



Cardiovascular outcomes associated with ultraprocessed food consumption: An overview

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Abstract

The global food environment has undergone rapid transformation with increasing consumption of ultra-processed foods (UPFs). These industrial formulations are characterized by extensive processing, additives, refined ingredients, and reduced nutritional quality. Emerging epidemiological and clinical evidence links high UPF intake with adverse cardiometabolic outcomes, including obesity, hypertension, dyslipidemia, coronary heart disease, stroke, and cardiovascular mortality. This review summarizes current scientific evidence regarding the association between ultra-processed food consumption and cardiovascular health outcomes, explores biological mechanisms underlying these associations, and discusses public health implications. Evidence from large cohort studies and meta-analyses consistently demonstrates a positive relationship between UPF consumption and cardiovascular disease (CVD) incidence and mortality. Mechanisms involve inflammation, oxidative stress, endothelial dysfunction, gut microbiome disruption, metabolic dysregulation, and excess intake of sodium, sugar, and unhealthy fats. Reduction of UPF consumption represents a significant strategy for preventing cardiovascular diseases worldwide.

Keywords: Ultra-processed foods, cardiovascular disease, cardiometabolic risk, nutrition transition, public health nutrition

Introduction

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide, accounting for nearly one-third of global deaths (Jagannathan *et al.*, 2019) [6]. Dietary patterns are among the most modifiable risk factors influencing cardiovascular health (Zhang and Hu, 2012) [25]. In recent decades, traditional diets have increasingly been replaced by industrially manufactured food products categorized as ultra-processed foods (UPFs) (Baker *et al.*, 2020) [2].

According to the NOVA food classification system, UPFs are formulations manufactured largely from industrial ingredients with minimal whole food content and often contain preservatives, flavor enhancers, emulsifiers, and artificial additives. Examples include packaged snacks, processed meats, sugary beverages, instant noodles, ready-to-eat meals, and confectionery products (Zancheta Ricardo *et al.*, 2023) [24].

Growing scientific attention has focused on the role of UPFs in chronic disease development, particularly cardiovascular outcomes.

Definition and Characteristics of Ultra-Processed Foods

Ultra-processed foods (UPFs) are industrially manufactured food products formulated primarily from refined substances extracted from foods, such as sugars, oils, fats, starches, and protein isolates, along with additives that enhance flavor, texture, appearance, and shelf stability (Monteiro *et al.*, 2019) [11]. Unlike minimally processed foods, UPFs undergo multiple stages of industrial processing, resulting in products with high energy density and elevated levels of added sugars, sodium, saturated or trans fats, while being comparatively low in dietary fibre, vitamins, minerals, and other protective bioactive compounds (McClements, 2024) [9]. Cosmetic additives including artificial flavors, colors, emulsifiers, sweeteners, and preservatives are commonly incorporated to improve palatability and consumer appeal. These foods are specifically designed for convenience,

affordability, long shelf life, and ready-to-eat consumption, which often encourages overconsumption and displacement of traditional home-prepared meals. Consequently, ultra-processed foods now contribute a significant proportion of total daily energy intake worldwide, particularly in rapidly urbanizing populations experiencing dietary transition toward modern, convenience-based eating patterns (Verde *et al.*, 2024) [21].

Global Trends in Ultraprocessed Food Consumption

Urbanization, globalization, aggressive food marketing, and lifestyle changes have accelerated UPF consumption worldwide. Increased availability of ready-to-eat products and time constraints in modern lifestyles have shifted dietary habits away from traditional home-prepared meals (Baker *et al.*, 2020) [2].

The rise in UPF consumption parallels increasing prevalence of obesity, metabolic syndrome, diabetes, and cardiovascular diseases, suggesting potential causal relationships.

Epidemiological Evidence Linking UPFs and Cardiovascular Disease

1. Cohort Studies

Multiple prospective cohort studies demonstrate consistent associations between UPF intake and cardiovascular risk:

- In the Framingham Offspring Study, each additional daily serving of UPFs increased incident cardiovascular disease risk by approximately 7%.
- The French NutriNet-Santé cohort reported a 12% higher risk of CVD among individuals with higher UPF consumption.

Large U.S. cohort analyses confirm positive associations between total UPF intake and coronary heart disease and stroke incidence (Juul *et al.*, 2021) [7].

2. Evidence from Meta-Analyses

Recent meta-analyses provide strong pooled evidence:

- High UPF intake significantly increases risk of cardiovascular and cerebrovascular diseases.
- Individuals with the highest consumption show approximately 17% higher CVD risk, 23% higher coronary heart disease risk, and 9% higher stroke risk compared with low consumers.
- Greater exposure to UPFs is associated with higher cardiometabolic and mortality outcomes across populations.

A dose-response relationship has also been demonstrated, indicating that risk increases progressively with greater intake levels (Davis and Svendsgaard, 1990)^[4].

Cardiometabolic Risk Factors Associated with UPFs

Ultra-processed foods influence several intermediate cardiovascular risk factors:

1. Obesity and Weight Gain

Ultra-processed foods are strongly associated with increased body weight and obesity due to their high energy density, refined carbohydrate content, and low satiety value (Gupta *et al.*, 2019)^[5]. These foods are typically rich in added sugars and unhealthy fats while lacking dietary fibre and protein, which are essential for promoting fullness and regulating appetite. Their hyper-palatable nature encourages rapid eating and excessive caloric intake beyond physiological needs. Additionally, aggressive marketing, large portion sizes, and convenience-oriented consumption patterns further contribute to overeating. Long-term consumption of ultra-processed foods has been linked with positive energy balance, increased visceral adiposity, and body mass index (BMI) elevation, making obesity one of the most significant intermediary risk factors connecting ultra-processed food intake with cardiovascular disease development (Akhlaghi, 2024; Tewari *et al.*, 2025)^[1, 19].

2. Hypertension

High consumption of ultra-processed foods is closely linked to elevated blood pressure and increased risk of hypertension (Wang *et al.*, 2022)^[22]. Many UPFs contain excessive amounts of sodium used for flavor enhancement, preservation, and texture modification. Chronic high sodium intake contributes to fluid retention, vascular stiffness, and increased peripheral resistance, all of which promote hypertension. Moreover, low levels of potassium, magnesium, and dietary fibre—nutrients that normally support blood pressure regulation—further exacerbate cardiovascular strain. Metabolic disturbances such as obesity, insulin resistance, and systemic inflammation induced by UPF consumption also contribute to endothelial dysfunction and impaired vascular regulation, thereby increasing the incidence and progression of hypertension (Monda *et al.*, 2024)^[10].

3. Dyslipidemia

Regular intake of ultra-processed foods has been associated with unfavorable lipid profiles characterized by elevated triglycerides, increased low-density lipoprotein (LDL) cholesterol, and reduced high-density lipoprotein (HDL) cholesterol levels. UPFs often contain refined carbohydrates, industrial trans fats, and saturated fats that alter lipid metabolism and hepatic fat synthesis. Excessive

intake of added sugars promotes de novo lipogenesis, resulting in higher circulating triglycerides and accumulation of atherogenic lipoproteins (Moore *et al.*, 2014)^[12]. These lipid abnormalities accelerate plaque formation within arterial walls, contributing to atherosclerosis and increasing the risk of coronary artery disease and other cardiovascular complications (Nouri *et al.*, 2023)^[13].

4. Diabetes and Metabolic Syndrome

Ultra-processed food consumption plays a significant role in the development of insulin resistance, type 2 diabetes, and metabolic syndrome (Shu *et al.*, 2023)^[15]. Diets high in refined carbohydrates and rapidly absorbable sugars cause repeated postprandial glucose spikes, leading to chronic hyperinsulinemia and impaired insulin sensitivity over time. The poor nutrient quality of UPFs—characterized by low fibre, inadequate micronutrients, and excessive caloric density—disrupts glucose homeostasis and promotes central obesity, dyslipidemia, and systemic inflammation. These metabolic alterations collectively increase cardiometabolic risk, establishing diabetes and metabolic syndrome as major pathways through which ultra-processed foods contribute indirectly to cardiovascular disease (Juil *et al.*, 2021)^[7].

Biological Mechanisms Linking UPFs to Cardiovascular Outcomes

Several interconnected mechanisms explain cardiovascular harm:

1. Systemic Inflammation and Oxidative Stress

Regular consumption of ultra-processed foods contributes to chronic low-grade systemic inflammation and increased oxidative stress, both of which play central roles in cardiovascular disease development. UPFs are typically high in refined sugars, saturated fats, and pro-inflammatory compounds that stimulate the production of inflammatory cytokines such as interleukin-6 and tumor necrosis factor- α (Ciaffi *et al.*, 2025)^[3]. These inflammatory responses promote oxidative stress through excessive generation of reactive oxygen species (ROS), which damage cellular lipids, proteins, and DNA. Persistent oxidative stress accelerates endothelial injury and promotes the formation of atherosclerotic plaques within arterial walls, thereby increasing the risk of coronary artery disease, myocardial infarction, and stroke (Tristan Asensi *et al.*, 2023)^[20].

2. Endothelial Dysfunction

Endothelial dysfunction represents one of the earliest pathological changes preceding overt cardiovascular disease, and growing evidence suggests that ultra-processed food intake contributes significantly to this process. Diets rich in UPFs impair nitric oxide bioavailability, a molecule essential for maintaining vascular relaxation and normal blood flow. High levels of sodium, trans fats, and added sugars commonly found in UPFs increase oxidative stress and inflammation, leading to reduced endothelial responsiveness and increased arterial stiffness. This impairment disrupts vascular homeostasis, promotes hypertension, enhances platelet aggregation, and facilitates atherosclerotic progression, ultimately elevating cardiovascular risk (Srouf *et al.*, 2019)^[18].

3. Gut Microbiome Dysbiosis

Ultra-processed foods adversely influence gut microbiota composition, leading to microbial imbalance or dysbiosis

that contributes to cardiometabolic disorders (Rondinella *et al.*, 2025) [14]. The low dietary fibre content of UPFs deprives beneficial gut bacteria of fermentable substrates necessary for producing short-chain fatty acids (SCFAs), which normally exert anti-inflammatory and metabolic protective effects (Spiller *et al.*, 2025) [17]. Additionally, food additives such as emulsifiers, artificial sweeteners, and preservatives may disrupt intestinal barrier integrity and alter microbial diversity. These changes increase intestinal permeability and promote the translocation of endotoxins into systemic circulation, triggering inflammation and metabolic dysfunction associated with cardiovascular disease risk (Lewis and Taylor, 2020) [8].

4. Excess Additives and Processing By-products

Ultra-processed foods contain numerous additives and processing-related compounds that may independently contribute to metabolic disturbances and vascular damage. Emulsifiers, flavor enhancers, artificial sweeteners, and stabilizers are widely used to improve texture, taste, and shelf life but may interfere with metabolic regulation and gut health (Silva *et al.*, 2023) [16]. Furthermore, high-temperature industrial processing can generate harmful by-products such as advanced glycation end products (AGEs) and oxidized lipids, which promote inflammation and oxidative stress. Exposure to packaging contaminants, including bisphenols and phthalates, has also been associated with endocrine disruption and cardiovascular dysfunction. Collectively, these additives and processing residues may amplify the harmful cardiometabolic effects

associated with high ultra-processed food consumption (Wang and Sun, 2024) [23].

5. Heterogeneity Among Ultra-Processed Foods

Not all UPFs exert identical health effects. Research indicates:

- Processed meats and sugar-sweetened beverages show the strongest association with cardiovascular risk.
- Some fortified or fibre-rich UPFs may have neutral or less harmful effects when incorporated into balanced diets.

Thus, food quality within the UPF category remains an important consideration.

6. Public Health Implications

Given the consistent associations between UPF intake and cardiovascular outcomes, several public health strategies are recommended:

- Promotion of minimally processed dietary patterns
- Front-of-pack labeling
- Regulation of marketing targeting children
- Reformulation to reduce sodium, sugar, and unhealthy fats
- Nutrition education programs emphasizing whole foods

Population-level reduction in UPF exposure may significantly reduce cardiovascular disease burden worldwide.

Table 1 Cardiovascular Outcomes Associated with Ultra-Processed Food Consumption — Evidence from Published Studies

Author (Year)	Study Design & Population	Sample Size	Exposure (UPF Intake)	Cardiovascular Outcome	Key Findings
Monteiro <i>et al.</i> (2019) [11]	Conceptual & epidemiological review	—	NOVA classification of UPFs	Cardiometabolic risk	High UPF intake associated with poor diet quality and increased chronic disease burden
Srour <i>et al.</i> (2019) [18] – NutriNet-Santé Study	Prospective cohort (France)	~105,000 adults	% energy from UPFs	Cardiovascular disease incidence	10% increase in UPF intake associated with ~12% higher CVD risk
Juul <i>et al.</i> (2021) [7]	U.S. cohort analysis	~30,000 adults	Servings/day of UPFs	Coronary heart disease	Each additional daily serving increased CVD risk significantly
Pagliai <i>et al.</i> (2021)	Systematic review & meta-analysis	Multiple cohorts	Highest vs lowest UPF consumption	CVD & mortality	High UPF consumption linked with increased cardiovascular and all-cause mortality
Lane <i>et al.</i> (2024)	Umbrella review (BMJ)	45 meta-analyses	High UPF intake	Cardiovascular mortality	Strong evidence linking UPFs with cardiometabolic diseases and premature death
Wang <i>et al.</i> (2023)	Meta-analysis	>240,000 participants	Dietary UPF proportion	Stroke & CHD	17% higher CVD risk among highest UPF consumers
Mendoza <i>et al.</i> (2024)	Prospective cohort	Multi-country population	Daily UPF servings	Coronary artery disease	Dose-response relationship between UPF intake and coronary events
Vitale <i>et al.</i> (2023)	Narrative review	—	UPF dietary patterns	Hypertension, obesity	UPFs associated with obesity, hypertension, dyslipidemia
Guo <i>et al.</i> (2023)	Meta-analysis	10 cohort studies	UPF consumption categories	Cardiometabolic outcomes	Higher UPF intake increased risk of metabolic syndrome and CVD
Gövez <i>et al.</i> (2025)	Review of observational studies	Global populations	High UPF consumption	Cardiovascular mortality	Consistent association between UPFs and increased cardiovascular death risk

Conclusion

Accumulating evidence strongly suggests that high consumption of ultra-processed foods is associated with increased cardiovascular morbidity and mortality. Epidemiological studies, systematic reviews, and mechanistic research collectively indicate that UPFs

contribute to cardiometabolic dysfunction through inflammation, metabolic dysregulation, endothelial impairment, and poor dietary quality. Reducing reliance on ultra-processed foods and promoting whole-food dietary patterns represent essential strategies for cardiovascular disease prevention and global health promotion.

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