

THE IMPACT OF FOOD ADDITIVES ON YOUTH AND ADOLESCENTS

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ABSTRACT

The present study analyzes the dietary patterns, health behaviors, and determinants among the young and adolescent population in Romania in the context of growing global concerns regarding the impact of lifestyle on health, including obesity, poor nutrition, and excessive exposure to food additives. Through a critical review of specialized literature, this approach analyzes the eating habits of young Romanians, their perceptions of health, and the influence of various variables on the formation and perpetuation of these behaviors. Particular attention is paid to the negative impact of frequent consumption of ultra-processed foods, which contain food additives with potentially harmful effects on metabolic, neurological, and gastrointestinal health, especially among young people and adolescents at a critical stage of development. The conclusions of the study highlight the fact that, by the precautionary principle, many international public health authorities have recently initiated recommendations aimed at limiting the consumption of ultra-processed foods and promoting superior choices from a nutritional point of view, characterized by a reduced or absent content of additives, to prevent long-term risks for the younger generation.

Key words: youth nutrition, adolescents' health, food safety, nutritional education, food additives, artificial sweeteners, ultra-processed foods, metabolic diseases, behavioural disorders, gut microbiota

INTRODUCTION

The continuous evolution of technology and the expansion of the consumption of packaged foods in contemporary society have significantly increased the use and need for food additives.

The transition from adolescence to young adulthood is considered a period of transformation, associated with changes in eating behavior. This stage of life, associated with a minimal risk of health problems, faces in recent years problems related to obesity, metabolic diseases, and cardiovascular

diseases, as a result of the change in eating behavior, in the sense of adopting an unhealthy diet. Adolescence is a period of immense growth, second only to the first year of life, and as such nutrient requirements increase substantially [1].

Overweight obesity can lead not only to physiological medical complications but also to severe psychological effects [2].

The presence of these risk factors in obese children and adolescents increases the risk for later development of type 2 diabetes and cardiovascular disease in young people.

Adolescents with obesity have a significantly increased risk of accelerated atherosclerosis [3]. Even in the absence of metabolic abnormalities, there is a strong association between obesity in adolescence and later development of the metabolic syndrome cluster in adulthood [4].

Young people's social and emotional well-being and self-esteem are particularly affected during this important developmental phase of life, with these negative consequences continuing into an individual's later life [5]. Over 90% of patients with eating disorders are diagnosed before the age of 25. Eating disorders occur in all racial and ethnic groups, with a 9:1 female predominance [1].

The effects of stress on metabolism and food choice plus the psychosocial stress experienced by adolescents with obesity may be critical points to consider [6]. Understanding the factors that influence these behaviors is very important for developing effective public health strategies, as the frequent consumption of highly processed and refined foods poses significant health risks.

Scientific progress and the development of food technology have led to the discovery and characterization of a considerable number of new compounds capable of performing various functions in processing and preservation processes. Globally, there are more than 2000 additive substances, an aspect that arouses special interest among specialists, considering that these compounds raise problems related to their metabolism and elimination from the human body, which can generate adverse effects on health. At the European level, approximately 397 compounds are authorized, according to Regulation (EC) no. 1333/2008, being classified into 27 distinct classes and which are constantly being re-evaluated. Food additives that have an E added at the beginning are those regulated by European regulation (the "E"

prefix means "Europe"). In addition, the number after the "E" classifies them according to the main technological use of these additives (numbers 100–199 are color additives, while numbers 500–599 are acidity regulators and anti-caking agents [7].

Their monitoring and the effects produced by them are carried out by health agencies, such as the FDA in the USA or the EFSA in Europe. Food additives can come from natural sources or can be obtained by synthesis, to integrate them into food technology to increase the commercial qualities of food products. The food additive is defined by the Food and Drug Administration (FDA) as "any substance the intended use of which results in or may reasonably be expected to become a component of or otherwise affect the characteristics of any food"[8].

Ultra-processed products are made to be very tasty and attractive, with a long shelf life, and can be consumed anywhere and anytime. Their formulation, presentation, and marketing often promote overconsumption [9]. It is estimated that more than 40% of annual deaths in Europe are attributable to medical or surgical conditions, including cardiovascular disease, obesity-related neoplasms, and diabetes are conditions directly related to an unbalanced diet. This fact underlines the persistent exposure of the population to food risks, often in the absence of an adequate understanding of their implications. Promoting healthy and sustainable food systems for current and future generations is essential to achieving the United Nations Sustainable Development Goals for 2030 [10,11].

Demographic growth at the global level, as well as the expansion of consumer societies, were determining factors in the emergence and development of the food additives industry. The expansion of the use of these substances today is mainly justified by the need to

diversify the supply of food products, especially ready-made ones, by optimizing their organoleptic characteristics, durability, and stability.

MATERIALS AND METHODS

This section of the paper presents the sources of information used, the electronic search strategy, the study selection process, the methodology used to minimize bias, the data extraction methods, and the analyses performed [12].

Providing this information ensures transparency of the study, understanding how the research was conducted, what the criteria were for selecting relevant studies, and the steps to minimize bias. The rigor and scientific integrity of the study are highlighted, as well as the comprehensive approach taken to collect and analyze data. To carry out this study, a comprehensive analysis of several databases was carried out to identify the sources of relevant information.

The following databases were used as information sources: major databases such as ScienceDirect, Springer, Wiley, PubMed, Scopus, and Web of Science covering the period 2014–2025 were searched to ensure that the most recent studies were included in the review.

The search strategy included several stages:

- The search terms were established as young people, adolescents, food additives, metabolic diseases, health risks, obesity, diabetes, and behavioral disorders.

- publication limits: 2014-2025, English language.

The search strategy was designed to be comprehensive and specific, aiming to include all relevant studies related to the topic of foods containing food additives among youth and adolescents.

The selection process involved several stages:

- Initially, all identified studies were screened based on their titles and abstracts to determine their relevance to the research. Irrelevant studies were excluded at this stage.

- Studies that met predefined inclusion criteria were selected for further analysis.

Selected studies were included in the systematic review, critically appraised, and synthesized.

The methodologies used in this review were designed to minimize bias. The comprehensive research carried out in this study aimed to identify all relevant studies on the complex relationship between the dietary habits of today's youth and adolescents and the possible pathologies associated with the content of food additives.

Thus, the findings derived and presented in the present study are based on the most current and relevant evidence available. Inclusion criteria were carefully determined in advance to ensure that the selection process was transparent, systematic, and unbiased.

These criteria were selected based on the research question and study objectives. For example, the study included both theoretical and experimental studies that investigated the relationship between eating habits specific to today's youth and adolescents and the possible pathologies associated with the content of food additives.

These criteria were established to ensure that the selected studies were relevant and appropriate for this review.

Risk of bias analysis consisted of critically evaluating the selected studies to identify any potential sources of bias that could affect the validity of the results.

The data extraction process aimed to retrieve relevant information from the selected studies. To gather additional information about the research topic, qualitative approaches such as literature reviews, case studies, or qualitative interviews were used.

RESULTS AND DISCUSSIONS

The increasing focus on public health in the context of identified threats results from the observation of alarming changes in the state of the population, as indicated by epidemiological data from different countries. This also refers to undesirable social behaviors that have a direct impact on the health of the population [13].

In Romania in recent years, a substantial change in the dietary habits of the population has been observed resulting from the "adoption" of the Western lifestyle and the orientation towards ultra-processed foods, implicitly increasing the consumption of food additives in their composition. Changes in eating habits from eating unprocessed or minimally processed foods to ultra-processed foods raise serious concerns about the health of the population.

Potential contaminants in packaging and processing material and the presence of food additives and other industrial ingredients, as well as nutrient-poor profiles (higher energy, salt, sugar, and saturated fat, with lower levels of dietary fiber, micronutrients, and vitamins) seriously harm consumer health [14].

Western diets are closely linked to the epidemics of obesity, high blood pressure, diabetes, atherosclerosis, Chron's disease, coronary heart disease, behavioral disorders, and cancer, in addition, about 35% of cancers are linked to diet [7]. These diets affect liver function by increasing triglycerides, low-density cholesterol, blood glucose, non-esterified fatty acids associated with hepatic steatosis, and insulin resistance.

It also disrupts the circadian rhythm, reduces sleep duration, increases the production of pro-inflammatory cytokines (TNF- α , IL-1 β) and secondary products of oxidative scavenging such as malondialdehyde, and decreases the body's

antioxidant capacity. Brain inflammation and oxidative stress are causes of neurodegenerative diseases, psychiatric diseases such as anxiety and depression [15]. In the absence of correct information for young people and teenagers regarding the consumption of unhealthy foods, they represent the vulnerable category to the impact these substances produce on the human body.

Obesity and other metabolic diseases, autism spectrum disorders, and the increasing incidence of various types of cancer at younger ages appear to be the consequence of consuming ultra-processed, additive-rich foods such as soft drinks, fast food, confectionery, and industrial frozen foods [16]. Higher exposure to ultra-processed foods was associated with a higher risk of adverse health outcomes, particularly cardiometabolic, common mental disorders, and mortality outcomes [17]. Most food additives cause unwanted effects through metabolism, such as aspartame, which is hydrolyzed to aspartic acid, phenylalanine, and methanol in the gut, while others are not metabolized but still have toxic effects, such as acesulfame-K which interacts with deoxyribonucleic acid (DNA) leading to genotoxicity [7].

Several studies have suggested a link between the consumption of certain food additives and an increased risk of developing cancer [18,19]. Evidence has accumulated to suggest an association between consumption of "ultra-processed foods" (which generally contain a wide range of food additives) and increased risk of several chronic diseases [20]. Evidence for the relationship between food processing and health outcomes has been steadily increasing. An obvious example is industrial trans fats, produced by the process of partial hydrogenation in the manufacture of a large number of products, including margarine, biscuits, and other "long-life" bakery products. Trans fats are a cause of

cardiovascular disease [21].

Information on the impact of regular and cumulative consumption of food additives on human health and their potential "cocktail" effects or interactions is still lacking [22]. Exposure to multiple chemicals from different sources at doses close to or well below regulatory levels can lead to additive, synergistic, antagonistic, or potentiating effects driven by interactions, the so-called "cocktail" effect.

It has been found that more than 50% of the food products on the market contain more than one food additive, which leads to the potentiation of their effects through synergism.

Teens are the specific age group for dessert and dairy consumption, breakfast cereals, cereal bars, and pastries. So, they are the biggest consumers of carrageenan E407, lactic acid E270, calcium propionate E282, polyphosphates E452, hydroxypropyl distarch phosphate E1442. A relatively high intake of carbohydrates is also found among young people and teenagers. Young people and teenagers represent an important category of consumers of industrial sauces and processed meat, so they register the highest intakes of sodium nitrite E250, sodium erythorbate E316, triphosphates E451, and cochineal red E120, which are used especially in processed meat. They also had the highest intakes of citric acid E330, xanthan gum E415, potassium sorbate E202, guar gum E412, potassium metabisulphite E224, and plain caramel E150a. Young people and teenagers are also the biggest consumers of the four main types of sweeteners (E950 acesulfame K, E951 aspartame, E955 sucralose, E960 stevia glycosides), and E440 pectin's, E160a carotenes, E331 sodium citrates, E301 sodium extract, E301 ascorbate, E301 caramel ammonia sulfite extract, E100 curcumin, E252 potassium nitrate, E338 phosphoric acid, E16b

lutein, E211 sodium benzoate, E472 esters of mono- and diglycerides and E212 potassium benzoate, additives found in sweet or artificially sweetened beverages. Carrageenans have been linked to fasting hyperglycemia and exacerbated glucose intolerance and hyperlipidemia. Due to their high binding to dietary proteins, they are mainly used in dairy and meat products. Carrageenan that mimics native glycosaminoglycans has emerged as a viable candidate in tissue engineering and regenerative medicine applications in recent years [23]. E171 influences the growth of pro-inflammatory immune cells and cytokines in the colonic mucosa and causes greater changes in the composition of the gut microbiota [24]. Some food additives can interfere with hormones and influence growth and development. It is one of the reasons why so many young people are overweight [23].

The consumption of food varieties rich in food additives and compounds generated by food processing can influence the development of various disorders. Worrying results, mainly derived from experimental animal and/or cell studies, have recently emerged regarding several additives.

For example, nitrates, carrageenan, glutamate, artificial sweeteners, phosphates, emulsifiers, caramel, tartrazine, and butylated hydroxyanisole/butylated hydroxytoluene (BHA/BHT) have previously been linked to metabolic, gut microbiota, or endocrine disruption, together with carcinogenic, inflammatory, and oxidative effects. Also in May 2021, following an updated assessment, EFSA revised its position on titanium dioxide (TiO₂) and stated that this additive can no longer be considered safe [25-27]. Food-grade titanium dioxide is a white additive used in baked goods, dressings, candy, chewing gum, yogurt, and personal care products such as toothpaste. It is used as an excipient in the

pharmaceutical industry. This additive causes intestinal inflammation, accumulates in the liver, and can cause colorectal cancers [28]. TiO₂ and silver nanoparticles have an impact on the intestinal microbiota because these nanoparticles have antimicrobial activity by disrupting bacterial cell walls and inducing apoptosis through the production of reactive oxygen species (ROS) [29,30].

Tartrazine hurts human health, such as hyperactivity, allergies, and asthma, causing mental disorders and a decrease in intellectual memory [31]. Tartrazine is considered a cheaper substitute for natural food colors such as curcumin and saffron and is the second most used food color, generally derived from coal tar. Cardiomegaly, hepatorenal damage, and splenic pigmentation are some complications of tartrazine consumption [23].

Aspartame, a sweetener used in soft drinks, inhibits the synthesis and release of the neurotransmitter's dopamine, norepinephrine, and serotonin, which are important in the development of depression [32]. Aspartame can also cause learning problems, headaches, seizures, migraines, irritability, anxiety, depression, and insomnia. It can influence increased cortisol levels and excess free

radicals, increasing the brain's vulnerability to oxidative stress, with neurobehavioral consequences. Unlike synthetic additives, natural food additives contribute to extending the shelf life of products, simultaneously reducing the risk of adverse effects.

Propyl gallate, theaflavins, and tea polyphenols are food additives approved for use by the National Food Safety Standard, Standard for the Use of Food Additives (GB2760–2024) [33]. In recent decades, the availability and variety of ultra-processed products sold have grown substantially and rapidly in countries with different levels of economic development, but especially in many highly populated low- and middle-income countries [34].

The replacement of unprocessed or minimally processed foods and freshly prepared foods and meals with ultra-processed foods and beverages is leading to the high and growing global burden of obesity and other diet-related non-communicable chronic diseases [35,36]. With obesity, cardiovascular disease, and cancer on the rise globally, the United Nations (UN) has designated 2016-2025 as the Decade of Action on Nutrition [9].

CONCLUSIONS

The use of chemical additives in the food industry is associated with significant health risks, which requires the elimination of their consumption. According to this study, chemical food additives can trigger severe ailments, the severity of which varies depending on the concentration and duration of exposure. Although some additives do not exert a direct impact, they may indirectly contribute to the appearance of physiological dysfunctions.

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A correlation was established between the analyzed additives and the pathologies they can generate, especially among young people and adolescents.

Health education and caloric deficit can be ways to change the eating behaviors of youth and adolescents. Family meals during adolescence can be considered protective against developing an unhealthy eating habit in young adulthood.

Institutional Review Board Statement

Not applicable

Informed Consent Statement

Not applicable

Data Availability Statement

The data presented in this study are available on reasonable request from the corresponding authors.

Conflicts of Interest

The authors declare no conflict of interest.

Author's contribution

The authors GS, CND, SST, CD, and NM had an equal scientific contribution to this research as IDF, the first author.

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