Food Production, Processing and Nutrition

REVIEW

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Demystifying the link between ultra-processed food, gut microbiome dysbiosis, and colon cancer: a narrative and bibliometric review

Sneha Nayak[1] and Arif Hussain[2*]

Abstract

Ultra-processed foods (UPFs) contain little or no intact whole food and are designed to be convenient, affordable, and highly palatable. UPFs are spiked with added sugars and synthetic additives, which in turn lead to obesity and health-related complications if left unaddressed. This bibliometric review analyses 273 articles published between 2013 and 2025 retrieved from the Scopus database to uncover the scientific trends, influential contributors, research hotspots, and emerging gaps and trending topics in UPFs and their link to colon cancer. Moreover, microbiome dysbiosis and mechanistic links to UPF consumption and its link with inflammatory and oncogenic pathways are uncovered, along with additional information on recent concerns in UPF intake with emphasis on research gaps and future directions. Therefore, by identifying research hotspots, underexplored regions, and collaboration dynamics, our review provides a strategic overview of this trending topic and stresses the need for more cohort and prospective studies. Further, this narrative review also discusses the need for the most transparent nutritional labels and the use of powerful technology like artificial intelligence (AI) for personalised health choices.

Keywords Public health, Food, Ultraprocessed food, Gut dysbiosis, Cancer, Colon cancer, Bibliometrix, VOSviewer

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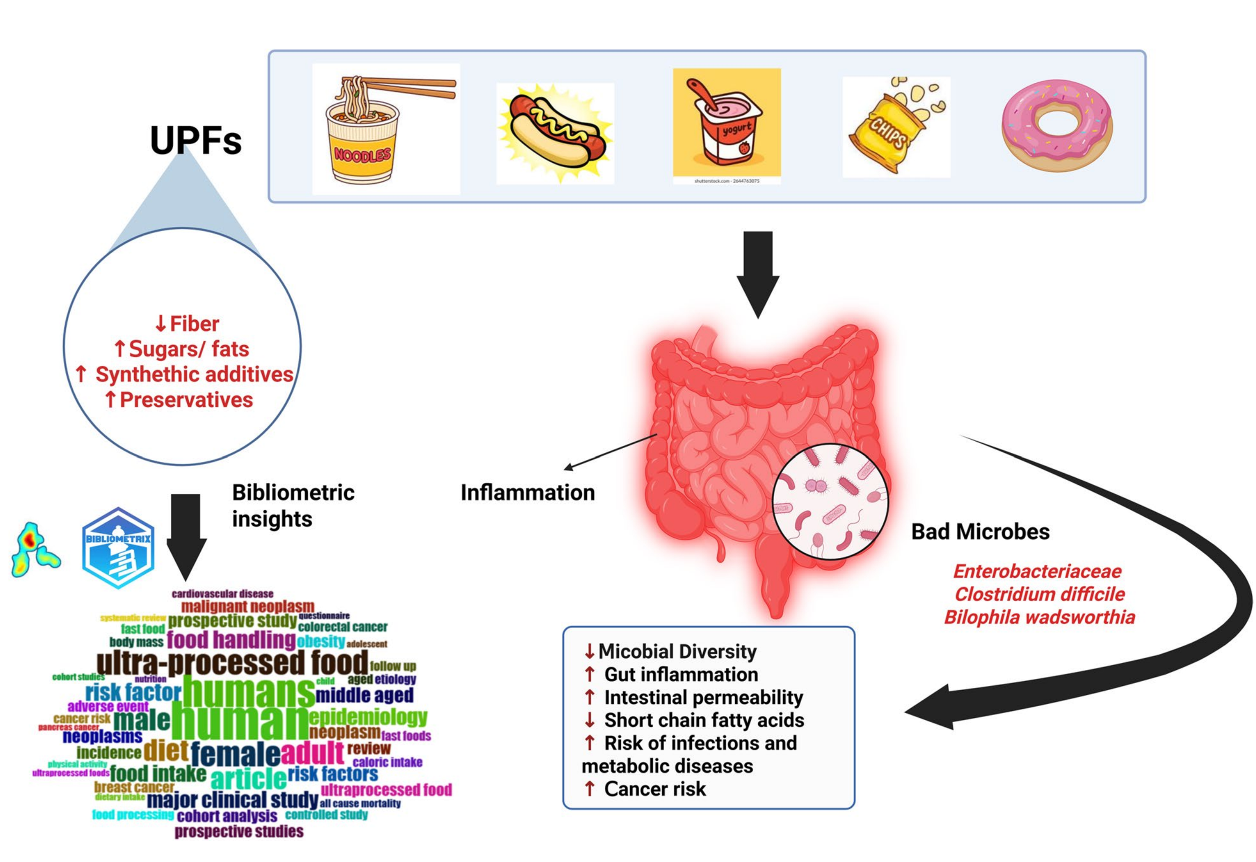
Graphical Abstract



Introduction

Ultra-processed foods (UPFs) are engineered industrial formulations made to maximise sensory pleasure using substances derived from foods like oils, fats, starches, sugars, and protein isolates with added additives like flavourings, colourings, emulsifiers, and preservatives (Aguilera, 2025). These additives, are non-nutritive substances, added intentionally during processing (Ahmed et al., 2024). The non-nutritive substances include preservatives, emulsifiers, artificial sweeteners, flavouring agents, colourants, antioxidants, thickeners, and bulking agents for varied reasons, which include enhanced shelf life, improved taste and appearance, and better mouthfeel (Ahmed et al., 2024). However, UPFs contain little or no intact whole food and are designed to be convenient, affordable, and highly palatable (Shannon & Avery, 2025). In the United States alone, UPFs can constitute > 60% of the daily caloric intake among children and adolescents, which is a significant concern (Moura & Carvalho, 2025). They are generally classified under Group 4 in the NOVA Food Classification System, which divides foods based on their level of processing rather than their nutrient content (Louie, 2025). The general overview of the classification of UPFs illustrating different categories and typical examples within each class is presented in Fig. 1.

For instance, Group 1 includes minimally processed foods like fresh fruits, vegetables, milk, meat, etc. Processed culinary ingredients like oil, butter, sugar, and salt come under group 2. Processed food, like canned vegetables and cheese, is included under Group 3. Products like Soft drinks, packaged snacks, instant noodles, reconstituted meat products, and sweetened cereals fall under the group 4 category. Consumption of UPFs has increased globally, according to a recent 2025 report from the Centres for Disease Control and Prevention (CDC), about 61.9% and 53% of average daily calories come from UPFs in youths and adults, respectively, which is a significant concern. UPFs are spiked with added sugars and additives, which in turn lead to obesity and health-related complications if left unaddressed. Additionally, obesity has been a growing global healthcare concern for decades, and one of the key contributors to this is increased UPF intake, which has been clinically proven by a few researchers (Dicken & Batterham, 2024). Global surge in

Fig. 1 General overview of the classification of ultra-processed foods (UPFs), illustrating different categories and typical examples within each class

UPFs consumption among adolescent and young adult groups has been linked to an alarming rise in early onset of cancer (Z.-Y. Wang et al., 2024b).

Biologically active compounds in UPFs, like endocrine disrupting chemicals (ECCs), interfere with hormone regulation, immune response, and microbial imbalance in the gut (Cai et al., 2025). Exposure to ECCs during vulnerable developmental stages can disrupt endocrine signalling pathways, promote chronic inflammation, and create physiological conditions that may create a hostile environment for cancer (Fajkić et al., 2025). Common examples of ECCs associated with ultra-processed foods include bisphenols (e.g., Bisphenol A) leaching from food containers (Tumu et al., 2023), phthalates originating from food-processing equipment and handling gloves, per- and polyfluoroalkyl substances (PFAS) from grease-resistant packaging such as fast-food wrappers and pizza boxes (Schaider et al., 2017), and preservatives such as parabens present in certain processed foods and beverages (Liao et al., 2025). Though the purpose of adding preservatives to UPFs is inhibition of microbial spoilage and enhanced shelf life, there are reports that indicate unintentional alteration in gut microbiota (Bevilacqua et al., 2024). Nitrites from preservatives could form carcinogenic nitrosamines in the colon (Mafe & Büsselberg, 2025; Menegassi & Vinciguerra, 2025). Although emulsifiers are incorporated into UPFs to prevent phase separation and ensure product uniformity, several studies have reported their potential to disrupt the gut mucus layer and promote intestinal inflammation in animal models (Urrutia-Pereira et al., 2025). Use of sucralose, saccharin, acesulfame K as artificial sweeteners in UPFs is linked to microbiome dysbiosis and glucose intolerance (Bevilacqua et al., 2024; Spiller et al., 2025) Moreover, flavour enhancers like monosodium glutamate (MSG) intensifies taste in UPFs and leads to binge eating by stimulating appetite and increase food palatability thus leading to obesity issues among adolescent and young adults (Ahmed et al., 2024).

Addition of colourants in UPFs for better appearance has been linked to gut barrier disruption and hyperactivity in children and also impacted brain development in prenatal and adolescent stages (Mottis et al., 2025; Rondinella et al., 2025). Additionally, butylated hydroxyanisole (BHA), used as an antioxidant in UPFs for preventing fat oxidation and rancidity, has shown growing evidence as a potential endocrine disruptor that may induce oxidative stress (Mafe & Büsselberg, 2025). Carrageenan, a thickener used to improve the viscosity and texture of UPFs, has been shown to be a silent trigger to intestinal inflammation and cancer (Whelan et al., 2024). Therefore, there is a growing need to mitigate the risk of cancers at early stages by identifying the prognostic factors by using omics(Li, 2025) and artificial intelligence approaches (Espinoza-Carhuancho et al., 2024). It includes categories like snack foods and fast foods, which include items like potato chips, nachos, instant noodles, cup noodles, French fries, burgers, and chicken nuggets. Moreover, bread, cake, pastries, cookies, sweetened breakfast cereals, and energy bars come under baked and baked goods. Soft drinks like cola, fruit juices with added sugars, sweetened iced teas and coffee beverages are classified under sugary drinks. Chocolates, ice-creams, candies. Toffies and gummies come under the sweets and dessert category, and products like frozen pizza, ready-to-eat pasta dishes, microwave-ready dinner, canned soups, and instant rice come under the broad classification of ready-to-eat category, and processed meat and dairy products include sausages, hot dogs, salami, processed cheese, and flavoured yoghurt with added sweeteners. All the above 6 categories fall under the broad classification of UPFs, which are linked to long-term health risks and obesity concerns in adolescent and adult age groups when consumed in excess(Beslay et al., 2020). Additionally, these UPFs are loaded with chemicals and synthetic agents either to improve the properties or enhance the shelf life of the products for enhanced profit goals.

Composition of ultra-processed foods and their health implications

A detailed overview about these chemicals and their health implications are presented which includes flavour enhancers, artificial sweeteners, emulsifiers, colourants, preservatives, humectants, artificial flavours, and bulking agents. Flavour enhancers are usually added to UPFs to intensify the taste and make foods more appealing and tastier (Vadiveloo et al., 2025). Artificial sweeteners are added to provide sweetness without calories or sugar (Vatavuk-Serrati et al., 2025). However, they have potential shortcoming, which may include alteration of gut microbiome (Bevilacqua et al., 2024), increased sugar cravings (Ahmed et al., 2024), impaired glucose tolerance (Angelin et al., 2024), risk of overeating due to confused hunger signals (Spiller et al., 2025), headaches in a few people due to aspartame usage (Aldabayan, 2025) and dental changes due to poor eating habits (Oyewole Babalola, 2025). Emulsifiers are generally added in UPFs with the intention of providing a smooth texture and keeping the product in a single phase by keeping the oil and water mixed (Oyewole Babalola, 2025). However, recent reports have shown their links to gut dysbiosis and increased permeability, low-grade intestinal inflammation (Spiller et al., 2025), metabolic disorders like obesity and insulin resistance (Ahmed et al., 2024), digestive discomfort including gas, bloating and diarrhoea (Jamal et al., 2025). Few cases in the literature have also shown the negative impact of emulsifiers on inflammatory immune responses, which is a matter of concern (Spiller et al., 2025). The use of food colourants in UPFs has risen sharply, primarily to restore pigments lost during processing or to enhance visual appeal (Chaimati et al., 2025). These additives offer no nutritional value or additional health benefits (Vadiveloo et al., 2025).

Most commonly, synthetic dyes are used and listed as E-numbers on food labels, information that many consumers may not recognise. Examples include E102 (tartrazine, a yellow dye), E110 (sunset yellow), E133 (brilliant blue), and E129 (carmine red) (See & Asfeen, 2025). Reported negative effects of such colourants include, increased ADHD-like behaviour in children (Chaimati et al., 2025), allergic reactions such as rashes and hives (especially with tartrazine) (Berni Canani et al., 2024), potential carcinogenicity in animal studies (Yang et al., 2025), gut irritation leading to dysbiosis, and possible endocrine disruption (Fajkić et al., 2025). UPFs usually contain preservatives added with a functional role to extend the shelf life by avoiding spoilage. However, they show several negative effects on a cumulative basis if these products are consumed on a regular basis. Addition of sodium benzoate, potassium sorbate, and calcium propionate in UPFs has been shown to have a detrimental impact on gut microbiota by causing dysbiosis, i.e. an imbalance created between good and bad bacteria. An increase in the count of proinflammatory bacteria and reduced loads of *lactobacillus* and *Bifidobacterium* have been reported. Additionally, a decrease in the production of short-chain fatty acids affects gut barrier integrity, leading to leaky gut by compromising the tight junction and allowing toxins, bacterial fragments, and inflammatory molecules to enter. Nitrites and Nitrates added as preservatives in UPFs can convert to nitrosamines in the body, which are known to be proven carcinogens.

Therefore, long-term intake of UPFs loaded with nitrites can be linked to elevated risks of colorectal and gastric cancers in the young population. Chemical additives such as humectants, commonly used in baked goods, confectionery, and ready-to-eat UPFs, help retain moisture by attracting and holding water molecules through hydrogen bonding. This maintains the softness, chewiness, and hyper-palatable texture of these products, which can promote overeating and weight gain (Ehrenberg & Cooper, 2025). Children with sensitive gastrointestinal systems may experience digestive discomfort due to the poor intestinal absorption of certain humectants like sorbitol (a polyol) (Martín Pérez & Martín Pérez, 2025). Although polyols have low glycemic indices, excessive consumption may still affect blood sugar regulation in individuals with diabetes and may place additional strain on kidney function in those with pre-existing renal conditions (Bai et al., 2025).

Artificial flavours are synthetic chemical compounds produced to mimic natural taste and aroma in food with enhanced shelf life, improved palatability and increased sensory appeal. For instance, ethyl vanillin gives vanilla-like aroma, isoamyl acetate gives banana flavour, and benzaldehyde gives almond flavour in food (Schmid et al., 2025). The main reason for using these chemicals is the reduced cost in comparison with natural ingredients, with longer shelf life. However, these are known to show similar chemical toxicity, including gut dysbiosis, inflammatory response and allergic reactions. Bulking agents, while useful for increasing the volume, texture, stability, and mouthfeel of UPFs, do not contribute to calories and often reduce production costs by replacing natural ingredients(Forde & Decker, 2022), however, their use raises several concerns. Nanosized silicon dioxide, commonly added to spices and powdered products to prevent clumping and extend shelf life, has been associated with tissue accumulation, and its long-term health effects remain unclear (Jeong et al., 2025). Magnesium stearate, frequently incorporated into spices and snack seasonings, has been reported to reduce nutrient absorption and may cause gut irritation(Younes et al., 2018). Similarly, calcium carbonate, used as a whitening and bulking agent in bakery products and noodles, is known to cause constipation and can interfere with the absorption of essential minerals (Zheng et al., 2025). Although UPFs are often discussed as a single category, they represent a heterogeneous group of products that differ considerably in formulation, additive composition, and processing techniques utilized. The physiological and microbiome responses to additives may significantly depend on the specific food matrix, dosage, and patterns of consumption. Detailed overview of synthetic and industrially derived chemicals added to UPFs to improve its properties and extend its shelf life. are depicted in Fig. 2.

Data collection

The data collection for te planned narrative review section of the review were identified through a thorough and comprehensive literature review using google scholar, pubmed and Scopus databases. Relevant keywords like UPFs, UPFs link to gut microbiome dysbiosis, UPFs link to colon/colorectal cancer, UPFs link to inflammation, use of food additives in UPFs and its impact on health and dietary lifestyle and its impact on health were used as search strings and priority was given to peer reviewed research articles, systematic reviews or meta-analysis papers. Papers were selected based on relevance to the present review, methodological quality and detailed information available on mechanistic insights published in English which addresses the link between UPFs, alterations in gut microbiota and colon carcinogenesis. For the bibliometric analysis by vosviewer, metadata from Scopus indexed publications were thoroughly analysed to evaluate publication trends, influential authors, collaborative networks, and evolving research themes. This combined approach enabled both qualitative synthesis and quantitative mapping of the current research landscape, thereby improving the transparency and comprehensiveness of the review.

The data for this bibliometric study was retrieved from the Scopus database, which offers wide coverage of publications and bibliometric information. Scopus database

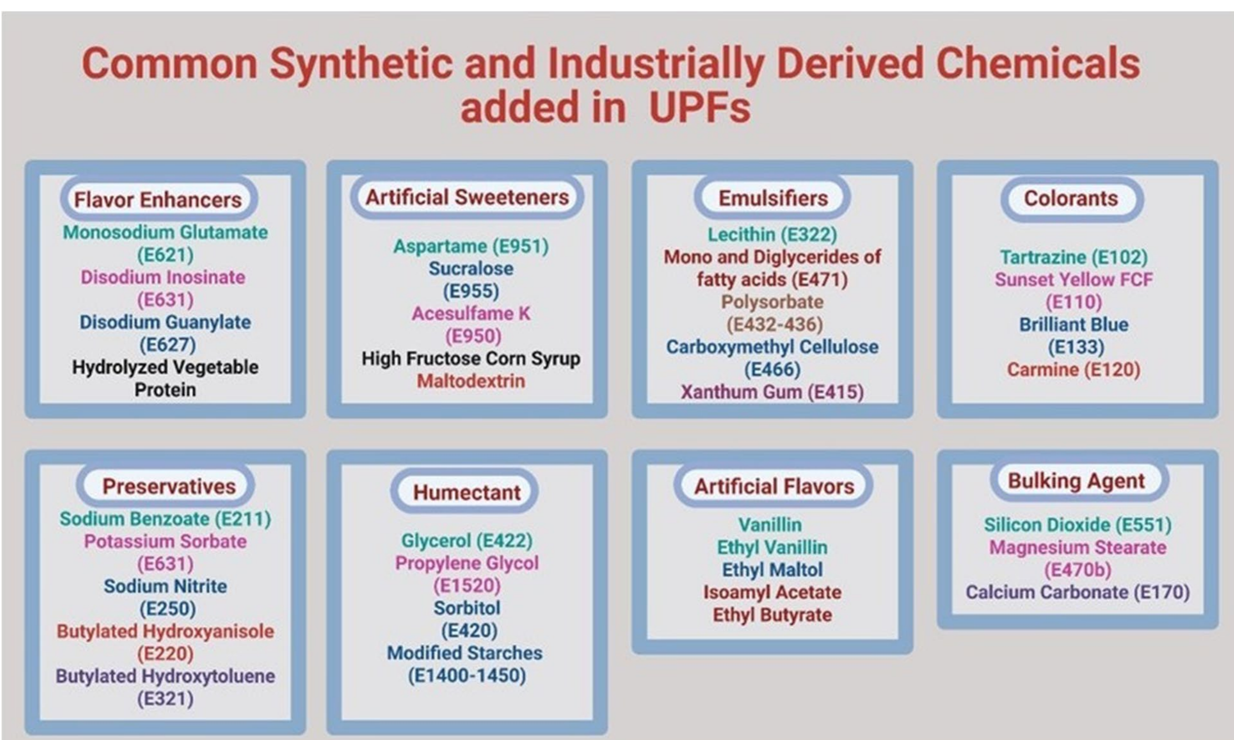


Fig. 2 Overview of synthetic and industrially derived chemicals added to UPFs to improve their properties and extend its shelf life

was selected due to its broad range of relevant documents, which provided a solid foundation for the bibliometric analysis. The search was conducted through predecided search strings presented in Fig. 3, ensuring a thorough capture of all the relevant literature. No restrictions were applied regarding the document type or language, or format of the publications, allowing for a global and inclusive analysis. Further, to visualize the bibliometric data, VOSviewer software (version 1.6.20) was utilized. It was used to create network maps based on keyword co-occurrence, and visualization, which help to identify emerging hot spots within the field. This approach enabled a thorough visual examination of the connections among various keywords and how the field has evolved over time, offering deeper insights into the global research landscape. The detailed flowchart of bibliometric analysis used in this review is presented in Fig. 3.

Data extraction using Scopus database and bibliometric analysis using vosviewer tool

To understand the extent of research happening in this area, a desk-based review of the Scopus database using the keywords search string "cancer" AND "ultraprocessed food" refined for the period 2013–2025 was conducted. With any restriction on document type or language. Since only Scopus database was used for bibliometric analysis, there was no need for any deduplication procedures.

Data interpretation using vosviewer tool

The results revealed a gradual rise in the number of publications, totalling 274 documents. Notably, 2025 and 2024 reported 66 and 67 publications respectively, compared to only one publication in 2013, indicating a growing research interest in the association between UPFs and cancer (Fig. 4a). Country-wise analysis further showed that the highest number of publications originated from the United States (N = 85), followed by Brazil (N = 55) and France (N = 39), while India (N = 6), Malaysia (N = 2), and South Africa (N = 3) contributed the fewest (Fig. 4b-c). A Scopus search using the keywords "colon cancer" AND "ultraprocessed food" yielded only 13 publications from 2022 onward, reflecting the limited evidence currently available on the association between UPFs and colon cancer (Fig. 5a). Each of the four years examined showed only 3–4 publications, underscoring the scarcity of research explicitly addressing this link. Country-wise analysis revealed that the United States contributed the highest number of publications (N = 6), followed by Brazil (N = 4) and France (N = 3). Several countries, including Greece, Italy, Norway, Denmark, Finland, Germany, Iran, Mexico, Portugal, Spain, and the United Kingdom, produced only a single publication each (Fig. 5b). Overall, these findings indicate that although research connecting UPFs with both general cancer risk and specifically colon cancer remains limited, there is a noticeable upward trend in publication frequency. This highlights the

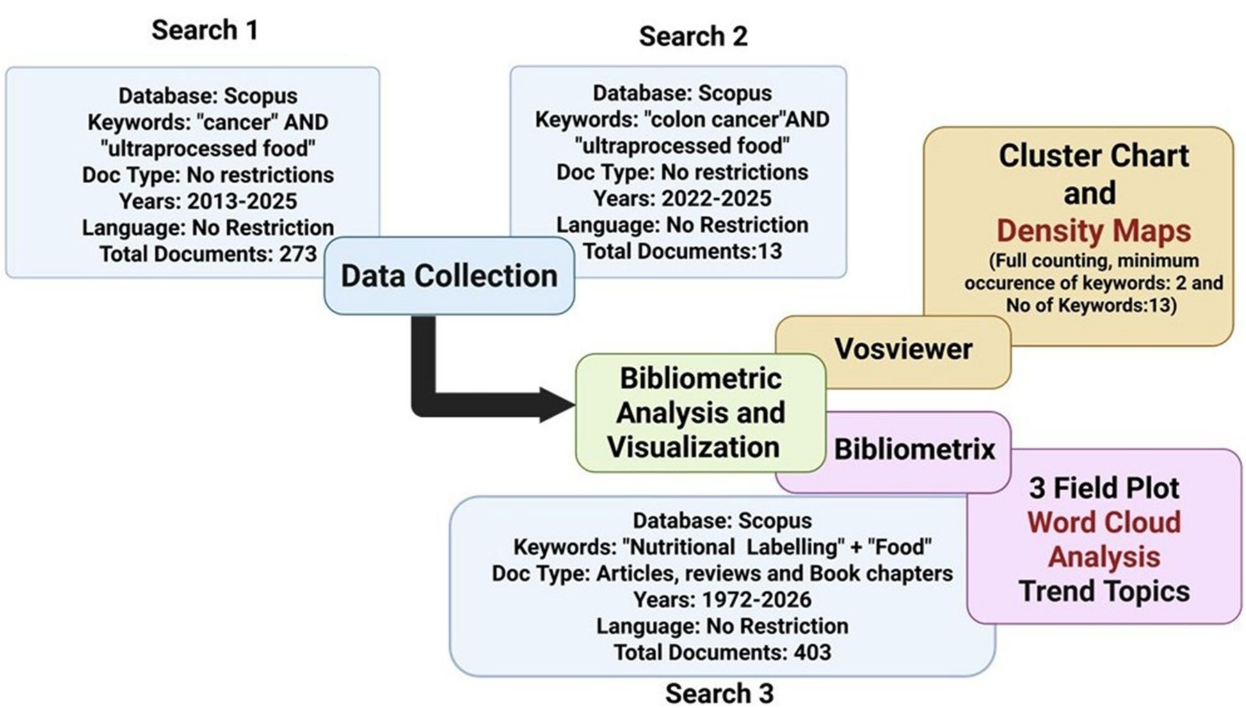


Fig. 3 The detailed flowchart of data collection and bibliometric analysis steps

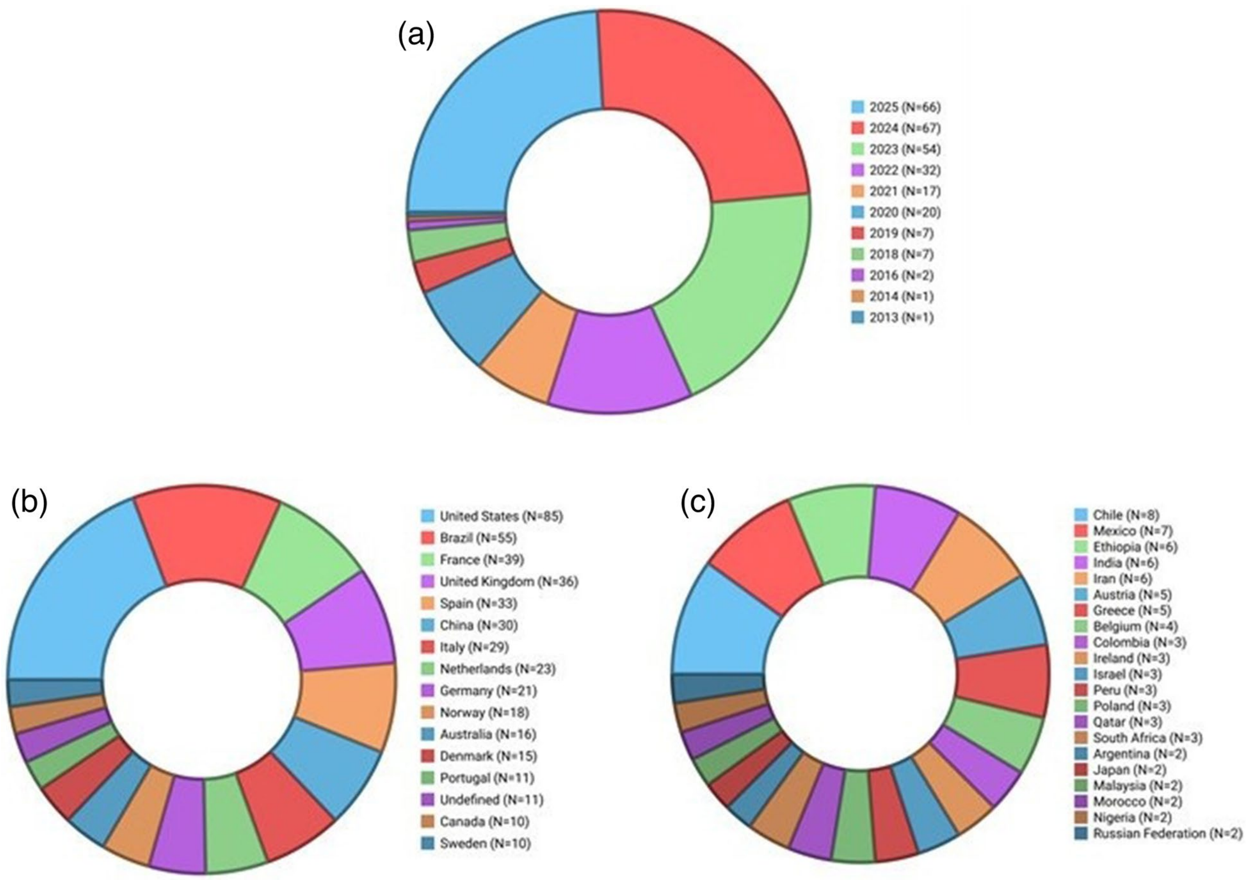


Fig. 4 **a** Year-wise distribution of publications retrieved using the search terms "cancer"+"ultraprocessed food" from 2013–2025; **b** country-wise publication output (countries with ≥ 10 publications) for the same search criteria; and **c** country-wise publication output for countries contributing fewer than 10 but more than 2 publications using Scopus database (accessed on 5 November 2025)

relevance and timeliness of the present Scopus-based analysis and the insights provided in this review.

To ensure that the bibliometric findings can be replicated vosviewer setting for co-occurrence search was selection of all keywords, full counting, minimum occurrence of keyword was 2 for its selection and no of keywords selected was 36 and a cluster-network chart (Fig. 6a), and a density map were drawn (Fig. 6b). A network visualisation map gives the relationship between the frequently occurring keywords and gives us information on how keywords are clustered or interconnected. The larger size nodes indicate more frequently occurring keywords, and thicker connecting lines indicate stronger co-occurrence between two keywords, showing they often appear together in papers (Fig. 6a). The density map indicates the frequency of keyword occurrence. For instance, a keyword with higher density appears more frequently across the analysed publications. The red cluster signifies epidemiological and population Studies with keywords like fast food, processed food, adverse event epidemiology, male, female adult, aged and risk factors, which explore the associated link between UPFs consumption and disease incidences, for example, cancer, obesity, and cardiovascular risks in human-based cohort studies. The green cluster signifies dietary behaviour and gut microbiome research with keywords like ultra-processed foods, plant-based diet, intestine flora, caloric intake, obesity, animal, food intake, which focuses on mechanistic and nutritional studies examining diet composition, gut flora changes, often involving experimental or controlled studies. The blue cluster signifies metabolic and lifestyle factors with keywords like nutrition, lifestyle, cardiovascular disease, and pathophysiology, which focus on the broader context linking dietary lifestyle patterns to metabolic and cardiovascular diseases. Thus, it represents preventive and public health research connecting UPFs to chronic disease burden. The central keywords include diet, human, ultra-processed food, and nutrition, indicating the core research topics that bridge across all three clusters. For example, ultra-processed food and obesity are closely linked, showing a strong research correlation. This review, therefore, fills this gap by offering

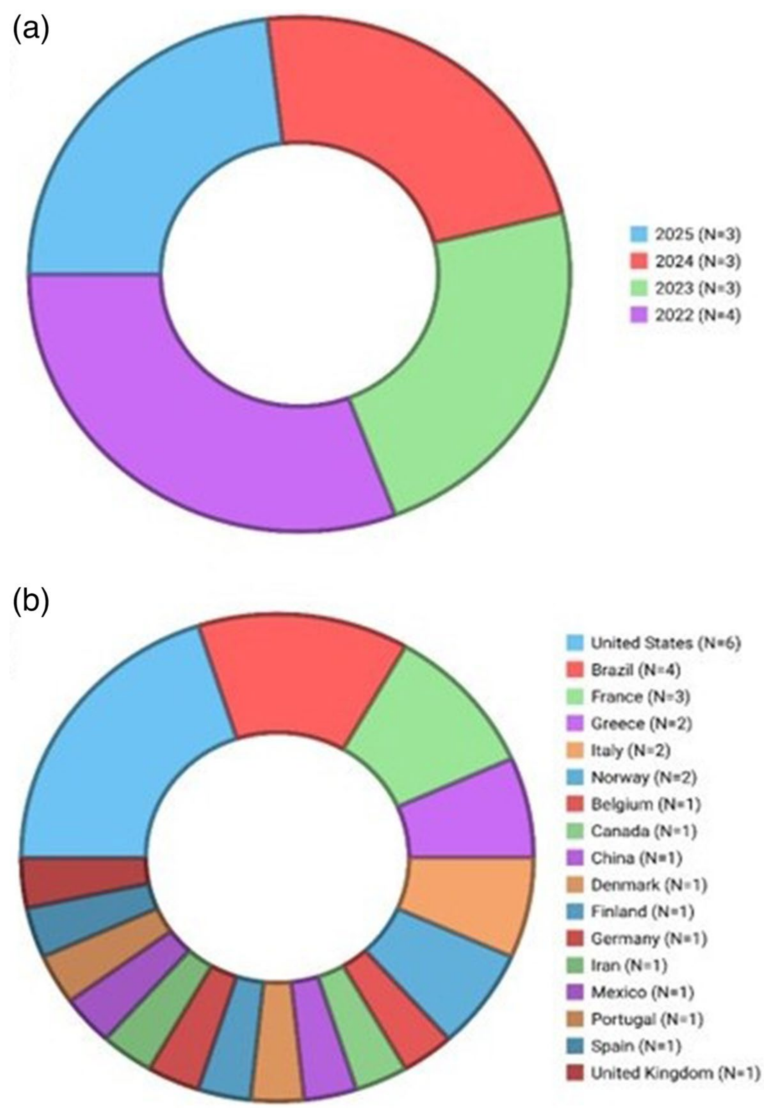


Fig. 5 **a** Year-wise distribution of publications retrieved using the search terms "colon cancer" + "ultraprocessed food" from 2022–2025; **b** country-wise publication output for the same search criteria using Scopus database (accessed on 5 November 2025)

the first bibliometric assessment of emerging insights and links between "UPFs" and "cancer", based on quantitative analyses using tools like VOSviewer. By identifying research hotspots, underexplored regions, and collaboration dynamics, our review provides a strategic overview of this trending topic.

The density visualisation map shows the heat map information. For instance, yellow areas in Fig. 6b, i.e. human, diet, ultra-processed food, adverse events, male and female, are hotspots which indicate keywords that are most studied co-occurring topics and blue areas keywords i.e. pathophysiology, cardiovascular disease, occur less frequently or are less explored areas, suggesting emerging frontiers. in publications. Additionally, Green peripheral regions, i.e. obesity, plant-based diet, and intestinal flora, represent growing subthemes in microbiome and metabolic research, which remains unexplored. Overall, it reveals the epidemiological and dietary risk of UPFs in humans, supporting literature supports which links UPFs consumption to microbiome imbalance, obesity and associated metabolic disorders. Promising areas such as gut microbiota and its link to inflammation, need for dietary transitions for bridging nutritional gaps in public health domains, with mechanistic microbiome research still developing (Fig. 6b).

Similarly, research gap identification by bibliometric analysis using Scopus database (as on 5th Nov 2025) with specific keywords "colon cancer" + "ultra-processed

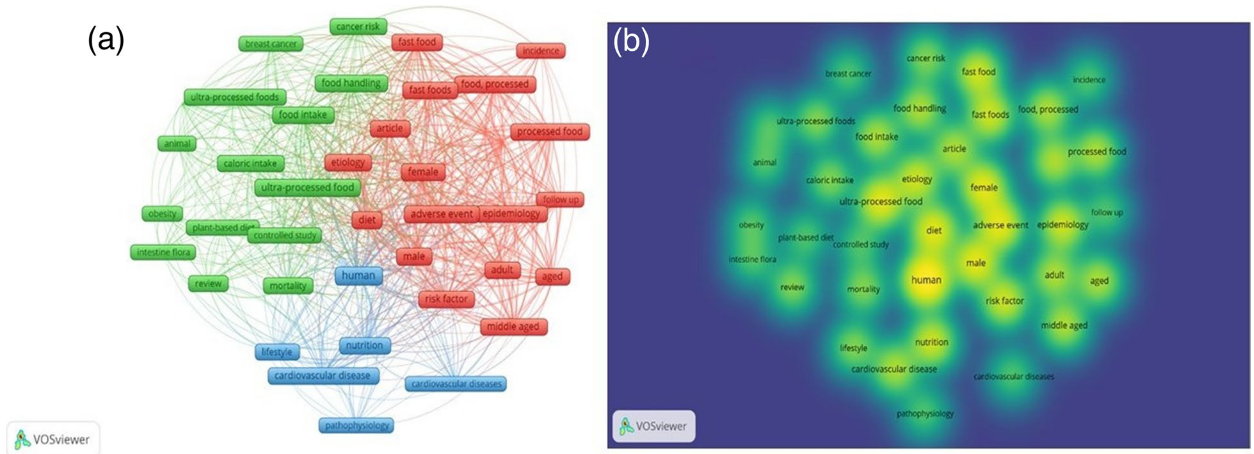


Fig. 6 Visualisation of co-occurrence of keywords for "Ultra-processed food" and "cancer" as **a** Cluster network Chart and **b** Density Chart (Data Source: Scopus, Nov 5th, 2025)

foods" with no additional filters or language restrictions was fed into the VOSviewer tool to generate a cluster-network chart (Fig. 7a) and a density map was drawn (Fig. 7b). The red cluster disease association and dietary risk with keywords like ultra-processed food, colorectal cancer, colon cancer, obesity, human, food intake, caloric intake, which explores the associated link between UPF consumption and cancer outcomes, particularly colorectal and colon cancer. Colon cancer specifically denotes malignancies that arise in the colon, whereas colorectal cancer is a broader term that encompasses cancers occurring in both the colon and the rectum. It also links to obesity and dietary energy intake, indicating studies that link metabolic imbalance from UPFs to cancer risk. The green cluster signifies demographics and epidemiology, with main keywords including male, female, adult, dietary intake, cancer risk, and articles that represent population-based and epidemiological studies that examine factors like age, sex, and diet patterns as influential parameters in cancer risk. These keywords every so often used in cohort and case–control studies exploring demographic risk stratifications (Fig. 7a). Overall, from fig research on ultra-processed foods and colon cancer centres on epidemiological evidence with links between dietary habits, obesity, and caloric intake to colorectal carcinogenesis. Additionally, the term ultra-processed food is powerfully interconnected with human obesity and cancer risk, confirming it to be a key emerging keyword cluster. The density map in Fig. 7b shows that most publications emphasise human-based dietary studies, while mechanistic/microbial links are much less represented.

Microbiome dysbiosis and mechanistic links due to UPF consumption

Dysbiosis is associated with to an unhealthy imbalance of the gut microbiota, characterised by the loss of beneficial microbes, may contribute towards overgrowth

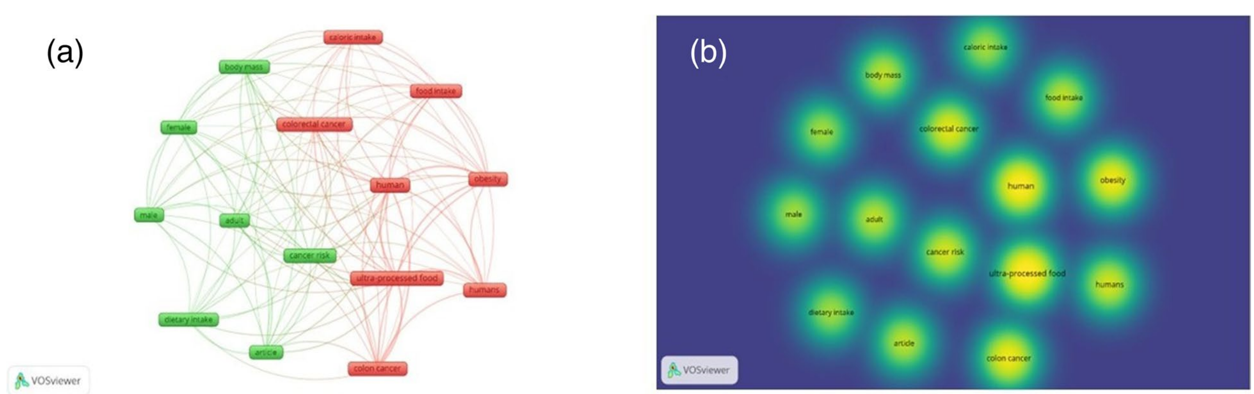


Fig. 7 Visualisation of co-occurrence of keywords for "Ultra-processed food" and "colon cancer" as **a** Cluster network Chart and **b** Density Chart (Data Source: Scopus, Nov 5th 2025)

of opportunistic species, alters the microbial metabolic activity, and impairs immune regulation. The gut, or gastrointestinal (GI) tract, extends from the mouth to the anus; however, most gut microbes reside in the large intestine (colon), with smaller populations inhabiting the ileum of the small intestine. Regular consumption of UPFs rich in refined sugars, unhealthy fats, sodium, and synthetic additives but low in dietary fibres has been strongly been associated to gut microbiome dysbiosis and subsequent impairment of gut function. Dysbiosis may also be exacerbated by factors such as poor diet, overuse of antibiotics, infections, and stress, making individuals more susceptible to disease. The healthy human Gastrointestinal (GI) tract contains beneficial microbes such as *Bifidobacterium, Lactobacillus, and Faecalibacterium prausnitzii.* Studies suggest that, when their populations are disrupted, it creates conditions that favour the growth of opportunistic and pathogenic bacteria, including *Enterobacteriaceae, Clostridium difficile, and Bilophila wadsworthia*, which produce harmful metabolites such as ammonia, hydrogen sulfide (H_2S), phenols, indoles, and altered short-chain fatty acids (Bevilacqua et al., 2024). Thus, microbial imbalance promotes gut inflammation and infections and is further associated with metabolic disorders such as obesity, type 2 diabetes, non-alcoholic fatty liver disease (NAFLD), and colorectal cancer (Sol Grinshpan et al., 2025).

UPFs, which are usually stripped of complex carbohydrates, are typically low in accessible carbohydrates (ACs) and fibres. However, these are the primary energy sources for good microbes to ferment and produce short-chain fatty acids (SCFs) like butyrates, acetates and propionates (Hägele et al., 2025). Additionally, the produced SCFs can help maintain the gut barrier integrity, enhance mucus formation, and upregulate the anti-inflammatory signals, leading to fewer complications. However, UPFs arrival in the colon region of the gut with almost no fibre and accessible carbohydrates can starve the good microbes, making them vulnerable to shift to alternate food sources like amino acids from proteins/host mucus, the protective barrier in the gut. This, eventually leads to effects like mucus thinning, lost gut integrity, inflammation, and ulcer-like damage, thus helping pathogenic bacteria to gain dominance (El-Hussuna et al., 2025). The long-term effect of this cascade reaction is linked to metabolic diseases and may contribute towards cancer.

Furthermore, the high levels of sugars (glucose and sucrose) and saturated fats present in UPFs may contribute towards alteration of gut microbiome by promoting the growth and mucosal encroachment of bile-tolerant, opportunistic pathogens, which in turn increase intestinal inflammation (Berni Canani et al., 2024; Chen et al., 2025). As illustrated in Fig. 8 consumption of UPFs containing food additives such as emulsifiers, artificial

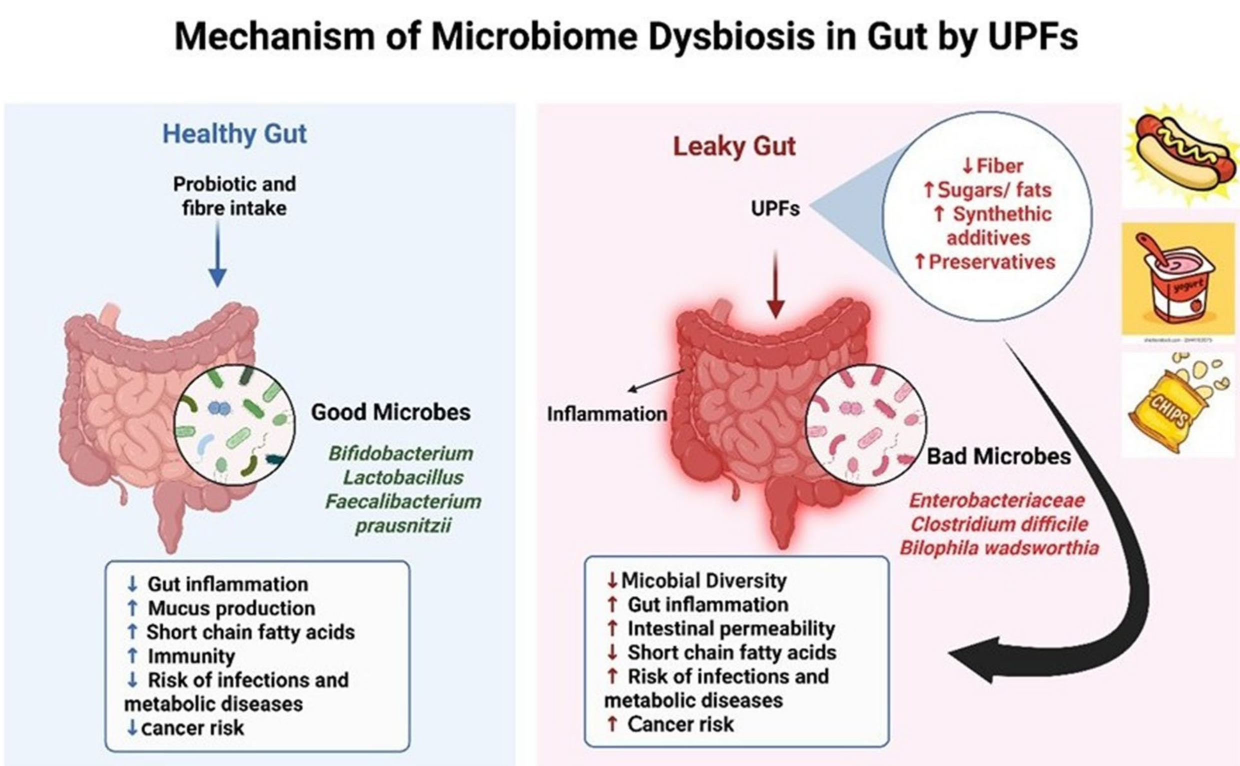


Fig. 8 Mechanistic overview highlighting UPF-driven disturbances in gut microbiota and their contrast with normal gut function

sweeteners, preservatives, and colourants may further contribute towards disruption of microbial balance by reducing beneficial bacterial populations and supporting the expansion of pathogenic strains, ultimately contributing to chronic low-grade inflammatory conditions (Chen et al., 2025). The suggested general mechanism of gut dysbiosis caused by UPFs and its comparison with the healthy gut is depicted in Fig. 8.

UPFs link with inflammatory and oncogenic pathways uncovered

Increased consumption of UPFs has been associated with the activation of inflammatory and oncogenic pathways through multiple biological mechanisms. UPFs rich in refined sugars, saturated and trans fats, artificial additives, emulsifiers, and heat-generated contaminants such as acrylamide and nitrosamines can negatively affect the gut microbiota and compromise gut barrier integrity (Chen et al., 2025). Endotoxins like lipopolysaccharides, bacterial toxins, and dietary or oxidative stress are known to activate the nuclear factor kappa-light-chain enhancer of activated B cells (NF-κB) signalling pathway (Marwarha & Ghribi, 2017). NF-κB, typically present in an inactive state in the cytoplasm, becomes activated under these conditions, leading to increased production of pro-inflammatory cytokines (IL-1β, IL-6, and TNF-α). This promotes chronic low-grade inflammation driven by oxidative stress and elevated levels of reactive oxygen and nitrogen species (ROS and RNS). Activation of NF-κB further triggers the expression of several genes involved in inflammation, uncontrolled cell proliferation, and anti-apoptotic signalling, creating a microenvironment conducive to oncogenesis (Cao et al., 2024). Collectively, these inflammatory conditions can damage DNA, impair DNA repair mechanisms, and promote mutations within cells (Pasqualucci & Klein, 2022). Several studies have also reported an increase in colonic polyp formation, an abnormal tissue growth arising from uncontrolled cell proliferation and enhanced anti-apoptotic signalling, which can progressively advance to colon cancer if left untreated (Hang et al., 2022). Consequently, polyps are widely regarded as precursors to colorectal cancer. This is supported by evidence from a human observational prospective cohort study involving 142,052 participants through evidence derived from human epidemiological studies, all of whom had undergone at least one lower gastrointestinal endoscopy during medical follow-ups (Hang et al., 2022).

Interestingly, increased UPF uptake over the past 2 decades due to changes in dietary patterns has contributed to a sharp increase in colorectal cancer cases in the age of < 50 yrs from middle- and high-income countries. World Health Organisation reports indicate approximately 650 million adults are obese worldwide; this number is projected to exceed 1.1 billion by the year 2030 due to increased intake of UPFs (Ahmed et al., 2024). Synchronously, colon cancer incidence has seen an annual increase of 2–3% in major countries like the United States, Canada, and Australia, indicating the potential link between UPF consumption, obesity, and colon cancer(Tin et al., 2025). Lifestyle factors like reduced physical activity, increased use of antibiotics and increased use of sweetened beverages and increased UPFs consumption due to good mouthfeel and binge eating have shown escalating obesity cases. Human observational study, including LC–MS analysis of 113 samples of potato chips from an Iranian brand between 2016–17 and 2020–21 showed 25.1 ng/g and 31.9 ng/g of acrylamide, respectively, indicating the need to evaluate the risk of these cancer-causing agents (acrylamide) and their presence in other starchy sources (Afsari et al., 2025). It is a known fact that high-temperature cooking of starchy food above 248 F/120 °C produces acrylamide by the Maillard reaction.

Another human observational study identified the presence of acrylamide and heavy metals in Lebanese corn and potato chips in vitro using GC–MS analysis, with levels ranging from 329 to 7310 μg/kg. Notably, the acrylamide concentration in these samples was approximately 3,500 times higher than the permissible limit in drinking water (0.05 μg/kg) (Hariri et al., 2015). Such elevated levels pose a significant health risk to consumers and highlight the need for moderation in the consumption of these products. Moreover, in vitro studies of meat products such as hot dogs in Poland were found to contain nitrites and nitrates at mean concentrations of 60.3 mg/kg and 72.63 mg/kg, respectively. The observational human studies with supported analysis showed that a single daily serving of hot dog in individuals aged 13 years and above exceeded acceptable nitrite and nitrate levels in at least one sample. In contrast, among children aged 1–2 years, more than 19 samples surpassed these limits, highlighting the heightened risk associated with regular hot dog consumption in young children(Jakkielska et al., 2025). Interestingly, in another observational human studies, it was observed that the during the dietary intake of processed meat by medical staff nitrosamine (a carcinogenic compound) concentration was highest in hot dog (159.24 ± 87 μg/g), followed by luncheon meat (18.53 μg/g). However, the least concentration of nitrosamine was seen in sausages and burgers, 2.36 and 2.37 μg/g, respectively, as evidenced by the UV–visible spectroscopic method of nitrosamine estimation (Tayel et al., 2025). Preservatives added in meat under acidic conditions convert into nitroso species (NO^+), which interact with natural amines R_2-NH to form N-nitrosamines ($R_2N\text{-}N=O$), which are carcinogenic compounds(Hussain et al., 2024). These studies thus help us uncover the indirect links between UPFs and possible inflammatory and oncogenic pathways. However, more studies with detailed mechanistic insights and long term impacts are unquestionably required for deducing solid conclusions.

Recent concerns in UPFs' intake with emphasis on research gaps and future directions

UPFs have been shown to elevate inflammatory biomarkers such as C-reactive protein (CRP), IL-6, IL-8, and TNF-α. Emerging evidence also links UPF intake to food addiction, eating disorders (EDs), anxiety, and depression (Ciaffi et al., 2025). Globally, UPF consumption has been associated with a range of adverse mental health outcomes, reflecting a growing concern that these products, often engineered to maximise corporate profits, may undermine public health (Mengist et al., 2025). This suggests the urgent need for a clear definition of UPFs, mandatory front-of-pack warning labels, and stronger regulations on taxation and advertising to curb consumption, aligning these efforts with the objectives of the Fit India movement to enable informed dietary choices. Supporting this concern, a study conducted in Los Angeles involving 304 adults seeking dietary counselling from a mental health nutrition specialist reported a positive correlation between UPF intake, UPF-related addiction, and ED symptoms with post-traumatic stress disorder and adverse childhood experiences (Wiss & LaFata, 2025). A recent review published in BMJ Open in 2024 highlights UPF consumption with ED, food addiction, and body image. It also stresses on limited correctional studies with methodological limitations and the lack of longitudinal studies, indicating the gaps in available literature on UPFs(Pereira et al., 2024). Another cross-sectional study in Turkey emphasised the relationship between night eating, UPF consumption and increased digital addiction in university students. Approximately 2512 students with a mean age of 21 ± 2 were involved in this study, and the data collection included the use of Google Forms shared via email and WhatsApp (Eroğlu et al., 2025).

One more recent article published in the BM Public Health in 2024 tried to map UPFs in India using online grocery retailer scans of food labels from 375 different brands, with at least 3 for each food type, and identified 81 foods to be UPFs. It was shocking to see that some traditional recipes also had UPF ingredients in it indicating the transparency in food labels(Ghosh-Jerath et al., 2024). Therefore, there is a growing need for research focused on the use of natural phytochemicals such as eugenol and allicin derived from natural sources, including cloves, ginger, garlic, and hibiscus as preservatives in UPFs. These compounds possess strong antimicrobial and antioxidant properties and can serve as natural preservatives, offering a safer alternative to synthetic additives (Okpoghono, 2026). In addition, plant-based biopolymers such as chitosan, alginate, and starch may be utilised as coating agents to prevent contamination and enhance product stability (Patel et al., 2024).

Improving consumer awareness of nutrition labels is equally important to support this initiative. Therefore, critical information such as manufacturer details, date of manufacture, batch number, expiry date, and complete nutritional composition should be presented in legible fonts (>6–7 mm) (Cannoosamy et al., 2014). Clear symbols indicating vegetarian, non-vegetarian, and fortified foods (F-symbol) further support transparent labelling(Al-Ma'aitah & Tayyem, 2021). Currently, many manufacturers have started displaying nutrition labels on the back of the product using very small fonts (3–4 mm), meeting only the minimum Food Safety and Standards Authority of India (FSSAI) requirement of 4 mm, which is often difficult for consumers to read and may contribute negatively to overeating (Shobana et al., 2024). In contrast, some food manufacturers have begun adopting to more transparent food labelling. For example, presenting details nutrition label prominently on the front of the product, with additional tables showing ingredient composition, sources, and benefits. Additionally, A pie chart illustrating the percentage breakdown of each ingredient could further enhance consumer understanding, compared with coded information commonly used by other brands. Further, the inclusion of a QR code in food labels further enables the translation of the nutritional information into multiple languages, greatly benefiting individuals who prefer local languages.

Additionally, some food manufacturers have also tried to provide a pamphlet containing a Braille-formatted nutrition label, ensuring accessibility for visually impaired consumers. They also try to perform essential quality tests such as protein content, heavy metal analysis, melamine detection, microbial contamination, pathogen screening, aflatoxin assessment, and pesticide residue testing on every batch, and make the results publicly accessible via a QR code, thereby promoting transparency(Only What's Needed - by Food Pharmer, 2025). In India, under the FSSAI Labelling and Display Regulations, 2020, manufacturers are increasingly required to present accurate and comprehensive food labels. This promising strategy truly shows how powerfully technology can enhance our health choices.

Additionally, the bibliometrix tool used in this review to understand the tree field plot, word cloud analysis and trend topics using Scopus search criteria "nutritional labelling" + "food" restricted to articles, reviews and book chapters and no restriction on language, showed 403 documents (as accessed on 9th Dec 2025). The results are displayed in Figs. 9, 10, and 11 (Aria & Cuccurullo, 2017).

The three-field plot (Sankey diagram) in Fig. 9 illustrates the interconnections between leading research institutions (left field), the primary research themes (middle field), and the journals in which these scientific contributions were published (right field). In the Sankey diagram, thicker flow lines denote stronger linkages, whereas thinner lines represent weaker associations. Notably, Universidad de Chile demonstrated strong involvement, as evidenced by substantial connections from the institutional field to research themes related to obesity, nutritional policy, and food labelling. The analysis further reveals that most institutions contributed to the research theme of national and food labelling, with these studies predominantly published in the journal Nutrients. This trend highlights the journal's broad acceptance of diverse research themes within this domain. Additionally, the comparatively smaller node size for nutrition policy (middle field) underscores an existing research gap and signals substantial scope for future investigations. This gap suggests the need for enhanced focus on transparent labelling practices and increased collaboration with regulatory bodies such as FSSAI to support evidence-based amendments to nutritional policies and ultimately improve public health outcomes.

Additionally, the word cloud analysis generated using the same tool provided a quick visual summary of the most frequently occurring keywords within the selected scientific publications (Fig. 10). Larger words in the cloud indicate higher frequency, with prominent terms such as human, ultraprocessed food, adult, female, diet, and articles. In contrast, terms like colon cancer, systematic review, and child appeared less frequently, as reflected by their smaller size. This observation highlights existing gaps in the literature and underscores the relevance and necessity of the present review. Thus, the smaller words also help in identifying the niche areas or underexplored topics for further researchers. Overall, the word cloud in Fig. 10 serves as a valuable preliminary analytical tool, aiding in the identification of core concepts, dominant topics, and recurring themes within the research landscape.

Interestingly, insights from the Bibliometrix analysis of trending topics over the 17 years from 2008 to 2025 revealed notable shifts in keyword usage (Fig. 11). The size of the node indicates the frequency of occurrence of the keywords for the given search criterion "nutritional labelling" + "food" as per a recent Scopus database search and its subsequent analysis using Bibliometrix tool. Terms such as food labels appeared as early as 2014, while nutritional labels, which first emerged in 2016, began gaining significant momentum by 2018. Keywords including obesity and national policy showed a marked increase in prominence starting in 2021. More recent terms Nutri-Score, consumer, and food choices, began appearing around 2023. The emergence of public health as a dominant keyword in 2025 indicates its relevance as one of the most current and trending topics in this research area (Fig. 11).

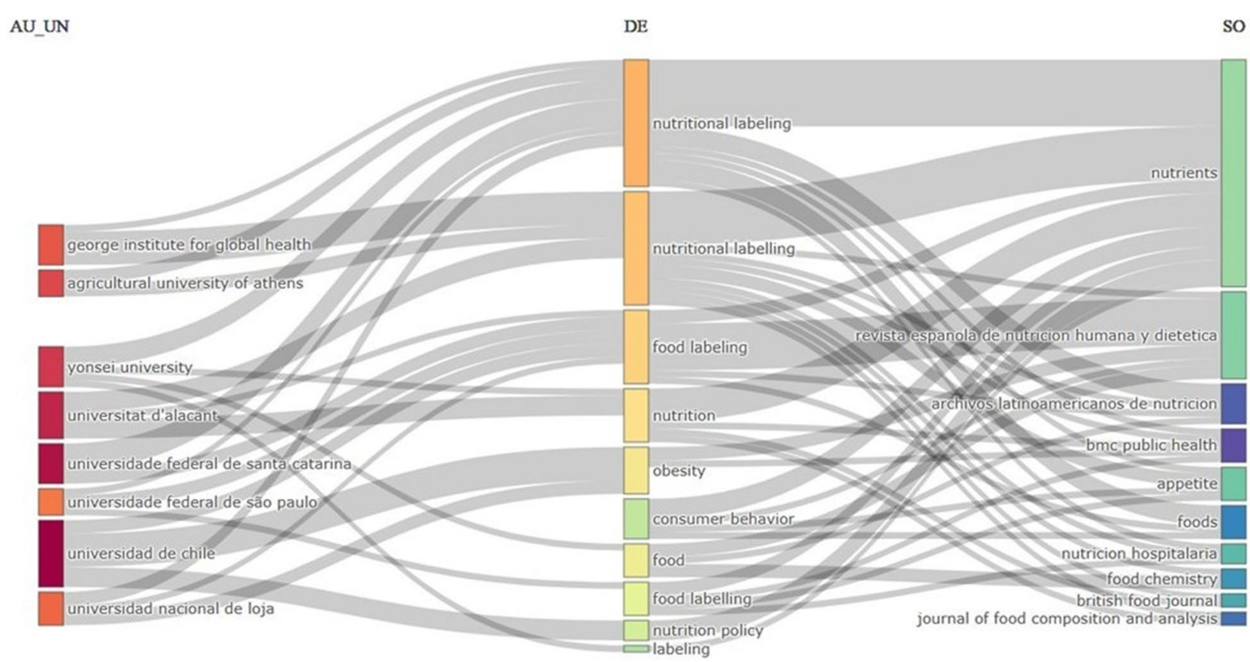


Fig. 9 Three field plot/Sankey diagram showing relationships of affiliation, keyword and journals (Data analysed using Bibliometrix tool)

Fig. 10 Word cloud analysis (Data analysed using Bibliometrix tool)

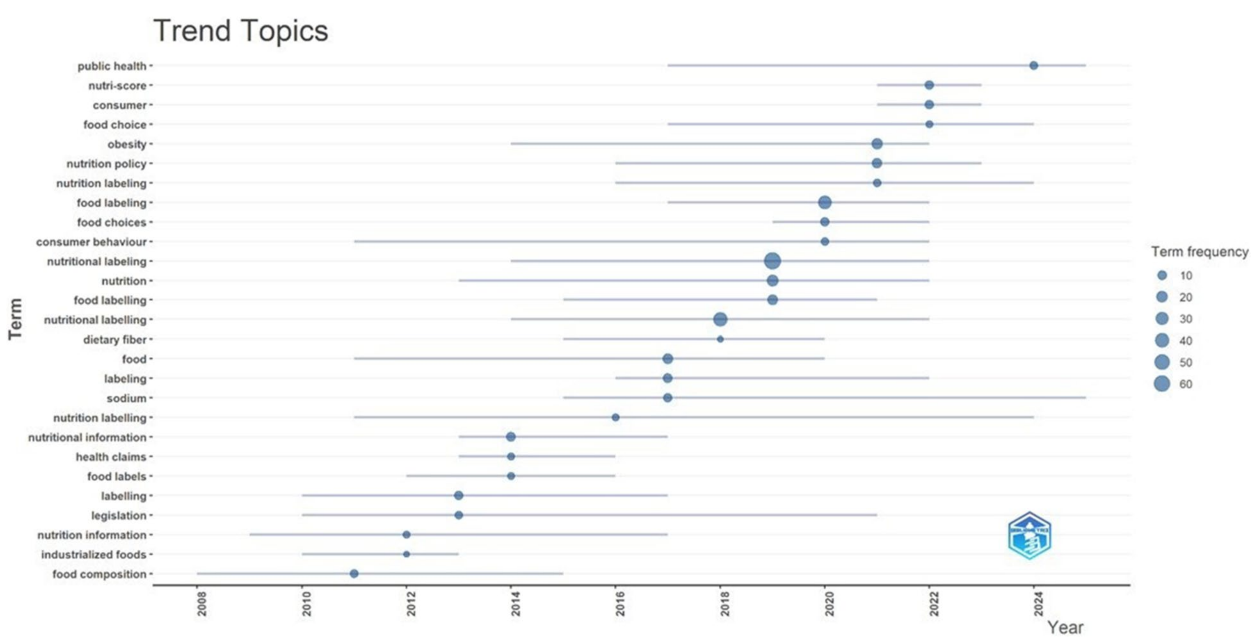


Fig. 11 Trending topics for search criterion "nutritional labelling"+"food" over 17 years (Data from Scopus database analysed using Bibliometrix)

Findings from the present review thus indicate that UPF consumption contributes to low-grade inflammation by altering the gut microbiome, compromising barrier integrity, activating pro-inflammatory signalling pathways, and elevating cytokine production through increased ROS and RNS generation(Quetglas-Llabrés et al., 2023). These changes collectively create a microenvironment that may favour cancer development, which is backed by literature support. Consequently, reducing UPF intake among young people is crucial. This can be achieved through increased awareness, limiting exposure, and implementing stricter regulatory policies/measures that are essential for curbing binge-eating behaviours and promoting healthier conditions during critical developmental periods. Some simple lifestyle and microbiome interventions like reducing intake of UPFs, reducing unnecessary antibiotics usage, which can hamper good microbes in the gut and increasing consumption of whole foods/fermented foods and minimising ready-to-eat foods loaded with preservatives and chemicals, would be of help(Brichacek et al., 2024). Additionally, stricter policies in place, making food labels more transparent and clearer to understand for the public, with bigger fonts, would be of help.

Although there are a few handpicked studies that indicate the cancer risk due to UPFs, there are only a limited number of studies exploring the integration of artificial intelligence and machine learning models for predicting dietary patterns (Al-Remawi et al., 2024). One study conducted on a Dutch population analysed national food consumption survey data using three clustering algorithms: K-means, K-medoids, and hierarchical clustering, with K-means demonstrating the best performance. The study further employed six classifiers, including Naïve Bayes, k-nearest neighbour, decision tree, random forest, support vector machine, and XGBoost, all of which achieved prediction accuracies between 60–68%. The findings indicated that age, BMI, and educational level were the strongest predictors of dietary behaviour, with health-conscious individuals showing higher consumption of fruits, vegetables, nuts, seeds, and breakfast cereals(van Houwelingen & Zhu, 2025). Table 1 gives an overview of different AI approaches used for cancer identification using non-invasive methods.

A general overview of Comprehensive table outlining the studies used in this review along with their major findings and references is presented in Table 2.

Conclusions

It is evident from the present review insights that global surge in UPFs consumption among adolescent and young adult groups have been linked to alarming rise in obesity, associated mental health issues due to body shaming and creates a microenvironment for early onset of cancer by reducing the good bacteria in gut and increasing the count of pathogenic organisms which can lead to inflammation, leaky gut and ultimately cancer if not intervened at early stages. The primary objective of this review is to synthesize evidence on the association between UPFs consumption and cancer risk, which can help inform public health awareness and guide dietary recommendations. The findings may further support clinicians, nutritionists, and policymakers in emphasizing the importance of reducing ultra-processed food intake as part of preventive health strategies. This bibliometric review has uncovered the evolution, collaborative efforts, and emerging frontiers in unravelling the link between ultraprocessed food- gut dysbiosis and colon cancer. Although there are a few handpicked studies that indicate the cancer risk due to UPFs, there are only a limited number of studies exploring the integration of artificial intelligence and machine

Table 1 Overview of different AI approaches used for cancer identification using non-invasive methods

Cancer Type	Sample/sample size (n)	Data	Gut Pathogens Identified by SHAP analysis	Approach	Results	Reference
Colorectal Cancer	Faeces, n = 453	16 s rRNA sequencing	*Fusobacterium Peptostreptococcus Porphyromonas Parvimonas*	Explainable AI and gut microbiome profiling	AUC-ROC: 0.71	(Novielli et al., 2025)
Gastric Cancer	Gastric mucosa, faeces, saliva, tongue coating, tumour tissue	16 s rRNA sequencing	*Veillonella, Fusobacterium, Prevotella* and *Porphyrmonas*	Random forest with LASSO and deep learning	AUC-ROC: 0.88-0.97	(Azhdarimoghaddam et al., 2025)
Colorectal Cancer	Stool Samples	16 s rRNA sequencing	*Fusobactrium and Parvimonas*	Random forest with SHAP analysis	AUC-ROC:0.668 ± 0.016	(Novielli et al., 2024)
Colorectal Cancer	Stool samples n = 1181	16 s rRNA sequencing	*Fusobacterium nucleatum, Poryphyromonas gingivalis*	Random forest with SHAP analysis	AUC-ROC: 0.82–0.90	(Tsai et al., 2025)
Colorectal Cancer	n = 1291	16 s rRNA sequencing with metagenomics	*Ruminococcaceae* and *Clostridium leptum*	Deep CRC model	AUC-ROC:0.982	(H. Wang et al., 2024a)

Lasso least absolute shrinkage and selection operator, *SHAP* SHapley Additive exPlanations, *AUC-ROC* Area under the Receiver Operating Characteristic Curve, *16 s rRNA* 16 Svedberg ribosomal Ribonucleic Acid

Table 2 Comprehensive table outlining the studies used in this review along with their major findings and references

General UPFs/Specific UPFs	Key findings	Reference
Potato chips	1. Source related hazard quotient was 6 times higher in adults and 5 times higher in children's	
	2. Emphasizes the need for a comprehensive risk evaluation that considers multiple sources of acrylamide exposure from fried chips	(Afsari et al., 2025)
Processed food products (PFPs)	Nutritional impact and bioavailability depend not only on composition but on the food matrix and processing	(Aguilera, 2025)
UPFs	Adverse effects of UPFs include addiction-like eating behaviours, increased risks for chronic diseases like cardiovascular disease, cancer, and metabolic disorders in humans	(Ahmed et al., 2024)
Processed food products (PFPs)	Potential health risks of flavour enhancers (diacetyl) and synthetic colours (Ponceau 4R) on lung health in animal models	(Aldabayan, 2025)
Artificial sweeteners in UPFs	Emphasizes the need for an evidence-based evaluation of artificial sweeteners in diabetes management, considering type of sweetener, dosage, and long-term impacts	(Al-Ma'aitah & Tayyem, 2021)
UPFs	Higher consumption of UPF positively associated with the increased risk of kidney stone in middle aged humans	(Bai et al., 2025)
UPFs	Exposure to UPFs and common ingredients in UPFs seem to be associated with increased occurrence of allergic diseases (asthma, wheezing, food allergies, atopic dermatitis, and allergic rhinitis) in children's	(Berni Canani et al., 2024)
UPFs	Higher consumption of UPF was associated with body mass index gain and higher risks of overweight and obesity in French population	(Beslay et al., 2020)
Food additives in UPFs	Ultra-processed food additives (e.g., sweeteners, emulsifiers, preservatives) can alter gut microbiota composition, potentially disrupting eubiosis and contributing to adverse health outcomes	(Bevilacqua et al., 2024)
UPFs	UPFs and its negative impact on human gut microbiome and health	(Brichacek et al., 2024)
UPFs	The presence of Acrylamide in certain UPFs and its potential to inflict serious harm on the human gut microbiota and brain	(Cai et al., 2025)
Plant-based meat (PBM) products	Concerns regarding the potential health impacts of advanced processing techniques on cardiovascular diseases	(Chaimati et al., 2025)
UPFs	1. Substantial influence on the modern diet owing to their affordability and extensive availability	(Chen et al., 2025)
	2. Increased intake of UPFs and the occurrence of gastrointestinal disorders	
UPFs	Higher UPF consumption is frequently associated with elevated systemic inflammatory biomarkers (CRP/hs-CRP) across adults	(Ciaffi et al., 2025)
UPFs	Studies demonstrate positive associations between UPF intake, weight gain, and overweight/obesity in adults than in children/adolescents	(Dicken & Batterham, 2024)
UPFs	Explained the relationship between digital addiction, night eating syndrome and ultra-processed food consumptions in university students of Turkey	(Eroğlu et al., 2025)
UPFs	1. May promote early-onset cancers via endocrine disruption, inflammation, microbiome imbalance, and epigenetic changes	
	2. High exposure to bisphenols and phthalates migrating from food packaging during vulnerable developmental periods may increase the risk of diseases later in life	(Fajkić et al., 2025)
UPFs	1. A range of packaged traditional recipes were also found to have UPF ingredients	(Ghosh-Jerath et al., 2024)
	2. UPFs are associated with diet-related non-communicable diseases (NCDs)	
Protein-enriched ultra-processed foods (UPFs)	1. High protein low carbohydrate ultraprocessed food (HPLC-UPF) are slightly better than normal processed foods	(Hägele et al., 2025)
	2. HPLC-UPF do not stop overeating in participants but lead to less energy intake in comparison with UPFs	

Table 2 (continued)

General UPFs/Specific UPFs	Key findings	Reference
UPFs	Higher consumption of UPFs is associated with an increased risk of colorectal cancer precursors (conventional adenomas and serrated lesions) in patients during 18–20 years of follow-up	(Hang et al., 2022)
UPFs	1. Acrylamide content in Lebanese potato/corn chips ranged from 329 to 7310 µg/kg which it was 3500-fold higher than its permissible limit in drinking water	
	2. Acrylamide intake poses a significant carcinogenic risk but no neurotoxic risk	(Hariri et al., 2015)
	3. Highlights the need for epidemiological studies in future to monitored the levels of acrylamide in food products	
Processed Meat products	1. Carcinogenic compounds (heterocyclic amines, polycyclic aromatic hydrocarbons, and N-nitroso compounds) are formed during meat processing	(Hussain et al., 2024)
	2. Use of natural antioxidants could help in inhibiting the formation of carcinogens during processing without compromising taste or nutritional value	
Hot Dog	1. Preservatives (Nitrites and nitrates) can pose serious health risks to humans	(Jakkielska et al., 2025)
	2. Regular consumption of 1 hot dog/day could pose health risk to young children (1–2 Yrs)	
UPFs	Lab Studies confirmed the mechanistic insights of UPFs and its potential for cancer risk using distinct serum metabolic profiles and differences in gut microbial composition	(Li, 2025)
UPFs	1. Future work should refine classification systems to combine processing level with nutritional quality	(Louie, 2025)
	2. Enabling smarter public health guidance instead of broadly excluding all UPFs	
Food Preservatives in UPFs	1. Review synthesizes recent clinical, epidemiological, mechanistic, and toxicological data to examine the potential link between synthetic food preservatives and early onset of colorectal cancer (EOCRC)	(Mafe & Büsselberg, 2025)
	2. Natural preservatives may offer a safer option in mitigating EOCRC risk	
		(Martín Pérez & Martín Pérez, 2025)
UPFs	Public education campaigns and improving transparency through labels serve as important step towards minimizing cancer risk due to UPFs	
UPFs	Adults with fibromyalgia exhibit a pro-inflammatory diet marked by high UPF intake and low protective nutrients	(Menegassi & Vinciguerra, 2025)
UPFs	As per a prospective study with 11,192 participants, A higher level of UPF consumption was associated with a higher risk of depressive symptoms and adversely affected mental health among older adults	(Mengist et al., 2025)
UPFs	1.During pregnancy, high UPF consumption is associated with gestational diabetes, hypertension, and adverse birth outcomes, increasing long-term metabolic risks in offspring	(Mottis et al., 2025)
	2. In early childhood, poor nutrition (linked to UPFs) can impair cognitive development and overall health	
UPFs	Ultra-processed foods (UPF) consumption among children and adolescents in the United States has become a critical public health concern	(Moura & Carvalho, 2025)
UPFs	1.UPFs consumption contributes to systemic inflammation and gut dysbiosis	
	2. A 10% increase in UPF consumption is associated with a 12% rise in cardiovascular and cancer risk	(Oyewole Babalola, 2025)
UPFs	Participants with higher intake of UPFs showed higher biomarkers (xanthine oxidase, tumor necrosis factor α (TNFα), interleukin (IL)–6, IL-15, and leptin levels)	(Quetglas-Llabrés et al., 2023)

Table 2 (continued)

General UPFs/Specific UPFs	Key findings	Reference
UPFs	1. UPFs disrupt gut health by reducing beneficial microbes, increases pro-inflammatory bacteria, and promotesg gut dysbiosis and permeability	
	2. Gut alterations drive chronic inflammation, contributing to metabolic, gastrointestinal, and even mental health disorders	(Rondinella et al., 2025)
Added Flavours in UPFs	1. Added flavour does not always increase intake but may enhance consumption of otherwise low flavour foods	(Schmid et al., 2025)
Food additives in UPFs	Food additives (emulsifiers, flavouring agents, and colorants) are linked to anxiety-like behavior, hyperactivity, and impaired social behavior through disruption of brain chemical signalling and the gut–brain axis	(See & Asfeen, 2025)
UPFs	1. UPF consumption is driven by affordability, convenience, despite awareness of their poor nutritional benefits	(Shannon & Avery, 2025)
	2. Marketing and media significantly influence perceptions, often creating confusion about the healthiness and classification of UPFs	
UPFs	Common additives in UPFs have been associated with allergic reactions, intolerances, and sensitivities	(Urrutia-Pereira et al., 2025)
UPFs	The prevalence of UPFs among newly launched products in America	(Vatavuk-Serrati et al., 2025)
UPFs	UPFs consumption and addiction partly explain how adverse childhood experiences contribute to eating disorders, highlighting a gap in trauma-informed care	(Whelan et al., 2024; Wiss & LaFata, 2025)

learning models for predicting dietary patterns. The Bibliometrix review insights point to several important gaps and a lack of prospective studies. There is a clear need for more transparent food labelling practices by companies through increased collaborations. Additionally, food regulatory agencies are also crucial to support evidence-based policy amendments for transparent national labels, thus improving public health outcomes. Therefore, future research integrating AI for the early detection of binge eating of UPFs and early prognosis of related colon cancer risks holds significant potential for reducing UPF consumption and improving public health outcomes.

Acknowledgements
The authors acknowledge Biorender.com for providing icons for images and the Bibliometrix tool for helping us carry out systematic bibliometric analysis. The authors utilised ChatGPT for grammar checking and sentence refinement for the preparation of this article. Following the usage of the tool, the contents were carefully reviewed and modified. They assume complete accountability for the final contents of this manuscript.

Declaration of generative AI and AI-assisted tools in writing
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Authors' contributions
Sneha Nayak: Writing – Conceptualisation, original draft, Investigation, Formal analysis, Data curation, Visualisation. review & editing, Arif Hussain -review & editing, Supervision.

Funding
Open access funding provided by Manipal Academy of Higher Education, Manipal This research received no external or internal funding.

Data availability
Data will be made available on request.

Declarations

Ethics approval and consent to participate
Ethics declaration not applicable.

Consent for publication
All authors agreed to submit this manuscript to this journal for publication.

Competing interests
The authors declare no competing interests.

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Received: 27 January 2026 Accepted: 4 June 2026
Published online: 12 August 2026

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