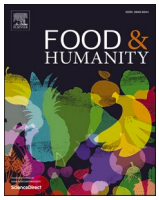
Food and Humanity 4 (2025) 100472

Contents lists available at ScienceDirect

Food and Humanity

journal homepage: www.editorialmanager.com/foohum/journal_overview.html



Preventing lifestyle disorders: The diet shift in India

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ARTICLE INFO

Keywords:
Food additives
Lifestyle disorders
Children foods
Good health

ABSTRACT

Food is an essential component of our daily lives. In ancient times, people preferred natural and unprocessed foods, but nowadays, instant and processed foods have become more popular. This shift in dietary habits has led to various lifestyle disorders such as cardiovascular disease, diabetes, and cancer, posing a significant threat to global healthcare in the coming years. Research has shown that nearly 55 % of men and 65 % of women are currently aged 20 years are more likely to develop diabetes (95 % of type 2 diabetes) in their lifetime. In India, it was estimated about 77 million adults have been affected by diabetes and this count is expected to double by 2045. To address this issue, the G20 has included Good Health and Well-being as one of its sustainable development goals. Therefore, it is essential to take steps towards correcting these lifestyle disorders from a young age through a healthy diet to protect current and future generations. Our current review aims to study the food additives and its impact on young adults and children.

1. Introduction

Food is any material that is consumed to provide the body with necessary nutrients, which are vital for generating energy, building and repairing tissues, supporting the immune system, and maintaining overall health. A healthy diet involves eating a wide range of nutritious foods in moderation to ensure the body receives all it needs to function optimally (Jones et al., 2014). This includes consuming essential nutrients such as carbohydrates, proteins, fats, vitamins, and minerals in the correct proportions. The diet should emphasize whole foods, fruits, and vegetables, and limit processed foods (World Health Organization, 2018). Consuming a balanced and nutritious diet, which provides essential nutrients (like rich dietary fibers, minerals and vitamins) for proper body metabolism, is imperative for reducing the risk of chronic diseases such as heart disease, diabetes, and obesity. According to research, consuming too much MSG can have several negative impacts, such as issues with the heart, gastrointestinal, neurological, muscular, and circulatory systems (Cencic and Walter, 2010). Furthermore, a variety of possible health hazards, such as the emergence of metabolic syndromes, which include dyslipidemia, obesity, and hypertension, have been discovered through clinical research including human as well as animal volunteers (Kayode et al., 2023).

The term "processed food" refers to foods that have been altered from their natural state in some way.It can include cooking, freezing, canning, or adding preservatives or other additives to extend shelf life. Ultra processed foods, on the other hand, are a sort of highly processed food which contain synthetic ingredients with minimal nutritional value can contribute to health issues such as obesity, type 2 diabetes, and cardiovascular disease (Almarshad et al., 2022; Baker et al., 2020).

Food additives are compounds added to food during the manufacturing or processing process in order to improve its taste, appearance, texture, or shelf life (Abedi-Firoozjah and Tavassoli, 2024). Natural or synthetic food additives are controlled by government bodies to guarantee that they are safe for ingestion. Some common types of food additives include preservatives, colorings, flavorings, emulsifiers, stabilizers etc. (Márcio et al., 2014). Ultra processed foods are heavy in calories, sugar, salt, and harmful fats, and they are frequently consumed in large quantities as snacks or convenience foods. In a study with 104, 980 participants, a higher intake of ultra-processed foods was linked to an increased risk of cancer. Specifically, a 10 % increase in ultra-processed food consumption was associated with a 12 % higher risk of overall cancer and an 11 % higher risk of breast cancer with a significant increase observed for postmenopausal breast cancer. Sugary drinks and products were the diet's primary sources of ultra-processed foods (Fiolet et al., 2018).

Whereas Natural foods are those that have been minimally or

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https://doi.org/10.1016/j.foohum.2024.100472
Received 24 May 2024; Received in revised form 29 November 2024; Accepted 4 December 2024
Available online 5 December 2024

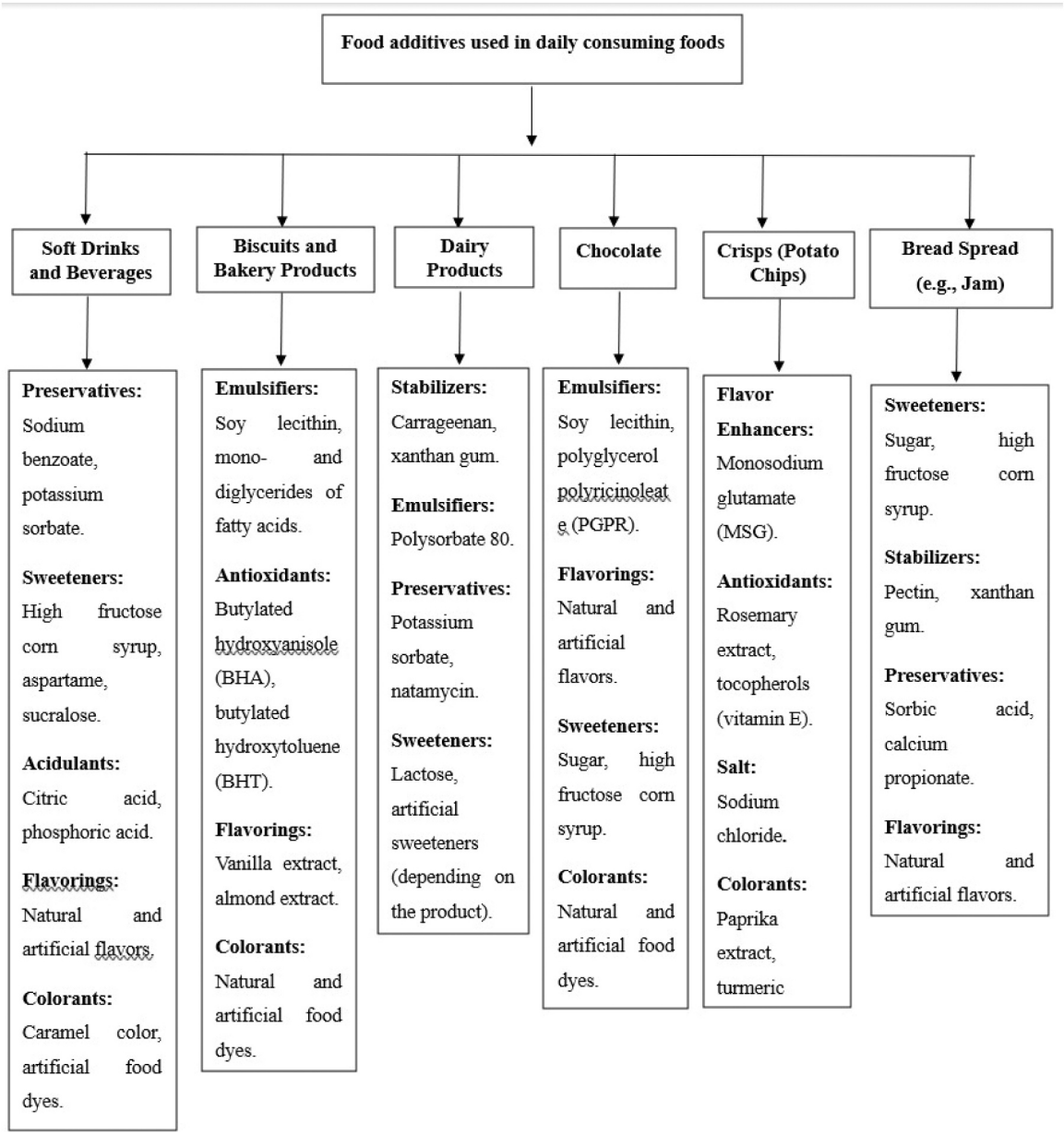

Fig. 1. Food additive used in daily consuming food.

completely processed and are as close to their natural state as possible (Phillip et al., 2020). Natural foods are often free of artificial additives, preservatives, and colors. Today, processed foods are more popular than natural food as they are instant and accessible (Awuchi et al., 2020). These fast foods are quite popular among children owing to taste, appearance and hype created by the mass media. Children are more susceptible to the effects of these additives as they have more exposure than adults due to their size and dietary intake (Harris et al., 2009). This causes lifestyle disorder.

Studies have shown that food additives more negatively impact children than adults are for a variety of reasons (Ahmed et al., 2021). Polycystic ovarian syndrome, obesity, and elevated cardiometabolic risks in children have all been related to exposure to bisphenol A (BPA) (Savin et al., 2022; Akgül et al., 2019). Artificial food colorings, or AFCs, are primarily found in drinks, cakes, ice cream, and juices. Children tend to eat these foods more frequently than adults due to their appealing color and texture, according to a Saudi Arabian study (Asif & Searcy, 2021). The consequences from this frequent consumption include hypersensitive reactions, attention and behavioral issues, and learning challenges (Arnold et al., 2012). Furthermore, the first year of life is critical for the development of biological systems. Children are particularly susceptible to the negative effects of these additives than adults are since their bodies are still developing and they consume more processed foods in relation to their body size (Savin et al., 2022).

Lifestyle disorders, also known as noncommunicable diseases (NCDs), are chronic health issues that are frequently caused by lifestyle factors such as a poor diet, a lack of physical activity, tobacco use, and excessive alcohol consumption. Lifestyle disorders such as cardiovascular disease, type 2 diabetes, obesity, cancer, respiratory disease etc. To prevent such lifestyle disorders in upcoming generations we have to add more natural foods into our regular dietary habits (Joy & Death, 2014).

Studies have indicated a number of adverse health consequences of food additive. Glycosidic enzyme digestion is inhibited by sucrose. Despite its resistance to fermentation, sucralose has bacteriostatic qualities that affect the gut microbiota (Pang et al., 2021) and contribute to a number of chronic illnesses, including cancer, obesity, and inflammatory bowel disease (Zhang et al., 2015). Furthermore, several studies have connected food chemicals and dyes to increased hyperactivity in

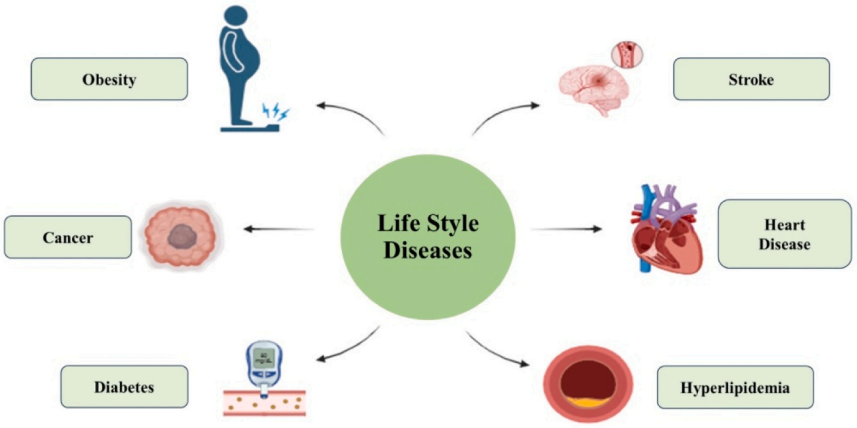

Fig. 2. Lifestyle disorders caused by intake of food additives.

children, with early research by Dr. Benjamin Feingold showing that eliminating these ingredients from children's diets reduced hyperactivity symptoms (Kanarek, 2011). Moreover, studies indicate that food additives like emulsifiers and detergents may make the intestinal epithelial barrier more bacterially permeable, which could have an effect on gut and metabolic health (Partridge et al., 2019).

Alternative dietary habits include substituting unsaturated fats, such as those rich in omega-3 fatty acids, for saturated and trans fats. Regularly consume fruits and vegetables and maintain adequate folic acid intake (Willett et al., 2006). Consume whole-grain, high-fiber cereals and limit sodium and sugary beverages, and include traditional rice and millet in your meals.

Here are some common food additives that can be found in the following products (Fig. 1)

The consumption of regular food additives contributes to many lifestyle disorders; therefore, this paper emphasizes the impact of food additives on both children and adults. We suggest the alternative dietary choice like incorporating natural foods such as traditional rice and millets into our modern dietary habits to provide a disease-free society for the upcoming generations.

2. Life style disorders

Lifestyle disorders are primarily driven by modifiable risk factors that are influenced by an individual's lifestyle choices (Fig. 2). Unhealthy diets high in processed foods, added sugars, and saturated fats can contribute to obesity, diabetes, and cardiovascular diseases. Lack of physical activity and sedentary behaviours increase the risk of obesity, diabetes, and certain types of cancer. Tobacco use, including smoking and smokeless tobacco, is a major risk factor for various cancers, respiratory diseases, and cardiovascular problems. Excessive alcohol consumption can lead to liver disease, cardiovascular complications, and other health issues. Chronic stress, inadequate sleep, and poor mental health also play a role in lifestyle disorders (Mozaffarian, 2016).

Lifestyle disorders are largely preventable and controllable through lifestyle modifications. Making positive changes in diet, exercise, and behaviour can significantly reduce the risk and severity of these conditions. This includes adopting a balanced and nutritious diet, engaging in regular physical activity, maintaining a healthy body weight, avoiding tobacco and excessive alcohol consumption, managing stress effectively, and prioritizing adequate sleep. Lifestyle disorders have become a global health concern, affecting individuals of all age groups and socioeconomic backgrounds. They are responsible for a significant portion of premature deaths and disability worldwide. According to the World Health Organization (WHO), NCDs account for approximately 70 % of global deaths, with cardiovascular diseases being the leading cause. The burden of lifestyle disorders is increasing rapidly, particularly in low- and middle-income countries undergoing rapid urbanization and lifestyle changes (World Health Organization, 2022).

3. Lifestyle disorders and it's impact on children

There has been a strong increase in diet and lifestyle-related diseases and disorders in children in Europe in the last decades (Bundred et al., 2001). According to a survey by the FAO (2006), on one side there is still prevalence of malnutrition and other deficiency diseases like anemia, vitamin A and iodine deficiency, improper immunization and food insecurity, while on the other side overweight and obesity are rampant among children in India.This portrays a dismal picture from the point of view of development of children into healthy adults of tomorrow. The consequences of underweight and deficiency diseases as well as overweight and obesity are extensive among children, resulting in reduction in the rate of productivity. Obesity, as one of the most important diet- and lifestyle-related diseases, results in enormous financial costs being borne by the health care systems and communities and is thus one of the most important challenges of public health in developed countries (Sassi et al., 2016).

4. Lifestyle disorders and it's impact on young adults

In young adults, these lifestyle choices can significantly impact their overall health and well-being, both in the short term and in the long run. Lifestyle disorders encompass a range of health conditions that are primarily influenced by a person's daily habits and choices. These disorders often stem from factors such as diet, physical activity, stress levels, sleep patterns, and substance abuse (Egger & Dixon, 2014). Here are some of the lifestyle disorders along with their pathophysiology.

5. Cardiovascular diseases (CVD)

Globally, the most common risk factors for cardiac arrest include abnormal cholesterol levels, sedentary lifestyles, poor dietary choices, smoking, hypertension, diabetes, abdominal obesity, psychosocial factors, tobacco alcohol use and irregular physical exercise (Yusuf et al., 2004; Sun et al., 2023). Around the world, cardiovascular disease (CVD) is the leading cause of death (Mahmoud & Gan, 2014). Cardiovascular disease (CVD) is a broad category of ailments that includes diseases of the heart muscle and the circulatory system that supplies the heart, brain, and other essential organs. CVDs are particularly important for public health because they cause 45 % of fatalities in Europe (Sanz et al., 2020). A group of illnesses known as CVDs damage the heart and blood vessels. The main causes of CVDs are atherosclerosis, coronary artery disease (CAD), and arterial hypertension (AH) (Cheung et al., 2014).

Atherosclerosis:

The majority of cardiac illnesses, such as coronary artery disease (CAD) and strokes, are primarily caused by atherosclerosis. The first stage is endothelial dysfunction, which is the result of damage to the blood vessel's inner lining brought on by things like smoking, high blood pressure, or an excess of cholesterol. This injury causes a buildup of lipids in the artery walls, notably low-density lipoproteins (LDL). Over time, these lipids oxidize, triggering an inflammatory response that draws in immune cells such as macrophages. Macrophages break down oxidized low-density lipoprotein (LDL) and become foam cells, which create the characteristic fatty streaks associated with early atherosclerosis. As the health problem progresses, smooth muscle cells migrate to the area and cover the plaque with a fibrous covering. Eventually, the plaque may crack and create a thrombus, or blood clot, which can impede blood flow and cause infarction, or tissue death, in vital organs like the heart or brain (Frąk et al., 2022).

5.1. IschemicHeartDisease

When the coronary arteries narrow as a result of atherosclerosis, it can lead to ischemic heart disease (IHD), sometimes referred to as coronary artery disease (CAD). Reduced blood flow leads to myocardial ischemia, or oxygen deprivation, which produces angina (chest pain). A myocardial infarction (heart attack), which causes irreversible damage to the heart tissue, may occur if the obstruction is total or if a plaque ruptures and a clot forms (Frąk et al., 2022).

5.2. *Hypertension*

High blood pressure, or hypertension, is a significant risk factor for cardiovascular disease. Left ventricular hypertrophy, or the expansion of the left pumping chamber, is the result of the heart having to work harder to pump blood when blood pressure is consistently high. The heart muscle becomes less effective and stiffens with time, making the person more vulnerable to heart failure. Moreover, hypertension accelerates the development of atherosclerosis by inflicting greater harm on the endothelium lining of arteries, which permits plaque to build up (Yusuf et al., 2004).

6. Cancer

Similarly, cancer remains a formidable adversary, with various types such as breast cancer, melanoma, lung cancer, colon cancer, leukemia, and lymphoma posing significant threats. The causes range from genetic predispositions to environmental factors like poverty, unhealthy diets, exposure to pollutants, and certain behaviors such as smoking and alcohol misuse (Avdhoot et al., 2023). All cancers, with the exception of leukemia (blood cancer), are caused by abnormalities in a subset of normal cells that lead to unchecked growth and the formation of a lump known as a tumor. Tumors can grow and spread into surrounding normal tissue, travel through the bloodstream and lymphatic systems to other parts of the body, and impact the neurological, circulatory, and digestive systems if they are left untreated (Angahar, 2017). Genes that encode proteins that control cell division are typically mutated to produce the anomalies seen in cancer cells. A greater number of genes mutate with time. This frequently occurs because the genes that produce the proteins that typically repair damage to DNA are also altered, which prevents them from operating normally. As a result, the cell starts to experience an increase in mutations, which leads to more abnormalities in both the parent cell and the daughter cells. While some of these mutant cells perish, other changes might provide the aberrant cell a selective advantage that lets it proliferate far faster than the regular cells. The majority of cancer cells, which have acquired capabilities suppressed in normal, healthy cells, are described by this accelerated growth. These cells are regarded as benign as long as they stay in their original place. They are regarded as malignant if they spread and become invasive. Cancer cells in malignant tumors can commonly metastasis, transporting cancer cells to distant locations in the body where new tumors may emerge (Olsen, 2015). Only 5–10 % of cancer cases are caused by genetic abnormalities; the remaining 90–95 % are caused by environmental and lifestyle factors. Certain lifestyle factors—like smoking, drinking alcohol, being obese, eating a diet high in fried foods and red meat, not exercising, and having reproductive and hormonal issues—are thought to be the primary causes of cancer and should be the focus of primary prevention (Katzke et al., 2015).Research suggests that nutrition plays a role in 30–35 % of cancer-related fatalities worldwide. The majority of ingested carcinogens, including pesticides, nitrosamines, nitrates, and dioxins, are derived from food, food additives, or cooking. It has been demonstrated that a number of dietary carcinogens trigger inflammatory pathways (Anand et al., 2008). Long-term exposure to food additives such as nitrite preservatives and azo dyes has been associated with the induction of carcinogenesis (Sasaki et al., 2002). Heavy consumption of red meat is also a risk factor for several cancers, especially for those of the gastrointestinal tract, but also for colorectal (Chao et al., 2005), prostate (Rodriguez et al., 2006), bladder (García-Closas et al., 2007), breast (Tappel, 2007), gastric (Kaur et al., 2019), pancreatic, and oral (Toporcov et al., 2004) cancers.

7. Diabetes

The complicated metabolic disease known as diabetes mellitus (DM), or just diabetes, is represented by hyperglycemia, a physiologically aberrant state manifested by persistently high blood glucose levels. Anomalies in insulin secretion, action, or both can cause hyperglycemia, which can cause chronic, diverse metabolic dysfunctions in the metabolism of fat, protein, and carbohydrates (Banday et al., 2020).

7.1. Type 1 diabetes mellitus (T1DM)

This kind of diabetes is characterized by the autoimmune destruction of the pancreatic beta cells, which results in an almost complete absence of insulin production. The immune response is thought to be triggered by a combination of environmental stimuli, including viral infections, and genetic predisposition. Insulin is required for the metabolism of glucose by cells, and its absence results in hyperglycemia. If ignored, this eventually leads to metabolic abnormalities in the metabolism of fat, protein, and carbohydrates, which can lead to ketosis and diabetic ketoacidosis (Banday et al., 2020).

7.2. Type 2 diabetes mellitus (T2DM)

T2DM is primarily characterized by insulin resistance, where the body's cells become less responsive to insulin, leading to insufficient glucose uptake despite normal or elevated insulin levels. Over time, pancreatic beta cells may fail, further decreasing insulin production. The main contributing factors include obesity, a sedentary lifestyle, and genetic predisposition. Chronic hyperglycemia leads to metabolic disturbances and an increased risk of cardiovascular diseases (Banday et al., 2020).

7.3. Gestational diabetes mellitus (GDM)

Usually recognized during the 2nd or 3rd trimester of pregnancy, GDM is a medical condition which develops during pregnancy. It can be brought on by insulin resistance brought on by placental hormones, which then causes hyperglycemia. People who are affected have an increased chance of acquiring type 2 diabetes later in life, even though most women recover their normal glucose metabolism after giving birth. GDM can result in issues such macrosomia, or big birth weight, and increase the mother's and child's risk of type 2 diabetes (Banday et al., 2020).

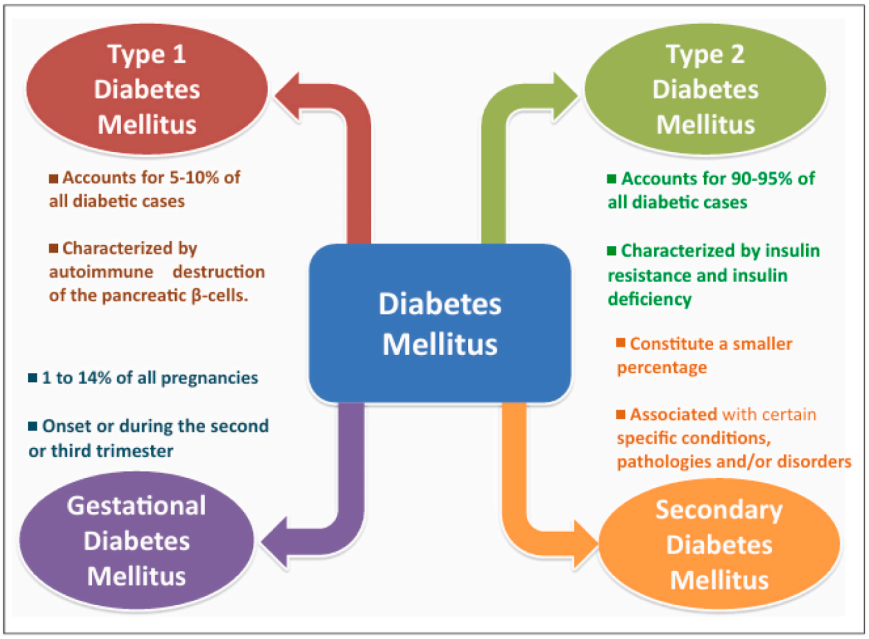

Fig. 3. Four types of diabetes Mellitus.

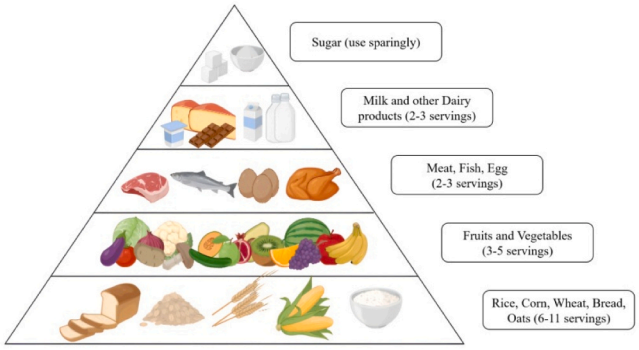

Fig. 4. Pyramid of healthy diet.

7.4. Secondary diabetes mellitus

Secondary diabetes arises due to other medical conditions or factors such as chronic pancreatitis, cystic fibrosis, or certain medications like corticosteroids. These conditions either impair the beta cells directly or cause insulin resistance. The pathophysiology mirrors the mechanisms seen in type 1 or type 2 diabetes but is secondary to the underlying condition or external cause (Banday et al., 2020).

Moreover, lifestyle factors significantly impact mental health outcomes. Poor sleep patterns, including both hypersomnia and insomnia, are associated with conditions like major depression. Furthermore, high blood pressure, smoking, high blood sugar, elevated body mass index, and childhood undernutrition stand out as leading risk factors for premature death, underscoring the critical role of lifestyle choices in shaping health outcomes (Fahmy, 2016).

8. History of food additives

Since the dawn of time, people have added various ingredients to food in order to preserve it, enhance its flavor and look, and create convenience foods. According to historians, food colorings date back to 1500 BC. In the third century BC, the Greek philosopher Theophrastus wrote on the use of artificial flavorings in food. In the first century AD, Pliny the Elder made a comment regarding the usage of animal feed and chalk in the production of bread. Galen, a renowned physician, issued a warning against adulterating plants and spices in the second century AD. For thousands of years, people have preserved food using sodium chloride, or common salt. Spices used to flavor food, such as nutmeg and cinnamon, have been sought for and sold throughout history (Panjagari, 2018).

Using food additives has been a common practice for many years. Meat was likely preserved by immersion in saltwater and smoked by our ancient ancestors to enhance flavor. The demand for food additives increased as a result of the expansion of the spice trade, which started in 3000 B.C. It's also probable that around this time, our forefathers learned about sugar's capacity for preservation. Additionally, according to historical accounts, spices were once used to preserve meat and stop bacteria from growing.

In the history of mankind, food additives have been used for centuries. The most important function of these ingredients is to impart artificial flavors and improve the quality of food and beverages (Sahu, 2016). History records the addition of additives to food as far back as 1500 BC in Ancient Egyptian papyri.

Food additives generally do not have any nutritional value and are usually added to food during preparation, manufacturing, packaging, or treatment to alter its chemical, biological, sensory, and physical properties. They also serve as thickeners, stabilizers, emulsifiers, anti-caking agents, flavor enhancers, and preservatives, as well as preservatives, antioxidants, acidity regulators, thickeners, stabilizers, emulsifiers, and emulsifiers (Wu, Richards, et al., 2022). In addition, food additives have been gaining popularity in food processing industries due to consumer preferences and commercial advantages, such as longer shelf lives, uniform compositions, and ease of processing (D'Incecco et al., 2021). In both animals and humans, dietary fiber is essential for weight management, diabetes, immune regulation, dental health, colon health, cardiovascular disease prevention, and digestion (Jha et al., 2017).

Alternatively, food additives have been criticized for their health impacts, such as cancer, asthma, allergies, and behavioural disorders in children. Therefore, regulatory authorities and law enforcement agencies have passed strict laws regarding food additives' approval and control. Nevertheless, in the last few decades, food science and technology has swiftly advanced, resulting in an increased number and variety of food additives. Moreover, the quality and safety of food additives have developed as well (Shafaq Asif et al., 2020).

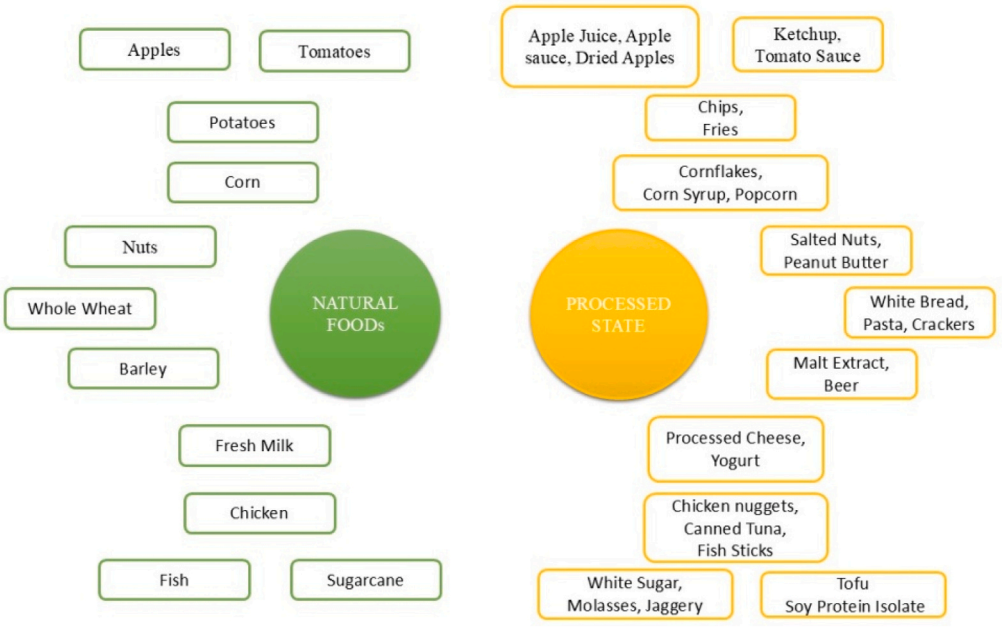

Fig. 5. Natural food vs processed food.

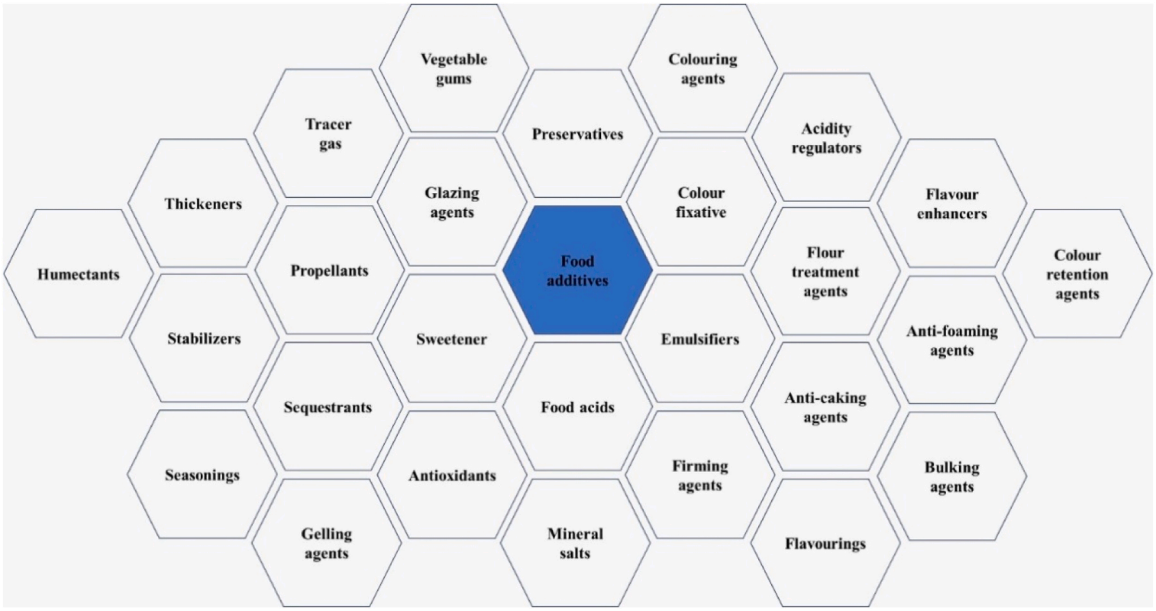

Fig. 6. Types of food additives.

9. Healthy diet

Healthy diet is crucial for maintaining good health and reducing the risk of chronic diseases such as obesity, diabetes, cardiovascular disease, and certain cancers (Fig. 3). It emphasizes the consumption of nutrient-dense foods, such as fruits, vegetables, whole grains, legumes, and lean proteins. Unhealthy diets, characterized by excessive consumption of processed foods, sugary beverages, and unhealthy fats, contribute significantly to the development of these diseases. The traditional approach of focusing on individual nutrients or food groups is limited. Therefore, an overall examination of dietary patterns provides a more comprehensive understanding of the relationship between diet and health.Several contemporary dietary patterns have been studied extensively, such as the Mediterranean diet, the Dietary Approaches to Stop Hypertension (DASH) diet, and the Healthy Eating Index. These patterns are characterized by a high intake of fruits, vegetables, whole grains, legumes, and lean proteins, while limiting the consumption of processed foods, sugary beverages, and saturated fats (Cena & Calder, 2020).

The evidence from various studies supports the health benefits of these dietary patterns. They discuss how these diets are associated with lower risks of obesity, diabetes, hypertension, cardiovascular disease, and certain types of cancer.Additionally, they highlight the potential mechanisms through which these diets exert their positive effects, such as reducing inflammation, improving insulin sensitivity, and promoting a healthy gut microbiota.The cultural, social, economic, and environmental factors influence our food choices. These factors impose great challenges in implementing healthy dietary patterns in real-world settings. Thus,healthy diet plays a crucial role in maintaining good health

Table 1
Food additives with their permissible limit in particular food product (Codex Alimentarius Commission, 2022).

S. NO	Type of food additives	Name of additives	Food product	Permissible limit
1	Preservatives	Sodium benzoateand Potassium benzoate	Chewing gum	1500 mg/kg
		Benzoyl peroxide	Whey products	100 mg/kg
		Calcium propionate	Whey protein cheese	3000 mg/kg
2	Artificial sweeteners	Aspartame	Flavoured fluid milk drinks	600 mg/kg
		Saccharin	Jams, jellies	200 mg/kg
		Cyclamate	Cocoa mixes (syrups)	250 mg/kg
		Aspartame	Breakfast cereals	1000 mg/kg
		Acesulfame k	Frozen fruit	500 mg/kg
3	Antioxidant	Ascorbic acid	Flour	300 mg/kg
		Tocopherol	Beverage	200 mg/kg
		Butylated hydroxy anisole (BHA)	Vegetable oils and fats	200 mg/kg
		Thiodipropionates	Ready-to-eat savouries	200 mg/kg
4	Emulsifiers	Polysorbates	Whipped creams	1000 mg/kg
		Mono- and diglycerides of fatty acids	Thermally oxidized soya bean oil	5000 mg/kg
		Triethyl citrate	Water-based flavoured drinks	200 mg/kg
5	Acidulants	Citric acid	Fruit juice	3000 mg/kg
		Phosphoric acid	Cheese	880 mg/kg
6	Anti-caking agents	Silicon dioxide	Powdered sugar	1500 mg/kg
		Calcium silicate	Powdered sugar	15,000 mg/kg
		Magnesium carbonate	Fermented vegetable	5000 mg/kg
		Calcium carbonate	Dried whey	10,000 mg/kg
7	Color	Zeaxanthin	Flavoured fluid milk drinks	100 mg/kg
		Azorubine (carmoisine)	Unripened cheese	150 mg/kg
		Brilliant black	Dairy-based desserts	150 mg/kg
		Canthaxanthin	Fruit fillings for pastries	15 mg/kg

and preventing chronic diseases. Therefore, shift towards these dietary patterns can have substantial public health benefits (Yu et al., 2018).

10. Natural food and processed food

Natural foods are typically referred to as minimally processed or unprocessed foods that are obtained from nature. These foods are often consumed in their most basic and whole form, without any significant alterations or additives. Natural foods are generally considered healthier because they retain their essential nutrients, fibre, and natural flavours. They are often lower in added sugars, unhealthy fats, and artificial ingredients that can be found in highly processed foods (Moubarac et al., 2014).

Processed foods refer to food products that have undergone various mechanical or chemical processes to alter their natural state. These processes typically involve adding ingredients, such as preservatives, flavourings, or additives, to improve the taste, texture, or shelf life of the food. The extent of processing can range from minimal, such as washing and packaging fruits and vegetables, to extensive, involving multiple steps like refining, cooking, and packaging (Jones & Clemens, 2017).

Table 2
Food additives and disorders in children.

Food additives	Disorder	Food products	References
Trans fats	• Heart disease • Diabetes (type−2) • Stroke	• Cookies • Popcorn • Cakes and Pizza	Fahmy (2016)
Sodium nitrite	• Pancreatic cancer • Respiratory disorders	• Processed meats • Sausages	Karwowska and Kononiuk (2020)
Monosodium glutamate	• Metabolic disorder • Diabetes	• Chips and crisps • Instant noodles	Muneer et al. (2020)
Artificial food colors	• Hyper active • Cancer	• Candies • Jams • Beverages	Okafor et al. (2016)
Aspartame	• Phenylketonuria	• Chewing gums • Sodas • Ice creams	Newbould et al. (2021)
Butylated hydroxy anisole (BHA) & Butylated hydroxytoluene (BHT)	• Neurological effects • Cancer	• Potato chips • Butter	Ghatak and Sen (2016)

Processed foods often contain a long list of ingredients, including artificial additives, flavour enhancers, stabilizers, and preservatives. These ingredients are added to enhance taste, improve texture, or increase the product's shelf life. Examples include packaged snacks, frozen meals, canned goods, and sugary beverages (Awuchi et al., 2020). Processing can affect the nutritional content of foods. In some cases, nutrients may be lost during processing due to exposure to heat, light, or air. For instance, refined grains have a lower nutritional value compared to whole grains, as the refining process removes the bran and germ, which contain fibre, vitamins, and minerals (Ritter & Mostert, 2019). Processed foods are often marketed for their convenience. They are typically pre-packaged, ready-to-eat, or require minimal preparation. Examples include microwave dinners, instant noodles, and fast-food items (Monteiro et al., 2019).Processing techniques, such as canning, freezing, or adding preservatives, extend the shelf life of processed foods, allowing them to be stored for longer periods. This increases their availability and convenience but may come at the expense of certain nutrients and freshness (Ghoshal, 2018). While some processed foods can be part of a balanced diet, many heavily processed options are associated with negative health effects. These include an increased risk of obesity, heart disease, type 2 diabetes, and certain types of cancer. Processed foods are often high in added sugars, unhealthy fats, and sodium, while being low in fibre and essential nutrients (Márcio, 2014).

It's important to note that not all processed foods are inherently unhealthy. Some minimally processed foods, like frozen vegetables, canned beans, or yogurt, can be nutritious options. However, it's generally recommended to prioritize whole, unprocessed or minimally processed foods, such as fruits, vegetables, whole grains, lean proteins, and nuts, for a well-rounded and healthy diet (Phillip et al., 2020).

11. Food additives

Food additives are substances that are added to food during processing to improve its flavour, appearance, texture, and shelf life (Fig. 5). They serve various functions and can be classified into different types based on their purposes. Here are some common types of food additives and their functions:

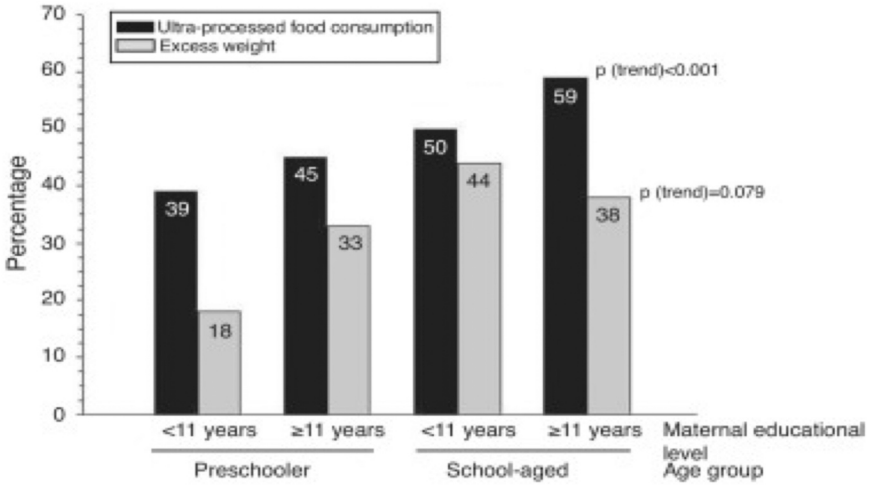

Fig. 7. Statistics related to obesity due to excess consumption of Ultra-processed food (Sassi et al., 2016).

11.1. Preservatives

Preservative is a substance which when added to food is capable of inhibiting, retarding or arresting the process of fermentation, acidification or other decomposition of food. These additives help prevent the growth of bacteria, fungi, and other microorganisms that can spoil food (Mirza et al., 2017).

They are classified into Class I and Class II preservatives.Class I preservatives are natural preservatives they include common salt, sugar, dextrose, glucose, spices, vinegar or acetic acid, honey, edible vegetable oils.Class II preservatives are man-made they include chemicals such as, benzoic acid, sulphurous acid including salts thereof, nitrates or nitrites, sorbic acid and its sodium, potassium and calcium salts, propionates of calcium or sodium, sodium, potassium and calcium salts of lactic acid, nisin, methyl or propyl parahydroxy benzoates, sodium diacetate. Commonly used in Jams, Jellies, Sauces and Ketchups (Sangani et al., 2023).

Artificial sweeteners: Artificial sweeteners include Saccharin, Dulcin, Cyclamate, Aspartame, Acesulfame k (Naik et al., 2024).

Antioxidants: Antioxidants are used to prevent or slow down the oxidation of fats and oils, which can lead to rancidity and spoilage. They help extend the shelf life of food products. Examples include vitamin C (ascorbic acid), vitamin E (tocopherols), and butylated hydroxy anisole (BHA) (Wu et al., 2022).

Permitted Antioxidants: Ethyl, Propyl, octyl, dodecyl gallates, butylated hydroxyanisole (BHA) tertiary butyl hydroquinone (TBHQ), resin guaic, ascorbic acid, tocopheropl.

Emulsifiers: Emulsifiers help stabilize mixtures of water and oil, preventing them from separating. They are commonly used in products like salad dressings, mayonnaise, and ice cream.Examples includeLecithin, Mono- and diglycerides, Polysorbate (Ketomäki et al., 2021).

Stabilizers and thickeners: These additives help improve the texture and consistency of food products. They prevent ingredients from separating or settling, and they can enhance the mouthfeel.Examples include Carrageenan, Xanthan gum, Pectin (Yu, 2023).

Flavour enhancers: These additives are used to enhance or intensify the taste and aroma of food. They can improve the overall flavour profile and make food more appealing. Examples include monosodium glutamate (MSG), yeast extract, and ribonucleotides (Awuchi et al., 2020).

Sweeteners: Sweeteners are used to add sweetness to food and beverages without the calories associated with sugar. They can be artificial or natural.Artificial sweeteners include Saccharin, Dulcin, Cyclamate, Aspartame, Acesulfame k (Babanovska-Milenkovska et al., 2022). Natural sweeteners include Stevia, Monk fruit extract.

Commonly used for in Non-alcoholic beverages, Chocolate bars, Jellies, Fruit Juices, Soft drinks (carbonated beverages and low-calorie drinks), Food sweetener tablets and concentrated liquids (Silva et al., 2021).

Colorants: Colour additives are used to enhance or restore the colour of food products. They make food visually appealing and can compensate for colour loss during processing.

The colouring matter in food may be (a) Natural and (b) Synthetic colours.

Natural colours: Chlorophyll, Carotenes, Cantaxanthene, Riboflavin, Annatto, Saffron, Turmeric, Curcumin, Caramel etc.

Synthetic colours: Synthetic colours are of importance as they are widely used in different foods. They are classified as acidic and basic dyes (Silva et al., 2022).

11.2. Permitted colours

Red shades: Carmoisine, Ponceau 4 R, Erythrosine.
Yellow shades: Sunset Yellow FCF, Tartrazine.
Blue shades: Brilliant Blue FCF, Indigo, Carmine.
Green shade: Fast Green FCF.
Non permitted colours: Certain unpermitted colours often appear as adulterants in foods.

Metanil yellow, Rhodamne B, Orange G, Blue VRS, Auramine, Certain unidentified water, oil soluble colours (Mishra, 2020).

Acidulants: Acidulants are used to add acidity to food products, adjust pH levels, and enhance flavour. They can also act as preservatives. Examples include citric acid, malic acid, and phosphoric acid (Abedi-Firoozjah & Tavassoli, 2024).

Anti-caking agents: These additives prevent ingredients from clumping or sticking together, especially in powdered or granulated products. They improve flowability and prevent moisture absorption. Examples include silicon dioxide, calcium silicate, and magnesium carbonate (Pandey & Upadhyay, 2012).

12. Effects of food additives on children

Research funded by the UK's Food Standards Agency and published by The Lancet in September 2007 indicated that a combination of additives commonly found in children's food contributes to increased hyperactivity levels. The study specifically focused on artificial colours and a sodium benzoate preservative, revealing their potential negative effects on children's behaviour. The research suggested that further investigations are necessary to identify other additives with similar impacts and to understand if mood and concentration disturbances might affect adults as well (Kraemer et al., 2022).

Table 3
Research and Statistics.

S. NO	Country	Evaluated additives	Inference	Reference
1	Kuwait	Artificial colorants: erythrosine, rapid green, indigo-carmine, brilliant blue, brilliant black, and chocolate brown HT. Tartrazine, sunset yellow, carmoisine, allura red, orange G, and allura red are also used.	3141 children over the age of five consumed. The consumption of the 4 dyes (tartrazine, sunset yellow, carmoisine, and allura red) under analysis was 2–8 times above the ADI.	Husain, et al. (2007)
2	Brazil	Artificial colors include tartrazine, amaranth, and sunset yellow.	150 kids under the age of 10 consumed. Amaranth and sunset yellow consumption may be above the ADI in 20 % and 90 % of kids, respectively.	Schumann et al. (2008)
3	Switzerland	Sunset yellow dye.	With 2390 people of all ages, the population is adequately represented. The average and maximum consumption rates in the 1-to−10-year age group exceeded the ADI.	Sardi et al. (2010)
4	India	Artificial colors include dazzling blue, erythrosine, tartrazine, carmoisine, and sunset yellow.	consumption by 245 people between the ages of 4 and 18. Erythrosine exceeded the ADI value when taking into account typical intake levels. Considering the 95th percentile values for maximum consumption, sunset yellow also surpassed the ADI in addition to erythrosine.	Dixit et al. (2011)
5	Sweden	Preservatives nitrites and nitrates.	Consumption by 2259 children below the ADI. However, considering the endogenous conversion of nitrate to nitrite, 12 % of 4-year-olds may exceed the ADI.	Larsson et al. (2011)

In February 2008, the American Academy of Pediatrics supported the idea of a low-additive diet as a valid approach for children with ADHD. They acknowledged the complexity of the study, praising its rigorous methodology and recognizing small yet statistically significant differences in behaviours of children who consumed additives. Even skeptics were compelled to reconsider their doubts about the influence of food on children's behaviour based on the study's findings.

13. Diseases caused by habitual intake of food additives

1. Allergic Reactions: Food additives, such as artificial colours, preservatives, and flavour enhancers, may trigger allergic reactions in susceptible individuals. Children are particularly vulnerable to allergies, and additives like tartrazine (Yellow 5) and sodium benzoate have been associated with allergic symptoms like hives, eczema, asthma, and gastrointestinal issues (Rao et al., 2021).

2. Hyperactivity and Behavioural Issues: Certain food additives, especially artificial food colours like Red 40, Yellow 5, and Yellow 6, have been linked to hyperactivity and behavioural problems in some children. These additives may exacerbate attention deficit hyperactivity disorder (ADHD) symptoms or cause restlessness, impulsivity, and difficulty concentrating (Stevenson, 2007).

3. Asthma and Respiratory Problems: Sulphites, commonly used as preservatives in foods like dried fruits, processed meats, and baked goods, can trigger asthma attacks and respiratory issues in susceptible children. It is important for parents of asthmatic children to be aware of the presence of sulphites in food products (Worm & Lotze, 2010).

4. Digestive Disturbances: Some food additives, such as artificial sweeteners (e.g., aspartame, saccharin) and certain emulsifiers, may cause digestive disturbances, including diarrhoea, bloating, and abdominal pain. These effects may be more pronounced in children who are already prone to gastrointestinal issues (Jedrzejczyk et al., 2020).

5. Developmental Concerns: Although more research is needed, some studies suggest a potential link between certain food additives and developmental issues in children. For instance, high levels of monosodium glutamate (MSG) have been associated with cognitive and neurological effects, although the evidence is not yet conclusive (Mueller et al., 2015).

6. Nutritional Impact: Food additives are often found in processed and packaged foods, which are typically low in nutritional value. Frequent consumption of such foods, rich in additives, can displace nutrient-dense whole foods from a child's diet, potentially leading to nutrient deficiencies and related health concerns (Table 2).

14. Research and statistics

According to the Centers for Disease Control and Prevention (CDC), more than 90 percent of the US population has been found to be exposed to BPA, and infants and children have the highest dailyintake estimates (Fig. 7) (Table 3). There has been evidence that children exposed to BPA are at greater risk for polycystic ovary syndrome, obesity, and cardiometabolic diseases (Vom Saal & Vandenberg, 2021).

In a study conducted in Turkey in 2016–2018, it was found that exposure to BPA has a negative effect on neuroendocrine, reproductive, and metabolic regulation, leading to polycystic ovary syndrome in adolescent girls (Akgül et al., 2019). Epigenetic changes in an

Adipogenic gene have been shown to be reversible when BPA is administered at low doses Longo et al. (2020). Study findings indicate that obesity is associated with higher urinary BPA concentrations in 2638 participants aged 6–19 years Trasande et al. (2012). A statistically significant association has been found between BPA exposure in children and adolescents aged 6–18 years and increases in waist circumference, body mass index, blood pressure, and glycemia Amin et al. (2019). As a result of numerous major manufacturers previously taking voluntary steps to remove BPA from their products, the FDA banned its use in baby bottles and children's drinking cups beginning in 2012. In spite of the ban on BPA in baby bottles, infants are still exposed to this substance through their mothers' breast milk or during pregnancy. The consumption of canned food and carbonated beverages should be avoided by pregnant and lactating women (Kaur, 2022). In response to the FDA's ban on producing bottles with BPA, bisphenol F and bisphenol S alternative compounds were synthesized. It has been shown, however, that some newly synthesized compounds are harmful to humans, including children Encarnação et al. (2019). In 2015, the International Agency for Research on Cancer categorized processed meat (which includes meat that has been salted, dried, or otherwise altered to improve flavor and preservation) as a Group 1 human carcinogen. Such meat processing leads to an increased formation of N-nitroso compounds, which are associated with colon cancer risk Bouvard et al. (2015). Children eat 45 % more when they see food advertisements, while adults consume more healthy and unhealthy snacks after watching snack food advertisements. In both experiments, advertising increased consumption of other products not shown in the ads, and this was not influenced by hunger or other conscious factors (Harris et al., 2009).

15. Conclusion

This review paper emphasizes the negative effects of food additives and promotes a disease-free society for future generations. The regular intake of nutritional foods made from natural and nutrient-rich ingredients like traditional rice and millets can play a significant role in improving the overall health and well-being of both children and adults. By shifting our dietary choices towards these traditional grains, we can reduce the consumption of processed and additive-laden foods that have been linked to chronic lifestyle disorders. The high nutritional content of traditional rice and millets, combined with their natural properties and minimal processing, provides a viable solution to combat the harmful effects of additives on our health.

By promoting the consumption of these nutritional drinks and bars, we can contribute to the prevention of lifestyle diseases, enhance immune function, and improve overall nutrition. Furthermore, by preserving and reintroducing traditional rice and millets into our diets, we can also support local agricultural practices, biodiversity, and sustainable food systems. It is essential to raise awareness among individuals, families, and communities about the benefits of these traditional grains and their potential to transform our modern diet. Further research and studies are warranted to explore the specific health benefits and optimal utilization of traditional rice and millets in various food products.

We conclude that embracing the regular consumption of nutrition rich traditional foods made from traditional rice, millets and other grains can pave the way for a healthier, more sustainable, and disease-free future for generations to come.

CRediT authorship contribution statement

S.Divya Sri: Writing – original draft, Formal analysis. **M. Udayamathi:** Supervision, Conceptualization. **D Yuvaraj:** Writing – review & editing, Supervision, Project administration. **M. Ganesh:** Writing – original draft. **S. Pramila:** Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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