=16$; 43.2%). Only eight studies (21.6%) reported at least one non-hyperpalatable food, and just two studies (5.4%) reported more non-hyperpalatable foods than hyperpalatable foods consumed during binge-eating episodes.

3.3 Hyperpalatability of all foods consumed

Among the 158 foods included in nutritional analysis of binge foods, the majority (88.6%; $n=140$) met criteria for hyperpalatability (see Table 3). This group of binge foods included duplicate food items that were mentioned more than once across all studies (see Supplementary Table 5 for further details on food frequency). Of these hyperpalatable binge foods, most met criteria for either the fat-and-sugar hyperpalatable food group ($n=66$; 47.1% of hyperpalatable foods) or

Table 3 Classification of Binge Foods by Hyperpalatability Status and Group

Category	<i>n</i>	Percent of Total (<i>N</i> =158)	Percent of Hyperpalatable (<i>n</i> =140)
Total binge foods analyzed	158	100.0%	N/A
Hyperpalatable Foods ^a	140	88.6%	100.0%
Fat-and-Sugar Hyperpalatable Food Group	66	41.8%	47.1%
Fat-and-Sodium Hyperpalatable Food Group	66	41.8%	47.1%
Carbohydrate-and-Sodium Hyperpalatable Food Group	29	18.4%	20.7%
Overlapping Hyperpalatable Food Groups ^b	21	13.3%	15.0%
Non-Hyperpalatable Foods ^c	18	11.4%	N/A
High in Sugar Only ^d	4	2.5%	N/A
Minimally Processed Foods ^d	8	5.1%	N/A

^aIncludes foods meeting ≥ 1 hyperpalatable criterion; ^b 16 foods overlap in Fat-and-Sugar & Fat-and-Sodium groups & 5 foods overlap in Fat-and-Sodium & Carbohydrates-and-Sodium groups; ^c 10 foods contained refined carbohydrates and/or added fats below the hyperpalatable food threshold; ^d Subset of non-hyperpalatable foods

Counts (*n*) and percentages are presented for all foods reported during binge episodes (Percent of Total; *N*=158) and for the subset of foods classified as hyperpalatable (Percent of Hyperpalatable; *n*=140). Hyperpalatable foods are further categorized into nutrient clusters (Fat-and-Sugar, Fat-and-Sodium, Carbohydrate-and-Sodium). Foods meeting criteria for more than one cluster are shown as overlapping hyperpalatable food groups

the fat-and-sodium hyperpalatable food group (*n*=66; 47.1% of hyperpalatable foods), whereas a smaller proportion satisfied criteria for the carbohydrate-and-sodium hyperpalatable food group (*n*=29; 20.7% of hyperpalatable foods). A subset of hyperpalatable foods (*n*=21; 15.0%) met criteria for more than one group: 16 hyperpalatable foods (11.4%) met criteria for both the fat-and-sugar and fat-and-sodium groups, and 5 hyperpalatable foods (3.6%) met criteria for both the fat-and-sodium and carbohydrate-and-sodium groups. Only 18 foods in the analysis (11.4% of overall binge foods) were not hyperpalatable. Of these, 10 foods (55.6%) still contained either refined carbohydrates and/or added fats but did not meet the threshold for hyperpalatability. For example, 4 (22.2%) of these binge foods that were not classified as hyperpalatable were solely high in sugar (but not fat or sodium). Overall, only 8 (5.1%) of the binge foods in this analysis were minimally processed foods (e.g., fruit, fresh vegetables).

4 Discussion

The present review synthesized five decades of research examining the prominence of hyperpalatable foods consumed during binge-eating episodes. Across 37 studies,

100% of studies reported at least one hyperpalatable food consumed during binge-eating episodes, and 88.6% of reported binge foods met criteria as hyperpalatable, suggesting that binge episodes overwhelmingly involved hedonically appealing, hyperpalatable food products, engineered with combinations of sugar, carbohydrates, fats, and sodium not found in nature [1]. Hyperpalatable foods most commonly consumed during binge occasions consisted of hyperpalatable foods belonging to the fat-and-sugar or fat-and-sodium groups. The primary consumption of hyperpalatable foods during binge eating occasions further suggests that the properties of the foods themselves may affect the selection of food stimuli selected in binge-eating episodes. This aligns with evidence from animal models and human neuroimaging studies indicating that energy-dense foods with high levels of fat and refined carbohydrates strongly activate reward and motivation systems [12, 13, 83]. The rewarding properties of these foods may promote overeating, thereby potentially increasing caloric intake during binge-eating episodes [7, 84].

Certain subtypes of hyperpalatable foods were particularly common in binge episodes. Of the hyperpalatable foods, 47.1% belonged to the fat-and-sugar group and 47.1% to the fat-and-sodium group. Notably, many foods (*n*=16; 24.2%) in the fat-and-sodium group also met criteria for the fat-and-sugar group (e.g., chocolate cake, pastries), and 80.3% (*n*=53) contained starchy or refined carbohydrates (e.g., flour in pizza). Some evidence suggests these nutrient combinations (fat and refined carbohydrates) may exert supra-additive effects on reward, producing greater reinforcing value than either macronutrient alone [12, 85]. From an evolutionary perspective, this sensitivity to energy-dense nutrients and sodium can be adaptive, helping to ensure survival in environments where such resources are scarce [4, 86]. In contrast, non-hyperpalatable, minimally processed foods rarely contain high levels of fat, carbohydrate, and sodium in a single item; fruits tend to be high in carbohydrates but low in fat, while nuts are high in fat but low in carbohydrates, and most natural foods contain less than 100 mg of sodium per 100 g [4, 85, 87]. However, industrial processing has fundamentally altered the nutritional landscaping, increasing the number of foods with highly rewarding nutrient combinations that exploit evolved reward systems [2, 8]. The proliferation of these foods over the past 50 years is thereby likely a major contributor to rising rates of obesity and binge-type eating disorders [9, 10, 88].

Within the small subset of binge foods that did not meet formal thresholds for hyperpalatability, roughly half still contained refined carbohydrates or added fats. Although levels of these ingredients fell outside quantitative hyperpalatability criteria, these foods remain sensory-enhancing and energy-dense, properties that promote overconsumption [85,

87]. Nearly one quarter of these non-hyperpalatable foods were high in sugar alone (e.g., licorice, jellybeans), echoing prior evidence that sugar-rich foods can elicit addictive-like eating behaviors and neural adaptations similar to those produced by hyperpalatable food combinations [89, 90]. The operational definition of hyperpalatable foods captures key nutrient combinations that amplify reward; however other aspects of foods not addressed by the hyperpalatable food definition may also influence reward and digestion, including some foods high in a single palatable component (such as sugar) or containing non-nutritive additives (e.g., artificial sweeteners, flavor enhancers, emulsifiers) that can modify the food matrix and accelerate absorption [1]. Future work should integrate multiple standardized frameworks, such as combining nutrient-based hyperpalatability measures with processing-based systems like NOVA, to better capture the influence of foods and beverages high in sugar or containing additives on binge eating and obesity risk [1, 91].

The predominance of hyperpalatable and high-sugar foods during binge-eating episodes may pose unique metabolic health implications beyond excess caloric intake alone. The elevated presence of fat, sodium, and refined carbohydrates in hyperpalatable foods not only increase their rewarding nature, but increase risk for weight gain, spikes in blood glucose, and increased insulin demand [11, 92, 93]. Repeated consumption of these foods in large quantities, such as binge-eating episodes, may therefore contribute to metabolic dysregulation, including insulin resistance, dyslipidemia, and increased cardiometabolic risk [94, 95]. Moreover, evidence suggests that binge-eating pathology is associated with an increased rate of health consequences such as hypertension, hypertriglyceridemia, and lower quality of life and health satisfaction independent of BMI [96–99]. Hyperpalatable foods may further exacerbate these vulnerabilities by increasing dietary intake of saturated fat and refined carbohydrates while displacing fiber- and micronutrient-dense foods, increasing risk for poor health outcomes and emotion dysregulation [100, 101]. Collectively, these findings underscore the need for future research integrating detailed reporting of binge foods with metabolic phenotyping (e.g., glucose/insulin indices, lipid profiles, inflammatory markers) to clarify the extent to which binge episodes containing predominantly hyperpalatable foods contribute to downstream endocrine and cardiometabolic consequences.

Experimental studies have demonstrated that hyperpalatable and ultra-processed foods promote excessive intake in the general population, but these paradigms have rarely been extended to individuals with binge-eating pathology. In tightly controlled feeding trials, Hall et al., 2019 showed that participants consumed substantially more calories when provided an ultra-processed diet than when provided

a minimally processed diet, largely due to the reinforcing properties of hyperpalatable foods [84]. Similarly, Dicken et al. (2025) found that exposure to minimally processed foods reduced cravings and overall intake—key antecedents of binge episodes [102]. However, neither study examined participants with binge-eating disorder, representing a major gap in the experimental literature. Applying these paradigms to binge-eating populations could clarify how exposure to different food types influences loss of control and craving intensity. This evidence has important implications for treatment: traditional “all foods fit” approaches may overlook the distinct reinforcing properties of hyperpalatable, energy-dense foods that drive compulsive intake [103]. Behavioral weight-loss interventions for binge eating (e.g., Grilo & Pittman, 2024, which often emphasize reducing intake of common hyperpalatable foods, tend to produce meaningful reductions in binge frequency, suggesting that strategic modification of dietary quality may positively impact treatment for binge-type eating behaviors [104]. Future research should test whether targeting exposure to hyperpalatable foods can improve outcomes beyond current approaches and inform a more nuanced, individualized framework for treatment that recognizes differences in the reinforcing potential of foods themselves.

The predominance of hyperpalatable foods in binge-eating episodes adds to a growing body of evidence suggesting that specific food characteristics, rather than merely calorie content, may drive dysregulated eating behaviors [20]. An important next step will be investigating the interaction between weight status, binge-eating severity, and exposure to hyperpalatable foods. Past evidence suggests that individuals with co-occurring binge-eating and obesity exhibit poorer dietary quality than individuals with obesity alone [105–107]. Determining whether binge episodes involving a higher proportion of hyperpalatable foods are more common among individuals with obesity, or whether these patterns may predict progression from normal weight to overweight, may help clarify how rewarding food properties contribute to weight gain trajectories.

5 Limitations and future directions

Several methodological considerations should be noted. This review was not systematically conducted according to PRISMA guidelines, so some eligible studies may not have been identified. Most studies relied on self-reported binge foods, which are subject to recall and reporting bias. Cross-national variability in energy-calculation methods (e.g., Jones’ vs. Modified Atwater factors) and linguistic differences in food names introduced additional uncertainty [108]. Additionally, the hyperpalatability criteria applied

in this review were developed for solid foods and do not extend to beverages; therefore, beverages (including sugar-sweetened beverages) were excluded from analyses, and may represent another component of binge eating episodes that requires future investigation. Given that sugar-sweetened beverages have been linked to binge-eating behaviors and adverse health outcomes such as cardiometabolic disease, future work should develop and validate beverage-specific hyperpalatability criteria [109–111]. Future studies should employ real-time assessment tools, such as ecological momentary assessment or digital food logs, to more accurately capture individual-level binge episodes and contextual factors [112, 113]. Additionally, all reviewed were conducted in the United States, Europe, or Australia, limiting the generalizability of findings. Expanding this work to low-income countries, particularly in regions currently experiencing a rapid nutrition transition from minimally processed to mass-produced, hyperpalatable foods, will be crucial for prevention efforts [114–116].

6 Conclusion

Hyperpalatable foods accounted for the vast majority of foods consumed during binge eating occasions, as identified across five decades of research. Their dominance underscores that the problem lies not only in individual behavior but in the engineered design of the modern food supply [6, 7]. As industrially produced, hyperpalatable foods increasingly permeate food systems worldwide, understanding how they drive craving, obesity, and binge eating is an urgent public-health priority [18, 115, 117]. Addressing the global spread and influence of these products will be essential to reducing the growing burden of binge-eating and obesity across diverse population.

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Data availability The dataset generated for this review—including hyperpalatability classifications, extracted nutritional information for all food items, and study-level characteristics—is available in the Supplementary Materials accompanying this manuscript. All underlying nutrition information was obtained from publicly available national food composition databases, which are cited in the manuscript.

Declarations

Ethics approval Not applicable. This study is a review of previously published research and did not involve human participants or collection of new data. Conducted in accordance with the principles of the Declaration of Helsinki.

Consent to participate Not applicable.

Consent for publication Not applicable.

Human ethics and consent Not applicable.

Approval committee/IRB Not applicable (no new human subjects data were collected).

Clinical trial number Not applicable.

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References

1. Fazzino TL, Rohde K, Sullivan DK. Hyper-palatable foods: development of a quantitative definition and application to the US food system database. *Obesity*. 2019;27:1761–8. <https://doi.org/10.1002/oby.22639>.
2. Fazzino TL, Jun D, Chollet-Hinton L, Bjorlie K. US tobacco companies selectively disseminated hyper-palatable foods into the US food system: empirical evidence and current implications. *Addiction*. 2024;119:62–71. <https://doi.org/10.1111/add.16332>.
3. Cordain L, Eaton SB, Sebastian A, Mann N, Lindeberg S, Watkins BA, et al. Origins and evolution of the Western diet: health implications for the 21st century. *Am J Clin Nutr*. 2005;81:341–54. <https://doi.org/10.1093/ajcn.81.2.341>.
4. Gearhardt AN, Schulte EM. Is food addictive? A review of the science. *Annu Rev Nutr*. 2021;41:387–410. <https://doi.org/10.1146/annurev-nutr-110420-111710>.
5. Ayton A, Ibrahim A, Dugan J, Galvin E, Wright OW. Ultra-processed foods and binge eating: a retrospective observational study. *Nutrition*. 2021;84:111023. <https://doi.org/10.1016/j.nut.2020.111023>.
6. Demeke S, Rohde K, Chollet-Hinton L, Sutton C, Kong KL, Fazzino TL. Change in hyper-palatable food availability in the US food system over 30 years: 1988–2018. *Public Health Nutr*. 2022;26:182–9. <https://doi.org/10.1017/S1368980022001227>.

7. Fazzino TL. The reinforcing natures of hyper-palatable foods: behavioral evidence for their reinforcing properties and the role of the US food industry in promoting their availability. *Curr Addict Rep.* 2022;9:298–306. <https://doi.org/10.1007/s40429-022-00417-8>.
8. Sutton CA, Stratton M, L'Insalata AM, Fazzino TL. Ultraprocessed, hyper-palatable, and high energy density foods: prevalence and distinction across 30 years in the United States. *Obesity.* 2024;32:166–75. <https://doi.org/10.1002/oby.23897>.
9. Hales CM, Carroll MD, Fryar CD, et al. Products - data briefs - number 360 - February 2020 [Internet]. 2020 [cited 2025 Nov 11]. <https://www.cdc.gov/nchs/products/databriefs/db360.htm>. Accessed 11 Nov 2025.
10. Galmiche M, Déchelotte P, Lambert G, Tavolacci MP. Prevalence of eating disorders over the 2000–2018 period: a systematic literature review. *Am J Clin Nutr.* 2019;109:1402–13. <https://doi.org/10.1093/ajcn/nqy342>.
11. Fazzino TL, Dorling JL, Apolzan JW, Martin CK. Meal composition during an ad libitum buffet meal and longitudinal predictions of weight and percent body fat change: the role of hyper-palatable, energy dense, and ultra-processed foods. *Appetite.* 2021;167:105592. <https://doi.org/10.1016/j.appet.2021.105592>.
12. DiFeliceantonio AG, Coppin G, Rigoux L, Thanarajah SE, Dagher A, Tittgemeyer M, et al. Supra-additive effects of combining fat and carbohydrate on food reward. *Cell Metab.* 2018;28:33–44.e3. <https://doi.org/10.1016/j.cmet.2018.05.018>.
13. de Macedo IC, de Freitas JS, da Silva Torres IL. The influence of palatable diets in reward system activation: a mini review. *Adv Pharmacol Sci.* 2016;2016:7238679. <https://doi.org/10.1155/2016/7238679>.
14. Parnarouskis L, Gearhardt AN. Preliminary evidence that tolerance and withdrawal occur in response to ultra-processed foods. *Curr Addict Rep.* 2022;9:282–9. <https://doi.org/10.1007/s40429-022-00425-8>.
15. Avena NM, Rada P, Hoebel BG. Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neurosci Biobehav Rev.* 2008;32:20–39. <https://doi.org/10.1016/j.neubiorev.2007.04.019>.
16. Berridge KC, Robinson TE. Liking, wanting, and the incentive-sensitization theory of addiction. *Am Psychol.* 2016;71:670–9. <https://doi.org/10.1037/amp0000059>.
17. Schag K, Leehr EJ, Meneguzzo P, Martus P, Zipfel S, Giel KE. Food-related impulsivity assessed by longitudinal laboratory tasks is reduced in patients with binge eating disorder in a randomized controlled trial. *Sci Rep.* 2021;11:8225. <https://doi.org/10.1038/s41598-021-87231-w>.
18. Giel KE, Bulik CM, Fernandez-Aranda F, Hay P, Keski-Rahkonen A, Schag K, et al. Binge eating disorder. *Nat Rev Dis Primers.* 2022;8:16. <https://doi.org/10.1038/s41572-022-00344-y>.
19. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th edn. 2022.
20. Bjorlie K, Forbush KT, Chapa DAN, Richson BN, Johnson SN, Fazzino TL. Hyper-palatable food consumption during binge-eating episodes: a comparison of intake during binge eating and restricting. *Int J Eat Disord.* 2022;55:688–96. <https://doi.org/10.1002/eat.23692>.
21. de Moraes CEFde, Hay P, Sichieri R, Fazzino TL, Mourilhe C, Appolinario JC, et al. Hyperpalatable foods consumption in a representative sample of the general population in Brazil: differences of binge and non-binge eating meals. *Behav Sci.* 2023;13:149. <https://doi.org/10.3390/bs13020149>.
22. Bellitti JS, L'Insalata AM, Fazzino TL. Multidisciplinary Digital Publishing Institute. Discounting of hyper-palatable foods is associated with eating motives and binge eating behavior. *Nutrients.* 2025;17:1356. <https://doi.org/10.3390/nu17081356>.
23. Wijesinghe B. Massed electrical aversion treatment of compulsive eating. *J Behav Ther Exp Psychiatry.* 1973;4:133–5. [https://doi.org/10.1016/0005-7916\(73\)90058-X](https://doi.org/10.1016/0005-7916(73)90058-X).
24. Castelnuovo-Tedesco P, Institute of Psycho-Analysis. Stealing, revenge and the Monte Cristo complex. *Int J Psychoanal.* 1974;55:169–77.
25. Rau JH, Green RS. Compulsive eating: a neuropsychologic approach to certain eating disorders. *Compr Psychiatry.* 1975;16:223–31. [https://doi.org/10.1016/0010-440X\(75\)90048-6](https://doi.org/10.1016/0010-440X(75)90048-6).
26. Orbach S, Division of Psychotherapy (29), American Psychological Association. Social dimensions in compulsive eating in women. *Psychother Theory Res Pract.* 1978;15:180–9. <https://doi.org/10.1037/h0085858>.
27. Smith GR. Modification of binge eating in obesity. *J Behav Ther Exp Psychiatry.* 1981;12:333–6. [https://doi.org/10.1016/0005-7916\(81\)90074-4](https://doi.org/10.1016/0005-7916(81)90074-4).
28. Abraham SF, Beumont PJ. How patients describe bulimia or binge eating. *Psychol Med.* 1982;12:625–35. <https://doi.org/10.1017/s0033291700055732>.
29. Carter JA, Duncan PA. Binge-eating and vomiting: a survey of a high school population. *Psychol Sch.* 1984;21:198–203. [https://doi.org/10.1002/1520-6807\(198404\)21:2<253C198::AID-PITS2310210211/253E3.0.CO;2-K](https://doi.org/10.1002/1520-6807(198404)21:2<253C198::AID-PITS2310210211/253E3.0.CO;2-K).
30. TARRIER N. A short behavioural treatment for bulimia and self-induced vomiting: a case study. *Scand J Behav Ther.* 1984;13:173–81. <https://doi.org/10.1080/16506078409455706>.
31. Leon GR, Carroll K, Chernyk B, Finn S. Binge eating and associated habit patterns within college student and identified bulimic populations. *Int J Eat Disord.* 1985;4:43–57. [https://doi.org/10.1002/1098-108X\(198502\)4:1<253C43::AID-EAT2260040106/253E3.0.CO;2-E](https://doi.org/10.1002/1098-108X(198502)4:1<253C43::AID-EAT2260040106/253E3.0.CO;2-E).
32. Robinson PH, Checkley SA, Russell GFM. Suppression of eating by fenfluramine in patients with bulimia nervosa. *Br J Psychiatry.* 1985;146:169–76. <https://doi.org/10.1192/bjp.146.2.169>.
33. Marcus MD, Wing RR, Hopkins J, American Psychological Association. Obese binge eaters: affect, cognitions, and response to behavioral weight control. *J Consult Clin Psychol.* 1988;56:433–9. <https://doi.org/10.1037/0022-006X.56.3.433>.
34. Schmidt U, Marks I. Cue exposure to food plus response prevention of binges for bulimia: a pilot study. *Int J Eat Disord.* 1988;7:663–72. [https://doi.org/10.1002/1098-108X\(198809\)7:5<253C663::AID-EAT2260070510/253E3.0.CO;2-X](https://doi.org/10.1002/1098-108X(198809)7:5<253C663::AID-EAT2260070510/253E3.0.CO;2-X).
35. Jansen A, den Van Hout MA, De Loof C, Zandbergen J, Griez E. A case of bulimia successfully treated by cue exposure. *J Behav Ther Exp Psychiatry.* 1989;20:327–32. [https://doi.org/10.1016/0005-7916\(89\)90064-5](https://doi.org/10.1016/0005-7916(89)90064-5).
36. Kales EF. Macronutrient analysis of binge eating in bulimia. *Physiol Behav.* 1990;48:837–40. [https://doi.org/10.1016/0031-9384\(90\)90236-W](https://doi.org/10.1016/0031-9384(90)90236-W).
37. Yanovski SZ, Leet M, Yanovski JA, Flood M, Gold PW, Kissileff HR, et al. Food selection and intake of obese women with binge-eating disorder. *Am J Clin Nutr.* 1992;56:975–80. <https://doi.org/10.1093/ajcn/56.6.975>.
38. Hetherington MM, MacDiarmid JI. Chocolate addiction?: a preliminary study of its description and its relationship to problem eating. *Appetite.* 1993;21:233–46. <https://doi.org/10.1006/appe.1993.1042>.
39. van der Ster Wallin G, Norring C, Holmgren S. Binge eating versus nonpurged eating in bulimics: is there a carbohydrate craving after all? *Acta Psychiatr Scand.* 1994;89:376–81. <https://doi.org/10.1111/j.1600-0447.1994.tb01532.x>.
40. Geraciotti TD, Loosen PT, Ebert MH, Schmidt D, Ekhaton NN. Fasting and postprandial cerebrospinal fluid glucose concentrations in healthy women and in an obese binge eater. *Int J Eat*

- Disord. 1995;18:365–9. [https://doi.org/10.1002/1098-108x\(199512\)18:4<253C365::aid-eat2260180410/253E3.0.co;2-0](https://doi.org/10.1002/1098-108x(199512)18:4<253C365::aid-eat2260180410/253E3.0.co;2-0).
41. Greeno CG, Wing RR, Marcus MD. Nocturnal eating in binge eating disorder and matched-weight controls. *Int J Eat Disord.* 1995;18:343–9. [https://doi.org/10.1002/1098-108x\(199512\)18:4/253C343::aid-eat2260180407/253E3.0.co;2-p](https://doi.org/10.1002/1098-108x(199512)18:4/253C343::aid-eat2260180407/253E3.0.co;2-p).
 42. Telch CF, Pratt EM, Niego SH. Obese women with binge eating disorder define the term binge. *Int J Eat Disord.* 1998;24:313–7. [https://doi.org/10.1002/\(sici\)1098-108x\(199811\)24:3<253C313::aid-eat9/253E3.0.co;2-p](https://doi.org/10.1002/(sici)1098-108x(199811)24:3<253C313::aid-eat9/253E3.0.co;2-p).
 43. Allison S, Timmerman GM. Anatomy of a binge: food environment and characteristics of nonpurge binge episodes. *Eat Behav.* 2007;8:31–8. <https://doi.org/10.1016/j.eatbeh.2005.01.004>.
 44. McIver S, McGartland M, O'Halloran P. Overeating is not about the food": women describe their experience of a yoga treatment program for binge eating. *Qual Health Res.* 2009;19:1234–45. <https://doi.org/10.1177/1049732309343954>.
 45. Cameron MJ, Maguire RW, McCormack J. Stress-induced binge eating: a behavior analytic approach to assessment and intervention. *J Adult Dev.* 2011;18:81–4. <https://doi.org/10.1007/s10804-010-9112-9>.
 46. Reslan S, Saules KK. College students' definitions of an eating "binge" differ as a function of gender and binge eating disorder status. *Eat Behav.* 2011;12:225–7. <https://doi.org/10.1016/j.eatbeh.2011.03.001>.
 47. Palmberg AA, Stern M, Kelly NR, Bulik C, Belgrave FZ, Trapp SK, et al. Adolescent girls and their mothers talk about experiences of binge and loss of control eating. *J Child Fam Stud.* 2014;23:1403–16. <https://doi.org/10.1007/s10826-013-9797-z>.
 48. Rigaud D, Jiang T, Pennacchio H, Brémont M, Perrin D. Les inducteurs des crises dans la boulimie et la compulsions: Validation du questionnaire «Start». *Encephale.* 2014;40:323–9. <https://doi.org/10.1016/j.encep.2013.06.008>.
 49. Phillips KE, Kelly-Weeder S, Farrell K. Binge eating behavior in college students: what is a binge? *Appl Nurs Res.* 2016;30:7–11. <https://doi.org/10.1016/j.apnr.2015.10.011>.
 50. Tester JM, Lang TC, Laraia BA. Disordered eating behaviours and food insecurity: a qualitative study about children with obesity in low-income households. *Obes Res Clin Pract.* 2016;10:544–52. <https://doi.org/10.1016/j.orcp.2015.11.007>.
 51. Carey JB, Saules KK, Carr MM. A qualitative analysis of men's experiences of binge eating. *Appetite.* 2017;116:184–95. <https://doi.org/10.1016/j.appet.2017.04.030>.
 52. Evans BC, Murray HB, Muratore AF, Lantz EL, Juarascio AS. Developing an acceptance-based behavioral weight loss treatment for individuals with binge eating pathology: a preliminary proof of concept study and clinical case series. *Cogn Behav Pract.* 2019;26:395–410. <https://doi.org/10.1016/j.cbpra.2018.05.004>.
 53. Lecomte A, Zerrouk A, Sibeoni J, Khan S, Revah-Levy A, Lachal J. The role of food in family relationships amongst adolescents with bulimia nervosa: a qualitative study using photo-elicitation. *Appetite.* 2019;141:104305. <https://doi.org/10.1016/j.appet.2019.05.036>.
 54. Carmen M, Safer DL, Saslow LR, Kalayjian T, Mason AE, Westman EC, et al. Treating binge eating and food addiction symptoms with low-carbohydrate ketogenic diets: a case series. *J Eat Disord.* 2020;8:2. <https://doi.org/10.1186/s40337-020-0278-7>.
 55. Brownstone LM, Mihap P, M Butler R, Maman S, Peterson CB, Bulik CM, et al. Lived experiences of subjective binge eating: An inductive thematic analysis. *Int J Eat Disord.* 2021;54:2192–205. <https://doi.org/10.1002/eat.23636>.
 56. Frayn M, Trainor C, Lin M, Pitts A, Drexler SA, Patarinski AGG, et al. Patient perceptions of the relationship between food insecurity and eating disorder treatment: a qualitative exploration. *Int J Eat Disord.* 2022;55:332–42. <https://doi.org/10.1002/eat.23661>.
 57. Bruzas MB, Tronieri JS, Chao AM, Jones E, McAllister C, Gruber K, et al. Binge size and loss of control as correlates of eating behavior and psychopathology among individuals with binge eating disorder and higher weight. *J Behav Med.* 2022;45:603–12. <https://doi.org/10.1007/s10865-022-00312-7>.
 58. Davis HA, Keel PK, Tangney JP, Smith GT. Increases in shame following binge eating among women: laboratory and longitudinal findings. *Appetite.* 2022;178:106276. <https://doi.org/10.1016/j.appet.2022.106276>.
 59. King PR, Buchholz LJ, Tauriello S, Wray LO. Qualitative exploration of factors influencing women veterans' disordered eating symptoms and treatment preferences in VHA primary care. *Fam Syst Health.* 2023;41:214–21. <https://doi.org/10.1037/fsh0000740>.
 60. Hostess Brands, LLC. Zingers® Iced Vanilla [Internet]. Hostess brands. [cited 2025 Oct 15]. <https://www.hostesscakes.com/everyday-snacks/zingers-vanilla>. Accessed 15 Oct 2025.
 61. McDonald's Corporation. Sausage, egg & cheese mcGriddles® breakfast sandwich [Internet]. McDonald's. [cited 2025 Oct 15]. <https://www.mcdonalds.com/us/en-us/product/sausage-egg-cheese-mcgriddles.html>. Accessed 15 Oct 2025.
 62. Domino's Pizza, LLC. Nutrition | Ingredients | Allergen info [Internet]. Dominos Pizza order online. [cited 2025 Oct 15]. <https://www.dominos.com/en/pages/content/nutritional/nutrition>. Accessed 15 Oct 2025.
 63. Frito-Lay, Inc. LAY'S® Classic potato chips [Internet]. LAY'S. [cited 2025 Oct 15]. <http://www.lays.com/products/lays-classic-potato-chips?id=%21ppbp4qsnfc%27>. Accessed 15 Oct 2025.
 64. Breyers, Inc. SNICKERS® [Internet]. Breyers. [cited 2025 Oct 15]. <https://www.breyers.com/us/en/p/snickers.html/00077567265302>. Accessed 15 Oct 2025.
 65. General Mills. Rice chex cereal | Gluten-free cereal [Internet]. Chex. [cited 2025 Oct 15]. <https://www.chex.com/products/rice-chex>. Accessed 15 Oct 2025.
 66. Kellogg Company. Club® original crackers - SmartLabel™ [Internet]. SmartLabel. [cited 2025 Oct 15]. <https://smartlabel.kelloggs.com/Product/Index/00030100100577>. Accessed 15 Oct 2025.
 67. Mondelez International. Chips Ahoy!, Original, real chocolate chip cookies - SmartLabel™ [Internet]. SmartLabel. [cited 2025 Oct 15]. <https://smartlabel.mondelez.info/044000033385-0001-e-n-US/index.html>. Accessed 15 Oct 2025.
 68. General Mills. Cheerios™ cereal single serve bowlpak 1 oz [Internet]. Gen. Mills Foodserv. [cited 2025 Oct 15]. <https://www.generalmillsfoodservice.com/products/category/cereal/single-serve-cereal/bowlpak/cheerios-1oz>. Accessed 15 Oct 2025.
 69. Mondelez International. Chocolate sandwich cookies, family size | OREO [Internet]. Oreo. [cited 2026 Jan 29]. <https://www.oreo.com/products/oreo-cookie>. Accessed 29 Jan 2026.
 70. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2021–2023 [Internet]. Food surveys research group home page; 2024. <http://www.ars.usda.gov/nea/bhnrc/fsrg>
 71. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2019–2020 [Internet]. Food surveys research group home page; 2022. <http://www.ars.usda.gov/nea/bhnrc/fsrg>
 72. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2017–2018 [Internet]. Food surveys research group home page; 2020. <http://www.ars.usda.gov/nea/bhnrc/fsrg>
 73. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2015–2016 [Internet]. Food surveys research group home page; 2018. <http://www.ars.usda.gov/nea/bhnrc/fsrg>

74. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2013–2014 [Internet]. Food surveys research group home page; 2016. <http://www.ars.usda.gov/nea/bhnrc/fsrg>
75. U.S. Department of Agriculture, Agricultural Research Service. USDA food and nutrient database for dietary studies 2011–2012 [Internet]. Food surveys research group home page; 2014. <http://www.ars.usda.gov/ba/bhnrc/fsrg>
76. Agricultural Research Service, Food Surveys Research Group. USDA food and nutrient database for dietary studies, 4.1. Beltsville, MD; 2010.
77. Agricultural Research Service, Food Surveys Research Group. USDA food and nutrient database for dietary studies, 1.0. Beltsville, MD; 2004.
78. Public Health England. McCance and Widdowson's the Composition of Foods Integrated Dataset (CoFID) [Internet]. London, UK: Public Health England, Department of Health and Social Care; 2021. <https://www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid>
79. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Nederlands Voedingsstoffenbestand (NEVO) [Internet]. Bilthoven, The Netherlands; <https://nevo-online.rivm.nl/>
80. Australian Bureau of Statistics. AUSNUT 2023: Australian food, supplement and nutrient database [Internet]. 2023. <https://www.foodstandards.gov.au/science-data/food-nutrient-databases/ausnut/data-files>
81. Livsmedelsverket (Swedish Food Agency). Swedish food composition database (Livsmedelsdatabasen) [Internet]. Uppsala, Sweden; 2025. <https://soknaringsinnehall.livsmedelsverket.se/>
82. Anses. Ciquel French food composition table. 2020.
83. Lalanza JF, Snoeren EMS. The cafeteria diet: a standardized protocol and its effects on behavior. *Neurosci Biobehav Rev.* 2021;122:92–119. <https://doi.org/10.1016/j.neubiorev.2020.11.003>.
84. Hall KD, Ayuketah A, Brychta R, Cai H, Cassimatis T, Chen KY, et al. Ultra-processed diets cause excess calorie intake and weight gain: an inpatient randomized controlled trial of ad libitum food intake. *Cell Metab.* 2019;30:67–77.e3. <https://doi.org/10.1016/j.cmet.2019.05.008>.
85. Schulte EM, Avena NM, Gearhardt AN. Which foods may be addictive? The roles of processing, fat content, and glycemic load. *PLoS One.* 2015;10:e0117959. <https://doi.org/10.1371/journal.pone.0117959>.
86. Ulijaszek SJ. Human eating behaviour in an evolutionary ecological context. *Proc Nutr Soc.* 2002;61:517–26. <https://doi.org/10.1079/PNS2002180>.
87. Schulte EM, Smeal JK, Gearhardt AN, Public Library of Science. Foods are differentially associated with subjective effect report questions of abuse liability. *PLoS ONE.* 2017;12:e0184220. <https://doi.org/10.1371/journal.pone.0184220>.
88. Kessler RC, Berglund PA, Chiu WT, Deitz AC, Hudson JI, Shahly V, et al. The prevalence and correlates of binge eating disorder in the World Health Organization world mental health surveys. *Biol Psychiatry.* 2013;73:904–14. <https://doi.org/10.1016/j.biopsych.2012.11.020>.
89. Stice E, Burger KS, Yokum S. Relative ability of fat and sugar tastes to activate reward, gustatory, and somatosensory regions. *Am J Clin Nutr.* 2013;98:1377–84. <https://doi.org/10.3945/ajcn.113.069443>.
90. Lustig RH, Schmidt LA, Brindis CD, Nature Publishing Group. The toxic truth about sugar. *Nature.* 2012;482:27–9. <https://doi.org/10.1038/482027a>.
91. Monteiro CA, Cannon G, Moubarac J-C, Levy RB, Louzada MLC, Jaime PC. The UN decade of nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr.* 2018;21:5–17. <https://doi.org/10.1017/S1368980017000234>.
92. Moradi S, Hojjati Kermani M, Bagheri R, Mohammadi H, Jayedi A, Lane MM, et al. Ultra-processed food consumption and adult diabetes risk: a systematic review and dose-response meta-analysis. *Nutrients.* 2021;13:4410. <https://doi.org/10.3390/nu13124410>.
93. Fardet A. Minimally processed foods are more satiating and less hyperglycemic than ultra-processed foods: a preliminary study with 98 ready-to-eat foods. *Food Funct.* 2016. <https://doi.org/10.1039/C6FO00107F>.
94. Vadevelo MK, Gardner CD, Bleich SN, Khandpur N, Lichtenstein AH, Otten JJ, et al. Ultraprocessed foods and their association with cardiometabolic health: evidence, gaps, and opportunities: a science advisory from the American Heart Association. *Circulation.* 2025;152:e245–63. <https://doi.org/10.1161/CIR.0000000000001365>.
95. Lawrence MA, Baker PI, British Medical Journal Publishing Group. Ultra-processed food and adverse health outcomes. *BMJ.* 2019;365:l2289. <https://doi.org/10.1136/bmj.l2289>.
96. Solmi F, Moreno AB, Lewis G, Angélica Nunes M, de Jesus Mens Fonseca M, Harter Griep R. Longitudinal association between binge eating and metabolic syndrome in adults: findings from the ELSA-Brasil cohort. *Acta Psychiatr Scand.* 2021;144:464–74. <https://doi.org/10.1111/acps.13356>.
97. Bulik CM, Sullivan PF, Kendler KS. Medical and psychiatric morbidity in obese women with and without binge eating. *Int J Eat Disord.* 2002;32:72–8. <https://doi.org/10.1002/eat.10072>.
98. Rieger E, Wilfley DE, Stein RI, Marino V, Crow SJ. A comparison of quality of life in obese individuals with and without binge eating disorder. *Int J Eat Disord.* 2005;37:234–40. <https://doi.org/10.1002/eat.20101>.
99. Abraham TM, Massaro JM, Hoffmann U, Yanovski JA, Fox CS. Metabolic characterization of adults with binge eating in the general population: the framingham heart study. *Obesity.* 2014;22:2441–9. <https://doi.org/10.1002/oby.20867>.
100. Fuente González CE, Chávez-Servín JL, de la Torre-Carbot K, Ronquillo González D, Aguilera Barreiro M, Ojeda Navarro LR. Relationship between emotional eating, consumption of hyperpalatable energy-dense foods, and indicators of nutritional status: a systematic review. *J Obes.* 2022;2022:4243868. <https://doi.org/10.1155/2022/4243868>.
101. Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. *Br J Nutr.* 2021;125:308–18. <https://doi.org/10.1017/S0007114520002688>.
102. Dicken SJ, Qamar S, Batterham RL. Who consumes ultra-processed food? A systematic review of sociodemographic determinants of ultra-processed food consumption from nationally representative samples. *Nutr Res Rev.* 2024;37:416–56. <https://doi.org/10.1017/S0954422423000240>.
103. Brewerton TD, Dennis K, Wiss DA. Dismantling the myth of “all foods fit” in eating disorder treatment. *J Eat Disord.* 2024;12:60. <https://doi.org/10.1186/s40337-024-01017-9>.
104. Grilo CM, Pittman B. Exploring dietary restraint as a mediator of behavioral and cognitive-behavioral treatments on outcomes for patients with binge-eating disorder with obesity. *Int J Eat Disord.* 2024;57:2475–81. <https://doi.org/10.1002/eat.24288>.
105. Marcus MD, Wing RR. Binge eating among the obese. *Ann Behav Med.* 1987;9:23–7. https://doi.org/10.1207/s15324796abm0904_5.
106. Boggiano MM, Artiga AI, Pritchett CE, Chandler-Laney PC, Smith ML, Eldridge AJ. High intake of palatable food predicts binge-eating independent of susceptibility to obesity: an animal model of lean vs obese binge-eating and obesity with and without binge-eating. *Int J Obes.* 2007;31:1357–67. <https://doi.org/10.1038/sj.ijo.0803614>.

107. Dalton M, Blundell J, Finlayson G. Effect of BMI and binge eating on food reward and energy intake: further evidence for a binge eating subtype of obesity. *Obes Facts*. 2013;6:348–59. <https://doi.org/10.1159/000354599>.
108. Charrondiere UR, Chevassus-Agnes S, Marroni S, Burlingame B. Impact of different macronutrient definitions and energy conversion factors on energy supply estimations. *J Food Compos Anal*. 2004;17:339–60. <https://doi.org/10.1016/j.jfca.2004.03.011>.
109. Falbe J, Thompson HR, Patel A, Madsen KA. Potentially addictive properties of sugar-sweetened beverages among adolescents. *Appetite*. 2019;133:130–7. <https://doi.org/10.1016/j.appet.2018.10.032>.
110. Malik VS, Hu FB. The role of sugar-sweetened beverages in the global epidemics of obesity and chronic diseases. *Nat Rev Endocrinol*. 2022;18:205–18. <https://doi.org/10.1038/s41574-021-00627-6>.
111. Luo Y, Morales JC, Dunton GF, Mason TB. Assessment of EMA binge-eating symptoms in adolescents: factor analysis and associations with social context and food types. *Appetite*. 2025;214:108212. <https://doi.org/10.1016/j.appet.2025.108212>.
112. Fuller NR, Fong M, Gerofi J, Ferkh F, Leung C, Leung L, et al. Comparison of an electronic versus traditional food diary for assessing dietary intake—a validation study. *Obes Res Clin Pract*. 2017;11:647–54. <https://doi.org/10.1016/j.orcp.2017.04.001>.
113. Maugeri A, Barchitta AM. A systematic review of ecological momentary assessment of diet: implications and perspectives for nutritional epidemiology. *Nutrients*. 2019;11:2696. <https://doi.org/10.3390/nu11112696>.
114. Pereira T, Mocellin CM, Curioni C. Association between ultraprocessed foods consumption, eating disorders, food addiction and body image: a systematic review. *BMJ Open*. 2024;14:e091223. <https://doi.org/10.1136/bmjopen-2024-091223>.
115. Popkin BM, Laar A. Nutrition transition's latest stage: are ultra-processed food increases in low- and middle-income countries dooming our preschoolers' diets and future health? *Pediatr Obes*. 2025;20:e70002. <https://doi.org/10.1111/ijpo.70002>.
116. Monteiro CA, Moubarac J-C, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obes Rev*. 2013;14:21–8. <https://doi.org/10.1111/obr.12107>.
117. Balasundaram P, Daley SF. Public health considerations regarding obesity. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Nov 12]. <http://www.ncbi.nlm.nih.gov/books/NBK572122/>. Accessed 12 Nov 2025.

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