SANAMED
Online First: October, 2024
ISSN-1452-662X

DOI: 10.5937/sanamed0-52856
Review article

CHRONIC NON-COMMUNICABLE DISEASES CAUSED BY ADOLESCENT EATING DISORDERS

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Primljen/Received: 19. 08. 2024. Prihvaćen/Accepted: 15. 10. 2024. Published Online First: October 2024.

Abstract: Decreased satisfaction with physical appearance during adolescence is significantly linked to reduced self-esteem and an increased prevalence of obesity and other chronic non-communicable diseases (NCDs). A major issue in today's world is the influence of media, which serves as the primary channel through which ideals of physical appearance and attractiveness are transmitted. According to a 2015 study, adolescents spend an average of 17 hours per week watching television. Scientific evidence indicates that an active lifestyle provides health benefits and prevents the occurrence of numerous chronic non-communicable diseases, while improper diet and physical inactivity among adolescents contribute to the development of these diseases. Improper nutrition during adolescence can be a significant risk factor for the development of NCDs. These diseases, including cardiovascular diseases, diabetes, and certain forms of cancer, often have complex causes, but dietary habits can be identified as a common risk factor. Excessive intake of saturated and trans fats, cholesterol, and a high consumption of processed foods are associated with an increased risk of cardiovascular diseases. Improper dietary habits can also contribute to the development of type 2 diabetes and increase cancer risk. Adopting a balanced and nutritionally rich diet, along with regular physical activity, can help prevent and manage these conditions. This review paper is based on a search of the scientific literature published in the last ten years, with a special focus on original research articles published in the last five years from the scientific databases: PubMed, SCOPUS, MEDLINE, and SCI index.

Keywords: public health, prevention, nutrition, risk factors.

INTRODUCTION

The prevalence of chronic non-communicable diseases caused by eating disorders is evident, with data showing that one in five deaths worldwide is a consequence of dietary issues (1). Despite this, the marketing of unhealthy foods and beverages on television, in newspapers, and online continues unabated. It is well-known that our food purchasing and consumption decisions are not solely based on evidence-based information but are significantly influenced by our environment, shaped by the culture of the surroundings, including advertising and media, which are readily available to everyone today (2). This leads to diminished control or moderation in the intake of healthy foods among both adults and children, resulting in either overweight or malnutrition, which consequently leads to the development of numerous non-communicable chronic diseases (2). Obesity, defined as excessive body weight, poses a significant public health challenge due to its wide range of metabolic complications, particularly type 2 diabetes mellitus and other components of metabolic syndrome. This issue affects both adult and pediatric populations, leading to an increased risk of associated endocrine, metabolic, cardiovascular, and other health disorders among adolescents. Globally, the prevalence of obesity among adolescents is estimated at 2-3%, while the prevalence of excessive weight, including obesity, is approximately 10%. This growing trend underscores the need for effective public health interventions aimed at promoting healthy lifestyles and reducing obesity rates in young people (3). It's important to note that the prevalence of these nutritional disorders among youth is not evenly distributed globally. In some countries in Africa and Asia, the prevalence of overweight and

obesity is below 10%. In contrast, in certain European and American countries, this figure exceeds 20%. This disparity highlights the need for tailored public health strategies that address the specific needs and circumstances of different regions (4, 5, 6). Diabetes mellitus is a chronic metabolic disorder characterized by impaired glucose metabolism, significantly affecting the quality of life for those affected. In recent decades, the prevalence of this condition has dramatically increased, largely due to poor dietary habits and physical inactivity, especially among younger populations. According to the International Diabetes Federation, approximately 463 million people worldwide aged 20 to 79 have diabetes, representing 9.3% of the population. Estimates suggest that as many as 50% of those affected are unaware of their condition. The World Health Organization predicts that by 2030, the number of people with diabetes could rise to 578 million, and by 2045, it may reach 700.2 million, marking a 51.2% increase from 2019. In Europe, as of 2019, around 59 million people (8.9% of the population) live with diabetes, with projections indicating that this number may grow to 66 million (9.8%) by 2030 and 68 million by 2045 (7, 8). Particularly concerning is the rise of type 2 diabetes among children and adolescents, often linked to factors such as obesity, reduced physical activity, and aging. In this context, prevention and education are crucial for combating this pandemic (9, 10).

When researching eating disorders in adolescents, we face numerous challenges and limitations. Challenges related to eating disorders encompass various forms, such as anorexia, bulimia, and binge eating, and improper and unbalanced nutrition can lead to numerous complications and chronic diseases like type 2 diabetes. Each of these disorders has specific characteristics that make uniform research difficult. Many adolescents with eating disorders do not acknowledge their problem or are unaware of it, which can hinder the collection of accurate data. Stigmatization is often a factor that may prevent adolescents from seeking help or participating in research.

Methodological limitations

Qualitative methods, such as interviews and focus groups, are prone to biases, while quantitative methods (e.g., surveys) may face issues with self-assessment. The ability to include diverse samples (e.g., age, gender, socio-economic status) may be limited. Small sample sizes or insufficient representativeness can reduce the generalizability of results. Many respondents rely on self-assessment of their habits, which can be unreliable due to body image awareness or shame.

Due to these challenges and limitations, conclusions about eating disorders in adolescents should be interpreted with caution. While the results may provide useful insights, it is important to consider the context and potential sources of bias. Approaches and methodologies should be comprehensive and tailored to minimize the possibility of errors and ensure greater accuracy in understanding this complex issue.

METHODOLOGY

This review paper is based on a search of the scientific literature published in the last ten years, with a special focus on original research articles published in the last five years from the scientific databases PubMed, SCOPUS, MEDLINE, and SCI Index. The literature we used dates back to at least ten years ago, and the keywords utilized to search the databases included: adolescence, nutritional deficiencies, obesity, diabetes mellitus type 2, and others.

PROPER NUTRITION

The preference for different types of food changes throughout life, from childhood to old age, influenced by numerous factors that significantly impact food choices and diet quality (11). One of the factors affecting food preferences is genetic predisposition, but this factor is not exclusive. This means that genetic predisposition to accept or reject food can be corrected if environmental factors positively influence an individual in shaping **healthy** attitudes toward nutrition (12). For instance, research has shown that regular physical activity positively impacts reducing the prevalence of obesity, insulin resistance, and metabolic syndrome in children and adolescents (13).

The factors that can significantly affect food choices have been divided into four groups:

1. Genetic predisposition (genetic inclination toward a particular type of food).
2. Personal factors (attitudes, demographic, and biological factors).
3. Social environment (interaction with family and peers).
4. Physical environment (availability of food in the surroundings where individuals eat or purchase food).
5. External factors (food advertisements, societal norms in which an individual lives, and agricultural policy) (13).

Principles of Proper Nutrition

The most commonly used guidelines for proper nutrition worldwide are those issued by the American Diabetic Association (ADA) in 2006. ADA defined several principles of proper nutrition (14). The main principles of proper nutrition are:

1. Understanding the primary nutrients in the food being consumed.

2. Using the healthy eating pyramid.

3. Knowing the glycemic index of foods.

4. Knowing how to create a daily meal plan.

5. Understanding the nutrient content of the menu and the representation of meals.

6. Knowing the recommended frequency of food consumption.

7. Learning how to calculate daily energy needs (14, 15).

According to most literature, the three key principles of proper nutrition are:

1. Balance, which implies that energy intake should match energy expenditure.

2. Moderation, which means limiting the intake of foods that can have negative health effects.

3. Variety, which means consuming a diverse range of foods from different food groups (16).

Healthy Eating Pyramid

The development of a new graphic representation to illustrate dietary patterns led to the creation of the healthy eating pyramid. The healthy eating pyramid was first published in 1992 in the United States, originally designed to help Americans choose foods that meet nutritional standards while limiting energy intake and those food components often consumed in large quantities. The pyramid's appearance has changed significantly from the original. The most significant changes were introduced in 2005 when "My Pyramid" was created (Figure 1). My Pyramid has six equal sections, indicating the variety and proportions of all food groups that should be represented in the daily diet. The importance of moderation in the diet is reflected in the pyramid's design, where the lines narrow from the base to the top. The pyramid's broader base represents foods with lower amounts of refined sugar and saturated fats, which should be most prevalent in the diet. Proportionality is shown by the different widths of the pyramid's colorful sections, indicating how much of each food group should be consumed daily, while the usefulness of regular physical activity is represented by a figure climbing toward the top of the pyramid. In My Pyramid, all foods are divided into six groups:

1. The first group consists of grains, represented in orange.

2. The second group consists of fruits, represented in red.

3. The third group consists of vegetables (green).

4. The fourth group consists of dairy and dairy products, represented in blue.

5. The fifth group consists of meat, eggs, fish, nuts, and legumes, represented in purple.

Figure 1. *Depiction of the Food Pyramid (Retrieved from: https://studylib.net/doc/8370805/my-pyramid.gov.)*

6. The sixth group consists of fats and dietary supplements, represented in yellow (Figure 1) (17).

Smith et al. (18) explained that the main mechanisms by which whole grains reduce the risk of type 2 diabetes and cardiovascular mortality include reducing obesity, significantly improving lipid profiles, and facilitating glucose metabolism (18). The importance of regular whole grain intake is demonstrated by the findings of Barton et al. (19), showing that children and adolescents aged 9 to 19 who eat breakfast cereals eight or more times during two weeks have a significantly lower Body Mass Index (BMI) compared to those who consume breakfast cereals three or fewer times during two weeks (19). Fruits and vegetables contain high concentrations of vitamins (especially vitamins A and C), minerals (especially electrolytes), and antioxidants. The Dietary Guidelines for Americans recommend that people consume at least nine servings of fruits and vegetables daily, i.e., four servings of fruits and five servings of vegetables, based on a 2,000 kcal diet (20). Dairy and dairy products are considered an essential part of the diet, being a source of protein, calcium, amino acids, essential fatty acids, and water-soluble vitamins. Calcium and vitamin D from dairy products positively influence bone mineralization in children and adolescents (21). Meat is a primary source of protein and fats, ensuring the intake of essential fatty acids. Consuming meat improves the absorption of many vitamins and minerals, such as vitamin A, vitamin B, iron, and zinc, which are highly bioavailable to the human body (22). The American Dietary Guidelines note that fish has numerous positive effects on heart and vascular health, and adults should consume about 227 grams of fish and seafood per week if their diet is based on 2,000 kcal per day (23). Eggs are also an important source of energy, protein, essential amino acids and fatty acids, vitamins, minerals, and especially iron (24).

Adolescent Nutrition

Adolescence is a period of human development and growth, representing a transition from childhood to adulthood, usually lasting from 10 to 19 years, during which rapid physiological, social, and cognitive changes occur, making proper nutrition crucial for optimal growth and development (25, 26). The World Health Organization (WHO) defines adolescence as the period from 10 to 19 years, youth as the period from 15 to 24 years, and the term "young people" encompasses individuals aged 10 to 24 years (27). A recent Lancet Commission on adolescent health further divided this time into three five-year categories:

1. Early adolescence (10 to 14 years)
2. Late adolescence (15 to 19 years)
3. Youth (20 to 24 years) (27, 28).

Adolescents represent an age group that poses a challenge as they require a complex approach due to the impact of their habits, attitudes, and behaviors on future health (25,26). Proper nutrition during adolescence involves meeting the body's needs for sufficient energy and nutrients necessary to maintain physiological functions, especially during this period of life when demands are higher due to rapid physical growth (29). Proper nutrition during adolescence is crucial to ensure adequate physical, cognitive, and psychosocial growth and development (30). Many behavioral patterns, such as developing lifestyle habits, health behaviors, and eating habits, are formed during adolescence (25). However, adolescents are at a higher risk of replacing regular meals at home with irregular meals outside due to long school hours, numerous obligations outside the home, and busy parents. The importance of developing dietary habits during childhood and adolescence is well known. It is also known that health problems related to diet acquired at a younger age can be corrected during adolescence (29). Adolescents develop responsibility for their body's health during this period, making it an ideal time for educating young people about healthy lifestyle habits to prevent future complications (14). Poor eating habits in adolescents can lead to health problems such as delayed sexual maturation, osteoporosis, reduced final body height, hyperlipidemia, anemia, obesity, anorexia, bulimia, and dental caries. A balanced diet can prevent long-term health problems such as cancer, stroke, osteoporosis, and hypertension (14, 31). Such a diet leads to increased intake of saturated and total fats, trans fats, cholesterol, salt, and rapidly absorbed sugars. About 25% of adolescents base their daily energy intake on these nutrients by consuming fast food, which contains many calories, fats, salt, and additives but very few vitamins, minerals, and fibers (14). Adolescents frequently exhibit specific deficiencies in iron, calcium, riboflavin, zinc, vitamins A and C, as well as thiamine, which result from an unbalanced diet. The role of nutrients is to ensure an adequate energy supply, regulate metabolism, and facilitate the proper development of tissues and organs (32). One of the most significant public health issues that arise during adolescence due to poor nutrition is overweight and obesity, which pose a considerable risk for the development of cardiovascular diseases. The prevalence of childhood obesity worldwide is steadily increasing; from 1999 to 2010, the prevalence of overweight and obesity rose from 4.2% to 6.7%, marking a 60% increase. It was estimated that this prevalence would reach 9.1% by 2020, with the number of children affected by these health problems reaching 60 million globally (17, 33). However, studies have shown that this number is significantly higher. According to research by the Noncommunicable Diseases (NCDs) Center from 2016, it was estimated that 124 million children and adolescents aged 5 to 19 years were obese, while 213 million were overweight. Furthermore, this study indicated that 190 million children in this age group were undernourished, particularly in developing countries (34). According to the Regulations on Nutrition Standards for Students in the Republic of Serbia, the ratio of animal-based to plant-based foods should be approximately 75% plant-based and 25% animal-based. Daily meals should be planned so that proteins account for 15% of total energy intake; lipids 25%; and carbohydrates 60%. The menu is planned so that the energy contribution of meals throughout the day is as follows: breakfast 25-30% of daily needs; lunch 35-45%; and dinner 30-35% of daily needs (35).

Overweight and Obesity

Excessive accumulation of fat in the body occurs when energy intake from food exceeds energy expenditure, and this condition is known as obesity. Obesity is considered one of the most significant public health issues and represents the second most common cause of preventable death. In 2011, 43 million children (7%) under the age of five were overweight, representing a 54% increase from 1990 when there were 28 million overweight children under five years old (28). An analysis of the burden of chronic noncommunicable diseases in 2017 concluded that the prevalence of obesity had doubled in more than 70 countries worldwide and continued to rise in all other countries (36). Statistical projections suggest that by 2030, over 85% of people living in America will be obese (37). Somer and colleagues (38) demonstrated in their study that adolescents with a BMI at the upper limit have a significantly

higher risk of developing cardiovascular diseases compared to adolescents with normal BMI values (38). The importance of overweight and obesity as risk factors for cardiovascular diseases is evident from data showing that around 30% of coronary heart diseases and strokes, as well as 60% of diseases related to arterial hypertension, result from elevated BMI values (38). Overweight or obesity increases the risk of developing metabolic syndrome, type 2 diabetes, cardiovascular diseases, certain types of cancer, reproductive disorders, depression, and other health disorders during adolescence (39). To reduce childhood obesity, it is necessary to instill habits of proper, balanced, and varied nutrition in children early on, along with daily moderate physical activity. For children who have reduced their weight to normal levels through food intake restriction and/or increased physical activity under the supervision of a nutritionist or doctor, it is essential to make permanent lifestyle changes to maintain normal body weight (39). It has been proven that weight loss achieved through restrictive diets is short-lived and does not have a positive effect on health, as the lost weight is quickly regained, and frequent sudden weight changes pose an additional risk for the development of certain diseases. Today, the most commonly used method for assessing nutritional status is BMI, which involves the ratio of body weight in kilograms to the square of height in meters. However, when calculating BMI, no distinction is made between muscle and fat tissue, so if the overall picture, previous habits, and the individual's diet are not taken into account, errors in assessing nutritional status can occur (39).

Malnutrition – Anorexia and Bulimia

During adolescence, body size is one of the best parameters for assessing nutritional status. Overnutrition manifests as overweight or obesity, while undernutrition manifests as stunted growth and/or development, weight loss, or nutrient deficiencies that do not necessarily result in changes in body size (26). Research has shown that protein malnutrition is one of the ten leading causes of death among children and adolescents, with a study reporting **an estimated** 225,906 adolescent deaths in 2013 due to malnutrition (40). Globally, approximately 34 deaths per 100,000 children and adolescents are caused by malnutrition, with this number varying significantly between developing countries (38.5 per 100,000) and developed countries (0.2 per 100,000) (40). Bulimia nervosa involves episodes of uncontrolled, compulsive, and rapid consumption of large amounts of food within a short period, leading to physical discomfort like nausea, stomach pain, and the urge to vomit, often followed by actual vomiting. This is then followed by feelings of guilt, depression, and disgust with one's own body. Bulimia usually begins in late adolescence or early adulthood (41).

Diabetes, Cardiovascular Diseases, and Cancer

Diabetes mellitus is a condition of chronic hyperglycemia where the metabolism of carbohydrates, proteins, and lipids is disrupted due to complete or partial pancreatic insufficiency in insulin secretion and/or insulin resistance at the cellular level. There are two main types of diabetes: Type 1 diabetes mellitus (T1DM), which is insulin-dependent, and Type 2 diabetes mellitus (T2DM), which is not insulin-dependent (41). T1DM is thought to result from the destruction of the insulin-producing beta cells of the endocrine pancreas, a process that is believed to be immunologically mediated. It typically occurs between the ages of 10 and 12 in girls or 12 and 14 in boys. Although previously considered a disorder of children and adolescents, T1DM can also occur in adults, so age is not a limiting factor. The main symptoms in children and adolescents with T1DM include polyuria, polydipsia, polyphagia, and weight loss. About 30% of children and adolescents experience an acute complication called diabetic ketoacidosis (42). T2DM is caused by a combination of factors, including genetic predisposition and poor lifestyle choices such as an unhealthy diet, physical inactivity, and obesity—the most significant risk factor for T2DM (43). Research has shown that preventive measures, like increasing physical activity and consequent weight loss, are more effective at reducing the risk of T2DM than any medication currently available for this purpose. Furthermore, T2DM can often be managed through proper diet and regular physical activity, without the need for medications like oral antidiabetics. For children and adolescents with diabetes, it is crucial to maintain a healthy and balanced diet, increase physical activity, and ensure that both the adolescent and their parents receive adequate education about diabetes. To maintain normal blood glucose levels, regular meals, careful planning of meal composition, and daily caloric intake are necessary (43). Cardiovascular diseases encompass a group of disorders affecting the heart and blood vessels, with atherosclerosis being the most common underlying cause. Atherosclerosis can be triggered by various etiological factors such as obesity, physical inactivity, smoking, hypertension, T2DM, and dyslipidemia. The World Health Organization (WHO) reports that approximately 70% of all cardiovascular disease deaths could be prevented through appropriate preventive measures (44). The foundation of cardiovascular dis-

ease prevention is smoking cessation, while a central element is a healthy diet that includes sufficient intake of saturated fatty acids (less than 10% of total daily caloric intake), less than 5 grams of salt per day, at least 45 grams of fiber per day, a minimum of 200 grams of fruits and vegetables daily, and fish consumption at least twice a week. Regular moderate physical activity has also been shown to be associated with a reduced risk of developing cardiovascular diseases such as myocardial infarction, stroke, or hypertension (45). Recent guidelines recommend 2 to 5 hours per week of moderate-intensity physical activity or aerobic exercise, or 1 to 2 hours per week of high-intensity physical activity, to minimize future cardiovascular disease risk. Reducing body weight in obese individuals is also an important aspect of cardiovascular prevention, as it lowers the risk of developing high blood pressure, dyslipidemia, or insulin resistance (45). A tumor is a mass of abnormal cells that grow uncontrollably and progressively. Tumors can be either malignant or benign. The difference between them lies in the aggressiveness of their growth; malignant tumors metastasize and spread to surrounding tissues, infiltrating healthy tissue, whereas benign tumors do not metastasize to other organs and do not infiltrate healthy tissue, instead growing expansively and displacing surrounding tissue. Benign tumors are typically treated with surgical removal (46). Diet and physical activity have been identified as important factors in the development of various types of cancer. The World Cancer Research Fund has shown that aflatoxins are linked to the development of hepatocellular carcinoma, red meat and/or processed meat consumption is linked to colorectal cancer, and frequent alcohol consumption is strongly associated with gastrointestinal cancers (47). In 2016, the World Cancer Research Fund (48) issued guidelines and recommendations for a lifestyle that can prevent and reduce the likelihood of developing cancer. These recommendations include achieving and maintaining a healthy weight throughout life, adopting a physically active lifestyle, maintaining healthy and moderate eating habits with an emphasis on plant-based foods, and limiting alcohol consumption (48). Studies show that about 35% of all cancers are linked to poor diet and dietary habits, making these dietary recommendations crucial for cancer prevention. Thousands of epidemiological and meta-analytic studies have shown that individuals with overweight and obesity have a significantly higher risk of developing various types of cancer. The mechanisms explaining the causal link between obesity and cancer are tissue-specific and involve complex interactions between multiple molecular signaling pathways (49). However, the primary cause is systemic inflammation induced by obesity, known to promote the development of several different types of cancer. The International Agency for Research on Cancer has concluded that maintaining a normal weight, i.e., avoiding overweight and obesity, significantly reduces the risk of developing colorectal cancer, esophageal cancer, breast cancer, uterine cancer, liver cancer, and several other types of cancer (50).

CONCLUSION

Improper nutrition during adolescence can be a significant risk factor for the development of chronic non-communicable diseases (NCDs). These diseases, including cardiovascular diseases, diabetes, and certain forms of cancer, often have complex causes, but dietary habits can be identified as a common factor. Excessive intake of saturated and trans fats, as well as cholesterol, are major risk factors for cardiovascular diseases. A diet high in processed foods and low in fruits, vegetables, and whole grains can lead to atherosclerosis, a condition characterized by the buildup of plaque in the arteries. Research shows that reducing intake of harmful fats and increasing consumption of heart-healthy foods can significantly lower the risk of cardiovascular diseases. Type 2 diabetes is closely related to improper dietary habits, particularly the consumption of sugary and high-calorie foods. These eating patterns contribute to obesity, which is a primary risk factor for insulin resistance and the subsequent development of type 2 diabetes. Reducing sugar and high-calorie food intake, along with adopting a balanced diet and regular physical activity, can help prevent and manage diabetes. Certain dietary habits are also associated with an increased risk of various types of cancer. For instance, high intake of red meat and processed foods is linked to a higher risk of colorectal cancer. It is recommended to increase the consumption of fruits, vegetables, whole grains, and healthy fats to reduce cancer risk. To lower the risk of chronic non-communicable diseases, it is important to adopt a balanced and nutritionally rich diet and engage in regular physical activity. This includes reducing the intake of harmful fats and sugars, increasing the intake of nutrient-dense foods, and leading an active lifestyle.

Conflict of Interests: The authors declare no conflicts of interest related to this article.

Funding: No.

Author contribution: All authors have contributed equally.

Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

HRONIČNE NEZARAZNE BOLESTI UZROKOVANE POREMEĆAJIMA ISHRANE KOD ADOLESCENATA

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Smanjeno zadovoljstvo fizičkim izgledom tokom adolescencije značajno je povezano sa smanjenjem samopouzdanja i povećanom prevalencijom gojaznosti i drugih hroničnih nezaraznih bolesti (HNZB).Veliki problem u današnjem vremenu predstavlja uticaj medija, koji je glavni kanal kroz koji se prenose ideali fizičkog izgleda i privlačnosti. Prema istraživanju iz 2015. godine, adolescenti provode u proseku 17 sati nedeljno gledajući televiziju. Postoje naučni dokazi da fizički aktivan način života donosi zdravstvene koristi i sprečava pojavu brojnih hroničnih nezaraznih bolesti, dok nepravilna ishrana i fizička neaktivnost kod adolescenata doprinose razvoju tih bolesti. Nepravilna ishrana tokom adolescencije može predstavljati značajan faktor rizika za razvoj HNZB. Ove bolesti, uključujući kardiovaskularne bolesti, dijabetes i određene oblike raka, često imaju složene uzroke, ali se prehrambene navike mogu identifikovati kao čest faktor rizika. Prekomerni unos zasićenih i trans masti, holesterola i visok unos procesuirane hrane povezani su sa većim rizikom od kardiovaskularnih bolesti. Nepravilne prehrambene navike takođe mogu doprineti razvoju dijabetesa tipa 2 i povećati rizik od raka. Usvajanje uravnotežene i nutritivno bogate ishrane, zajedno sa redovnim fizičkim aktivnostima, može pomoći u prevenciji i upravljanju ovim stanjima. Ovaj pregledni rad se temelji na pretraživanju naučne literature objavljene u poslednjih deset godina, sa posebnim fokusom na originalne naučne članke objavljene u poslednjih pet godina u naučnim bazama podataka: PubMed, SCOPUS, MEDLINE i SCI index.

Ključne reči: Javno zdravlje, prevencija, ishrana, faktori rizika.

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***How to cite this article**:* Konatar R, Pelicic D, Maras B, Music K. Chronic non-communicable diseases caused by adolescent eating disorders. Sanamed. Online First, October 2024. doi: 10.5937/sanamed0-52856.

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