

## THE IMPACT OF ULTRA-PROCESSED FOODS ON HUMAN HEALTH: A REVIEW OF DISEASE-SPECIFIC RISKS

**Komal Bela**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Muhammad Tayyab Waqas**

*Punjab Food Authority, Punjab, Pakistan*

**Sabiha Abbas**

*Department of Food Science and Technology, Riphah College of Rehabilitation and Allied Health Sciences, Sahiwal, Pakistan.*

**Mahtab Ahmad Khan**

*Punjab Food Authority, Punjab, Pakistan*

**Rai Muhammad Amir**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Hasnain Khan**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Kinza Amjad**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Anam Sagheer**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Sana Naz**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Abdus Samee\***

*\*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

*\*[abdussamee68@gmail.com](mailto:abdussamee68@gmail.com)*

**Fareeha Anwar**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Ayesha Zainab**

*Institute of Food and Nutritional Sciences, PMAS Arid Agriculture University Rawalpindi, Punjab*

**Irsa Imtiaz**

*Department of Human nutrition and Environmental Design Allama Iqbal Open University, Islamabad*

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Corresponding E-mails &

Authors\*:

Abdus Samee\*

\*[abdussamee68@gmail.com](mailto:abdussamee68@gmail.com)

**Abstract**

Ultra processed food is those that are more flavorful with good texture and is the least expensive food. There are many components which are added during the processing time to enhance their flavors, texture and odor such as additives, emulsifiers, preservatives and microparticle during different processing techniques. The widespread availability and marketing of ultra processed food have led to significant consumption of ultra processed food mostly in urban population and low- and middle-income countries undergoing nutrition transition. Ultra processed foods are energy dense food that contain high number of salts, sodium and fats with

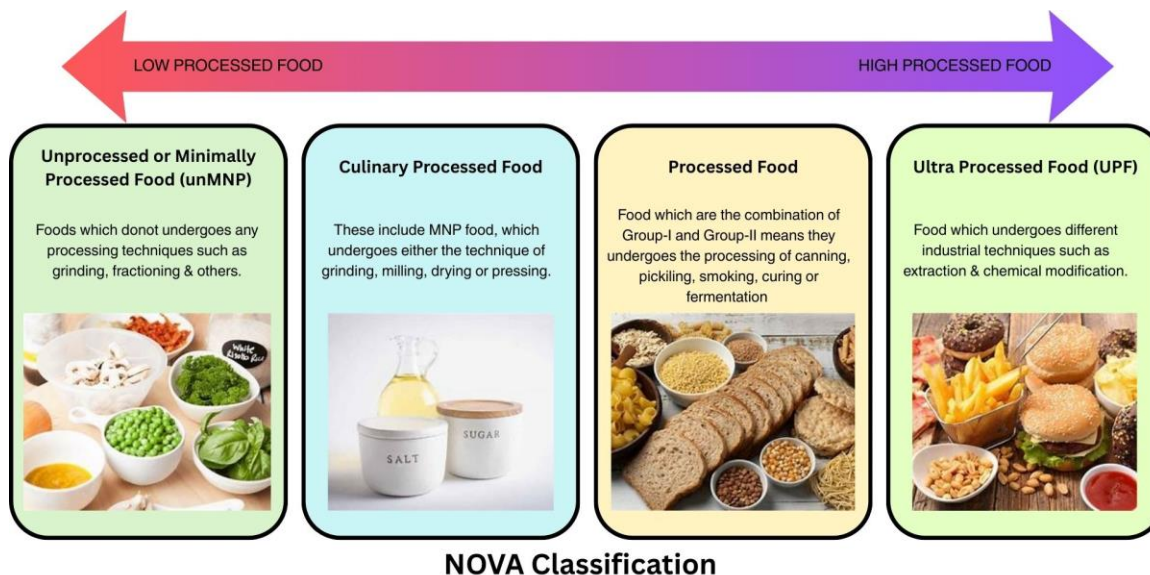
low nutritional value and low amount of fiber, protein and essential vitamins & minerals. These components also possessed damaging effects to health such as obesity, diabetes, cardiovascular disease, cancer and irritable bowel syndrome. In more severe cases these diseases are not preventable and can pose serious threat to health. UPF also has negative effect on mental health, through the disruption of anti-inflammatory biomarkers and are also a source of malnutrition in children due to low-nutrient availability.

**INTRODUCTION**

As the world is going towards advancement and people are getting increasingly busier. Now, every consumer has less time for themselves, and they want some quick options. Diet is an essential part of every consumer, as the world is advancing and people are now moving from traditional to modern way. So, in the same way the pattern of their food is also changing. Now people prefer those food products which are cheap and take less time for their production. Ultra processed food are the food options which every consumer buys. Ultra Processed foods are those foods that undergoes processing, refining and addition of additives and preservatives in industry to enhance their color, flavors, and texture. According to the classification of NOVA, it is categorized in its four categories. NOVA

classification is the process of classifying food into various categories based on level of processing. The first category includes unprocessed food (unPF) or minimally processed food (MPF) like original fruits, vegetables, and meat. The second category includes the culinary processed food in which there is use of additives or preservatives like salt, sugar, and fat on minimally processed food by refining, processing, grinding, and milling. The third category is known as Processed food which is the combination of minimally processed food and culinary processed food. The fourth and last category is Ultra Processed food (UPF), which is created by application of multiple industry techniques. UPFs are those which cannot be prepared at home, as they need multiple techniques for their preparation which are available at the industry level. [Petrus et al., 2021]

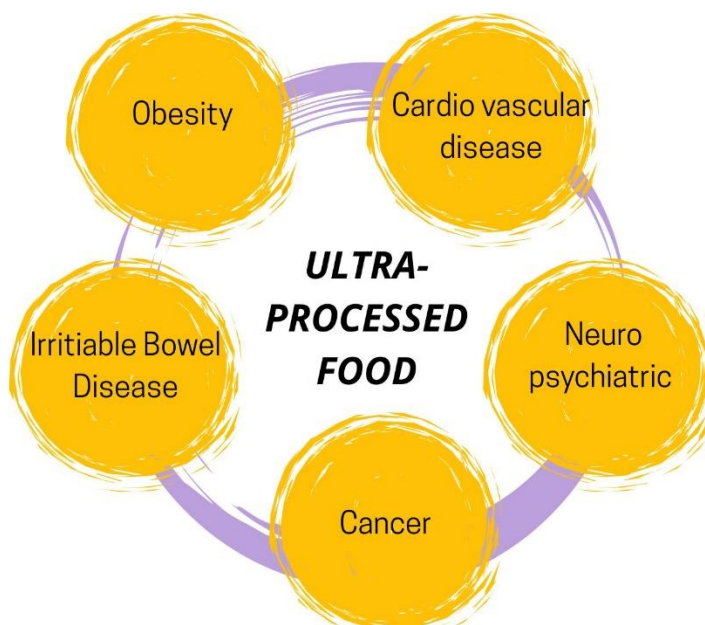
Recent evidence shows that ultra-processed foods account for 58% of total daily caloric addition in cost-effective countries and around 30% in appearing economies, underscoring a global transition toward diets dominated by industrially formulated foods. It is because they are easy to cook and save consumers time for cooking purposes. UP food is energy dense, which means they are excessive in sugar, salts, and unhealthy fats while they are low in vitamins, proteins, and essential minerals. The utilization of UP food is increasing day by day. There is a great imbalance of nutrients in UPF and high rate of microbes in it due to which there is imbalance of gut microbes in intestine, along with high rate of other diseases such as cancer, cardiovascular disease, obesity, dyslipidemia, hypertension, neuropsychiatric, metabolic syndrome, cerebrovascular diseases. [Monteiro et al., 2019]



## EFFECT OF ULTRA PROCESSED FOOD ON HEALTH

Due to multiple processing techniques, the nutritional value, chemical and physical characteristics of food decreases, While the bacterial load in the food may also increases. Consumption of ultra-processed foods, characterized by low micronutrient density and prominent levels of additives, has been associated with increased oxidative stress and suppression of immune responses. The utilization of ultra processed food is also related to inflammation due to intake of elevated levels of sucrose, fructose, fat, and sodium. Also, the packaging material in which food is packaged is also a source of contamination for human body. Packaging material can be a source of chemicals such as bisphenol and phthalates which work as an endocrine disruptor which causes increase in inflammatory biomarkers such as CRP, IL-06 and IL-10 which are the biggest biomarkers of causing Non-Communicable Diseases (NCD).

Thus, its consumption relates to low-grade and non-communicable diseases like cancer, obesity, cardiovascular and gastrointestinal disorders etc.



## OBESITY

Obesity is the major health concern in the growing world. According to World Health Organization (WHO), approximately 2.5 billion adults are overweight and 890 million of them are obese in the world. A national press release cited by outlets on World Obesity Day 2024 reported that 58.1% of Pakistanis were overweight, with 43.9% obese using WHO criteria [Riaz & Lodhi 2025]. A comparative risk assessment from Belgium estimated that about 21% of obesity cases in that population could be attributable to UPF consumption. [Shim et al., 2025]

Diet plays an important part in upbringing of human health. From the past few years, people are continuously changing their mode of lifestyle and eating pattern. There is a big shift from the traditional food of minimally processed food to highly processed foods which are high-caloric, low in nutrients and minerals and increased in fats, salt, and sugar. [Dicken & Batterham 2024]. Due to current increase in the level of obesity, Nutrition experts recommended eating a nutritionally well-balanced diet, which include low fat and sodium diet, and high intake of fruits and vegetables which promotes a healthy weight. The consumption of UPFs food varies from country to country and

continent to continent. It is seen that there is high consumption of UPF in high income countries due to development, advancement, and availability of resources. [Juul et al., 2018]

UPFs food is more energy dense food than MPF. UPFs foods are highly linked to obesity as these foods are rich in carbs, sodium, saturated fats, free sugar, and total energy which increases the bulk of human body, and they are low in protein, fibers, vitamins, and minerals. Consumption of high fructose foods such as soft drinks, sweets, sauces, and dairy products results in high fat storage, reduced satiety, increased insulin resistance, and visceral adiposity. The emulsifiers used in assorted products such as ice-creams, sauces and bakery items results in disrupting gut muscular layer which causes alteration in gut microbiota and even promotes fat gain without consuming extra calories. In food such as instant food and flavory food, there is use of diverse types of flavor enhancer such as Monosodium Glutamate, it causes increase palatability and hedonic eating, along with disrupt hypothalamic appetite regulation and promotes hyperphagia. These foods are convenient to buy and reduce the time for cooking purposes, encouraging mindless eating and overconsumption of food. Therefore, consumption of high UPFs food is increasingly linked with low nutritional value, poor dietary intake, and greater energy consumption [Yusufali et al., 2024].

Recent studies shows that increased consumption of ultra-processed foods (UPFs) is associated not only with obesity but also with adverse adiposity indicators, even after adjustment for suspected confounders such as age, socioeconomic, sex status, and health-related behaviors, as well as disparate dietary factors including total energy and nutrient intake, specific food group consumption, and overall dietary quality. These findings suggest that the association between UPF intake and obesity is only relatively explained by conventional dietary factors, highlighting food processing itself as a potential independent contributor to the pathogenesis of obesity. [De Amicis et al., 2022]

## CARDIOVASCULAR DISORDER

Cardiovascular disorder is the most prominent and leading cause of death globally. In this large prospective cohort, a net increase of ten in the percentage of ultra-processed foods in the diet was related to 12%, 13%, and 11% statistically significant increase in the rates of overall cerebrovascular,

coronary heart, and cardiovascular disease, respectively. Balanced diet plays a primary and secondary role in its prevention. The biological pathway through which Ultra processed food causes cardiovascular disease is more complex and still unknown. The underlying physio pathological interrelationships involved in atherogenesis and cardiovascular disease (CVD) progression are complex and involve multiple interconnected pathways. A constellation of factors including metabolic disturbances, pro-inflammatory and pro-thrombotic states, oxidative stress, and endothelial dysfunction coexist and potentiate one another. [Deaton et al., 2011]

Consumption of savory foods such as bakery products, fried snacks and margarine contain prominent level of industrial trans fatty acids which leads to elevated level of high-density lipoprotein (HDL) cholesterol and increased low-density lipoprotein (LDL) cholesterol and increased atherosclerotic plaque formation [Mozaffarian et al., 2010] Excessive sodium and sugar in food, along with the addition of preservatives (Nitrites, Nitrates) emulsifiers (carboxymethylcellulose, Polysorbate-80) and artificial sweeteners (Aspartame) in ultra processed foods (UPFs) have increased effect on cardio health such as left ventricular hypertrophy (LVH), increased stroke and heart failures and promote nitrosative stress. [Babalola et al., 2026]

Sodium, a mineral which is present in excessive amounts in ultra processed food, is important for maintaining homeostasis and normal body functioning. Sodium in ultra processed food is added during the time of processing, preservation, and packaging to contribute to the flavor, texture and as a preservative [Juul et al., 2021]. Excessive sodium intake than the body requirement can result in increased cardiovascular problems probably by increasing blood pressure and vascular damage. Elevated level of sodium intake causes retention of fluid, and increased extracellular fluid volume and elevates cardiac output, contributing to hypertension, a major risk factor to CVD. The high sodium food is related to increased blood pressure by disrupting renin-angiotensin aldosterone system, which increases plasma volume, damages vascular endothelial cells, and promotes arterial stiffness. [O'Donnell et al., 2020]

## CANCER

Cancer, the disease of which the rate of mortality and morbidity have been increasing in recent years [Iwaloye et al., 2023]. Mutagens are the agents that cause cancer. Mutagens are found naturally and through human activities. They come from environmental, dietary, occupational, biological, and life-style related resources. Mutagens are the compounds that cause alteration in genes by changing DNA sequences [Basu 2018]. Ultra processed food is the one that is produced industrially by involving different processes in which there is addition of chemicals. These chemicals can be the main reasons for causing carcinogenic effects on human health. Food additive use in processing industry is one of the main concerns due to distinct reasons such as the quantity and its labelling on nutrition labels. Moreover, the synergistic effects between additives and other ingredients in the development of cancer and other diseases remain poorly understood [Agboola et al., 2025].

Naturally, mutagens can enter the body by eating improperly cooked food and by eating processed food that undergoes feverish temperature or by overcooking food. The thermal processing of smoked meat generates cancer inducing agents, such as polycyclic aromatic hydrocarbons (PAHs), heterocyclic amines (HCAs), monochloropropane diols and their esters, and N-nitroso compounds (NOCs) which are toxic and carcinogenic. These oncogenic factors are formed by different reactions in processing units such as moisture, heat and sugar/lipid content in food. Furthermore, during meat processing there is appearance of sodium nitrate, a preservative that led to the development of nitrosamines in stomach. One of the forms of nitrosamines is diethylnitrosamines, it is mutagenic and carcinogenic that causes alteration in DNA which leads to liver cancer. [Menegassi & Vinciguerra 2025]

Many other factors such as packaging and presence of additives and preservatives also contribute to carcinogenesis in ultra processed foods. Carcinogenesis in food not only depends on extrinsic factors, but there are also some intrinsic factors which also contribute to carcinogenesis. Substances such as acrylamide and Nitrosamines particularly show strong carcinogenic effect even at low doses. [Kliemann et al., 2022]

Chronic inflammation is caused by ultra processed food and can also cause tumors. There are varied factors such as intake of elevated level of sugar which results in insulin disruption and induction of inflammation [Tristan et al., 2023]. Increased intake of salt, trans fat and saturated fats which are the directly source of persisted inflammation. Also, the low presence of fiber in ultra processed food due to removal of protective fiber layer during the processing can cause proinflammatory gut microbiota profile and lead to a condition known as Intestinal Dysbiosis. Inflammatory cells such as tumor-associated macrophage cells (TAM), fibroblast, myeloid-derived suppressor cells (MDSCs), and lymphocytes are signed to inflammatory sites where their liberate chemokines, cytokines and other signaling molecules which promote immune response, cellular response and inflammation [Greten & Grivennikov 2019]. During chronic inflammation, an overabundance of cytokines, growth factors, proteases, inflammatory cells and chemokines, and rises at these spots, exhilarating tissue regeneration and alteration of the extracellular matrix (ECM). This creates a microenvironment favorable to carcinogenesis, characterized by immunosuppression, angiogenesis, sustained cell proliferation, and tumor initiation. [Colotta et al.,2009]

### INFLAMMATORY BOWEL DISEASE (IBD)

Inflammatory bowel disease, a condition which is a combination of Chron's disease (CD) and Ulcerative colitis (UC) is a chronic and inflammatory disease of gastrointestinal tract [Spiller et al., 2025]. This disease is influenced by three main factors: host gene, gut microbiota health, and dietary factors. Diet is the key factor for promoting health effects in human body. The plant source diet which includes high level of fiber, proteins and vitamin and minerals are beneficial for gut health and production of essential short chain fatty acids (SCFAs), while the westernized diet which include high level of sugar, salt, trans fat and low level of fiber are linked to dysbiosis and proinflammatory profiles. [Mayorga et al., 2026]

High intake of ultra processed food which is low in fiber results in increased risk of IBD. Fiber is essential for the process of digestion in small intestines and reaches the colon largely intact. Fiber acts as a prebiotic. They are the primary source of commensal bacteria such as *Bifidobacterium* and

*Lactobacillus*. They also help in the production of short chain fatty acids (SCFAs) like butyrate, acetate, and propionate which helps in strengthening of intestinal barriers, and reduces intestinal inflammation. Butyrate is the main source for colon cells (colonocytes).

Intake of ultra processed foods which are high in salts and sugar such as packaged snacks, processed meat and soft drinks can lead to metabolic shift like increased in pro-inflammatory metabolites and decreased in short chain fatty acids (SCFAs), upregulation of innate and adaptive immune signaling such as TLR4-NF- $\kappa$ B activation and Th-17 skewing. Chronic exposure to dietary emulsifiers can lead to thinning protective mucus, reduced microbial diversity and even lead to development of colitis which can be prolonged and dangerous [Chassaing et al., 2015]. Carrageenan (CGN) subjection activates the TLR4-Bcl10-NF- $\kappa$ B signaling axis and cause IL-8 secretion in human intestinal epithelial cells [Bhattacharyya et al., 2017]. Maltodextrin is widely used in ultra processed food; they are the source of invasion of bacteria in food through biofilm formation and impair anti-microbial defenses in intestinal epithelial cells. [Zangara et al., 2022]

Microparticles and colorants such as Titanium dioxide (E171) also interact with microbial guts and cause disruption in intestinal cells [Bischoff et al., 2020]. Diets high in ultra processed food (UPF) are typically rich in refined carbohydrates and additives which can generate reactive oxygen species (ROS) during absorption and digestion. Excessive oxidative stress can lead to damage to epithelial cells and promote cytokines which lead to inflammation. [Choi & Moon 2025].

## NEUROPSYCHIATRIC

Mental disorders which are also known as psychiatric disorder or a mental health condition comprises of different symptoms such as depression, dementia, anxiety, agitation, paranoia, and psychosis. Mental disorder is also the biggest contributor to world's disease burden. Approximately 30% of individuals are facing mental disorder problems throughout their life span. Despite many psychotherapies and pharmacological treatments, many people still do not get better at all. Recent studies show that diet is also a great contributor towards mental disease. [Firth et al., 2020]. Consumption of elevated levels of sugar and fatty food products also result in low- grade

inflammation involving their low supply of prebiotics, anti-inflammatory and antioxidant compounds, and fiber compounds and low density of nutrients availability. The packaging material used for UPF food is also the origin of chemicals such as phthalates and bisphenol which act as endocrine disruptors and increase the level of biomarkers of inflammation such as IL-10, CRP and IL-6 which leads to the evolution of non-communicable diseases [Buckley et al., 2019]

In the central nervous system (CNS), microglia are crucial for performing normal function by applying both neuroprotective and neurotoxic effects. Microglia activation by inflammatory mediators and cytotoxic molecules i.e., interferon- $\gamma$  (IFN- $\gamma$ ),  $\alpha$ -synuclein( $\alpha$ -syn), lipopolysaccharide (LPS),  $\beta$ -amyloid (A $\beta$ ), and induce neuroinflammation, nitric oxide (NO) and reactive oxygen species (ROS) complicating neurotoxicity, which is crucial in AD and other dementias [Contreras-Rodriguez et al., 2023]. Studies revealed that nanosized particles such as additives and emulsifiers which are also added in UPF also disrupt amygdala-hippocampal complex, a functional region for emotion regulation. Inflammatory processes have also shown association with pathophysiology of depression, disrupt the innate and adaptive immune pathway in a depressed patient and block beneficial prognosis, involving anti-depressant response [Beurel et al., 2020].

Acrolein, an extremely reactive form of aldehyde which is a derivative of syngas of carbohydrate and lipoprotein is formed in feverish temperature food products. Acrolein also encourages oxidative damage which may induce neuro-degenerative disorders. It depletes antioxidants, leading to ROS formation and results in oxidative stress which damages cell DNA and genes. An approximate amount of acrolein is found in Alzheimer's patients. The alliance of acrolein with AD patients preoccupy the initiation of hypo-phosphorylation of microtubule associated protein and encouragement of AB aggregation in senile plaque granting to pathogenesis of disease [Singh et al., 2010]. Diet elevated in UPF can also result in nutritional deficiencies, as well as intake of additives, emulsifiers, heavy metals and epigenetics factors also show association to autism and hyperactivity disorders [Lutz et al., 2025].

One of the most crucial factors that leads to neuropsychiatric disorder is the socioeconomic factors. Families who have low educational background and poor income are often associated with diverse

and low-quality diets leading to consumption of affordable and high intake of ultra processed food. These products are more appealing, affordable and take less time for their preparation. This method is mostly used in those houses where there are jobholders, single parents, or blended families, where time, cost and energy for cooking meals are limited. Environment also plays a significant role in eating habits. School meal program is a part of almost every country’s school, but their quality varies, there are some schools where the provision of Ultra processed food for children is high. The snacking, dinning out, and poor sleep quality has been identified a key driver of UPF consumption. Extensive marketing through media, television and food bloggers is also a thorough source of high consumption of ultra processed foods. These marketing strategies are designed to attract most people by damaging the cognitive and sensory mechanism and reinforcing its appeal while hiding the negative consequences of its consumption. [Mottis et al., 2025]

| DISEASE                 | EXAMPLE OF UPF   | KEY COMPONENTS INVOLVED                       | PROPOSED BIOLOGICAL MECHANISM                            |
|-------------------------|--|---|--|
| Obesity                 | Sugar sweetened beverages, ice-cream, sauces, bakery items | Added sugar, carbohydrates and saturated fats | Increased energy density, insulin disruption             |
| Cardiovascular Disease  | Processed meat, Fried snacks, margarine                    | High sodium, trans fat, additives             | Hypertension, left ventricular hypertrophy (LVH), stroke |
| Cancer                  | Smoked meat, packaged food                                 | Nitrosomes and acrylamide                     | Oxidative stress, inflammation, tumor                    |
| Irritable Bowel Disease | Soft drinks, processed snacks                              | Emulsifiers and Additives                     | Dysbiosis, disruption of intestinal cells                |

|                 |  |                                    |                                     |
|-----------------|--|------------------------------------|-------------------------------------|
| Neuropsychiatry | Processed meat, Instant noodles, packaged snacks | Acrolein, additive and emulsifiers | Oxidative stress, Neuroinflammation |
|-----------------|--|------------------------------------|-------------------------------------|

**PUBLIC HEALTH AND POLICY IMPLICATIONS**

The increased utilization of ultraprocessed food has led to important level of non-communicable diseases in today’s world. The mortality rate of NCD reached 74% worldwide. World Health Organization (WHO) established a plan to monitor and evaluate the rate of obesity which is associated with NCD. This plan basically focusses on various environmental strategies, including limitation on ultra processed food marketing, nutrition labeling regulation, physical activity promotion, and fiscal policies, [Monteiro et al., 2013]. Chile has implemented a front of pack labeling (FOPL) rule, as well as a ban on marketing and promoting healthy environments in schools, which has led to the reframe of UPF and household UPF purchases. Peru has invoked an FOPL law in the country, which has led to companies in these countries making efforts to reduce the amounts of nutrients of concern in foods and drinks. [Saavedra-Garcia et al., 2022]

In Columbia, many policies were introduced to reduce the level of UPF consumption. Different strategies were introduced such as introduction of FOPL, Maximum Sodium Content (MSC), implementation of taxes on high sodium UPF and sugar sweetened beverages [Cadena et al., 2025]. It is critically important to evaluate the dietary intake of consumers. The manufacturing companies should properly label the ingredients used in food, also there should be proper guidelines mentioned for allergens. There are some bioactive compounds which can cause allergies to extremely sensitive people, there should be properly guidelines mentioned to avoid such hazardous effects.

**CONCLUSION**

The consumption of ultra processed food is increasing in modern era. Ultra processed foods are beneficial; it can be only harmful if its consumption rate is increased. These foods are extremely

helpful in emergencies such as natural disasters and in remote areas. They have foremost importance because of high shelf life, cheap production, easy to cook and easy availability. The increasing reliability of ultraprocesed food represents significant public health concern, particularly in developing countries due to more consumption over there. There is need for more epidemiological investigation to investigate its impact on children, adolescents and elderly people. For addressing all these issues there is need of coordination among government and private sectors by forming rules and policies, providing nutrition education, reformulation of food products, proper labeling on packages and policies which aimed on restrictive consumption. More studies are needed to find out the immunological, physiological, hormonal and neurobiological pathways to understand its effect on human being.

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