

# HRANA U ZDRAVLJU I BOLESTI FOOD IN HEALTH AND DISEASE

ZNANSTVENO-STRUČNI ČASOPIS ZA NUTRICIONIZAM I DIJETETIKU  
SCIENTIFIC-PROFESSIONAL JOURNAL OF NUTRITION AND DIETETICS

vol. 12. broj 2. Prosinac / December 2023. ISSN 2233-1220

ISSN 2233-1239 (online)





UNIVERZITET U TUZLI  
FARMACEUTSKI FAKULTET/TEHNOLOŠKI FAKULTET  
UNIVERSITY OF TUZLA  
FACULTY OF PHARMACY/FACULTY OF TECHNOLOGY

SVEUČILIŠTE JOSIPA JURJA STROSSMAYERA U OSIJEKU  
PREHRAMBENO-TEHNOLOŠKI FAKULTET OSIJEK  
JOSIP JURAJ STROSSMAYER UNIVERSITY OF OSIJEK  
FACULTY OF FOOD TECHNOLOGY OSIJEK

**HRANA U ZDRAVLJU I BOLESTI**  
**FOOD IN HEALTH AND DISEASE**

ZNANSTVENO-STRUČNI ČASOPIS ZA NUTRICIONIZAM I DIJETETIKU  
SCIENTIFIC-PROFESSIONAL JOURNAL OF NUTRITION AND DIETETICS

Osijek, Tuzla, Prosinac/December 2023

**HRANA U ZDRAVLJU I BOLESTI**  
**ZNANSTVENO-STRUČNI ČASOPIS ZA NUTRICIONIZAM I DIJETETIKU**  
**www.hranomdozdravlja.com**  
**ISSN 2233-1220**  
**ISSN: 2233-1239 (Online)**  
**VOLUMEN 12 (2) 2023**

**Glavni i odgovorni urednik:** Midhat Jašić (Tuzla, BiH)

**Gost urednik:** Benjamin Muhamedbegović (Tuzla, BiH)

**Urednici**

Drago Šubarić (Osijek, Hrvatska), Zlata Mujagić (Tuzla BiH), Amra Odošić (Tuzla, BiH)

**Pomoćnici urednika**

Damir Alihodžić (Tuzla, BiH), Ivana Lauš (Osijek, Hrvatska)

**Uređivački odbor**

Đurđica Ačkar (Osijek, Hrvatska),  
Zahida Ademović (Tuzla, BiH),  
Krunoslav Aladić (Osijek, Hrvatska),  
Damir Alihodžić (Tuzla, BiH),  
Jurislav Babić (Osijek, Hrvatska),  
Ines Banjari (Osijek, Hrvatska),  
Azijada Beganlić (Tuzla, BiH),  
Tamara Bosnić (Tuzla, BiH),  
Ramzija Cvrk (Tuzla, BiH),  
Daniela Čačić Kenjerić (Osijek, Hrvatska),  
Ines Drenjančević (Osijek, Hrvatska),  
Brigita Đorđević (Beograd, Srbija),  
Slavica Grujić (Banja Luka, BiH),  
Rubin Gulaboski (Štip, Sjeverna Makedonija),  
Vezirka Jankuloska (Veles, Sjeverna Makedonija),  
Stela Jokić (Osijek, Hrvatska),  
Antun Jozinović (Osijek, Hrvatska),  
Mislav Kovačić (Osijek, Hrvatska),  
Greta Krešić (Opatija, Hrvatska),

Jørgen Lerfall (Trondheim, Norveška),  
Ante Lončarić (Osijek, Hrvatska),  
Snježana Marić (Tuzla, BiH),  
Borislav Miličević (Požega, Hrvatska),  
Maja Miškulin (Osijek, Hrvatska),  
Benjamin Muhamedbegović (Tuzla, BiH),  
Darko Velić (Osijek, Hrvatska),  
Dubravka Vitali Čepo (Zagreb, Hrvatska),

**Naučni savjet**

Jongjit Angkatavanich (Bangkok, Tajland),  
Lejla Begić (Tuzla, BiH),  
Irena Colić Barić (Zagreb, Hrvatska),  
Ibrahim Elmadfa (Beč, Austrija),  
Radoslav Grujić (Istočno Sarajevo, BiH),  
Lisabet Mehli (Trondheim, Norveška),  
Michael Murkovich (Graz, Austrija),  
Nurka Pranjić (Tuzla, BiH),  
Irena Vedrinar-Dragojević (Zagreb, Hrvatska)

**Izdavač:**

Farmaceutski fakultet/Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75 000 Tuzla, BiH

**Suizdavač:**

Sveučilište Josipa Jurja Strossmayera u Osijeku, Prehrambeno-tehnološki fakultet Osijek,  
Franje Kuhača 18, 31000 Osijek, Hrvatska

**Tehnička priprema i dizajn:**

Damir Alihodžić (Tuzla, BiH), Ivana Lauš (Osijek, Hrvatska), Kenan Biberkić (Tuzla, BiH)

Časopis HRANA U ZDRAVLJU I BOLESTI izlazi dva puta godišnje. Ovaj broj tiskan je u 100 primjeraka.

Cijena godišnje pretplate (BiH) 30 €; Cijena godišnje pretplate (Inostranstvo) 50 €

**Broj bankovnog računa:**

NLB BANKA

Transakcijski račun: 1321000256000080

Budžetska organizacija: 2404019

Poziv na broj: 7013000000

**Časopis HRANA U ZDRAVLJU I BOLESTI indeksiran je u/na:**

CAB abstracts bazi podataka; FSTA (Food Science and Technology Abstract) bazi podataka;  
EBSCO Publishing, Inc. bazi podataka; portalu HRČAK (Portal znanstvenih časopisa Republike Hrvatske);  
platformi COBISS (Kooperativni online bibliografski sistem i servisi)

**Štampa:**

Foto - Ćiro Gradačac

**FOOD IN HEALTH AND DISEASE**  
**SCIENTIFIC-PROFESSIONAL JOURNAL OF NUTRITION AND DIETETICS**  
**www.hranomdozdravlja.com**  
**ISSN 2233-1220**  
**ISSN: 2233-1239 (Online)**  
**VOLUME 12 (2) 2023**

**Editor-in-Chief:** Midhat Jašić (Tuzla, B&H)  
**Guest Editor:** Benjamin Muhamedbegović (Tuzla, B&H)

**Editors**

Drago Šubarić (Osijek, Croatia), Zlata Mujagić (Tuzla, B&H), Amra Odobašić (Tuzla, B&H)

**Assistant Editors**

Damir Alihodžić (Tuzla, B&H), Ivana Lauš (Osijek, Croatia)

**Editorial board**

Đurđica Ačkar (Osijek, Croatia),  
Zahida Ademović (Tuzla, B&H),  
Krunoslav Aladić (Osijek, Croatia),  
Damir Alihodžić (Tuzla, B&H),  
Jurislav Babić (Osijek, Croatia),  
Ines Banjari (Osijek, Croatia),  
Azijada Beganlić (Tuzla, BiH),  
Tamara Bosnić (Tuzla, B&H),  
Ramzija Cvrk (Tuzla, B&H),  
Daniela Čačić Kenjerić (Osijek, Croatia)  
Ines Drenjančević (Osijek, Croatia),  
Brigita Đorđević (Belgrade, Serbia),  
Slavica Grujić (Banja Luka, B&H),  
Rubin Gulaboski (Stip, Republic of North Macedonia),  
Vezirka Jankuloska (Veles, Republic of North Macedonia)  
Stela Jokić (Osijek, Croatia),  
Antun Jozinović (Osijek, Croatia),  
Mislav Kovačić (Osijek, Croatia),  
Greta Krešić (Opatija, Croatia),

Jørgen Lerfall (Trondheim, Norway),  
Ante Lončarić (Osijek, Croatia),  
Snježana Marić (Tuzla, B&H),  
Borislav Miličević (Požega, Croatia),  
Maja Miškulin (Osijek, Croatia)  
Benjamin Muhamedbegović (Tuzla, B&H),  
Darko Velić (Osijek, Croatia)  
Dubravka Vitali Čepo (Zagreb, Croatia),

**Scientific board**

Jongjit Angkatavanich (Bangkok, Thailand),  
Lejla Begić (Tuzla, B&H),  
Irena Colić Barić (Zagreb, Croatia)  
Ibrahim Elmadfa (Vienna, Austria),  
Radoslav Grujić (East Sarajevo, B&H),  
Lisabet Mehli (Trondheim, Norway),  
Michael Murkovich (Graz, Austria),  
Nurka Pranjić (Tuzla, B&H),  
Irena Vedrina-Dragojević (Zagreb, Croatia)

**Publisher:**

Faculty of Pharmacy/Faculty of Technology, University of Tuzla, Univerzitetska 8, 75 000 Tuzla, B&H

**Co-Publisher:**

Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek,  
Franje Kuhača 18, 31000 Osijek, Croatia

**Technical preparation and design:**

Damir Alihodžić (Tuzla, B&H), Ivana Lauš (Osijek, Croatia), Kenan Biberkić (Tuzla, B&H)

FOOD IN HEALTH AND DISEASE journal is published twice a year. This issue is published in 100 copies.

Annual subscription price (B&H) 30 €; Annual subscription price (Foreign countries) 50 €

**Bank account number:**

NLB BANKA

Transaction account: 1321000256000080

Budget organization: 2404019

Reference number: 7013000000

**Journal FOOD IN HEALTH AND DISEASE is indexed in:**

CAB Abstracts database; FSTA (Food Science and Technology Abstract) database;  
EBSCO Publishing, Inc. database; Portal of Croatian Scientific Journals (HRCAK);  
COBISS Platform (Co-operative Online Bibliographic System and Services)

**Printed by:**

Foto - Ćiro Gradačac



**Hrana u zdravlju i bolesti / Food in Health and Disease**  
ZNAJSTVENO-STRUČNI ČASOPIS ZA NUTRICIONIZAM I DIJETETIKU  
SCIENTIFIC-PROFESSIONAL JOURNAL OF NUTRITION AND DIETETICS

Farmaceutski fakultet/Tehnološki fakultet, Univerzitet u Tuzli, Tuzla, BiH  
*Faculty of Pharmacy/Faculty of Technology, University of Tuzla, Tuzla, B&H*

Sveučilište Josipa Jurja Strossmayera u Osijeku, Prehrambeno-tehnološki fakultet Osijek, Osijek, Hrvatska  
*Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Osijek, Croatia*

ISSN: 2233-1220

ISSN: 2233-1239 (Online)

VOLUMEN / VOLUME 12 2023

(2023) 12 (2) 46 - 93

**SADRŽAJ / CONTENT**

Izvorni znanstveni rad / *Original scientific paper*

**Eleonora Delinikolova, Vezirka Jankuloska, Tatjana Blazhevska, Tatjana Kalevska, Tanja Stojanovska, Katerina Temelkovska, Daniela Nikolovska Nedelkoska**  
INFLUENCE OF FREQUENCY OF FERMENTED MILK PRODUCTS CONSUMPTION  
IN PERSONS WITH HYPERINSULINEMIA AND ELEVATED BODY MASS  
ON THE DEGREE OF INSULIN RESISTANCE.....46-51

**Una Suljić Fatić, Besim Prnjavorac, Sumeja Hadžalić, Hana Helać**  
IMPACT OF METABOLIC THERAPY WITH TRIMETAZIDINE, PROPER NUTRITION  
AND PHYSICAL ACTIVITY ON QUALITY OF LIFE AND ON INCIDENCE  
OF REHOSPITALIZATIONS OF PATIENTS WITH ISCHEMIC HEART DISEASE .....52-58

**Tihomir Moslavac, Drago Šubarić, Sandra Budžaki, Marta Ostojčić, Asmir Aldžić**  
THE INFLUENCE OF THE ELECTROMOTOR FREQUENCY, THE TEMPERATURE  
OF THE PRESS HEAD AND THE ATTACHMENT FOR THE CAKE OUTLET  
DURING THE PRESSING OF LINSEEDS ON THE OIL YIELD .....59-65

**Anja Pozaić, Dominik Lončarić, Ivana Rumora Samarin, Ines Panjkota Krbavčić**  
RAZLIKA U ZNANJU O PRAVILNOJ PREHRANI IZMEĐU  
PROFESIONALNIH SPORTAŠA I REKREATIVACA /  
*DIFFERENCE IN NUTRITION KNOWLEDGE BETWEEN  
PROFESSIONAL AND RECREATIONAL ATHLETES*.....66-73

Pregledni rad / *Review paper*

**Tanja Marković, Benjamin Muhamedbegović, Drago Šubarić, Đurđica Ačkar**  
POTENTIAL HARMFUL EFFECTS OF ARTIFICIAL FOOD COLORS  
ON CHILDREN'S HEALTH - REVIEW OF LITERATURE .....74-83

Stručni rad / *Professional paper*

**Nikolina Pranić, Aleksandra Žigić Forić, Ivan Pokec, Zrinka Puharić**  
POREMEĆAJI PREHRANE / *EATING DISORDERS* .....84-89

Upute autorima / *Instructions to authors*.....90-93

# INFLUENCE OF FREQUENCY OF FERMENTED MILK PRODUCTS CONSUMPTION IN PERSONS WITH HYPERINSULINEMIA AND ELEVATED BODY MASS ON THE DEGREE OF INSULIN RESISTANCE

Eleonora Delinikolova\*, Vezirka Jankuloska, Tatjana Blazhevaska, Tatjana Kalevska, Tanja Stojanovska, Katerina Temelkovska, Daniela Nikolovska Nedelkoska

Faculty of Technology and Technical Sciences, Veles, "St. Kliment Ohridski" University- Bitola, Dimitar Vlahov 57, 1400 Veles, Republic of North Macedonia

*original scientific paper*

## Summary

Fermented dairy products with a low percentage of fat play a role in modulating the function of  $\beta$ -cells of the pancreas and increased sensitivity to insulin. The purpose of this research is to verify the influence of the type and quantity, of consumed fermented milk products (yogurt and kefir), on the degree of insulin resistance, through Homeostatic Model Assessment for Insulin Resistance (HOMA-IR). The research was conducted on 175 people, from whom 103 women and 73 men, aged 25 to 75 years, with hyperinsulinemia and have increased body mass. Respondents were interviewed with a survey questionnaire that refers to the frequency, quantity, and type of consumed fermented milk products with different percentages of fats. From the obtained results, 56 (32%) have a habit of daily consumption, and the most frequently used daily amount is 250 mL in 127 (74.70%) participants. Statistical significance ( $p=0.015$ ) was determined between the frequency of consumption and HOMA-IR in the age group between 41 and 55 years. The participants of this age group who have a higher value of the index tend to consume fermented milk products more often, which leads to the conclusion that the consumption of the fermented milk products can have an impact on HOMA-IR in this age group. The statistical analysis of the results obtained for the age groups: 25 to 40 years, and 56 to 75 years showed that there is no significant difference between the frequency of fermented dairy products consumption and HOMA-IR index of the subjects in the groups.

**Keywords:** hiperinsulinemia, nutrition, fermented dairy products, insulin resistance

## Introduction

Lifestyle diseases are conditions resulting from our lifestyle, work habits, and daily functioning (Balwan et al., 2021). Metabolic syndrome (MetS) is a cluster of comorbid conditions including obesity, hypertension, and disordered carbohydrate and lipid metabolism (Alberti et al., 2009; Dobrowolski et al., 2022). Abdominal obesity and insulin resistance are among the most prominent factors contributing to the development of MetS, along with other associated health issues, sedentary lifestyles, the aging process, and hormonal imbalances (Grundy et al., 2005). The distribution of body fat is also a critical factor; an increased proportion of visceral fat relative to subcutaneous adipose tissue can lead to a greater degree of insulin resistance. This is attributed to the release of non-esterified fatty acids that accumulate in other tissues and internal organs, thereby exacerbating insulin resistance (Swarup et al., 2022). In the development of metabolic syndrome, the changes often commence with the onset of hyperinsulinemia, followed by an increase in body mass. In such instances, the initial visible symptom of metabolic alterations is the increase in body mass (Crofts et al., 2016). Type 2 diabetes (T2D) is usually preceded by increased insulin resistance, i.e. decreased insulin sensitivity, which can be assessed by the insulin resistance index (HOMA-IR) (Vladu et al., 2022). Insulin resistance is closely linked to hyperinsulinemia. Both insulin

resistance (IR) and inadequate insulin secretion are the primary pathogenic factors contributing to impaired glucose tolerance (IGT) and the onset of type 2 diabetes (T2D) (Kelly et al., 2014; Crofts et al., 2015). Mortality associated with hyperglycemia and overweight/obesity is estimated at 6% and 5%, respectively (Wylie-Rosett & Jhangiani, 2015).

Diet and lifestyle play a significant role in influencing hyperinsulinemia (Crofts et al., 2016). The consumption of low-fat fermented dairy products, such as yogurt, has shown positive effects in preventing glucose intolerance and the development of type 2 diabetes. Research indicates that consuming 200 g of yogurt per day results in a 57% risk reduction for the development of MetS and a 22% risk reduction for T2D, while consuming 244 g of yogurt per day leads to an 18% risk reduction, and 80 g of yogurt per day results in a 14% risk reduction compared to a diet without yogurt (Cheraghi et al., 2016; Fernandez et al., 2017).

Milk contains multiple components that promote insulin sensitivity, including calcium, magnesium, potassium, vitamin D, protein, and other compounds (Fumeron et al., 2011; Aune et al., 2013). Additionally, the positive impact of whey protein on the regulation of certain hormones related to satiety, lipid metabolism, and insulin secretion has been observed (Elwood et al., 2010). Cis-9, trans-11 conjugated linolenic acid present in milk products has been shown to play a role in regulating body weight

\*Corresponding author: eleonora.delinikolova@uklo.edu.mk



(Moloney et al., 2007; Mozaffarian et al., 2010). Furthermore, the lactic acid bacteria found in fermented products have an impact on gut microbiota and sensations of satiety (Sluijs et al., 2012; García-Burgos et al., 2020). On the other hand, the consumption of dairy products with a high energy content, such as full-fat dairy products, may lead to adverse metabolic effects (Struijk et al., 2013). As per a meta-analysis conducted by Tong et al. (2011), individuals with the highest consumption of milk and dairy products had a 14% lower risk of developing type 2 diabetes (T2D) compared to those who consumed fewer or no dairy products. The same authors also observed an inverse correlation between the consumption of full-fat dairy products and the risk of T2D, a correlation that was evident only in the case of skimmed milk and low-fat dairy products. The association has not been confirmed for full-fat dairy products (Tong et al., 2011). The consumption of full-fat dairy products, including cheese with 25% and 32% fat, or reduced-fat cheese with 13% and 16% fat, does not have a direct impact on fasting glycemia, fasting insulin, or HOMA-IR (Raziani et al., 2016). Fermentation enhances the nutritional value of yogurt compared to milk, as it improves the bioavailability of certain trace elements, including calcium, magnesium, and vitamin B<sub>12</sub>, which are associated with a reduced risk of type 2 diabetes (T2D) (Pittas et al., 2007). Dietary guidelines in the United States suggest a daily consumption of 3 cups of fat-free or low-fat (up to 1%) milk, yogurt and dairy products. Similarly, in the UK, low-fat, low-sugar dairy products are recommended as part of the Eatwell Guide, but no specific quantity recommendations are provided (Middleton et al., 2016).

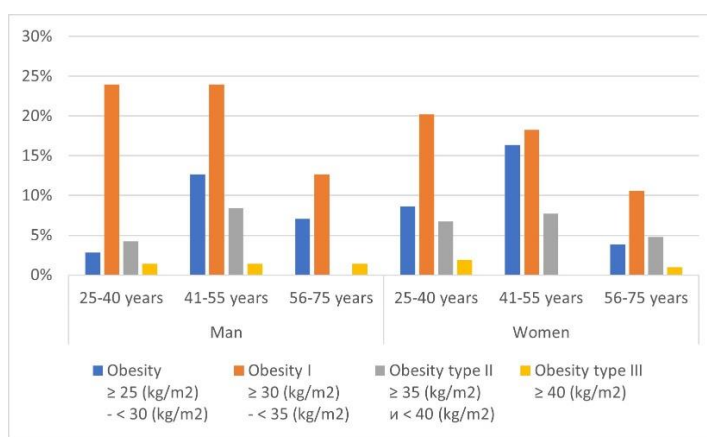
## Materials and methods

In this study, a group of 175 individuals, consisting of 71 men and 104 women, who had been diagnosed with hyperinsulinemia and had elevated body mass, were included. All participants were aged 25 or older and had a body mass index (BMI) indicating excessive weight gain

or obesity. Through survey questionnaires, participants were interviewed regarding the quantities and frequencies of dietary product consumption. Additionally, the same criteria were applied to assess the inclusion and inquire about the frequency, amount, and percentage of fat content in fermented dairy products, specifically yogurt and kefir, in their diet. The data collected through subjective responses served as the basis for further analysis (Delinikolova & Jankuloska, 2022). The degree of insulin resistance, as calculated using the formula for Homeostatic model assessment for insulin resistance (HOMA-IR), is obtained by dividing the product of fasting glucose (mmol/L) and fasting insulin (mIU/L) by 22.5 (Matthews, 1985). The degree of obesity is calculated using the formula for Body Mass Index (BMI), which involves the ratio of body mass (kg) to the square of body height (m)<sup>2</sup> (Weir, 2023). The analysis was conducted using Python software, specifically version 3.4 (Payton, 2014). To test the hypotheses, Pearson's chi-square ( $\chi^2$ ) test was applied at a significance level of  $\alpha=0.05$  (Ludbrook, 2008).

## Results and discussion

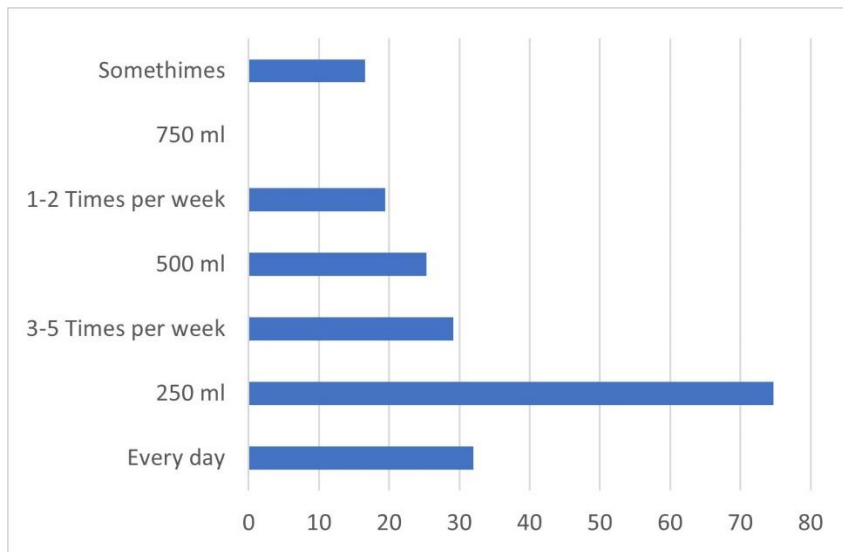
The anthropometric characteristics of the subjects were as follows: In women, the average age was  $34.33 \pm 12.66$  years, the average height was  $163.48 \pm 6.69$  cm, and the average weight was  $86.44 \pm 13.35$  kg. For men, the average age was  $47.06 \pm 11.00$  years, the average height was  $172.26 \pm 7.24$  cm, and the average weight was  $98.11 \pm 12.48$  kg. From these parameters, average BMI values were derived, with values of  $32.21 \pm 3.57$  kg/m<sup>2</sup> in women and  $33.02 \pm 3.32$  kg/m<sup>2</sup> in men. For the purposes of the study, the subjects were categorized into three age groups: 25 to 40 years, 41 to 55 years, and 56 to 75 years. In both sexes, the most prevalent BMI range was  $\geq 30$  (kg/m<sup>2</sup>) and  $< 35$  (kg/m<sup>2</sup>) in the age groups of 25 to 40 years, accounting for 24% of women and 20% of men. Body mass, expressed as a percentage, for all subjects within each gender and age group is shown in Figure 1.



**Figure 1.** Body mass by sex and age in all age groups

The degree of insulin resistance was determined using the HOMA-IR formula. In women, fasting glucose levels were  $6.10 \pm 0.46$  mmol/L, and fasting insulin levels were  $18.87 \pm 5.04$  mIU/L. In men, fasting glucose measured  $6.24 \pm 0.51$  mmol/L, while fasting insulin was  $19.14 \pm 4.35$  mIU/L. The mean HOMA-IR for all subjects was  $5.21 \pm 1.44$ . Of the 175 subjects, the majority, 130 individuals, exhibited high insulin resistance ( $\text{HOMA-IR} \geq 3.8$ ), 44 subjects had

moderate insulin resistance ( $\text{HOMA-IR} = 2.6$  to  $3.8$ ), and only one subject had low insulin resistance ( $\text{HOMA-IR} < 2.6$ ). This analysis confirms that all subjects exhibit hyperinsulinemia or a pre-diabetic condition, putting them at risk of developing type 2 diabetes (T2D) (Delinikolova & Jankuloska, 2022). The results regarding the consumption of dairy products, such as yogurts and kefir, are shown in the Figure 2.



**Figure 2.** Fermented dairy products (quantity and frequency)

The results indicate that dairy products, such as yogurt and/or kefir, are a part of the subjects' diet. A significant portion of respondents have a daily consumption habit, with 32% of them incorporating these products into their diet every day. Additionally, 29.14% consume them three to five times a week. There is also a percentage of individuals who consume yogurt and kefir once to twice a week, accounting for 19.42%, and occasionally, with a percentage of 6.57%. Regarding the quantity of consumption, 74.70% of those who consume yogurt and kefir do so in the amount of 250 mL, while 25.29% consume 500 mL. Only a small portion, 2.8% of the total respondents, do not consume yogurt and kefir at all.

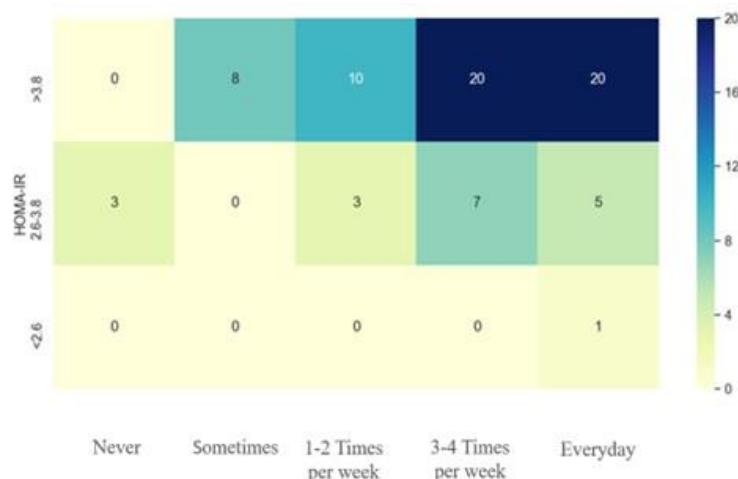
The dependence of HOMA-IR and the consumption of fermented milk products was tested. This was done by formulating the following hypotheses:

$H_0$ : HOMA-IR index and frequency of consumption of fermented dairy products are independent variables.

$H_1$ : HOMA-IR index depends on the frequency of consumption of fermented dairy products.

The statistical analysis of the results confirmed that the frequency of consumption of fermented dairy products has a statistically significant difference with the HOMA-IR index of the subjects in the most numerous ( $N= 77$ ) age group of subjects, aged between 41 and 55 years ( $\chi^2(4) = 12.415$ ,  $p < 0.015$ ).

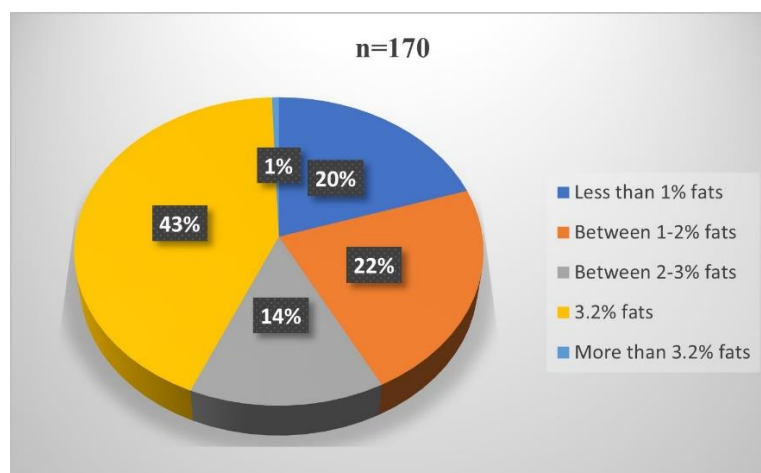
The distribution of the number of subjects in each of the categories related to the HOMA-IR index and their weekly consumption of yogurt and kefir, as shown in Figure 3, indicates correlation with the level of insulin resistance observed in the subjects in the age group between 41 and 55 years. In other words, individuals with higher HOMA-IR index values tend to consume yogurt and kefir more frequently on a weekly basis.



**Figure 3.** Fermented dairy (yogurt and kefir) and HOMA-IR

The statistical analysis of the results obtained for the age groups: 25 to 40 years, and 56 to 75 years showed that there is no significant difference between the frequency of consumption of fermented dairy products and HOMA-IR index of the subjects in the groups ( $p > 0.05$ ).

The results of the analysis regarding the consumption of products with varying levels of fat content are presented in Figure 4.



**Figure 4.** Fermented dairy products (% fat content of yogurt and kefir)

From Figure 4, it is evident that the most commonly consumed fermented dairy products (yogurts and kefir), at 43%, are those with a full-fat content of 3.2%. Approximately 22% of the subjects consume fermented dairy products with fat content between 1% and 2%, while 14% choose products with fat content between 2% and 3%. About 20% of the subjects prefer fermented dairy products with low fat content. The results indicate that the more frequent consumption of full-fat and semi-fat fermented dairy products partially explains the high HOMA-IR values in the subjects who consume them.

### Conclusion

The conducted research has led to the conclusion that diet can influence the insulin resistance index and hyperinsulinemia. Further exploration is needed to better understand the effects of nutrition and other factors, such as lifestyle, genetic characteristics etc., in order to promote public health and prevent the progression of type 2 diabetes in the modern society.

## References

- Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., Fruchart, J. C., James, W. P., Loria, C. M., Smith, S. C. (2009): Harmonizing the metabolic syndrome, *Circulation* 120(16), 1640-1645.
- Aune, D., Norat, T., Romundstad, P., & Vatten, L. J. (2013): Dairy products and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of cohort studies, *The American journal of clinical nutrition* 98(4), 1066-1083.
- Balwan, W. K., & Kour, S. (2021): Lifestyle Diseases: The link between modern lifestyle and threat to public health, *Saudi Journal of Medical and Pharmaceutical Sciences* 7(4),179-184.
- Cheraghi, Z., Mirmiran, P., Mansournia, M. A., Moslehi, N., Khalili, D., & Nedjat, S. (2016): The association between nutritional exposures and metabolic syndrome in the Tehran Lipid and Glucose Study (TLGS): a cohort study, *Public health* 140, 163-171.
- Crofts, C. & Wheldon, M., (2015): Hyperinsulinemia: A unifying theory of chronic disease?, *Diabetes* 1(4), 34.
- Crofts, C., Zinn, C., Wheldon, M. & Schofield, G., (2016): Hyperinsulinemia: Best management practice, *Diabetes* 2(1), 1-11.
- Delinikolova, E. & Jankuloska, V. (2022): The influence of certain leading factors on the development of insulin resistance and proposed dietary models as nutrition therapy, *Knowledge International Journal* 54(3), 431-436.
- Dobrowolski, P., Prejbisz, A., Kuryłowicz, A., Baska, A., Burchardt, P., Chlebus, K., Dzida, G., Jankowski, P., Jaroszewicz, J., Jaworski, P., Kamiński, K., Kapłon-Cieślicka, A., Klocek, M., Kukła, M., Mamcarz, A., Mastalerz-Migas, A., Narkiewicz, K., Ostrowska, L., Śliż, D., Tarnowski, W. & Bogdański, P. (2022): Metabolic syndrome-a new definition and management guidelines, *Archives of medical science* 18(5), 1133-1156.
- Elwood P.C., Pickering J.E., Givens, D.I. & Gallacher J.E. (2010): The consumption of milk and dairy foods and the incidence of vascular disease and diabetes: an overview of the evidence, *Lipids* 45(10), 925-939.
- Fernandez, M. A., Panahi, S., Daniel, N., Tremblay, A., & Marette, A. (2017): Yogurt and Cardiometabolic Diseases: A Critical Review of Potential Mechanisms, *Advances in nutrition* 8(6), 812-829.
- Fumeron, F., Lamri, A., Emery, N. C., Bellili, N., Jaziri, R., Porchay-Baldérelli, I., Lantieri, O., Balkau, B., & Marre, M. (2011): Dairy products and the metabolic syndrome in a prospective study, DESIR, *Journal of the American College of Nutrition* 30(5), 454-463.
- García-Burgos, M., Moreno-Fernández, J., Alférez, M. J. M., Díaz-Castro, J., & López-Aliaga, I. (2020): New perspectives in fermented dairy products and their health relevance, *Journal of Functional Foods* 72, 104059.
- Grundy, M., Cleeman, I., Daniels, R., Donato, A., Eckel, H., Franklin, A., Gordon, J., Krauss, M., Savage, J., Smith, C., Spertus, A., & Costa, F. (2005): Diagnosis and Management of the Metabolic Syndrome, *Circulation* 112(17), 2735-2752.
- Kelly, C. T., Mansoor, J., Dohm, G. L., Chapman, W. H., 3rd, Pender, J. R., 4th, & Pories, W. J. (2014): Hyperinsulinemic syndrome: the metabolic syndrome is broader than you think, *Surgery* 156(2), 405-411.
- Ludbrook, J.(2008), Analysis of 2×2 tables of frequencies: matching test to experimental design, *International Journal of Epidemiology* 37(6), 1430-1435.
- Matthews, D. R., Hosker, J. P., Rudenski, A. S., Naylor, B. A., Treacher, D. F., & Turner, R. C. (1985): Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man, *Diabetologia* 28(7), 412-419.
- Middleton J. (2017): Public health in England in 2016-the health of the public and the public health system: a review, *British medical bulletin* 121(1), 31-46.
- Moloney, F., Toomey, S., Noone, E., Nugent, A. P., Allan, B. B., Loscher, C. E., & Roche, H. M. (2007): Antidiabetic Effects of cis-9, trans-11-Conjugated Linoleic Acid May Be Mediated via Anti-Inflammatory Effects in White Adipose Tissue, *Diabetes* 56(3), 574-582.
- Mozaffarian, D., Cao, H., King, I. B., Lemaitre, R. N., Song, X., Siscovick, D. S., & Hotamisligil, G. S. (2010): Trans-palmitoleic acid, metabolic risk factors, and new-onset diabetes in U.S. adults: a cohort study, *Annals of internal medicine* 153(12), 790-799.
- Pittas, A. G., Lau, J., Hu, F. B., & Dawson-Hughes, B. (2007): The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis, *The Journal of clinical endocrinology and metabolism* 92(6), 2017-2029.
- Python Release Python 3.4.0. (2014): Python.org. <https://www.python.org/downloads/release/python-340/>
- Raziani, F., Tholstrup, T., Kristensen, M. D., Svanegaard, M. L., Ritz, C., Astrup, A., & Raben, A. (2016): High intake of regular-fat cheese compared with reduced-fat cheese does not affect LDL cholesterol or risk markers of the metabolic syndrome: a randomized controlled trial, *American Journal of Clinical Nutrition* 104(4), 973-981.
- Sluijs, I., Forouhi, N. G., Beulens, J. W., van der Schouw, Y. T., Agnoli, C., Arriola, L., Balkau, B., Barricarte, A., Boeing, H., Bueno-de-Mesquita, H. B., Clavel-Chapelon, F., Crowe, F. L., de Lauzon-Guillain, B., Drogan, D., Franks, P. W., Gavrila, D., Gonzalez, C., Halkjaer, J., Kaaks, R. & Moskal, A., (2012): The amount and type of dairy product intake and incident type 2 diabetes: results from the EPIC-InterAct Study, *The American journal of clinical nutrition* 96(2), 382-390.

- Struijk, E. A., Heraclides, A., Witte, D. R., Soedamah-Muthu, S. S., Geleijnse, J. M., Toft, U., & Lau, C. J. (2013): Dairy product intake in relation to glucose regulation indices and risk of type 2 diabetes, *Nutrition, metabolism, and cardiovascular diseases* 23(9),822-828.
- Swarup S., Goyal A., Grigorova Y. and Zeltser R., (2022): Metabolic Syndrome, Treasure Island (FL), StatPearls Publishing.
- Tong, X., Dong, J. Y., Wu, Z. W., Li, W., & Qin, L. Q. (2011): Dairy consumption and risk of type 2 diabetes mellitus: a meta-analysis of cohort studies, *European journal of clinical nutrition* 65(9), 1027-1031.
- Vladu, I. M., Forțofoiu, M., Clenciu, D., Forțofoiu, M. C., Pădureanu, R., Radu, L., Cojan, Ș. T. Ț., Rădulescu, P. M., & Pădureanu, V. (2022): Insulin resistance quantified by the value of HOMA-IR and cardiovascular risk in patients with type 2 diabetes, *Experimental and therapeutic medicine* 23(1), 73.
- Weir, C.B. & Jan A., (2023): BMI Classification Percentile And Cut Off Points, Treasure Island (FL), StatPearls Publishing.
- Wylie-Rosett J. & Jhangiani S. S. (2015): Obesity and Disease in an Interconnected World: A Systems Approach to Turn Huge Challenges into Amazing Opportunities. Bentham Science Publishers.

# IMPACT OF METABOLIC THERAPY WITH TRIMETAZIDINE, PROPER NUTRITION AND PHYSICAL ACTIVITY ON QUALITY OF LIFE AND ON INCIDENCE OF REHOSPITALIZATIONS OF PATIENTS WITH ISCHEMIC HEART DISEASE

Una Suljić Fatić<sup>1\*</sup>, Besim Prnjavorac<sup>2</sup>, Sumeja Hadžalić<sup>3</sup>, Hana Helać<sup>3</sup>

<sup>1</sup>Faculty of Pharmacy, University Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia & Herzegovina

<sup>2</sup>General Hospital, Tešanj, Braće Pabrića 17, 74260 Tešanj, Bosnia & Herzegovina

<sup>3</sup>Faculty of Pharmacy, University Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia & Herzegovina

*original scientific paper*

## Summary

**Aim:** To investigate whether additional treatment of ischemic heart disease with trimetazidine, proper nutrition and physical activity could decrease the number of rehospitalizations and overall quality of life of patients with ischemic heart disease. **Methods:** The study included 200 patients with ischemic heart disease. The sample is divided into 2 randomly selected groups: the experimental and control group. The diagnostic procedures included: trade-mill test according to Bruce protocol, heart ultrasound for assessment of ejection fraction, test for the assessment of quality of life and subjective problems (Short Form SF 36). Patients were tested on time of discharge from hospital, after 6 and 12 months, including reevaluation of the overall condition of the previous period. **Results:** Patients have been tested for the endurance of effort with the measurement Metabolic Equivalent of TASK (METs) which is the equivalent of physical labor. Patients treated with trimetazidine since the time of hospital discharge have achieved an average of 3.68, after 6 months 5.68, and after 12 months 7.79 METs. Control and experimental groups showed a significant difference in the number of hospitalizations for the periods of 6 months and 12 months after treatment. Fewer hospitalizations were in the group treated with trimetazidine than in those with only conventional therapy after 6 and 12 months. There is a significant difference in values Respondents' attitudes about how much they shortened their time at work or other activities as a result of physical health before starting therapy (Ppt <0.001), as well as for a period of 12 months after starting therapy shows a significant difference (P12 <0.001). The results we have for HDL and LDL after the clinical study show that patients who were on conventional therapy and trimetazidine and who used a proper diet as well as those who had physical activity, that their HDL and LDL values were better than at the beginning studies. **Conclusion:** Patients treated with conventional therapy including trimetazidine have better tolerance to effort and fewer hospitalizations in the comparison with those treated without trimetazidine, so trimetazidine has a beneficial effect on reducing the number of hospitalizations and productiveness at work and improving the quality of life. They had a better lipid status compared to patients who only used conventional therapy. BMI index was better in patients who used trimetazidine along with conventional therapy and had better psychological health.

**Keywords:** ischemic heart disease, quality of life with heart ischemia, metabolic therapy, rehospitalization

## Introduction

Ischemic heart disease is a clinical syndrome that occurs after structural heart diseases that directly lead to heart function disorders, due to which the heart can not provide enough blood to reconcile the body's need for oxygen. These patients have symptoms of heart failure (suffocation, fatigue, edema), as well as objective signs of cardiac dysfunction while the patient is at rest, with a positive response to treatment (McMurray et al., 2012; Mohan SB et al., 2012). Physiologically cardiomyocytes are replaced with connective tissue in elderly people. This process is known as cardiac remodeling (Vlodaver Z and et al., 2012).

Significant changes have taken place in recent years in the treatment and rehabilitation of heart patients, especially those diagnosed with coronary heart disease. Physical training is accepted as an important

way of prevention and rehabilitation of cardiovascular patients. There are two main reasons for this. First, physical inactivity is one of the risk factors for the development of atherosclerosis and coronary heart disease. Although it does not belong to the group of so-called of the main risk factors - arterial hypertension, dyslipidemia and smoking, its importance is not small. During physical activity, the cardiovascular system goes through numerous changes, such as an increase in the cardiac output, which is closely related to the degree of expansion of the blood vessels of the skeletal muscles, which means also to the metabolic changes that occur in the skeletal muscles during physical activity. In addition to this basic relationship in relation to metabolic events, there is also a reflex activation of sympathetic nerves in relation to the heart, as well as in relation to the resistance and capacity of blood vessels of the systemic circulation. As a result, there is a reflex

regulation of peripheral vascular resistance, so that the increased cardiac output from the left ventricle is directed to the active muscles, and systemic arterial pressure is maintained within reasonable limits, despite a large increase in cardiac output.

A proper (healthy, sensible) diet implies a healthy intake of all necessary nutrients (carbohydrates, fats, proteins, vitamins, minerals and water), in moderation quantitative, diverse, suitable for age, physical and mental constitution, work and intellectual efforts, the climate and working environment in which we live. Science confirms that improper nutrition, the dangers that come from food, and in a big way measures lifestyle, risk factors of chronic non-communicable diseases that are the causes of 65% of mortality in the world and which have become a worrying public health problem (Colić-Barić 2007).

Heart failure (HF) is a dominant and growing problem of public health and society as a whole, accounting for about 1.2 million hospitalizations per year, despite all available therapeutic agents, new generations of drugs, and diagnostic devices (Abraham WT et al., 2011).

In developed countries heart failure occurs in late phases of life, but in underdeveloped countries heart failure occurs earlier. It is known that if one person does not suffer from any other disease, they will die from heart failure (Task Force Members, Montalescot et al., 2013). If there are no other diseases, atherosclerosis develops in blood vessels and in the heart at the same time. The dynamic of this process is affected by many factors, including metabolic, genetic, dietary, physical activity, hormonal, and many others (Roffi M. et al., 2016). It is estimated that in the countries of the European Union, about 2% of adults suffer from heart failure, while that number grows after the age of 65 to 6-10%. Epidemiological studies conducted over the years suggest that the incidence of HF of a certain age and sex has increased three to four times in the last few decades. In contrast, the incidence of age- and sex-specific HF increased from the 1970s to the early 1990s, due to improved survival of patients with HF (McMurray JJ. et al., 2012, Abouezzeddine OF, Redfield MM, 2011).

Converting enzyme inhibitors (ACE inhibitors) are among the most important drugs today, whose primary goal is to stop the progression of the cardiovascular continuum. In addition to ACE inhibitors, conventional therapy includes calcium channel blockers, diuretics, and beta-blockers (Wijins et al., 2010; Stergiopoulos et al., 2014; Teerlink JR, Sliva L, Opie LH., 2013; Munzel T et al., 2011).

Trimetazidine as a metabolic drug in combination with standard therapy in ischemic heart disease acts by

selectively inhibiting KAT-(catalytically active) enzymes and reducing oxidation of fatty acids, stimulating glycolysis with the formation of a higher amount of ATP (Adenosine triphosphate) (Belardinelli R, Solenghi M, Volpe L, Purcaro A., 2011). It proves acidosis in the cell by increasing the calcium concentration, increasing the metabolic rate of phospholipids (Fragasso G, et al., 2011). In the same time it protects the cell membrane from oxidative stress caused by beta-oxidation of fatty acids, increases myocardial contractility, prevents myocardial apoptosis (through MAPK/YAKT pathway), reduces cardiomyocytes sensitivity to oxygen radicals and reduces the occurrence of interstitial myocardial fibrosis (through ROS / CTGF pathway) (Belardinelli R et al., 2007).

Heart failure could be asymptomatic for a few months or a few years. The first symptoms of heart failure will develop during an effort, in the beginning just during great effort, but later with just limited effort (Ng K et al., 2016).

## Patients and methods

### *Patients and study design*

The study was performed in the Department of Cardiology in University Clinical Center (UCC) in Tuzla during the year 2017. The study includes 200 patients with ischemic heart disease, by randomization divided into two groups. The first one, experimental, was treated with conventional therapy and metabolic drug trimetazidine in dose of 35 mg daily. Patients were on a special diet that included smaller meals several times a day, reduced carbohydrate intake, fatty and spiced food, but included larger amounts of fruits and vegetables, cooked dishes and not fried dishes. Olive was preferred for cooking. Patients had physical activity for half an hour every day.

The second group was treated only with conventional therapy, without trimetazidine, and on special diet same as the experimental group of patients and physical activity for half an hour every day. At the end of the study, after one year, in experimental group 95 patients were completely followed up (47 females and 48 males), and in control group 84 (44 females and 40 males).

All patients signed informative consent.

### *Methods*

Patients were examined for conventional risks of ischemic heart disease, including blood cell count, total cholesterol, high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL)



cholesterol, triglycerides, urea, creatinine, and fasting blood glucose.

Patient's tolerance to effort was examined by treadmill stress testing according to Bruce protocol (Guazzi et al., 2013). For all patients echocardiography were performed with measurement of ejection fraction (EF) (Lang RM et al., 2015; Komajda M et al., 2014).

The ergometry test and measurement of ejection fraction on echocardiography, as well as analysis of quality of life considered with standardized questionnaires, were performed on time of discharge from hospital, after six months and after 12 months (Alagiakrishnan et al., 2013).

Standardized and authoritative questionnaires were used for a realistic assessment of the all aspects quality of life, including personal satisfaction with emotional life, life energy, emotional state, mood or depression, especially parameters of the physical effort. Laboratory diagnostic conditions, the Bruce protocol of ergometry, and on the tolerance to the effort that affects the possibility of daily activities, such as staging along the stairs, was analyzed in all patients. Gradation applied as: easily climbing to the third floor along the stairs represents a good tolerance to effort, fatigue already at the beginning of the second floor, as moderate restriction, and fatigue already in the climb to the first floor as a significant limitation of the possibility of climbing the stairs.

Quality of life was assessed with standardized questionnaire, short version (Short Form SF 36) (Ware JE, Sherbourne CD., 1992; Gužić et al., 1998).

Patients were assessed after discharge from hospital, after six months and after twelve months.

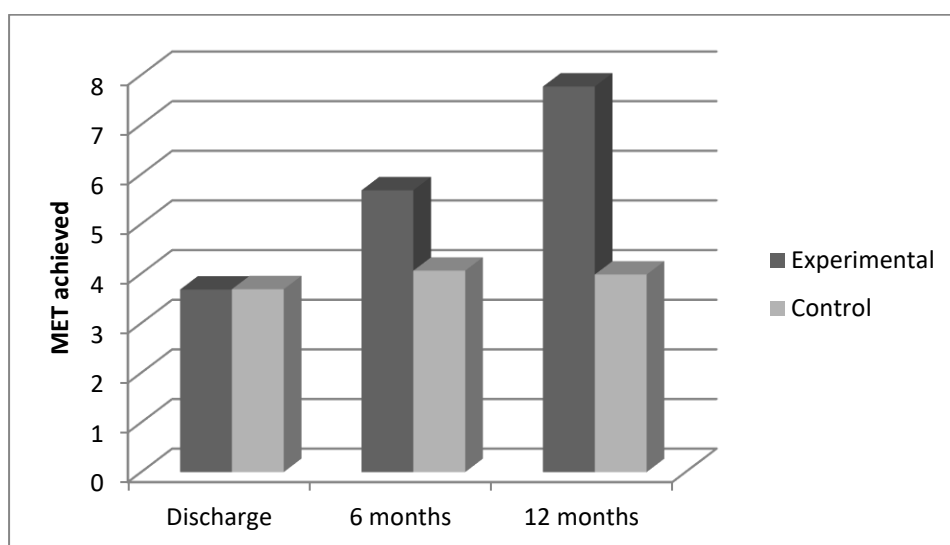
### Statistical analysis

Laboratory data were assessed using Kolmogorow-Smirnov test with nonparametric Mann-Whitney test. The results of quality of life questionnaire were calculated using nonparametric Fisher exact test, if frequency was less than 5, otherwise by  $\chi^2$  test.  $p < 0.05$  was used as statistically significant.

### Results

All 200 patients were followed up during twelve months. In both groups, there were 100 respondents at the beginning of the study, and by the end of the expert group, 93 respondents (45 women and 48 men) were followed, and in the control group, 80 respondents (38 women and 42 men) were followed. The experimental group received trimetazidine while the control group did not and both groups had the same diet and exercise plan. Both groups have approximately the same anthropological and social characteristics.

On the day of discharge from the hospital, there was no difference between the patients in the effort tolerance by measure of the achieved METs, 3.6774 METs in experimental and 3.6838 control group ( $p = 0.880$ ). After six months of treatment treadmill showed statistically significant difference e. g., patients of experimental group had better tolerance to effort ( $p < 0.001$ ). Greater tolerance for effort was recorded after 12 months, 7.77 METs and 3.87 METs, respectively (Figure 1).

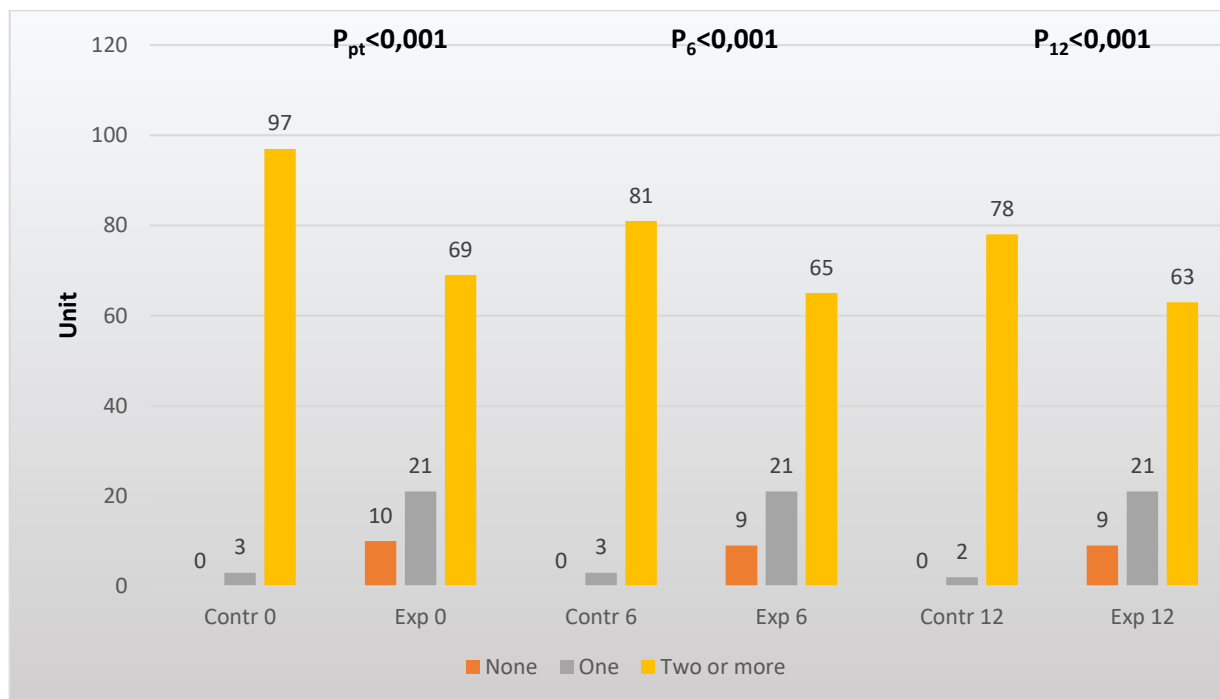


**Figure 1.** Achievement of Metabolic Equivalent of TASK (METs) in ergometry, trade-mill exercise testing according to Bruce protocol, in three periods of assessment



The number of hospitalizations between the control and experimental groups showed a significant difference for the period of 6 months after treatment ( $P_6 < 0.001$ ), as well as a significant difference for 12 months after treatment ( $P_{12} < 0.001$ ) and a significant

difference in values before the start of therapy ( $P_{pt} < 0.001$ ) (Figure 2). The treated group had a significantly lower number of hospitalizations after 6 and 12 months of metabolic therapy used compared to the control group.



**Figure 2.** Number of hospitalizations

Results of value comparison Respondents' attitudes about how much they shortened their time at work or other activities as a result of physical health between the control and experimental groups did not show a significant difference for 6 months after

treatment ( $P_6 = 0.741$ ), while there is a significant difference in values for before starting therapy ( $P_{pt} < 0.001$ ), as well as for a period of 12 months after starting therapy shows a significant difference ( $P_{12} < 0.001$ ) (Table 1).

**Table 1.** Respondents' attitude about how much they shortened their time at work or other activities as a result of physical health

	Before therapy		6 months after therapy		12 months after therapy	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
	Frequency (n=100)	Frequency (n=100)	Frequency (n=84)	Frequency (n=95)	Frequency (n=80)	Frequency (n=93)
Without change	3	0	0	0	0	10
A small part of time	0	0	3	7	17	34
Part of time	24	0	21	18	17	28
Most of the time	0	5	27	36	30	18
All the time	73	95	33	34	16	3
<b>Total:</b>	<b>100</b>	<b>100</b>	<b>84</b>	<b>95</b>	<b>80</b>	<b>93</b>
<b>P</b>	<b><math>P_{pt} &lt; 0.001</math></b>		<b><math>P_6 = 0.741</math></b>		<b><math>P_{12} &lt; 0.001</math></b>	

The results we have for HDL and LDL after the clinical study show that patients who were on conventional therapy and trimetazidine and who used

a proper diet as well as those who had physical activity, that their HDL and LDL values were better than at the beginning studies.

**Table 2.** Body mass index (BMI)

	Before therapy		6 months after therapy		12 months after therapy	
	Frequency (n=100)	Percentage (%)	Frequency (n=95)	Percentage (%)	Frequency (n=93)	Percentage (%)
Less than 19,0	0	0	0	0	0	0
19,1 – 24,9	42	42	38	40	39	42
25,0 i više	58	58	57	60	54	58
<b>In total:</b>	<b>100</b>	<b>100</b>	<b>95</b>	<b>100</b>	<b>93</b>	<b>100</b>

Source: Own research

Table 2 shows the body mass index of the subjects. More than half of the respondents who were examined before therapy, i.e. 58% of them had a high BMI, and 42% had a normal BMI, while none of the subjects from the experimental group had a low BMI. Furthermore, 6 months after therapy, i.e. 60% had an increased body mass index, while 40% of them had a normal BMI. None of the subjects had a low BMI. The body mass index before therapy and 12 months after therapy was identical, and there were 58% of those with a high BMI, i.e. above 25.0, and 42% of those with a normal BMI, i.e. between 19.1 – 24.9. none of the subjects had a low BMI 12 months after therapy.

**Table 3.** Physical activity of the patients

	Before therapy		6 months after therapy		12 months after therapy	
	Frequency (n=100)	Percentage (%)	Frequency (n=95)	Percentage (%)	Frequency (n=93)	Percentage (%)
Yes	83	83	78	82	83	89
No	17	17	17	18	10	11
<b>In total:</b>	<b>100</b>	<b>100</b>	<b>95</b>	<b>100</b>	<b>93</b>	<b>100</b>

Source: Own research

Table 3 shows whether the respondents engaged in physical activity before the therapy and 6 months after the therapy. The results showed that 83% of the respondents examined before the therapy were engaged in physical activity, and 17% were not. Furthermore, 82% of the respondents examined 6 months after therapy engaged in physical activity, while 18% did not. Finally, 89% of subjects who were examined 12 months after therapy were engaged in physical activity, while 11% were not.

**Table 4.** Adherence to a proper diet

	Before therapy		6 months after therapy		12 months after therapy	
	Frequency (n=100)	Percentage (%)	Frequency (n=95)	Percentage (%)	Frequency (n=93)	Percentage (%)
Yes	93	93	88	93	87	94
No	7	7	7	7	6	6
<b>In total:</b>	<b>100</b>	<b>100</b>	<b>95</b>	<b>100</b>	<b>93</b>	<b>100</b>

Source: Own research

Table 4 shows whether the respondents followed the recommendations on proper nutrition. Namely, 93% of respondents followed the recommendations on proper nutrition before therapy and 6 months after therapy, while 7% did not. Also, 12 months after therapy, 94% of respondents followed the recommendations on proper nutrition, and 7% did not.

**Table 5.** HDL level

	Before therapy		6 months after therapy		12 months after therapy	
	Frequency (n=100)	Percentage (%)	Frequency (n=95)	Percentage (%)	Frequency (n=93)	Percentage (%)
Low	34	34	11	12	11	12
Normal	62	62	80	84	82	88
High	4	4	4	4	0	0
<b>In total:</b>	<b>100</b>	<b>100</b>	<b>95</b>	<b>100</b>	<b>93</b>	<b>100</b>

Source: Own research

Table 5 shows the level of HDL that the experimental group of subjects had before therapy, and 6 and 12 months after therapy. The results showed that 62% of the subjects had normal HDL before therapy, 34% low, and 4% high. Six months after therapy, 84% of subjects had normal HDL, 12% low, and 4% high. Furthermore, 12 months after therapy, 88% of subjects had normal HDL, 12% had low, and none of the subjects had high HDL.

**Table 6.** LDL level

	Before therapy		6 months after therapy		12 months after therapy	
	Frequency (n=100)	Percentage (%)	Frequency (n=95)	Percentage (%)	Frequency (n=93)	Percentage (%)
Low	0	0	0	0	0	0
Normal	56	56	61	64	59	63
High	44	44	34	36	34	37
<b>In total:</b>	<b>100</b>	<b>100</b>	<b>95</b>	<b>100</b>	<b>93</b>	<b>100</b>

**Source: Own research**

Table 6 shows the LDL level of the experimental group of subjects treated with conventional therapy with trimetazidine, before therapy, and 6 and 12 months after therapy. The results showed that 56% of subjects had normal LDL before therapy, 44% had low, and none had high LDL. Six months after therapy, 64% of subjects had normal LDL, 36% had low, and none had high LDL. Furthermore, 12 months after therapy, 63% of subjects had normal LDL, and 37% had low, while none of the subjects had high LDL.

## Discussion

Heart failure (HF) is classified as an epidemic and represents both clinical and public health problems associated with high mortality rates, morbidity and health expenditures, frequent hospitalizations, especially among those  $\geq 65$  years of age. HF is a major public health issue, with a prevalence of over 5.8 million in the U.S. and over 23 million worldwide. In clinical practice, the effectiveness of treatment for a patient with advanced heart failure is often assessed using parameters such as clinical status, hemodynamics, neurohormonal status, and echo / MRI indices. From the patient's perspective, parameters related to the quality of life, such as functional capacity, exercise, psychological status, and frequency of rehospitalization, are much more significant parameters (Nieminen et al., 2015; Bui Al et al., 2011).

One study examined the need for hospitalization in patients with diabetes mellitus and ischemic heart disease. The need for hospitalization was significantly lower in the trimetazidine-treated group (Zhang L et al., 2012). Particular attention has been shown to comorbidities of coronary heart disease, especially with diabetes mellitus. The positive effect of trimetazidine in diabetics has been shown (Belardinelli R et al., 2007). Similar to numerous studies, ours has shown significant effectiveness in better endurance, reducing the number of nitroglycerin linguals used equivalent to the number of anginal attacks during the week. Several questionnaires examined the effectiveness of many aspects of quality of life (feelings of self-reliance, improvement of strength for everyday life, hidden or larvae depression). Quality of life was better in patients who used trimetazidine, compared to those who did not, in virtually all relevant respects.

To conclude, the result of this study has shown that the addition of trimetazidine to conventional therapy improves ischemic cardiomyocyte's metabolism with the improvement of patient's ability for effort, results in fewer hospitalizations in the comparison with those

treated without trimetazidine, and productiveness at work so as well as the quality of life is raised.

### Funding

No specific funding received for this study.

### Transparency declaration

Competing interest: None to declare.

## References

- McMurray, JJ, Adamopoulos, S, Anker, SD, Auricchio, A, Böhm, M, Dickstein, K, Falk, V, Filippatos, G, Fonseca, C, Gomez-Sanchez, MA (2012): ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC, *European heart journal* 33(14), 1787-847.
- Mohan, SB, Parker, M, Wehbi, M, Douglas, P (2002): Idiopathic dilated cardiomyopathy : a common but mystifying cause of heart failure, *Clev Clin J Med* 69(6), 481-7.
- Vlodaver, Z, Vilson, RF, Garry, DJ. Coronary Heart Disease: Clinical, Pathological, Imaging, and Molecular Profiles. New York, NY: Springer Science & Business Media LLC; 2012.
- Abraham, WT, Compton, S, Haas, G, Foreman, B, Canby, RC, Fishel, R, McRae, S, Toledo, GB, Sarkar, S, Hettrick, DA (2011): Intrathoracic impedance vs daily weight monitoring for predicting worsening heart failure events: results of the Fluid Accumulation Status Trial (FAST), *Congestive Heart Failure* 17(2), 51-5.
- Task Force Members, Montalescot, G, Sechtem, U, Achenbach, S, Andreotti, F, Arden, C, Budaj, A, Bugiardini, R, Crea, F, Cuisset, T, Di Mario, C, Ferreira, JR, Gersh, BJ, Gitt, AK, Hulot, JS, Marx, N, Opie, LH, Pfisterer, M, Prescott, E, Ruschitzka, F, Sabaté, M, Senior, R, Taggart, DP, van der Wall, EE, Vrints, CJ; ESC Committee for Practice Guidelines, Zamorano, JL, Achenbach, S, Baumgartner, H, Bax, JJ, Bueno, H, Dean, V, Deaton, C, Erol, C, Fagard, R, Ferrari, R, Hasdai, D, Hoes, AW, Kirchhof, P, Knuuti,

- J, Kolh, P, Lancellotti, P, Linhart, A, Nihoyannopoulos, P, Piepoli, MF, Ponikowski, P, Sirnes, PA, Tamargo, JL, Tendera, M, Torbicki, A, Wijns, W, Windecker, S; Document Reviewers, Knuuti, J, Valgimigli, M, Bueno, H, Claeys, MJ, Donner-Banzhoff, N, Erol, C, Frank, H, Funck-Brentano, C, Gaemperli, O, Gonzalez-Juanatey, JR, Hamilos, M, Hasdai, D, Husted, S, James, SK, Kervinen, K, Kolh, P, Kristensen, SD, Lancellotti, P, Maggioni, AP, Piepoli, MF, Pries, AR, Romeo, F, Rydén, L, Simoons, ML, Sirnes, PA, Steg, PG, Timmis, A, Wijns, W, Windecker, S, Yildirim, A, Zamorano, JL (2013): ESC guidelines on the management of stable coronary artery disease: The Task Force on the management of stable coronary artery disease of the European Society of Cardiology, *Eur Heart J* 34, 2949-3003
- Roffi, M, Patrono, C, Collet, JP, Mueller, C, Valgimigli, M, Andreotti, F, Bax, JJ, Borger, MA, Brotons, C, Chew, DP, Gencer, B, Hasenfuss, G, Kjeldsen, K, Lancellotti, P, Landmesser, U, Mehilli, J, Mukherjee, D, Storey, RF, Windecker, S (2016): ESC Scientific Document Group . 015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC), *Eur Heart J* 37, 267-315.
- Colić-Barić, I (2007): Predavanja, postdiplomski studij Prehrambeno biotehnoškog fakulteta Sveučilišta u Zagrebu.
- Abouezzedine, OF, Redfield, MM (2011): Who has advanced heart failure? Definition and epidemiology, *Congestive Heart Failure* 17(4), 160-8.
- Wijns, W, Kolh, P, Danchin, N, Di Mario, C, Falk, V, Folliguet, T et al. (2010): Guidelines on myocardial revascularization. The task force on myocardial revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS), *Euro Heart J* 31, 2501-2555.
- Stergiopoulos, K, Boden, WE, Hartigan, P, Möbius-Winkler, S, Hambrecht, R, Hueb, W, Hardison, RM, Abbott, JD, Brown, DL (2014): Percutaneous coronary intervention outcomes in patients with stable obstructive coronary artery disease and myocardial ischemia: a collaborative meta-analysis of contemporary randomized clinical trials, *JAMA internal medicine* 174(2), 232-40.
- Teerlink, JR, Sliva, K, Opie, LH. Heart Failure. In: Opie LH and Gersh, BJ (Eds) (2013): *Drugs for the Heart*, Elsevier Saunders. Philadelphia 169-223.
- Munzel, T et al. (2011): Nitrate therapy: new aspects concerning molecular action and tolerance, *Circulation* 123, 2132-2144.
- Fragasso, G et al. (2011): Effect of partial inhibition of fatty acid oxidation by trimetazidine on whole body energy metabolism in patients with chronic heart failure, *Heart* 97, 1495-1500.
- Belardinelli, R, Solenghi, M, Volpe, L, Purcaro, A (2007): Trimetazidine improves endothelial dysfunction in chronic heart failure: an antioxidant effect, *Eur Heart J* 28, 1102-8.
- Kota, SK, Kota, SK, Jammula, S, Panda, S, Modi, KD (2011): Effect of diabetes on alteration of metabolism in cardiac myocytes: therapeutic implications, *Diabetes Technol Ther* 13, 1155-60.
- Ng, K, Steinhubl, SR, deFilippi, C, Dey, S, Stewart, WF (2016): Early detection of heart failure using electronic health records practical implications for time before diagnosis, data diversity, data quantity, and data density, *Circ Cardiovasc Qual Outcomes* 9, 649-58.
- Guazzi, M, Adams, V, Conraads, V, Halle, M, Mezzani, A, Vanhees, L, Arena, R, Fletcher, GF, Forman, DE, Kitzman, DW, Lavie, CJ, Myers, J; EACPR; AHA (2012): EACPR/AHA Joint Scientific Statement: Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations, *Eur Heart J* 3, 2917.
- Lang, RM, Badano, LP, Mor-Avi, V, Afilalo, J, Armstrong, A, Ernande, L, Flachskampf, FA, Foster, E, Goldstein, SA, Kuznetsova, T, Lancellotti, P, Muraru, D, Picard, MH, Rietzschel, ER, Rudski, L, Spencer, KT, Tsang, W, Voigt, JU (2015): Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging, *J Am Soc Echocardiogr* 28:1-39.
- Komajda, M, Lam, CS (2014): Heart failure with preserved ejection fraction: a clinical dilemma, *European heart journal* 35, 1022-32.
- Alagiakrishnan, K, Banach, M, Jones, LG, Datta, S, Ahmed, A, Aronow, WS (2013): Update on diastolic heart failure or heart failure with preserved ejection fraction in the older adults, *Ann Med* 45, 37-50.
- Ware, JE, Sherbourne, CD (1992): The MOS 36-item Short-Form health survey (SF-36), *Med Care* 30, 473-83.
- Gužić Salobir, B, Keber, I, Kurija, S, Vreg, F (1998): Quality of life after myocardial infarction, *Cardiovasc Dis* 29, 465-73.
- Nieminen, MS, Dickstein, K, Fonseca, C, Serrano, JM, Parissis, J, Fedele, F, Wikström, G, Agostoni, P, Atar, S, Baholli, L, Brito, D (2015): The patient perspective: quality of life in advanced heart failure with frequent hospitalisations, *International journal of cardiology* 191, 256-64.
- Bui, AL, Horwich, TB, Fonarow, GC (2011): Epidemiology and risk profile of heart failure, *Nature Reviews Cardiology* 8(1), 30.
- Zhang, L, Lu Y, Jiang, H et al. (2012): Additional use of trimetazidine in patients with chronic heart failure: meta-analysis, *J Am Coll Cardiol* 59, 913-922.
- Belardinelli, R, Solenghi, M, Volpe, L et al. (2007): Trimetazidine improves endothelial dysfunction in chronic heart failure: an antioxidant effect, *Eur Heart J* 28, 1102-1108.

# THE INFLUENCE OF THE ELECTROMOTOR FREQUENCY, THE TEMPERATURE OF THE PRESS HEAD AND THE ATTACHMENT FOR THE CAKE OUTLET DURING THE PRESSING OF LINSEEDS ON THE OIL YIELD

Tihomir Moslavac<sup>1</sup>, Drago Šubarić<sup>1</sup>, Sandra Budžaki<sup>1</sup>, Marta Ostojčić<sup>1\*</sup>, Asmir Aldžić<sup>2</sup>

<sup>1</sup>Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, HR-31000 Osijek, Croatia

<sup>2</sup>University of Bihać, Faculty of Health Studies, Nositelja hrvatskog trolista 4, BA- 77 000 Bihać, Bosnia and Herzegovina

*original scientific paper*

## Summary

Linseeds are rich in oil and protein and have a high proportion of unsaturated fatty acids. Raw linseed oil has a dark yellow color and a strong specific smell and taste. In this study, cold-pressed linseed oil was produced on a continuous screw press and the influence of the process parameters during the pressing of linseed on the utilization of cold-pressed oil was investigated. The following parameters were tested: the size of the attachment for the cake output, temperature of the press head heater and the electromotor frequency. The basic parameters of oil quality were determined on the produced cold-pressed linseed oil: peroxide value, free fatty acids, water content and insoluble impurities. Compliance with the Ordinance on Edible Oils and Fats (OG 11/19) was established. The results show that the investigated pressing parameters influence the utilization of linseed oil. The greater quantity of the produced linseed oil was achieved at a press head temperature of 90 °C, frequency of 22 Hz and a press head extension of 6 mm. The results also show that the studied quality parameters of the oil are in accordance with the values of the regulation, with the exception of insoluble impurities, which have slightly increased, and that it is necessary to extend the settling time of the crude oil. The fatty acid composition of linseed oil is well in accordance with the literature data, with linolenic fatty acid ( $\Omega$ -3) predominating.

*Keywords:* linseed oil, screw press, process parameters, yield

## Introduction

Linseed, *Linum usitatissimum* L., was already cultivated 3000 years ago. It is the oldest and former most important textile plant in areas with a colder climate. Today, linseed is used in many different industries such as chemical, textile, livestock, paper, pharmaceutical and food industry (Kołodziejczyk et al., 1995). A new direction of processing, which is still under development, is the use of linseed as a raw material for biofuels (Ayhan, 2009). It is an important oilseed grown in more than 50 countries, mainly for fiber and oil. Today, Canada is the leading producer, followed by Argentina, China, USA, Russia and India. Linseeds contain about 45% lipids, 30 % fibers and 20% proteins (Przybylski and Shahidi, 2005). The current interest in linseeds is due to its protective effect against coronary heart disease (Nagaraj, 2009; Boucher et al., 2012). In the diet, linseed is known as a rich source of  $\alpha$ -linolenic acid (ALA), which can account for 52-60 % of total fatty acids (Daun et al., 2003). Several studies have shown that ALA may have beneficial effects on dyslipidemia, hypertension, atherosclerosis, platelet aggregation and cardiac arrhythmias (Shahidi, 2005). Linseeds are also known for their content of phytoestrogens, the so-called

lignans, which are said to have a health-promoting and anti-cancer effect (Božan and Temelli, 2002). On the food market, linseed is mainly available in the form of whole seeds, ground seeds, partially defatted linseed cake or cold-pressed linseed oil. Depending on the type of raw material used and the growing conditions, linseed oil can be dark yellow, brown or dark amber color (Rubilar et al., 2010). Linseed oil is the natural edible oil mostly consumed without additives. This oil is one of the most unstable vegetable oils in relation to oxidation. The oxidative stability of oils may be influenced by many factors, such as light, metal ions, oxygen, temperature, and enzymes (Nawar, 1985). Because of the polyunsaturated fatty acids, vegetable oil is susceptible to oxidation (Braddock et al., 1995). The effect of fatty acid composition on the oxidative stability of oil has been studied by a number of investigators (O'Keefe et al., 1993). The production of edible cold pressed oil is done with a continuous screw press without the use of organic solvents. The processing of oil through the cold pressing procedure ensures the maximum retention of active compounds in oil, like essential fatty acids, phenolic and flavonoid compounds, tocopherols, tocotrienols, phytosterols, and others (Teh and Birch, 2013), as well as the preservation of characteristic sensory properties of the oil. This pressing procedure results in crude oil, which

\*Corresponding author: marta.ostojcic@ptfos.hr

must undergo the procedure of removing insoluble solid particles (through sedimentation, filtration and/or centrifuge) in order to obtain final cold pressed oil. One of the by-products in the process of pressing is cake, which retains a certain amount of oil, significant proteins, minerals, fibre, and other ingredients (Zubr, 1997; Quezada and Cherian, 2012). Jokić et al. (2014) investigated the optimisation of the production of cold pressed walnut oil with a screw press and determined that the processing parameters of the pressing process have an effect on the utilisation of oil. Moslavac et al. (2014) indicated that the process parameters of cold pressing have an effect on the utilisation of camelina oil (*Camelina sativa* L.).

The aim of this study was to investigate the influence of the process parameters during the pressing of linseeds on the utilization of cold pressed oil. The cold pressed oil was produced using a continuous screw press. Of the pressing process parameters, the influence of the attachment, i.e. the size of the opening for the cake outlet (6, 8 and 11 mm), the electromotor frequency (22, 28, 34 and 40 Hz) and the temperature of the press head (90, 100, 110 and 120 °C) on the oil utilization was investigated. The composition of the fatty acids and basic quality parameters of the produced cold pressed oil were determined: peroxide value, free fatty acids, water content, insoluble impurities, iodine and saponification value, and compliance with the Regulation on edible oils and fats (NN 11/19) was established.

## Materials and methods

### Materials

The raw material for the production of cold pressed linseed oil were cleaned, dried and unground linseeds purchased from the OPG Luka Ivoš, Croatia. All other chemicals and reagents were of analytical reagent grade.

### Methods

#### Determination of oil and water content

The initial oil content in linseeds and cake residual oil (CRO) were measured using the automatic extraction system Soxterm by Gerhart with *n*-hexane (Aladić et al., 2014). The initial water content (moisture) of the linseeds was determined according to the AOAC Official Method 925.40 (AOAC, 2000). The determination of moisture in the defatted cake was done using the modified standard HRN EN ISO 6496 (2001). The measurements were performed in duplicate.

### Cold-pressing

The linseed oil was obtained by pressing, using different process conditions. The linseeds (1 kg) were pressed in a screw expeller (power of the electric motor 1.5 kW, press capacity 20–25 kg/hour). The produced crude oil was collected in a graduated cylinder and the volume and temperature were measured. After the precipitation of crude oil (nine days), vacuum filtration was carried out to remove insoluble particles from the oil.

### Oil quality parameters

The peroxide value (PV) of produced oil was determined according to HRN EN ISO 3960 (1998) and expressed as mmol O<sub>2</sub>/kg of oil. Free fatty acids (FFA) were determined using HRN EN ISO 660 (2020) and expressed as % of oleic acid. Insoluble impurities and moisture content were determined according to HRN EN ISO 663 (1992) and HRN EN ISO 662 (1999), respectively. All measurements were carried out in duplicate.

### Parameters for oil identification

Saponification number and iodine number of produced cold pressed linseed oil were determined by ISO methods HRN EN ISO 3657 (2013) and HRN EN ISO 3961 (2018), and expressed as mg KOH/g and g I<sub>2</sub>/100 g of oil, respectively.

### Determination of fatty acids

The fatty acids methyl esters (FAMES) were prepared with cold methanolic potassium hydroxide solution according to the procedure described in Annex X B of the Commission Regulation No 796/2002 (EC, 2002). FAMES were afterwards separated on a Shimadzu GC-2010 Plus gas chromatograph equipped with a flame ionization detector (FID) and fitted with a SH-Rtx-Wax capillary column (30 m, 0.25 mm i.d. and 0.25 µm thick stationary phase). Nitrogen was used as carrier gas, flowing at the constant linear velocity of 1.33 ml/min. The split/splitless injector was set at 250 °C, split ratio was 1:10, and the injection volume 2 µl. Initial column temperature of 110 °C was held for 2 minutes, then gradually increased 10 °C/min until temperature of 175 °C that was hold for 8 minutes, followed by gradual increase 5 °C/min until 210 °C hold for 5 minutes, and temperature increase to final temperature of 230 °C by rate of 5 °C/min. Final temperature was hold for 7 minutes. Flame ionization detector temperature was 300 °C. Identification of separated FAMES in samples was achieved based on

the comparison of retention times with the retention times of certified reference standard (Supelco F.A.M.E. Mix, C4-C24, St. Louis, USA) analyzed under the same conditions. The results were expressed as a percentage of identified fatty acid on total fatty acids (%).

## Results and discussion

Table 1 shows the results of determining the basic quality parameters of linseeds. The resulting values were for the oil content  $39.72 \pm 0.12$  % and for the moisture content  $6.69 \pm 0.09$  %.

**Table 1.** Linseed oil and moisture content

Parameter	Content (%)
Oil	$39.72 \pm 0.12$
Moisture	$6.69 \pm 0.09$

The results of testing the influence of pressing process parameters on the utilization of cold pressed linseed oil are shown in Tables 2-4. Table 2 shows the influence of the temperature of the press head on the utilization of cold pressed linseed oil. The tested temperatures of the press head were 90, 100, 110 and 120 °C. The extension on the head of the press for the cake output used in these tests was 8 mm, and the frequency regulator was set at 22 Hz to ensure a constant speed of the auger. By pressing linseeds at a press head temperature of 90 °C, a volume of crude oil of 400 mL and a temperature of 47 °C were obtained. After settling (sedimentation) of the produced crude oil for nine days and vacuum filtration, in order to

remove residual insoluble impurities, the obtained volume of cold pressed oil was 330 mL (final oil). The share of residual oil in the cake was 14.67%. By applying higher temperatures of the press head heater (100, 110 and 120 °C), a gradually decreasing volume of crude oil (390, 385 and 370 mL) was obtained with a gradual increase in the temperature of the crude oil. It is evident that the largest volume of crude oil was obtained at 90 °C, and that at higher temperatures of the press head heater, the volume decreases. After sedimentation and vacuum filtration of the crude oil, a decreasing amount of final oil (cold pressed oil) was obtained. Based on the obtained results, it can be concluded that the tested temperatures of the press head do not have a significant impact on the amount of oil obtained. At higher temperatures of the press head, the volume of produced cold pressed linseed oil is slightly smaller. This phenomenon can be explained by the composition of the linseed, which affects the utilization of oil during pressing at the mentioned process parameters. Moslavac et al. (2016), Vladić et al. (2020) and Martinez et al. (2013) published in their papers that the increase in the temperature of the head increases the process pressure and lowers the viscosity of the oil, which results in greater oil draining as well as greater utilization during pressing. The temperature of the produced crude linseed oil increased as the heating temperature of the press head increased. At press head temperatures of 110 and 120 °C, the temperature of the raw oil slightly exceeded the requirement for the cold-pressed oil category (50 °C) (Regulation on Edible Oils and Fats, NN 11/19). The content of remained oil in the cake was highest (15.72%) at the highest temperature of the press head (120 °C), and the lowest at 90 °C (14.67%).

**Table 2.** The influence of press head heater temperature on oil yield

	Linseeds (kg)	Crude oil (mL)	Temp. crude oil (°C)	Cold pressed oil (mL)	Cake (g)	Oil content in cake (%)	Water content in cake (%)
$N = 8$ mm $T = 90$ °C $F = 22$ Hz	1	400	47	330	634.10	14.67	7.71
$N = 8$ mm $T = 100$ °C $F = 22$ Hz	1	390	49.5	320	641.15	14.78	7.55
$N = 8$ mm $T = 110$ °C $F = 22$ Hz	1	385	51	315	641.80	14.93	7.18
$N = 8$ mm $T = 120$ °C $F = 22$ Hz	1	370	52	306	644.44	15.72	7.30

$N$  - extension on the press head that defines the diameter of the cake output (mm),

$F$  - frequency regulator, regulates the screw speed of the press (Hz),

$T$  - the temperature of the press head heater at the outlet of the cake (°C).



Table 3 shows the influence of the electromotor frequency (screw speed) during pressing on the utilization of the cold pressed linseed oil. The electromotor frequencies used for pressing were 22, 28, 34 and 40 Hz. The temperature of the press head heater at the cake outlet was 90 °C and the extension on the press head, which defines the diameter of the cake outlet, was 11 mm. Pressing linseed at 22 Hz produced the largest amount of crude oil (370 mL). On the other hand, at 28 Hz the crude oil volume was 360 mL, at 34 Hz was 340 mL and at 40 Hz the smallest amount of oil was produced (335 mL). The results show a direct influence of the electromotor frequency on the amount of crude oil extracted. The slower the screw was at the tested speeds, the greater the amount of linseed oil was extracted. Jokić et al. (2016) found the same phenomenon in their study, in which increasing the frequency resulted in a lower quantity

of cold pressed hazelnut oil. After nine days of settling and vacuum filtration, the influence of the screw speed on the amount of the obtained cold pressed oil was clearly observed, as the most oil was obtained at 22 Hz (310 mL) and the least at 40 Hz (260 mL). The temperature of the crude oil corresponds to the conditions for cold pressed oils (Regulation on Edible Oils and Fats, NN 11/19), as it is below 50 °C in all cases. The proportion of residual oil is lowest in the cake obtained by pressing at 22 Hz (15.26%). When pressing at 28 Hz, the proportion of residual oil in cake was 17.73%, at 34 Hz 18.69% and at 40 Hz 20.79%. The direct influence of the electromotor frequency on the amount of oil remaining in the cake is therefore visible. The lower the frequency, the lower the amount of residual oil in the cake, and thus the greater utilization of oil by pressing the linseeds, thus the greater the amount of linseed oil produced.

**Table 3.** The influence of electric motor frequency (screw speed) on oil yield

	Linseeds (kg)	Crude oil (mL)	Temp. crude oil (°C)	Cold pressed oil (mL)	Cake (g)	Oil content in cake (%)	Water content in cake (%)
<i>N</i> = 11 mm <i>T</i> = 90 °C <i>F</i> = 22 Hz	1	370	46	310	650.40	15.26	8.60
<i>N</i> = 11 mm <i>T</i> = 90 °C <i>F</i> = 28 Hz	1	360	48	295	666.83	17.73	8.13
<i>N</i> = 11 mm <i>T</i> = 90 °C <i>F</i> = 34 Hz	1	340	44	270	676.46	18.69	8.17
<i>N</i> = 11 mm <i>T</i> = 90 °C <i>F</i> = 40 Hz	1	335	45	260	687.15	20.79	7.89

*N* - extension on the press head that defines the diameter of the cake output (mm),

*F* - frequency regulator, regulates the screw speed of the press (Hz),

*T* - the temperature of the press head heater at the outlet of the cake (°C).

Table 4 shows the influence of the attachment on the press head, which determines the diameter of the outlet opening of the cake, on the utilization of the linseed oil. The used attachments had a diameter of 6, 8 or 11 mm. The temperature of the press head heater used in this test was 90 °C and the electromotor frequency was 22 Hz. When pressing, the largest volume of crude oil was obtained with a 6 mm diameter attachment and amounted to 420 mL. The highest process pressure was generated here during pressing, which leads to greater extraction of the crude oil. A slightly lower amount of crude oil was obtained with an 8 mm (400 mL) attachment. The smallest volume of crude oil was obtained using 11 mm diameter attachment and amounted to 370 mL. After nine days of sedimentation

and vacuum filtration of the crude oil, the largest volume of final cold pressed oil was 340 mL using the 6 mm diameter attachment. The temperature of the crude oil at the outlet is within the limits of the Regulation on edible oils and fats (NN 11/19). The proportion of oil remaining in the cake was lowest with the 6 mm attachment and amounts to 12.55%. Cvetković et al. (2020) and Moslavac et al. (2016) explain that reducing the size of the cake outlet on the press head increases the working pressure during seed preparation.



**Table 4.** The influence of extension on the press head, which defines the diameter of cake outlet, on oil yield

	Linseeds (kg)	Crude oil (mL)	Temp. crude oil (°C)	Cold pressed oil (mL)	Cake (g)	Oil content in cake (%)	Water content in cake (%)
<i>N</i> = 6 mm <i>T</i> = 90 °C <i>F</i> = 22 Hz	1	420	47	340	620.37	12.55	8.15
<i>N</i> = 8 mm <i>T</i> = 90 °C <i>F</i> = 22 Hz	1	400	47	330	634.10	14.67	7.71
<i>N</i> = 11 mm <i>T</i> = 90 °C <i>F</i> = 22 Hz	1	370	46	310	650.40	15.26	8.60

*N* - extension on the press head that defines the diameter of the cake output (mm),

*F* - frequency regulator, regulates the screw speed of the press (Hz),

*T* - the temperature of the press head heater at the outlet of the cake (°C).

The determined quality parameters of the cold pressed linseed oil were in accordance with the Regulation on edible oils and fats (NN 11/19), and are presented in Table 5. The results show that the peroxide value (PV), free fatty acids (FFA) and moisture content comply with the prescribed values. The share of insoluble impurities in the oil (0.16%) was slightly higher than specified in the regulation (max. 0.05%) but increased sedimentation time of the crude oil could be implemented to separate the solid particles from the oil. The values of the parameters for oil identification (saponification value and iodine value) corresponded to the values given in the literature.

**Table 5.** The basic quality parameters of produced cold pressed linseed oil

Oil quality parameters	Content
Peroxide value (PV), mmol O <sub>2</sub> /kg	0
Free fatty acids (FFA), %	0.39
Moisture, %	0.067
Insoluble impurities, %	0.16
Saponification number, mgKOH/g	191
Iodine number, g I <sub>2</sub> /100g	176

Table 6 shows the composition of the fatty acids contained in cold pressed linseed oil. The analysis was carried out using gas chromatography with an FID detector. The analysis of the composition of the fatty acids in a sample of linseed oil showed that polyunsaturated linolenic acid (C18:3) dominated with 54.21%, followed by monounsaturated oleic acid (C18:1) with 18.11% and linoleic acid with 16.65%. The saturated fatty acids are dominated by palmitic acid (C16:0) 6.28% and stearic acid (C18:0) 4.73%. These data were consistent with the literature (Dimić, 2003).

**Table 6.** Fatty acid composition of cold-pressed linseed oil

Fatty acid	Content (%)
Palmitic acid C16:0	6.28
Stearic acid C18:0	4.73
Oleic acid C18:1	18.11
Linoleic acid C18:2	16.65
Linolenic acid C18:3	54.21

## Conclusions

The results show that the pressing parameters investigated influence the utilization of cold pressed linseed oil. The heating temperature of the press head has a minor influence on the oil utilization when pressing linseeds. By pressing linseed at a press head temperature of 90 °C, a larger quantity of raw and cold pressed linseed oil was obtained. On the other hand, the electromotor frequency had larger effect on oil utilization. When using a lower frequency (22 Hz), a larger amount of linseed oil (raw and ready pressed) was obtained and the amount of residual oil in the cake was lower. The use of a different attachment on the head of the press for dispensing the cake affects the use of the oil when pressing linseeds. The smaller the diameter of the nozzle (6 mm), the greater the amount of oil was produced. The results show that the studied quality parameters of the oil comply with the values of the Regulation on edible oils and fats (NN 11/19), with the exception of insoluble impurities, which have slightly increased, and that it is necessary to increase the settling time of solid particles from the crude oil. The temperature of the obtained crude oils complied with the conditions for cold pressed oils (Regulation on Edible Oils and Fats), as they were below 50 °C, with the exception of the press head temperatures of 110 °C and 120 °C. The fatty acid composition of linseed oil corresponds to the information in the literature. It was found that linolenic fatty acid (omega-3) dominates.

## References

- Aladić, K., Jokić, S., Moslavac, T., Tomas, S., Vidović, S., Vladić, J., Šubarić, D. (2014): Cold pressing and supercritical CO<sub>2</sub> extraction of hemp (*Cannabis sativa*) seed, *Chem. Biochem. Eng.* 28 (4), 481-490.
- Ayhan, D. (2009): Production of biodiesel fuel from linseed oil using methanol and ethanol under non-catalytic SCF conditions, *Biomass Bioenergy.* 33, 113–118.
- AOAC, Official Method of Analysis 925.40, seventeenth ed. Association of Official Analytical Chemists, Washington, USA, 2000.
- Boucher, B. A., Cotterchio, M., Curca, I. A., Kreiger, N. (2012): Intake of phytoestrogen foods and supplements among women recently diagnosed with breast cancer in Ontario, *Canada. Nutr. Cancer.* 64, 695–703.
- Božan, B., Temelli, F. (2002): Supercritical CO<sub>2</sub> extraction of linseed, *J. Am. Oil Chem. Soc.*, 79, 231–235.
- Braddock, J.C., Sims, C.A., O'Keeffe, S.F. (1995): Flavor and Oxidative Stability of Roasted High Oleic Acid Peanuts, *J. Food Sci.* 60 (3), 489-493.
- Cvetković, T., Ranilović, J., Gajari, D., Tomić-Obrdalj, H., Šubarić, D., Moslavac, T., Cikoš, A.-M., & Jokić, S. (2020): Podravka and Slavonka Varieties of Pepper Seeds (*Capsicum annuum* L.) as a New Source of Highly Nutritional Edible Oil, *Foods* 9 (9), 1262.
- Daun, J., Barthet, V., Chornick, T., Duguid, S., in: Thompson, L., Cunanne, S. (Eds.) (2003): Flaxseed in Human Nutrition, AOCS Publishing, Champaign, USA, p. 1–40.
- Dimić, E., Dimić, V., Romanid, R. (2003): Essential fatty acids and nutritive value of edible nonrefined linseed oil, 9th Symposium: Vitamine und Zusatzstoffe in der Ernährung von Mensch und Tier, Proceedings, pp. 480-483.
- EC, Commission Regulation (EC) No 796/2002 of 6 May 2002 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-pomace oil and on the relevant methods of analysis and the additional notes in the Annex to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff. *Off. J. Eur. Comm.* 2002, L128, 8-28.
- Fruhvirth, G.O., Hermetter, A. (2008): Production technology and characteristic of Styrian pumpkin seed oil, *Eur. J. Lipid Sci. Tech.* 110 (7), 637-644.
- HRN ISO 6496:2001, Animal feeding stuffs – Determination of moisture and other volatile matter content.
- HRN EN ISO 3960:1998, Animal and vegetable fats and oils – Determination of peroxide value.
- HRN EN ISO 3961:2018, Animal and vegetable fats and oils – Determination of iodine value.
- HRN EN ISO 3657:2013, Animal and vegetable fats and oils – Determination of the saponification value.
- HRN EN ISO 663:1992, Animal and vegetable fats and oils – Determination of insoluble impurities content.
- HRN EN ISO 662:1999, Animal and vegetable fats and oils – Determination of moisture and volatile matter content.
- HRN EN ISO 660:2020, Animal and vegetable fats and oils – Determination of acid value and acidity (free fatty acids-FFA).
- Jokić, S., Moslavac, T., Bošnjak, A., Aladić, K., Rajić, M., Bilić, M. (2014): Optimisation of walnut oil production, *Croat. J. Food Sci. Technol.* 6 (1), 27-35.
- Jokić, S., Moslavac, T., Aladić, K., Bilić, M., Ačkar, Đ., & Šubarić, D. (2016): Hazelnut oil production using pressing and supercritical CO<sub>2</sub> extraction, *Hemjska industrija* 70 (4), 359-366.
- Kołodziejczyk, P., Fedec, P., in: Cunnane, S.C., Thompson, L.U. (Ed.) (1995): Flaxseed in Human Nutrition, AOCS Press, Champaign, USA, p. 261–280 (view, expert).
- Martinez, M., Penci, C., Marin, A., Ribotta, P. (2013): Screw press extraction of almond: Oil recovery and oxidative stability, *J. Food Eng.* 72, 40-45.
- Moslavac, T., Jokić, S., Aladić, K., Galović, M., Šubarić, D. (2016): Proizvodnja hladno prešanog makovog ulja. Hranom do zdravlja: 9. međunarodni znanstveno-stručni skup, 132- 143.
- Moslavac, T., Jokić, S., Šubarić, D., Aladić, K., Vukoja, J., Prc, N. (2014): Pressing and Supercritical CO<sub>2</sub> extraction of *Camellina sativa* oil, *Ind. Cro. Prod.* 54, 122-129.
- Murković, M., Pfannhauser, W. (2000): Stability of pumpkin seed oil, *Eur. J. Lipid Sci. Tech.* 102 (10), 607-611.
- Nagaraj, G. (2009): Oilseeds, Properties, Processing, Products and Processes, New Indian Publishing Agency, India.
- Nawar, W. W. (1985): Lipid. In O. R. Fennema (Ed.), Food chemistry, USA: Marcel Dekker Inc., pp. 200-205.
- Nederal, N.S., Rade, D., Škevin, D., Štrucelj, D., Mokrovčak, Ž., Bartolić, M. (2006): Chemical characteristic of oils from naked and husk seeds of *Cucurbita pepo* L., *Eur. J. Lipid Sci. Tech.* 108, 936 – 943.
- O'Keefe, S.F., Wiley, V.A., Knauft, D.A. (1993): Comparison of oxidative stability of high- and normal-oleic peanut oils, *JAACS.* 70 (5), 489-492.
- Quezada, N., Cherian, G. (2012): Lipid characterization and antioxidant status of the seeds and meals of *Camelina sativa* and flax, *Eur. J. Lipid Sci. Technol.* 114, 974-982.
- Przybylski, R., in: Shahidi, F. (ed., (2005): Linseed Oil and High Linolenic Acid Oils, John Wiley & Sons, Hoboken (USA), pp. 281-301.
- Regulation on edible oils and fats. NN 11/19. Zagreb, Croatia: Ministry of Agriculture; 2019.
- Rubilar, M., Gutiérrez, C., Verdugo, M., Shene, C., Sineiro, J. (2010): Flaxseed as a source of functional ingredients, *J. Soil Sci. Plant Nutr.* 10, 373–377.
- Shahidi, F. (2005): Bailey's Industrial Oil & Fat Products (Sixth edition), Volume 1, Edible Oil & Fat Products: Chemistry, Properties and Health Effects, Eiley-Interscience publication, pp. 269-513.

- Vladić, J., Gavarić, A., Jokić, S., Pavlović, N., Moslavac, T., Popović, Lj., Matias, A., Agostinho, A., Banožić, M., & Vidović, S. (2020): Alternative to Conventional Edible Oil Sources: Cold Pressing and Supercritical CO<sub>2</sub> Extraction of Plum (*Prunus domestica* L.) Kernel Seed, *Acta Chimica Slovenica*. 67 (3), 778-784.
- Teh, S.S., Birch, J. (2013): Physicochemical and quality characteristics of cold-pressed hemp, flax and canola seed oils, *J. Food Compos. Anal.* 30, 26–31.
- Zubr, J. (1997): Oil-seed crop: Camelina sativa, *Ind. Crop. Prod.* 6, 113–119.

## RAZLIKA U ZNANJU O PRAVILNOJ PREHRANI IZMEĐU PROFESIONALNIH SPORTAŠA I REKREATIVACA

Anja Pozaić\*, Dominik Lončarić, Ivana Rumora Samarin, Ines Panjkota Krbavčić

Sveučilište u Zagrebu, Prehrambeno-biotehnološki fakultet, Pierottijeva 6, 10000 Zagreb, Hrvatska

izvorni znanstveni rad

### Sažetak

Pravilna sportska prehrana neophodna je za održavanje optimalnog stanja organizma sportaša u trenažnom, natjecateljskom te procesu oporavka uz zadovoljavanje svih energijskih i nutritivnih potreba. Istraživanja su pokazala da je znanje sportaša jedan od čimbenika za provedbu pravilne sportske prehrane, što je usmjerilo fokus znanstvenih istraživanja na procjenu znanja u različitim populacijama sportaša. Cilj ovog presječnog rada bio je procijeniti znanje profesionalnih sportaša i sportaša rekreativaca o pravilnoj sportskoj prehrani. Opće znanje o pravilnoj prehrani i znanje o sportskoj prehrani procijenjeno je pomoću validiranog upitnika *Abridged version of The Nutrition for Sport Knowledge Questionnaire (A-NSKQ)* prevedenog na hrvatski jezik za potrebe istraživanja. Rezultati istraživanja pokazali su da najveći udio ispitanika (63,2 %) ima loše znanje o pravilnoj prehrani s postignutim prosječnim rezultatom od  $16,0 \pm 5,0$  bodova dok je tek 0,9 % ispitanika pokazalo odlično znanje. Ne postoji značajna razlika u znanju s obzirom na spol ( $p=0,729$ ), dob ( $p=0,731$ ) i stupanj obrazovanja ispitanika ( $p=0,900$ ), ali ni između profesionalnih i rekreativnih sportaša ( $p=0,643$ ). Kod 54,3 % profesionalnih i 69,1 % rekreativnih sportaša znanje o prehrani procijenjeno je kao loše. Dobiveni rezultati ukazuju na potrebu za edukacijom rekreativnih i profesionalnih sportaša o pravilnoj sportskoj prehrani koja je neophodna u osiguravanju optimalne sportske izvedbe. Potreban je multidisciplinarni pristup u postizanju i održavanju forme sportaša i uključivanje nutricionista u proces edukacije kako bi se sportašima pružio profesionalni pristup i provjerene informacije o sportskoj prehrani uz podizanje svijesti o izvoru informacija koji koriste u svojoj svakodnevnoj edukaciji, uključujući učestalije korištenje znanstvene i stručne literature.

*Ključne riječi:* A-NSKQ, znanje, sportska prehrana, profesionalni sportaš, rekreativni sportaš

### Uvod

Redovita tjelesna aktivnost ima mnogobrojne pozitivne utjecaje na zdravlje, kao što su kontrola tjelesne mase, poboljšanje zdravlja kostiju, smanjenje rizika za razvoj koronarnih bolesti srca i hipertenzije, ali i smanjenje razine anksioznosti i depresije. Za osobe starije dobi od 18 do 65 godina preporučuje se minimalno 150 minuta umjerene tjelesne aktivnosti ili 75 minuta intenzivne tjelesne aktivnosti tjedno (Svjetska zdravstvena organizacija, 2017). Europska zdravstvena anketa (Antoljak i sur., 2016) pokazala je da je čak 45,8 % muškaraca i 30,5 % žena u Hrvatskoj prekomjerne tjelesne mase, dok je 20,1 % muškaraca i 16,2 % žena pretilo. Nadalje, 52,9 % Hrvata ne prakticira tjelesnu aktivnost duže od 60 minuta tjedno, pri čemu navedena statistika svrstava Hrvate na europsko začelje što se tiče osviještenosti o važnosti i utjecaju tjelesne aktivnosti na sveukupno zdravlje, također dovodeći u pitanje aspekt znanja o pravilnoj prehrani.

Tjelesno aktivne osobe dijele se na rekreativne i profesionalne sportaše, pri čemu se rekreativni sportaš definira kao osoba koja je tjelesno aktivna s fokusom na tjelesnu formu, opuštanje i zabavu te ne trenira intenzitetom koji zahtijeva natjecateljski

ritam (Blake, 2008). S druge strane, profesionalni sportaš trenira većim intenzitetom od rekreativca kako bi bio spreman za napore koje donosi natjecateljska sezona sporta kojim se bavi, fokusirajući se na snagu, agilnost i izdržljivost (Dunford i Doyle, 2008). U oba slučaja, prehrana ima pozitivan utjecaj na sportsku izvedbu, unaprjeđuje adaptaciju na trening i povećava sposobnost oporavka (Kreider i sur., 2010) te bi prehrana za svakog sportaša trebala biti personalizirana prema vrsti sporta, ciljevima, preferencijama prema određenoj vrsti hrane te ostalim individualnim čimbenicima (Kerksick i sur., 2018). Važnost pravilne prehrane posebno je naglašena u profesionalnih sportaša koji trebaju težiti tome da natjecanju pristupe u optimalnom stanju sa zadovoljenim svim energijskim i nutritivnim potrebama uz pravilan odabir hrane tijekom natjecanja, što može utjecati na sportsku izvedbu i na krajnji rezultat. Također, prehrana ima značajnu ulogu u procesu oporavka nakon natjecanja te je u navedenim slučajevima sportski nutricionist od velikog značaja pojedinom sportašu ili sportskoj momčadi (Parks i sur., 2016; Thomas i sur., 2016).

S obzirom na neraskidivu povezanost prehrane i sportske izvedbe, znanje o pravilnoj prehrani sve je češće u fokusu znanstvenih istraživanja.

Istraživanja provedena na različitim populacijama sportaša su pokazala da je znanje o pravilnoj prehrani varijabilna komponenta koja utječe na prehrambeni unos (Nelson i sur., 2008), kao i na sportsku izvedbu (Trakman i sur., 2016). Nutritivne intervencije u populaciji sportaša uglavnom se baziraju na edukaciji o pravilnoj prehrani s ciljem podizanja svijesti o prehranbenim preporukama i njihovoj primjeni u praksi, zbog čega je značajan interes usmjeren prema procjeni znanja sportaša o pravilnoj prehrani i njihovom znanju o specifičnoj sportskoj prehrani (Raymond-Barker i sur., 2007). Rezultati procjene znanja u različitim populacijama sportaša do sada su se pokazali uglavnom razočaravajući (Trakman i sur., 2016; Heaney i sur., 2011). Naime, u nekim je istraživanjima utvrđeno da ne postoji značajna razlika u znanju o prehrani između sportaša i opće populacije koja se ne bavi sportom. Primjerice, u istraživanju provedenom na mladim košarkašima iz Srbije, rezultati su pokazali da, u usporedbi s mladim osobama koje nisu tjelesno aktivne, nema razlike u znanju o pravilnoj prehrani, raspodjeli makronutrijenata kao izvora energije tijekom dana, odabiru namirnica i kvaliteti prehrane (Nikić i sur., 2014). Nadalje, istraživanja su pokazala da treneri često nisu adekvatna potpora rekreativnim i profesionalnim sportašima u provođenju pravilne prehrane uslijed nedostatnog znanja, ukazujući na potrebu za dodatnom edukacijom trenera i sportaša te uključivanjem nutricionista u rad s tjelesno aktivnim osobama na rekreativnoj i profesionalnoj razini (Danaher i Curley, 2014; Feldvari i sur., 2018). Cilj ovog istraživanja bio je procijeniti znanje profesionalnih sportaša i sportaša rekreativaca o pravilnoj sportskoj prehrani pomoću validiranog A-NSKQ upitnika kako bi se pridonijelo boljem razumijevanju znanja o prehrani populacije koja je tjelesno aktivna uz osnovnu hipotezu istraživanja da profesionalni sportaši posjeduju bolje znanje o pravilnoj prehrani od rekreativnih sportaša.

## Materijali i metode

### Ispitanici

U ovom poprečnom istraživanju je sudjelovalo ukupno 127 ispitanika. Istraživanje je provedeno u razdoblju od 1. lipnja 2020. godine do 15. srpnja 2020. godine. Svi ispitanici koji su sudjelovali u istraživanju bili su povezani sa sportom na rekreativnoj ili profesionalnoj razini, u istraživanju su sudjelovali dobrovoljno, osigurani su im anonimnost i zaštita podataka te su im objašnjene metode, cilj istraživanja i način rješavanja upitnika. Osnovne karakteristike ispitanika, kao što su stupanj i područje obrazovanja, razina profesionalnosti i vrsta sporta kojim se bave te izvori informacija kojima se služe za učenje i nadopunu znanja o pravilnoj prehrani, prikupljeni su općim upitnikom. Ispitanici su prikupljeni individualno, upitnik je proveden putem interneta, a prosječno vrijeme potrebno za rješavanje cjelokupnog upitnika bilo je 12 minuta. Nakon što su iz istraživanja uklonjeni nepotpuno riješeni upitnici, dobiven je konačni broj od 114 ispitanika, 59 muškaraca i 55 žena dobi od 19 do 66 godina.

### A-NSKQ upitnik

Provjera znanja o pravilnoj prehrani provedena je uz pomoć validiranog upitnika *Abridged version of The Nutrition for Sport Knowledge Questionnaire* (A-NSKQ) (Trakman i sur., 2018) koji je izveden sažimanjem upitnika *The Nutrition for Sport Knowledge Questionnaire* (NSKQ) (Trakman i sur., 2017) sastavljenog od strane sportskih nutricionista i validiranog na sportskoj populaciji. U ovom istraživanju, korištena je posljednja revidirana verzija upitnika iz 2019. godine (Trakman i sur., 2019a). Za korištenje upitnika traženo je dopuštenje autora, a upitnik je za potrebe istraživanja preveden na hrvatski jezik. U Tablici 1 prikazana je ocjena znanja ispitanika ovisno o postotku točnih odgovora u upitniku.

**Tablica 1.** Kategorije za vrednovanje rezultata upitnika A-NSKQ (eng. *Abridged version of The Nutrition for Sport Knowledge Questionnaire*) (Trakman i sur., 2018)

**Table 1.** Categories for evaluation of A-NSKQ (*Abridged version of The Nutrition for Sport Knowledge Questionnaire*) results (Trakman et al., 2018)

Ocjena znanja ispitanika	Udio (%) točnih odgovora
Loše	< 50 %
Prosječno	50 - 65 %
Dobro	66 - 75 %
Odlično	> 75 %

## Statističke metode

Prilikom statističke obrade podataka korišteni su Microsoft® Excel® (verzija 16.0.) i STATISTICA, StatSoft Inc. (verzija 8.0). Za statističku obradu podataka korištene su standardne metode deskriptivne statistike. Varijable s normalnom statističkom razdiobom prikazane su kao srednja vrijednost, dok su one koje nemaju normalnu statističku razdiobu prikazane kao medijan. Za usporedbu rezultata upitnika između muškaraca i žena te između rekreativaca i profesionalnih sportaša korišten je t-test, dok je za utvrđivanje razlike između ispitanika s obzirom na stupanj i područje obrazovanja korištena ANOVA. Pearsonovim koeficijentom korelacije utvrđeno je postoji li korelacija između rezultata upitnika i određenih karakteristika ispitanika, pri čemu su rezultati bili značajni ako je  $p < 0,05$ .

**Tablica 2.** Karakterizacija uzorka ispitanika (N=114) obuhvaćenog istraživanjem  
**Table 2.** Characterization of the sample of respondents (N=114) included in the research

Uzorak ispitanika	N	Udio (%)
Spol		
Muškarci	59	51,8
Žene	55	48,2
Stupanj obrazovanja		
Osnovna škola	0	0,0
Srednja stručna sprema	39	34,2
Stručni prvostupnik	28	24,6
Visoka stručna sprema	41	36,0
Doktorat	6	5,5
Razina profesionalnosti		
Rekreativni sportaš	68	60,0
Profesionalni sportaš	46	40,0

**Tablica 3.** Dobne karakteristike ispitanika (N=114)  
**Table 3.** Age characteristics of respondents (N=114)

Ispitanici	N	Prosjeck	SD	Minimum	Maksimum	Medijan	p-vrijednost
Ukupno	114	29,9	10,5	19	66	24	-
Muškarci	59	26,1	8,0	19	53	24	<0,001
Žene	55	34,1	11,3	19	66	32	
Rekreativni sportaši	68	34,1	11,4	19	66	33,5	0,010
Profesionalni sportaši	46	23,7	4,3	19	40	23	

Od rekreativnih sportaša, njih 57,4 % treniralo je do 3 puta tjedno, dok su preostali rekreativci (42,6 %) trenirali više od 3 puta tjedno. Nogometom se bavio najveći udio

profesionalnih sportaša (58,7 %), dok se najveći udio rekreativnih sportaša bavio *fitnessom*, odnosno vježbama snage koje su izvodili u teretani (29,4 %) (Tablica 4).

**Tablica 4.** Raspodjela svih ispitanika (N=114), profesionalnih (n=46) i rekreativnih sportaša (n=68) prema primarnoj vrsti sporta  
**Table 4.** Distribution of all respondents (N=114), professional (n=46) and recreational athletes (n=68) according to the primary type of sport

Vrste sporta i tjelesne aktivnosti	Svi ispitanici, N (%)	Profesionalni sportaši, n (%)	Rekreativni sportaši, n (%)
Nogomet	30 (26,3)	27 (58,7)	3 (4,4)
Trčanje	21 (18,4)	2 (4,3)	19 (27,9)
<i>Fitness</i>	20 (17,5)	0 (0,0)	20 (29,4)
Odbojka	9 (7,9)	7 (15,2)	2 (2,9)
Ostalo	34 (29,9)	10 (21,8)	24 (35,4)
Ukupno	114 (100)	46 (100)	68 (100)



### Rezultati A-NSKQ upitnika

Prosječni broj bodova koje su ispitanici ostvarili u A-NSKQ upitniku iznosio je  $16,0 \pm 5,0$  bodova od maksimalnih 35. Najveći udio ispitanika (63,2 %) imao je loše znanje o pravilnoj prehrani. Konačni rezultati upitnika zajedno s pripadajućom ocjenom

znanja ispitanika prikazani su na Slici 1. Neka znanstvena istraživanja koja su se bavila procjenom znanja različitih populacija sportaša o pravilnoj prehrani također su znanje sportaša procijenila kao nedovoljno (Cockburn i sur., 2014; Spendlove i sur., 2012; Torres-McGehee i sur., 2012; Pašalić i sur., 2012).



**Slika 1.** Izvori informacija za učenje i nadopunu znanja među ispitanicima (N=114); bio je moguć višestruki izbor odgovora

**Figure 1.** Sources of information for learning and supplementing knowledge among respondents (N=114); multiple choice answers were possible

Na temelju ostvarenih bodova A-NSKQ upitnikom, nije utvrđena značajna razlika između muškaraca ( $16,0 \pm 5,7$ ) i žena ( $16,1 \pm 4,2$ ) s obzirom na znanje o prehrani ( $p=0,729$ ). Čak 59 % ispitanika (N=59) i 67 % ispitanica (N=55) imalo je loše znanje o prehrani, dok je odlično znanje pokazalo samo 2 % ispitanika i nijedna ispitanica. Suprotno dobivenim rezultatima, Spronk i sur. (2015) procjenjivali su znanje o prehrani među australskim profesionalnim sportašima i sportašicama te su zaključili da sportašice posjeduju veću razinu znanja o prehrani od sportaša. Jednake rezultate pokazalo je istraživanje provedeno na ultramaratoncima i ultramaratonkama u Italiji (Citarella i sur., 2019), kao i u finskih sportaša i sportašica koji se bave sportovima izdržljivosti (Heikkilä i sur., 2018).

Iako u ovom istraživanju nije utvrđena korelacija između rezultata A-NSKQ upitnika i dobi ispitanika ( $p=0,731$ ), druga istraživanja su pokazala da postoji korelacija između dobi profesionalnih sportaša i znanja o pravilnoj prehrani, odnosno stariji ispitanici pokazali su bolje znanje (Heikkilä i sur., 2018; Spendlove i sur., 2012). Istraživanje provedeno na poluprofesionalnih nogometašima u Grčkoj također je pokazalo veću razinu znanja u starijih nogometaša (Nikolaidis i Theodoropoulou, 2014).

Nije utvrđena značajna razlika u rezultatima upitnika s obzirom na stupanj obrazovanja ispitanika ( $p=0,900$ ). Najbolji rezultat upitnika postigao je ispitanik s najvišim stupnjem obrazovanja (titula doktora znanosti), dok je najlošiji rezultat postigao ispitanik sa srednjoškolskim stupnjem obrazovanja. Ipak, postoji razlika u rezultatima upitnika s obzirom na područje obrazovanja ispitanika ( $p<0,001$ ). Prema prosjeku ostvarenih bodova u A-NSKQ upitniku, najbolje znanje su pokazali ispitanici u biotehničkom području ( $21,0 \pm 4,7$ ), dok su najlošije znanje pokazali ispitanici u tehničkom području ( $14,8 \pm 4,5$ ) obrazovanja, što se može objasniti time što u biotehničko područje spadaju znanosti koje se primarno bave znanosti o prehrani, kao što su nutricionizam i prehrambena tehnologija, za razliku od ostalih znanstvenih područja koja nemaju poveznicu s edukacijom o prehrani.

Iako su istraživanja pokazala da razina profesionalizma i uspješnosti u sportaša može biti povezana sa znanjem sportaša o pravilnoj prehrani (Trakman i sur., 2016), u ovom istraživanju ne postoji značajna razlika u znanju između profesionalnih i rekreativnih sportaša ( $p=0,643$ ) (Tablica 5). Loše znanje o prehrani pokazalo je 69 % rekreativnih sportaša (N=68) i 54 % profesionalnih sportaša

(N=46) (Tablica 6). Ove rezultate potvrđuje istraživanje provedeno u Australiji na profesionalnim i poluprofesionalnim igračima australskog nogometa i profesionalnim igračima klasičnog nogometa gdje nije utvrđena razlika u znanju između sportaša s obzirom na razinu profesionalnosti, jednako kao i u australskom istraživanju gdje nije utvrđena razlika u znanju između profesionalnih i amaterskih

nogometaša (Andrews i Itsiopoulos, 2016). Također, Dragičević i Šatalić (2015) su u svome radu ispitivali opće znanje o prehrani u hrvatskih profesionalnih nogometaša i uspoređivali ga s populacijom koja se ne bavi sportom. Znanje nogometaša o pravilnoj prehrani procijenjeno je kao loše te nije bilo značajne razlike u usporedbi s općom populacijom.

**Tablica 5.** Bodovni rezultati A-NSKQ upitnika (eng. *Abridged version of The Nutrition for Sport Knowledge Questionnaire*) profesionalnih sportaša i rekreativaca (N=114)

**Table 5.** Score results of the A-NSKQ (*Abridged version of The Nutrition for Sport Knowledge Questionnaire*) questionnaire of professional and recreational athletes

Razina profesionalnosti	Prosjek	SD	Minimum	Maksimum	p-vrijednost
Profesionalni sportaši	16,1	5,0	7	26	0,643
Rekreativni sportaši	16,0	5,1	1	29	

SD – standardna devijacija

**Tablica 6.** Rezultati upitnika A-NSKQ (eng. *Abridged version of The Nutrition for Sport Knowledge Questionnaire*) izraženi za sve ispitanike te za rekreativne i profesionalne sportaše

**Table 6.** A-NSKQ (*Abridged version of The Nutrition for Sport Knowledge Questionnaire*) results for all respondents and for recreational and professional athletes

Rezultati A-NSKQ	n (%)
Svi ispitanici (N=114)	
Loše	72 (63,2)
Prosječno	31 (27,2)
Dobro	10 (8,8)
Odlično	1 (0,9)
Profesionalni sportaši (n=46)	
Loše	25 (54,3)
Prosječno	16 (34,8)
Dobro	5 (10,9)
Odlično	0 (0,0)
Rekreativni sportaši (n=68)	
Loše	47 (69,1)
Prosječno	15 (22,1)
Dobro	5 (7,3)
Odlično	1 (1,5)

Na pitanja unutar A-NSKQ upitnika kojima se provjeravalo znanje ispitanika o izboru namirnica i jela ispitanici u ovom istraživanju uglavnom nisu točno odgovorili. Primjerice, na pitanje koje nudi višestruki izbor jela za bolji oporavak poslije treninga za sportaša koji želi povećati mišićnu masu točno je odgovorilo 26 % ispitanika izabравši obrok od cjelovitih namirnica koji sadrži sve skupine makronutrijenata. Taj udio ispitanika može se smatrati niskim ako se u obzir uzme da je povećanje mišićne mase uobičajen cilj mnogih sportaša te da se značajan udio ispitanika u ovom istraživanju bavi prvenstveno treninzima snage uz korištenje težinskih opterećenja. Najviši udio ispitanika (32 %) u ovom je pitanju odabralo proteinski dodatak prehrani i kajganu kao optimalni obrok za oporavak, što pokazuje

misperpciju tjelesno aktivnih pojedinaca o vrijednosti korištenja dodatka prehrani naspram konzumacije cjelovitog obroka, ali i pridavanje velike važnosti unosu proteina pri oporavku od treninga, gdje ugljikohidrati imaju značajniju ulogu. Pregledni rad iz 2019. godine ukazuje da čokoladno mlijeko produljuje vrijeme koje sportaši mogu provesti u maksimalnom naporu u usporedbi s korištenjem placeba i dodatka prehrani koji sadrže ugljikohidrate, proteine i masti (Amiri i sur., 2019) te se banana se tijekom naporne tjelesne aktivnosti (npr. 75 km vožnje bicikla) pokazala kao jednako djelotvoran izvor ugljikohidrata kao i napitak s ugljikohidratima (Nieman i sur., 2012). U skladu s navedenim, 67 % ispitanika točno je procijenilo da jedna srednja banana ne sadrži dovoljno ugljikohidrata za oporavak nakon aerobnog treninga



visokog intenziteta u trajanju jednog sata uz pretpostavku da sportaš ima 70 kg te da sljedeći dan također ima važan trening. Ipak, na identično pitanje u kojem je jedna srednja banana zamijenjena obrokom koji se sastoji od jedne šalice kuhane kvinoje uz jednu konzervu tune, pri čemu navedeni obrok sadrži vrlo sličnu količinu ugljikohidrata kao jedna banana, 32 % ispitanika točno je procijenilo da navedeni obrok neće biti dovoljan za oporavak nakon treninga. Razlika u udjelu ispitanika koji je dao točan odgovor može se objasniti time što je u odgovoru uz namirnicu bogatu ugljikohidratima navedena i namirnica bogata proteinima, što još jednom potvrđuje pridavanje velike važnosti unosu proteina pri oporavku od tjelesne aktivnosti. Razlog ovakvog odgovora može biti neznanje ispitanika o sastavu pojedinih namirnica i/ili o primarnoj funkciji određenog makronutrijenta. Još jedan mogući razlog ovakvih odgovora je taj da ispitanici misle da je energijska vrijednost obroka najvažniji čimbenik za oporavak, no negativne posljedice pretreniranosti mogu se spriječiti većim unosom ugljikohidrata, dok nedovoljan unos ugljikohidrata može negativno utjecati na sportske rezultate (Šatalić i sur., 2016).

S tvrdnjom da veći unos energije iz proteina nego što je to organizmu potrebno može dovesti do nakupljanja udjela masti u organizmu ispravno se složilo 40 % ispitanika. Prevelik unos energije, premda on bio iz proteina, dovest će do nakupljanja udjela masti u organizmu, što može izazvati lošiju izvedbu i nezadovoljstvo u sportaša te je primarno potrebno voditi računa o unosu energije u skladu s individualnim potrebama sportaša (Šatalić i sur., 2016).

#### *Izvori informacija*

Ispitanici u ovom istraživanju koriste internetske portale kao glavne izvore informacija o pravilnoj prehrani (Slika 1). Internetske portale kao isključivi izvor informacija koristi 30,9 % rekreativnih i 17,4 % profesionalnih sportaša. Stručne i znanstvene radove koriste više profesionalni (39,1 %) od rekreativnih sportaša (29,4 %), pri čemu su oni isključivi izvor informacija za 8,6 % profesionalnih i 2,9 % rekreativnih sportaša. Potrebno je ukazati na važnost znanja o pravilnoj prehrani i na profesionalno iskustvo kako bi se dostupne informacije kritički analizirale i kako bi se sa sigurnošću procijenilo koji se izvori informacija mogu smatrati pouzdanima. Pošto su internetski portali najčešći izvor informacija i s obzirom na udio profesionalnih sportaša koji se informiraju isključivo putem internetskih portala, potrebno je težiti stvaranju baza informacija temeljenih isključivo na znanstvenim i stručnim

činjenicama neupitne vjerodostojnosti. Nadalje, potrebno je usmjeriti sportaše k učestalijem korištenju znanstvene i stručne literature. Naspram ispitanika u ovom istraživanju, treneri u Australiji su smatrali znanstvenu literaturu najvažnijim izvorom informacija koji je poželjno slijediti (Barnes i sur., 2016), dok su australski profesionalni i amaterski sportaši ocijenili dijetetičare i nutricioniste, uz Internet, najvažnijim izvorom informacija (Trakman i sur., 2019b).

#### **Zaključak**

Ovo istraživanje je pokazalo da je znanje o pravilnoj sportskoj prehrani u rekreativnih i profesionalnih sportaša uglavnom loše. Uspoređujući znanje između rekreativnih i profesionalnih sportaša, gotovo da ne postoji razlika u prosječnom broju ostvarenih bodova između te dvije populacije te samim time ne postoji značajna razlika u njihovom znanju unatoč očekivanju da će znanje profesionalnih sportaša biti bolje s obzirom na intenzitet bavljenja sportom i profesionalne ciljeve. Također, razlika u znanju ispitanika o pravilnoj sportskoj prehrani nije utvrđena s obzirom na spol, dob i stupanj obrazovanja, dok razlika ipak postoji s obzirom na područje obrazovanja ispitanika, pri čemu prednjače ispitanici obrazovani u biotehničkom području čija edukacija uključuje i znanost o prehrani. Dobiveni rezultati naglašavaju potrebu za intervencijom u pogledu edukacije rekreativnih i profesionalnih sportaša o pravilnoj sportskoj prehrani koja je neophodni čimbenik u održavanju tjelesnog zdravlja sportaša i osiguravanju optimalne sportske izvedbe. Također, rezultati ukazuju na važnost uključivanja nutricionista u rad rekreativnih i profesionalnih sportaša kako bi se osigurao što kvalitetniji obrazovni program i sportašima pružile provjerene informacije o sportskoj prehrani.

#### **Literatura**

- Amiri, M., Ghiasvand, R., Kaviani, M., Forbes, S. C., Salehi-Abargouei, A. (2019): Chocolate milk for recovery from exercise: a systematic review and meta-analysis of controlled clinical trials, *Eur. J. Clin. Nutr.* 73, 835-849. <https://doi.org/10.1038/s41430-018-0187-x>
- Andrews, M. C., Itsiopoulos, C. (2016): Room for improvement in nutrition knowledge and dietary intake of male football (soccer) players in Australia, *Int. J. Sport. Nutr. Exerc. Metab.* 1, 55-64. <https://doi.org/10.1123/ijsnem.2015-0064>
- Antoljak, N., Benjak, T., Brkić Biloš, I., Dečković-Vukres, V., Erceg, M., Ivičević Uhernik, A., Kralj, V., Krtalić, S., Markelić, M., Mihel, S., Musić Milanović, A.,

- Muslić, Lj., Nakić, D., Poljičanin, T., Silobračić Radić, M., Stevanović, R., Šekerija, M., Šupe Parun, A. (2016): Europska zdravstvena anketa u Hrvatskoj 2014–2015: Osnovni pokazatelji. Hrvatski zavod za javno zdravstvo, Zagreb.
- Barnes, K., Ball, L., Desbrow, B. (2016): Promotion of nutrition care by Australian fitness businesses: A website analysis, *Public Health* 140, 45-49. <https://doi.org/10.1016/j.puhe.2016.08.026>
- Blake, J. (2008): Nutrition and You, San Francisco, SAD: Pearson Benjamin Cummings Publishing Company.
- Citarella, R., Itani, L., Intini, V., Zucchini, G., Scevaroli, S., Kreidieh, D., Tannir, H., El Masri, D., El Ghoch, M. (2019): Nutritional Knowledge and Dietary Practice in Elite 24-Hour Ultramarathon Runners: A Brief Report, *Sports* 7, 1-7. <https://doi.org/10.3390/sports7020044>
- Cockburn, E., Fortune, A., Briggs, M., Rumbold, P. (2014): Nutritional Knowledge of UK Coaches, *Nutrients* 6, 1442-1453. <https://doi.org/10.3390/nu6041442>
- Danaher, K., Curley, T. (2014): Nutrition Knowledge and Practices of Varsity Coaches at a Canadian University, *Can. J. Diet Pract. Res.* 75, 210-213. <https://doi.org/10.3148/cjdp-2014-021>
- Dragičević, I., Šatalić, Z. (2015): Znanje profesionalnih nogometaša o pravilnoj prehrani, *Hrvatski časopis za prehrambenu tehnologiju, biotehnologiju i nutricionizam* 10, 101-108.
- Dunford, M., Doyle, J. (2008): Nutrition for Sport and Exercise, Boston, SAD: Cengage learning.
- Feldvari, K., Balog, K. P., Tanacković, S.F. (2018): Workplace Information Literacy of Croatian Fitness and Conditioning Personal Trainers. U: ECIL 2018: Communications in Computer and Information Science, Kurbanoglu, S. (ured.), Oulu, Finska: Springer, str. 191-200. [https://doi.org/10.1007/978-3-030-13472-3\\_18](https://doi.org/10.1007/978-3-030-13472-3_18)
- Heaney, S., O'Connor, H., Naughton, G., Gifford, J. (2008): Towards an understanding of the barriers to good nutrition for elite athletes, *Int. J. Sports Sci. Coach.* 3, 391-401. <http://dx.doi.org/10.1260/1747954087862385>
- Heikkilä, M., Valve, R., Lehtovirta, M., Fogelholm, M. (2018): Nutrition Knowledge Among Young Finnish Endurance Athletes and Their Coaches. *Int. J. Sport Nutr. Exerc. Metab.* 28, 522-527. <https://doi.org/10.1123/ijsnem.2017-0264>
- Kerksick, C. M., Wilborn, C. D., Roberts, M. D. i sur. (2018): ISSN exercise & sports nutrition review update: research & recommendations. *J. Int. Soc. Sports Nutr.* 15, 1-58. <https://doi.org/10.1186/s12970-018-0242-y>
- Kreider, R. B., Wilborn, C. D., Taylor, L., Campbell, B., Almada, A. L., Collins, R., Cooke, M., Earnest, C. P., Greenwood, M., Kalman, D. S. i sur. (2010): ISSN exercise & sport nutrition review: research & recommendations, *J. Int. Soc. Sports Nutr.* 7, 7-50. <https://doi.org/10.1186/1550-2783-7-7>
- Nelson, M. C., Story, M., Larson, N. I., Neumark-Sztainer, D., Lytle, L. A. (2008): Emerging adulthood and college-aged youth: An overlooked age for weight-related behavior change, *Obesity* 16, 2205-2211. <https://doi.org/10.1038/oby.2008.365>
- Nieman, D. C., Gillitt, N. D., Henson, D. A. i sur. (2012): Bananas as an energy source during exercise: a metabolomics approach, *PLoS One* 7, 374-379. <https://doi.org/10.1371/journal.pone.0037479>
- Nikić, M., Pedišić, Ž., Šatalić, Z., Jakovljević, S., Venus D. (2014): Adequacy of Nutrient Intakes in Elite Junior Basketball Players, *Int. J. Sport Nutr. Exerc. Metab.* 24, 516-523.
- Nikolaidis, P. T., Theodoropoulou, E. (2014): Relationship between Nutrition Knowledge and Physical Fitness in Semiprofessional Soccer Players, *Scientifica* 2014, 180353. <https://doi.org/10.1155/2014/180353>
- Parks, R. B., Helwig, D., Dettmann, J., Taggart, T., Woodruff, B., Horsfall, K., Brooks, M. A. (2016): Developing a performance nutrition curriculum for collegiate athletics, *J. Nutr. Educ. Behav.* 6, 419-424. <https://doi.org/10.1016/j.jneb.2016.03.002>
- Pašalić, A., Jusupović, F., Obradović, Z., Mahmutović, J. (2012): Nutritional awareness and habits of Premier league sportsmen in the Sarajevo Canton, *J. Health Sci.* 2, 54-60. <https://doi.org/10.17532/jhsci.2012.64>
- Raymond-Barker, P., Petroczi, A., Quested, E. (2007): Assessment of nutritional knowledge in female athletes susceptible to the female athlete triad syndrome, *J. Occup. Med. Toxicol.* 2, 10-21. <https://doi.org/10.1186/1745-6673-2-10>
- Spendlove, J. K., Heaney, S. E., Gifford, J. A., Prvan, T., Denyer, G. S., O'Connor, H. T. (2012): Evaluation of general nutrition knowledge in elite Australian athletes, *Br. J. Nutr.* 107, 1871-1880. <https://doi.org/10.1017/S0007114511005125>
- Spronk, I., Heaney, S. E., Prvan, T., O'Connor, H. T. (2015): Relationship Between General Nutrition Knowledge and Dietary Quality in Elite Athletes, *Int. J. Sport Nutr. Exerc. Metab.* 25, 243-251. <https://doi.org/10.1123/ijsnem.2014-0034>
- Šatalić, Z., Sorić, M., Mišigoj-Duraković, M. (2016): Sportska prehrana, Znanje, Zagreb.
- Thomas, D. T., Erdman, K. A., Burke, L. M. (2016): American College of Sports Medicine Joint Position Statement. Nutrition and Athletic Performance, *Med. Sci. Sports Exerc.* 48, 543-568. <https://doi.org/10.1249/MSS.0000000000000852>
- Torres-McGehee, T. M., Pritchett, K. L., Zippel, D., Minton, D. M., Cellamare, A., Sibilia, M. (2012): Sports Nutrition Knowledge Among Collegiate Athletes, Coaches, Athletic trainers, and Strength and Conditioning Specialists, *J. Athl. Train.* 47, 205-211. <https://doi.org/10.4085/1062-6050-47.2.205>
- Trakman, G., Forsyth, A., Devlin, B., Belski, R. (2016): A systematic review of athletes' and coaches' nutrition knowledge and reflections on the quality of current nutrition knowledge measures, *Nutrients* 8, 570-593. <https://doi.org/10.3390/nu8090570>

- Trakman, G. L., Forsyth, A., Hoyer, R., Belski, R. (2017): Developing and validating a nutrition knowledge questionnaire: key methods and considerations, *Public Health Nutr.* 15, 2670-2679. <https://doi.org/10.1017/S1368980017001471>
- Trakman, G.L., Forsyth, A., Hoyer, R., Belski, R. (2018): Development and validation of a brief general and sports nutrition knowledge questionnaire and assessment of athletes' nutrition knowledge, *J. Int. Soc. Sports Nutr.* 15, 17-25. <https://doi.org/10.1186/s12970-018-0223-1>
- Trakman, G. L., Brown, F., Forsyth, A., Belski, R. (2019a): Modifications to the nutrition for sport knowledge questionnaire (NSQK) and abridged nutrition for sport knowledge questionnaire (ANSKQ), *J. Int. Soc. Sports Nutr.* 16, 26-29. <https://doi.org/10.1186/s12970-019-0293-8>
- Trakman, G. L., Forsyth, A., Hoyer, R., Belski, R (2019b): Australian team sports athletes prefer dietitians, the internet and nutritionist for sports nutrition information, *Nutr Diet* 76 (4), 428-437. <https://doi.org/10.1111/1747-0080.12569>
- Svjetska zdravstvena organizacija. 2017. *Global Health Risks-Mortality and burden of disease attributable to selected major risks.* <https://www.who.int/publications/i/item/9789241563871>. Pristupljeno 1. rujna 2023.

## DIFFERENCE IN NUTRITION KNOWLEDGE BETWEEN PROFESSIONAL AND RECREATIONAL ATHLETES

Anja Pozaić, Dominik Lončarić, Ivana Rumora Samarin, Ines Panjkota Krbavčić

University of Zagreb, Faculty of Food Technology and Biotechnology, Pierottijeva 6, 10000 Zagreb, Croatia

*original scientific paper*

### Summary

Proper sports nutrition is necessary to maintain the optimal state of the athlete's body during training, competition and recovery, while meeting all energy and nutritional needs. Research has shown that one of the factors for the implementation of proper sports nutrition is the knowledge of athletes, which has directed the focus of scientific research on the assessment of knowledge in different populations of athletes. This cross-sectional study aimed to assess the knowledge of professional and recreational athletes about proper sports nutrition. General knowledge about proper nutrition and knowledge about sports nutrition were assessed using the validated Abridged version of The Nutrition for Sport Knowledge Questionnaire (A-NSKQ) translated into Croatian for research purposes. The results of the research showed that the largest share of respondents (63.2%) had poor knowledge about proper nutrition, achieving an average score of  $16.0 \pm 5.0$  points, and only 0.9% of respondents showed excellent knowledge. There is no significant difference in knowledge with regard to gender ( $p=0.729$ ), age ( $p=0.731$ ) and level of education of the respondents ( $p=0.900$ ), but neither between professional and recreational athletes ( $p=0.643$ ). In 54.3% of professional and 69.1% of recreational athletes, nutrition knowledge was assessed as poor. The obtained results indicate the need for education of recreational and professional athletes about proper sports nutrition, which is necessary to ensure optimal sports performance. A multidisciplinary approach is needed in achieving and maintaining the shape of athletes, also involving nutritionists in the education process to provide athletes with a professional approach and verified information about sports nutrition while raising awareness of the source of information they use in their daily education, including more frequent use of scientific and professional literature.

**Keywords:** A-NSKQ, knowledge, sports nutrition, professional athlete, recreational athlete

# POTENTIAL HARMFUL EFFECTS OF ARTIFICIAL FOOD COLORS ON CHILDREN'S HEALTH - REVIEW OF LITERATURE

Tanja Marković<sup>1\*</sup>, Benjamin Muhamedbegović<sup>2</sup>, Drago Šubarić<sup>3</sup>, Đurđica Ačkar<sup>3</sup>

<sup>1</sup>Teaching Institute of Public Health Osijek-Baranja County, Franje Krežme 1, 31000 Osijek, Croatia

<sup>2</sup>University of Tuzla, Faculty of Technology, Univerzitetska 8, Tuzla, Bosnia and Herzegovina

<sup>3</sup>Josip Juraj Strossmayer of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia

*review paper*

## Summary

The choice of food by modern consumers is highly affected by its visual appearance, with color as a key constituent making it more attractive to consumers. The emergence of food technology has brought about a wide range of artificial food colors and the possibilities of their use. Colors are additives used to provide or enhance characteristic colors in food products. They are routinely added to foods and beverages to improve their appearance, compensate color loss during processing, and give color to otherwise colorless food products. Food additives marked with E-numbers, the use of which is approved in the European Union, are also allowed in Croatia according to the national legislation, with defined maximum permitted amounts of certain colors in foodstuffs. Artificial food colorings have been the subject of controversy for many years and have been scrutinized for possible links to cancer, allergies, and hyperactivity. The negative impact on children's attention and activity is most often mentioned. The aim of this review is to give an overview of current knowledge on the toxicity issues and possible detrimental effects of food colorants on children's health.

*Keywords:* additives, artificial colors, children, health, negative impacts

### ABBREVIATIONS:

WHO – World Health Organization

FDA – Food and Drug Administration

EFSA - The European Food Safety Agency

NOAEL - No Observed Adverse Effect Level

ADI - acceptable daily intake

AFC – artificial food colors

NHANES - National Health and Nutrition Examination Survey

ADHD - attention deficit/hyperactivity disorder

## Introduction

Food scientists and producers know that, alongside flavor and texture, color plays a crucial role in taste and food perception (Burrows, 2009). The visual aspect is one of the main decision factors for food consumers. In this context, food colors are added to increase the visual attractiveness or to compensate for natural color variations in food (Oplatowska-Stachowiak and Elliott, 2017). Historically, ancient Egyptians added colorants to wine and confectionaries (Oplatowska-Stachowiak and Elliot, 2017). Food coloring could only be obtained from natural sources (saffron, pepper, turmeric, beet extract, and various flowers) (Sigurdson et al., 2017). For example, wheat starch, egg whites, or crushed almonds were used for white, one of the world's most expensive spices, saffron was used as a yellow or golden colorant, and mint, spinach, and parsley for green (Spence, 2022). In the 17th and 18th centuries, tea was colored with copper carbonate, and whiteness of a bread was

enhanced with chalk (Sharma et al., 2011). The first synthetic color was developed by William Henry Perkin in 1856 while working with anillines (petroleum products). It was a purple pigment called „mauveine" (Mota et al., 2021), which led to synthesis of thousands of new coloring compounds for industrial applications (Oplatowska-Stachowiak and Elliott, 2017).

Food coloring can be artificial, created in the same way as natural coloring, or naturally derived. Natural colors are extracted from natural sources by more or less complicated processes. They have many positive features, such as reliability, functionality, biological potential, and health benefits, but they also have certain drawbacks, including sensitivity toward other food ingredients or in the presence of scents or odors, as well as instability in water, light and/or heat (Silva et al., 2022).

In contrast to natural colors that are extracted from natural sources, artificial colors are produced by the chemical synthesis or modification of several

\*Corresponding author: tanja.markovic@zzjzjosijek.hr

precursors (König, 2015). Nowadays, the food industry prefers artificial colors for their ease of production, low cost, high stability, and better coloring properties (Oplatowska-Stachowiak and Elliott, 2017). Additionally, they give the product a strong color without adding any unwelcome flavors (Barciela et al., 2023).

Foods on the market may contain excessive amounts of artificial colors. They have been linked to health issues including allergenicity, behavioral issues such as childhood hyperactivity syndrome, neurotoxicity, genotoxicity, and carcinogenicity, and are a major cause of food intoxication, according to a number of studies (Dey and Nagababu, 2022; Corradini, 2019). Since many synthetic compounds have been shown to be toxic and harmful to humans, the use of colors as food additives in the developed world is strictly controlled by legislation, which varies from country to

country (Oplatowska-Stachowiak and Elliott, 2017). The European Food Safety Agency (EFSA) of the European Union (EU) and the Food and Drug Administration (FDA) of the United States of America are the two primary regulatory bodies in the world for food additives. These institutions carry out safety regulations, review scientific data, assess potential toxicity, and estimate human dietary exposure to food additives. Beyond just naming them, the EFSA gives each food additive a special identification code made up of the letter "E" and a number. Colorants range from E100 (Curcumin) to E180 (Litholrubine BK). Artificial food colors are restricted by Regulation (EC) 1333/2008. Only those colors listed in Annex II (European Commission, 2011) are authorized for foods. A list of the currently authorized artificial food colors is shown in Table 1.

**Table 1.** Artificial food colours authorized in the EU according to Regulation (EC) 1333/2008

ARTIFICIAL FOOD COLORS	
E-NUMBER	NAME
E 102	Tartrazine*
E 104	Quinoline Yellow
E 110	Sunset Yellow FCF/Orange Yellow S
E 122	Azorubine, Carmoisine*
E 123	Amaranth*
E 124	Ponceau 4R, Cochineal Red A*
E 127	Erythrosine
E 129	Allura Red AC*
E 131	Patent Blue V
E 133	Brilliant Blue FCF
E 142	Green S
E 151	Brilliant Blac BN, Black PN*
E 154	Brown FK*
E 155	Brown HT*
E 160e	Beta-apo-8'-carotenal (C30)
E 180	Litholrubin BK*

\*azo-color

Since all chemicals have the potential to be harmful, the minimal exposure level at which adverse health consequences might manifest is estimated to establish the quantities that should be utilized in meals. This limit, known as the No Observed Adverse Effect Level (NOAEL), is mostly established through research conducted on animals. In order to account for interspecies differences between test animals and humans and intraspecies variability among humans, sensitive populations are taken into consideration when safety factors are added to the NOAEL. This results in the chemical's acceptable daily intake (ADI) value. The ADI is defined as 'the amount of a substance that people can consume on a daily basis during their whole life without any appreciable risk to health'. ADIs are usually expressed in mg per kg of

body weight per day (mg/kg body weight/day), (Martyn et al., 2013).

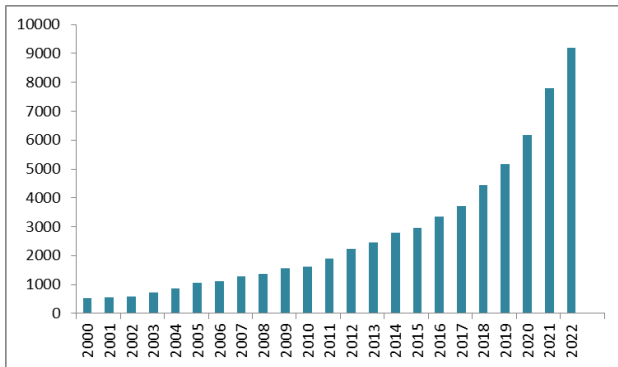
The level of exposure and individual sensitivity have direct influence in assessing toxic potential of substances, including additives. Since the acceptable daily intake (ADI) is calculated per kilogram of weight, children may be more sensitive to additive toxicity.

Compared to adults, children consume more food, drink more water, and breathe more air per unit of body weight. Additionally, since children may live longer than adults in the future, they have more time to develop chronic diseases brought on by early exposure to environmental toxins like food additives (Kraemer et al., 2022).

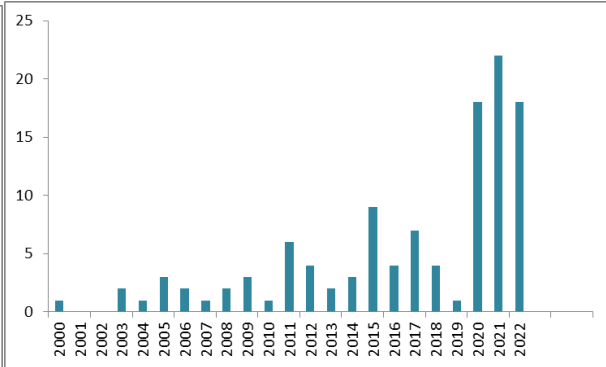
## Methods

A review of the literature was carried out between June and September 2023, with a bibliographic search in

the databases ScienceDirect, PubMed, and Google Scholar. Official documents and studies published since 2000 were selected (Figures 1 and 2). Keywords related to food additives, children, artificial colors, and health effects were used for the search.



**Figure 1.** Dynamics of publication (2000 – 2022) of searches for food colors and health relationships (Based on data retrieved from Science direct) – visited 05.09.2023.



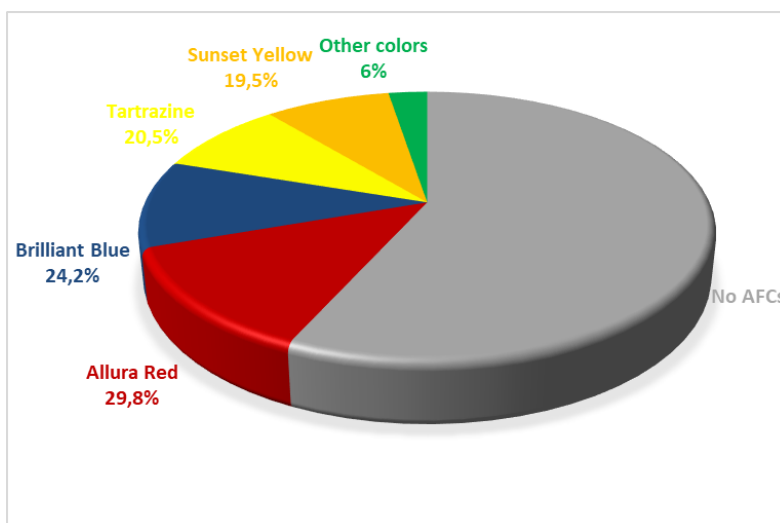
**Figure 2.** Dynamics of publication (2000 – 2022) of searches for food colors and health relationships (Based on data retrieved from PubMed) – visited 05.09.2023.

## Results and discussion

### Researches

A survey on the percentage of goods containing artificial colors (AFC) at one supermarket shop was done in North Carolina in 2014. For 810 goods in 19 categories, the research team gathered data on the products and food colorings. 350 goods overall (43.2%) contained AFC. Allura Red (29.8% of items), Brilliant Blue (24.2%), Tartrazine (20.5%), and Sunset Yellow (19.5%) were the most prevalent AFCs (Figure 3). Candy accounted for

96.3% of all products in this category, followed by fruit-flavored snacks (94.7%), drink mixes and powders (89.7%), and frozen breakfast (85.7%). The AFC most frequently used, found in 29.8% of items geared at children, was Allura Red. Categories with a high proportion of products containing Allura Red included candies (77.8%), drink mixes and powders (71.8%), and toaster cakes (66.7%), which were present in products in all 19 categories with products that contained AFC. Fast green, erythrosine, and other AFCs were found in less than 5% of items or not at all (Batada and Jacobson, 2016).



**Figure 1.** An illustration of the findings from a survey on the proportion of products containing artificial colors in one supermarket conducted in North Carolina in 2014 (adapted from Batada and Jacobson, 2014)

In the Netherlands, a study was carried out between September 2012 and December 2013 to determine the acceptable daily intake (ADI) of artificial food colors among schoolchildren using a prospective three-day food diary (two weekdays and one weekend day). It was found that the colors Brilliant Blue (E133), Patent Blue (E131), and Indigotine (E132) predominantly appear in their products in supermarkets (mainly sweets and carbonated drinks). None of the children consumed yellow, orange or red artificial food color. Only Brilliant Blue (E133), Patent Blue (E131), Indigotine (E132), and Green S (E142) were found to be used by children in Amsterdam as artificial food colorings, and their intake was shown to be much lower than the ADI (Kist-van Holthe et al., 2015).

A German database on the prevalence of food additives was built in order to obtain a more accurate estimate of toddlers' and kids' intake of food additives. It combines qualitative data on the presence of food additives in the consumed food with consumption data from two recent national nutrition surveys for toddlers and kids. Two dietary surveys from 2001–2002 and 2006, respectively, were utilized to collect data on consumption. The information regarding the presence of food additives is based on food labeling. Children in Germany ingest a variety of red hues (E110, E124, and E129), and their mean intake is 0.16-0.50 mg/kg/day, which is comparable to findings from the Netherlands (Diouf et al., 2014).

A 24-hour dietary recall was carried out twice in 58 schools to evaluate the use of artificial food color additives by children aged 5 to 14 in the State of Kuwait. To assess the potential risk connected to children in Kuwait consuming artificial color additives, a comparison with the recommended daily intakes (ADIs) was made. The findings showed that four of the nine approved colors: Tartrazine, Sunset Yellow, Carmoisine, and Allura Red exceed their ADIs by factors of 2–8. Further research is required to shed light on any potential negative health effects linked to the excessive use of these artificial color additives in the test population (Husain et al., 2006).

For Australian children, food exposure assessments to added colors were conducted in 2006. To ascertain whether food intake on a daily basis was likely to result in a significant health issue, the estimated dietary exposure to each particular color was compared to the pertinent, internationally accepted Acceptable Daily Intake (ADI). Even for high consumers, dietary exposure to certain added colors was below the ADI (Stevens et al., 2014).

Utilizing data on food and beverage dietary intake gathered from individuals in the 2015–2016 NHANES, researchers in the USA estimated AFC

exposure in women of reproductive age, pregnant women, and children. The NHANES program polls a sample of roughly 5,000 people from across the country to determine the health and nutritional status of children and adults living in the United States. They compared them to the acceptable daily intakes (ADIs) recommended by the FDA and the WHO. Currently, there are seven FD&C (Federal Food, Drug, and Cosmetic Act, FDA) color additives approved for general use in food in the United States: Brilliant Blue, Indigo Carmine, Fast Green, Erythrosine, Allura Red, Tartrazine, and Sunset Yellow. The highest projected exposures for AFC consumers to the seven regularly used food colors were Allura Red, followed by Sunset Yellow and Tartrazine. The lowest exposures were found for Fast Green. Overall, children's estimated exposure to Allura Red and Erythrosine, as well as the other five food colors, tended to be higher compared with adult women (Bradman et al., 2022).

As they are the biggest consumers of artificial colors, research was also done in Saudi Arabia among school-aged children between the ages of 6 and 17. In order to acquire the data necessary to evaluate how much and what kind of food the children consume, individual interviews with the kids were done in their schools. Data from the 24-hour field survey of dietary recall were entered into the database and statistically processed. The questionnaire was used to identify the colors Sunset Yellow (E110), Tartrazine (E102), Carmoisine (E122), Brilliant Blue (E133), Allura Red (E129), Black PN (E151), Indigo Carmine (E132), and Fast Green (E143). According to the findings, schoolchildren consumed Carmoisine (32.3%) and Sunset Yellow (30.1%) of artificial food colors the most frequently, while Erythrosine (0.05%) was the least popular. In both sexes, the ADI of AFC declines with age to varying degrees. Most permitted colors surpassed their ADIs in the 6- to 11-year old group and most permitted colors were within the recommended ADIs in the 12- to 17-year-old age group when compared to the Food and Agriculture Organization and World Health Organization acceptable daily intakes, which indicates age-related decreases in schoolchildren's average daily consumption of AFC (Ahmed et al., 2023).

Utilizing information from 142 primary school students in three districts of Hong Kong, China, ages 8 to 9, who completed food-frequency questionnaires, it was possible to calculate the dietary exposure to artificial colors. The average amount of colored foods ingested was multiplied by the average levels of the color additives in those meals, and the result was divided by the average body weight for each group to get the ADI of authorized artificial food colors. With

the exception of Sunset Yellow, an average primary school student's dietary exposure to artificial colors was significantly lower than the ADI for their ages. According to the data, 9-year-old boys had an average daily intake of Sunset Yellow (E110) that was 51% higher than the ADI threshold. The increasing consumption of soft drinks and treats like jellies, which contain high levels of this artificial color additive, was primarily to blame for the higher intakes of Sunset Yellow (Lok et al., 2011).

Based on research on food consumption and the concentration of food additives in accordance with WHO guidelines, a risk assessment study of six different types of food additives (including benzoates, sorbates, cyclamates, saccharin, Tartrazine and Sunset Yellow) in Vietnamese diets was carried out. Surveys on food consumption and food sampling were conducted in six provinces. According to the survey findings, different food product categories are consumed in varied amounts by people of various ages. The amount of coloring chemicals was

significantly smaller and was mostly found in chili sauce. Total intake for Tartrazine and Sunset Yellow was substantially lower than their ADIs (Long et al., 2019).

The Brazilian Institute of Geography and Statistics' Household Budget Survey (HBS) data on food consumption were used in this study to calculate the theoretical maximum daily intake of the synthetic food color Sunset Yellow by the Brazilian population. In order to determine whether it was possible to surpass the ADI, the study included people from all age groups and urban and rural populations in the five regions of the nation. This was determined by comparing food items from Brazil's main retail chains that contain this color. These findings indicated that none of the aforementioned population groups' average Sunset Yellow consumption per capita exceeded the ADI (Feitosa et al., 2017).

Table 2 provides a summary of all these studies that evaluated the consumption of food colors by children.

**Table 2.** Studies that evaluated the consumption of food colors by children (dos Santos Kraemer et al., 2022)

Country	Population (age)	Period	Type of research	Analyzed type of synthetic colors	Intake estimations compared with the Acceptable Daily Intake (ADI)	Reference
Netherlands	Median age 7.0, range 5–12 years	between September 2012 and December 2013	three-day prospective food diary and compared to the acceptable daily intake (ADI)	E102 Tartrazine E104 Chinoline Yellow E110 Sunset Yellow E122 Azorubine E124 Ponceau 4R E129 Allura Red E131 Patent Blue E132 Indigotine E133 Brilliant Blue E142 Green S	Intake of artificial food colourings is well below the acceptable daily intake (ADI) and is limited to Brilliant Blue (E133), Patent Blue (E131), Indigotine (E132) and Green S (E142)	Kist-van Holthe et al., 2015
Germany	Infants and toddlers aged 6 months to <5 years	in 2001/02 and 2006	It uses consumption data of two recent national nutrition surveys for children in combination with qualitative information of food additive occurrence in the consumed food	E110 Sunset Yellow E124 Ponceau 4R E129 Allura Red	Exposure for high-level consumers exceeded the ADI for two of the food additives; E120 Carmine acid (natural), E129 Allura Red	Diouf et al., 2014
State of Kuwait	5–14-year-old children	Not defined	24-h dietary recall field survey	E102 Tartrazine E110 Sunset yellow F E122 Carmoisine. E127 Erythrosine E129 Allura red E143 Fast green E132 Indigotine E133 Brilliant blue E151 Brilliant black E155 Brown HT	The results indicated that out of nine permitted colours, four exceeded their ADIs by factors of 2–8: tartrazine, sunset yellow, carmoisine and allura red	Husain et al., 2006
Australia	The Australian population aged 2 years and above, children aged 2-5 years, children aged 6-12 years.	three month period between June and August 2006	Dietary modelling as a tool used to estimate exposure to food chemicals from the diet as part of the risk assessment process.	E129 Allura red E122 Amaranth E122 Azorubine E151 Brilliant Black E133 Brilliant Blue	For the Australian population and all population sub-groups assessed, dietary exposure to individual added colours was below the ADI even for high (90th percentile) consumers.	Stevens et al., 2014



	adolescents aged 13-18 years, adults aged 19-24 years, adults aged 25 years and above			E155 Brown HT E127 Erythrosine E143 Fast Green E142 Green S E132 Indigotine E124 Ponceau 4R E104 Quinoline Yellow E110 Sunset Yellow E102 Tartrazine		
USA	women of reproductive age, pregnant women, and children	2015-2016	NHANES (National Health and Nutrition Examination Survey)	E133 Brilliant Blue E132 Indigotine E127 Erythrosine E102 Tartrazine E129 Allura red E143 Fast green E110 Sunset Yellow	The highest projected exposures for AFC consumers to the seven regularly used FD&C food colors were Allura Red, followed by Sunset Yellow and Tartrazine. The lowest exposures were found for Fast Green	Bradman et al., 2022
Saudi Arabia	school-aged children from 6 to 17 years	Not defined	Individual interviews, 24-hour field survey of dietary recall	E132 Indigotine E127 Erythrosine E102 Tartrazine E122 Carmoisine. E129 Allura red E143 Fast green E110 Sunset Yellow E151 Brilliant Black E133 Brilliant Blue	Carmoisine (32.3 %) and Sunset Yellow (30.1 %) were the most frequently consumed, while Erythrosine (0.05 %) was the least consumed	Ahmed et al., 2023
Vietnam	Young children ( $\leq 5$ years), elementary students (6–10 years) high school students (11-18 years) adults (19–40 age) and middle/elderly people ( $> 40$ years)	Not defined	24-h dietary recall	E102 Tartrazine E110 Sunset Yellow	Average food additive intakes of consumer in Vietnam were within the recommendation of Codex Alimentarius.	Long et al., 2019
Brazil	Adolescents (10–18 years old) Adults (19–54 years old) Seniors (over 55 years old)	2008/2009	Official government data	E110 Sunset Yellow	Consumption of Sunset Yellow per capita did not exceed the ADI	Feitosa et al., 2017
Hong Kong, China	Primary school children aged 8–9 years	Not defined	Food frequency questionnaire	E102 Tartrazine E104 Quinoline Yellow E110 Sunset Yellow E122 Carmoisine E123 Amaranth E124 Ponceau 4R E127 Erythrosine E129 Allura Red E132 Indigo Carmine E133 Erioglaucine Disodium E142 Lissamine Green B	Dietary exposure was considerably lower than the threshold for acceptable daily intake (ADI) for their ages, except for sunset yellow FCF. Data obtained showed that the average daily intake of sunset yellow FCF (E110) was 51% over the ADI threshold in 9-year-old boys.	Lok et al., 2011

The idea that food allergies or sensitivities lead to behavioral and learning problems dates back to the 1920s, but it wasn't until 1973 that Dr. Benjamin Feingold proposed that artificial food colors were common causes of hyperactivity (Arnold et al., 2012). More than 3,000 distinct food additive effects were tested on 1,200 people, but his research was not only refuted but also made fun of. Feingold claimed that a

diet devoid of these additives significantly reduced hyperactive symptoms, and more than 50% of the population benefited. Numerous studies were conducted to determine the validity of this claim, three of which, carried out at Southampton University, provided the first conclusive and scientific evidence of the negative effects of these colors (Mittal, 2020).

### *Food colors and ADHD*

By 1980, the terminology “hyperactivity” was changed to “attention-deficit disorder” (ADD) to describe children who were inattentive but not hyperactive and “attention deficit/hyperactivity disorder” (ADHD) to describe children who were hyperactive, impulsive, and inattentive (Stevens et al., 2013). ADHD, commonly known as attention deficit hyperactivity disorder, is a neurological condition that affects children. It is often first diagnosed in infancy and frequently continues into adulthood. Although the actual etiology of ADHD is unknown, environmental variables such as pollutants and food may have an impact on symptom severity in addition to genetics. The Food and Drug Administration (FDA) has allowed artificial food coloring (AFC); however, according to Rambler et al. (2022), research suggested that it might have been linked to symptoms of ADHD. Bateman et al. (2004) conducted research on whether artificial colors in food affect hyperactivity in children. 1873 of four-year-olds underwent tests for the presence of hyperactivity. The children underwent a baseline assessment and were then put on a diet that excluded artificial colors and benzoate preservatives for one week. Over the course of the following three weeks, they participated in a double-blind cross-over study where they were given, in a random order, periods of dietary challenge with either a drink containing artificial colors (20 mg per day) and sodium benzoate (45 mg per day) (active period) or a placebo mixture. Behavior was assessed by an examiner who was blind to nutritional status and parent ratings. During the weaning phase, hyperactive behavior significantly decreased. Additionally, according to parent reports, hyperactive behavior increased during the active phase far more than it did during the placebo period. According to the study's findings, parents could have noticed an overall unfavorable impact of artificial food colors and benzoate preservatives on their children's behavior at the age of 3, but not by straightforward clinical evaluation. Bateman et al. (2004) believe that research suggests that all children would benefit if artificial food colors and benzoate preservatives were removed from their diets.

Some conclusions have been drawn from research on the effects of blue food coloring on children's health. The study was conducted on Brilliant Blue (Blue No. 1) and Indigotine (Blue No. 2), two of the most widely used synthetic blues. While concerns regarding the safety of AFCs continue to emerge, the toxicity of artificial blue food coloring has been evaluated in mice and rats in a lab setting (Rambler et al., 2022). Brilliant Blue and Indigotine have not been shown to be

harmful or carcinogenic in rats or mice. On the other hand, Brilliant Blue showed potential for neurotoxicity in an in vitro study by inhibiting neurite development and cooperating with L-glutamic acid. The blood-brain barrier is still developing in fetuses and infants younger than 6 months, so this is especially concerning. To assess the safety of this color with more certainty, more research is required. Regarding Indigotine, it was shown that rats exposed to high concentrations of the color developed tumors (brain gliomas) at substantial rates. Despite this fact, the FDA found reasons to excuse that evidence and approved the continued use of the dye (Kobylewski and Jacobson, 2012; Olas et al., 2021).

### *Food colors and allergies*

Since the usage of food additives has increased significantly over the past 20 years around the globe, numerous allergies and other immune reactivities have been documented (Vojdani, 2015). Dietary allergies include allergic responses to dietary additives. The cause of food allergy (hypersensitivity) is an immunologic reaction brought on by eating a food. The biggest foreign antigenic load that the human immune system encounters comes from eating. Food antigens, which frequently enter the body proper in most people, cause tolerance to develop. However, the immune system responds with some type of hypersensitive reaction if tolerance building is unsuccessful (Gultekin and Doguc, 2012). Food coloring and other additives are made of very small molecules, to which we have not developed a tolerance yet. These food additives become the main cause of the breakdown of immunological tolerance if they are able to attach to body proteins after metabolization or to food proteins during food production. They are thought to contribute significantly yet covertly to these immunological reactivities (Vojdani, 2015). Additionally, Tartrazine in particular has been mentioned as a potential asthma and urticaria trigger, especially in aspirin-intolerant patients. These reactions have happened after consuming meals or items that include Tartrazine and other food colors (Elhkim, 2007). Children with severe atopic dermatitis had an even higher percentage of reactions to Tartrazine. There have been reports of Tartrazine and other colorants being involved in numerous chemical sensitivity disorders that are not IgE-mediated (Inomata et al., 2006). Other research and case reports have linked the use of many food additives, including Tartrazine, to allergic, immunologic abnormalities like chronic urticaria, angioedema, and rhinitis, which are typically linked to food allergies. These other studies and case reports

include Allura Red and Erythrosine. This study and numerous others pertaining to immunological reactions to food coloring were evaluated in great detail in a review paper, which came to the conclusion that allergic and immune reactions to food additives can be thought of as triggers or aggravating factors in sensitive people. Deleting these triggers can significantly alleviate a patient's symptomatology, hence clinicians and sensitive consumers in particular should be aware of the allergic qualities of food additives (Vojdani, 2015).

#### *Food colors and carcinogenicity*

Highly processed foods have become a part of our daily diet. Such meals are frequently colored with food colors, particularly synthetic ones, which might have genotoxic or carcinogenic qualities. This poses a risk to the public's health. Children are the main consumers of artificial food color, which has multiplied over the past 50 years. Some colors could have carcinogens in them. The main factors causing liver cancer are food colors such as Erythrosine, Carmoisine, and Tartrazine (Malabadi et al, 2022). Research by Reza et al. (2019) was done to ascertain the relationship between carcinogenicity and the toxicities of the azo color Carmoisine on mice. The animals were placed into 4 groups when the trial began and were around 6 weeks old. For mice, Carmoisine was added to a standard diet at a variety of doses. Every day, the animal's overall health, mortality, and any signs of sickness were examined, and once a week, each animal's body weight was recorded separately. According to this study, treatment with large doses of Carmoisine can cause hepatotoxicity and renal failure. It might also be thought to be the cause of liver cancer development (Reza et al, 2019). There are nine colors that are now permitted in the US, and each of them has been linked to a range of health issues. Animal studies have shown carcinogenic effect of erythrosine, and there is evidence that numerous other colors have similar effect. It was discovered that three colors (Allura Red, Tartrazine and Sunset Yellow) contained benzidine or other carcinogens. There is no evidence that ingesting Erythrosine or any other artificial food colors causes cancer on humans. Scientists, however, tend to use the results of animal studies to understand possible effects in people. Although there are no FDA-approved artificial food colors that are categorized as carcinogenic, current research suggests possible health hazards that may be alarming (Kobylewski and Jacobson, 2012).

## **Conclusion**

An essential component of a significant amount of the food sold nowadays is artificial food coloring. They do not increase the nutritional value or safety of food, in contrast to some other additives. They were just introduced to enhance the food's aesthetic identity and appeal to consumers, particularly children. The use of artificial food colors is still controversial. Some studies clearly indicate that the use of artificial colors can have toxic and harmful effects. Children are the most vulnerable group because of how quickly their bodies grow and change as well as how much more exposure to toxins they receive per kilogram of body weight. Since the FDA concluded that artificial food colors are not harmful to health, many scientists try to make the public aware of the fact that artificial food colors are not so harmless through their research and presentation of results in their scientific works. An additive consumption limit, or ADI, is established by taking into account the effects found in toxicological research conducted, mostly, on animal models. Since the early stages of life are not taken into account when setting safety limits, the context of consumption restrictions and the assessment of the toxicity of additives are more complicated when applied to children. Food color exposure is associated with negative behavioral outcomes in children, both with and without pre-existing behavioral abnormalities, according to recent human investigations, most notably controlled exposure studies in children. To further understand the relationship between consumption and harmful health effects, additional exposure analyses of legal artificial colors, particularly in youngsters, are urgently needed. Without this information, it would be very difficult to protect customers, especially the most helpless ones (children). It is advised that regulatory agencies demand better and independent toxicity testing, use more caution when approving certain hues moving forward, and only approve well-researched, secure colors. Also, due to concerns that artificial colors can affect children's behavior, in recent years, California's Office of Environmental Health Hazard Assessment (OEHHA) has been conducting the most rigorous assessment undertaken to date of the relationship between synthetic colors and their effects on child behavior. Based on multiple evidence, they conclude that the neurobehavioral effects of synthetic food colors in children should be acknowledged and steps taken to reduce exposure (Miller et al., 2022).

## References

- Ahmed, M.A., Al-Khalifa, A.S., Al-Nouri, D.M., El-din, M.F.S. (2023): Average Daily Intake of Artificially Food Color Additives by School Children in Saudi Arabia, *J King Saud Univ Sci* 35(4), 102596. <https://doi.org/10.1016/j.jksus.2023.102596>.
- Arnold, L.E., Lofthouse, N., Hurt, E. (2012): Artificial Food Colors and Attention-Deficit/Hyperactivity Symptoms: Conclusions to Dye For, *Neurotherapeutics* 9(3), 599–609. <https://doi.org/10.1007/s13311-012-0133-x>.
- Barciela, P., Perez-Vazquez, A., Prieto, M.A. (2023): Azo Dyes in the Food Industry: Features, Classification, Toxicity, Alternatives, and Regulation, *Food Chem Toxicol* 178, 113935. <https://doi.org/10.1016/j.fct.2023.113935>.
- Batada, A., Jacobson, M.F. (2016): Prevalence of Artificial Food Colors in Grocery Store Products Marketed to Children, *Clin Pediatr* 55(12), 1113–19. <https://doi.org/10.1177/0009922816651621>.
- Bateman, B., Warner, J.O., Hutchinson, E., Dean, T., Rowlandson, P., Gant, C., Grundy, J., Fitzgerald, C., Stevenson, J. (2004): The Effects of a Double Blind, Placebo Controlled, Artificial Food Colourings and Benzoate Preservative Challenge on Hyperactivity in a General Population Sample of Preschool Children, *Arch Dis Child* 89(6), 506–11. <https://doi.org/10.1136/adc.2003.031435>.
- Bradman, A., Castorina, R., Thilakarathne, R., Gillan, M., Pattabhiraman, T., Nirula, A., Marty, M., Miller, M.D. (2022): Dietary Exposure to United States Food and Drug Administration-Approved Synthetic Food Colors in Children, Pregnant Women, and Women of Childbearing Age Living in the United States, *Int J Environ Res Pub Health* 19(15), 9661. <https://doi.org/10.3390/ijerph19159661>.
- Burrows, A.J.D. (2009): Palette of Our Palates: A Brief History of Food Coloring and Its Regulation, *Compr Rev Food Sci Food Saf* 8(4), 394–408. <https://doi.org/10.1111/j.1541-4337.2009.00089.x>.
- Chung, K.-T. (2016): Azo Dyes and Human Health: A Review, *J Environ Sci Health Part C* 34(4), 233–61. <https://doi.org/10.1080/10590501.2016.1236602>.
- Corradini, M.G. (2019): Synthetic Food Colors, In *Encyclopedia of Food Chemistry* 291–96. Elsevier. <https://doi.org/10.1016/B978-0-08-100596-5.21606-5>.
- Dey, S., Nagababu, B.H. (2022): Applications of Food Color and Bio-Preservatives in the Food and Its Effect on the Human Health, *Food Chem Adv* 1, 100019. <https://doi.org/10.1016/j.focha.2022.100019>.
- Diouf, F., Berg, K., Ptok, S., Lindtner, O., Heinemeyer, G., Hesecker, H. (2014): German Database on the Occurrence of Food Additives: Application for Intake Estimation of Five Food Colours for Toddlers and Children, *Food Addit Contam: Part A* 31(2), 197–206. <https://doi.org/10.1080/19440049.2013.865146>.
- Durazzo, A., Carochi, M., Heleno, S., Barros, L., Souto, E.B., Santini, A., Lucarini, M. (2022): Food Dyes and Health: Literature Quantitative Research Analysis, *Measurement: Food* 7, 100050. <https://doi.org/10.1016/j.meafoo.2022.100050>.
- Elhkim, M.O., Héraud, F., Bemrah, N., Gauchard, F., Lorino, T., Lambré, C., Frémy, J.M., Poul, J.M. (2007): New Considerations Regarding the Risk Assessment on Tartrazine, *Regul Toxicol Pharmacol* 47(3), 308–16. <https://doi.org/10.1016/j.yrtph.2006.11.004>.
- Feitosa, L.C.A., Da Silva Rodrigues, P., Da Silva, A.S., De Oliveira Rios, A., Cladera-Olivera, F. (2017): Estimate of the Theoretical Maximum Daily Intake of Sunset Yellow FCF by the Brazilian Population, *Food Addit Contam: Part A* 20, 1–8. <https://doi.org/10.1080/19440049.2017.1290829>.
- Feketea, G., Tsaouri, S. (2017): Common Food Colorants and Allergic Reactions in Children: Myth or Reality?, *Food Chem* 230, 578–88. <https://doi.org/10.1016/j.foodchem.2017.03.043>.
- Gultekin, F., Doguc, D.K. (2013): Allergic and Immunologic Reactions to Food Additives, *Clin Rev Allergy Immunol* 45(1), 6–29. <https://doi.org/10.1007/s12016-012-8300-8>.
- Husain, A., Sawaya, W., Al-Omar, A., Al-Zenki, S., Al-Amiri, H., Ahmed, N., Al-Sinan, M. Estimates of Dietary Exposure of Children to Artificial Food Colours in Kuwait, *Food Addit Contam* 23(3), <https://doi.org/10.1080/02652030500429125>.
- Inomata, N., Hiroyuki O., Hiroyuki F., Toru O., Zenro I. (2006): Multiple Chemical Sensitivities Following Intolerance to Azo Dye in Sweets in a 5-Year-Old Girl, *Allergol Int* 55(2), 203–5. <https://doi.org/10.2332/allergolint.55.203>.
- Kist-van Holthe, J., Altenburg, T., Bolakhrif, S., El Hamdi, L., Man, M.W., Tu, J., Chin, M.J., Paw, M.C.A. (2015): Consumption of Artificial Food Colourings by School Children in the Netherlands, *Adv Pediatr Res* 2, 5. <https://doi.org/10.12715/apr.2015.2.5>.
- Kobylewski, S., Jacobson, M.F. (2012): Toxicology of Food Dyes, *Int J Occupat Environ Health* 18(3), 220–46. <https://doi.org/10.1179/1077352512Z.00000000034>.
- König, J. (2015): Food Colour Additives of Synthetic Origin, In *Colour Additives for Foods and Beverages* 35–60. Elsevier. <https://doi.org/10.1016/B978-1-78242-011-8.00002-7>.
- Kraemer, M. V. dos S., Fernandes, A. C., Chaddad, M. C. C., Uggioni, P. L., Rodrigues, V. M., Bernardo, G. L., Proença, R. P. da C. (2022): Aditivos Alimentares Na Infância: Uma Revisão Sobre Consumo e Consequências à Saúde, *Rev Saúde Pública* 56, 32. <https://doi.org/10.11606/s1518-8787.2022056004060>.
- Lok, K.Y.W., Chung, Y.W., Benzie, I.F.F., Woo, J. (2011): Synthetic Colourings of Some Snack Foods Consumed by Primary School Children Aged 8–9 Years in Hong Kong, *Food Addit Contam: Part B* 4(3), 162–67. <https://doi.org/10.1080/19393210.2011.585246>.

- Malabadi, R.B., Kolkar, K.P., Chalannavar, R.K. (2022): Plant Natural Pigment Colorants-Health Benefits: Toxicity Of Synthetic Or Artificial Food Colorants, *Int J Innov Sci Res Rev* 04(10), 3418-3429.
- Martyn, D.M., McNulty, B.A., Nugent, A.P., Gibney, M.J. (2013): Food Additives and Preschool Children, *Proceedings of the Nutrition Society* 72(1), 109–116. <https://doi.org/10.1017/S0029665112002935>.
- Miller, M.D., Steinmaus, C., Golub, M.S., Castorina, R., Thilakartne, R., Bradman, A., Marty, M.A. (2022): Potential Impacts of Synthetic Food Dyes on Activity and Attention in Children: A Review of the Human and Animal Evidence, *Environ Health* 21(1), 45. <https://doi.org/10.1186/s12940-022-00849-9>.
- Mittal, J. (2020): Permissible Synthetic Food Dyes in India, *Resonance* 25(4), 567–577. <https://doi.org/10.1007/s12045-020-0970-6>.
- Mota, I.G.C., Das Neves, R.A.M., Da Cruz Nascimento, S.S., Maciel, B.L.L., De Araújo Moraes, A.H., Passos, T.S. (2023): Artificial Dyes: Health Risks and the Need for Revision of International Regulations, *Food Rev Int* 39(3), 1578–1593. <https://doi.org/10.1080/87559129.2021.1934694>.
- Nguyen H.L., Hao, L.T.H., Trang, V.T., Son, C., Hung, L.Q. (2019): Assessing Dietary Risks Caused by Food Additives: A Case Study of Total Diet in Vietnam, *Health Risk Analysis* 2, 74–82. <https://doi.org/10.21668/health.risk/2019.2.08.eng>.
- Olas, B., Białocki, J., Urbańska, K., Bryś, M. (2021): The Effects of Natural and Synthetic Blue Dyes on Human Health: A Review of Current Knowledge and Therapeutic Perspectives, *Adv Nutr* 12(6), 2301–11. <https://doi.org/10.1093/advances/nmab081>.
- Oplatowska-Stachowiak, M., Elliott, C.T. (2017): Food Colors: Existing and Emerging Food Safety Concerns, *Crit Rev Food Sci Nutr* 57(3), 524–548. <https://doi.org/10.1080/10408398.2014.889652>.
- Rambler, R.M., Rinehart, E., Boehmler, W., Gait, P., Moore, J., Schlenker, M., Kashyap, R. (2022): A Review of the Association of Blue Food Coloring With Attention Deficit Hyperactivity Disorder Symptoms in Children, *Cureus* 14(9), e29241. <https://doi.org/10.7759/cureus.29241>.
- Regulation (EC), 2008. Of the European Parliament and of the Council of 16 December 2008 on Food Additives. No 1333/2008. *Official Journal of the European Union* L. Pub. L. No. 1333/2008, 51.
- Reza, S. A., Hasan, M., Hossain, K.I., Zubair, A., Bari, L., Abedin, Z., Khandaker, K.B.F., Haque, K.F., Islam, K., Ahmed, M.U., Hossain, K. (2019): Study of a Common Azo Food Dye in Mice Model: Toxicity Reports and Its Relation to Carcinogenicity, *Food Sci Nutr* 7(2), 667–77. <https://doi.org/10.1002/fsn3.906>.
- Sharma, V., McKone, H.T., Markow, P.G. (2011): A Global Perspective on the History, Use, and Identification of Synthetic Food Dyes, *J Chem Edu* 88(1), 24–28. <https://doi.org/10.1021/ed100545v>.
- Sigurdson, G.T., Tang, P., Giusti, M.M. (2017): Natural Colorants: Food Colorants from Natural Sources, *Annu Rev Food Sci Technol* 8(1), 261–80. <https://doi.org/10.1146/annurev-food-030216-025923>.
- Silva, M.M., Reboredo, F.H., Lidon, F.C. (2022): Food Colour Additives: A Synoptical Overview on Their Chemical Properties, Applications in Food Products, and Health Side Effects, *Foods* 11(3), 379. <https://doi.org/10.3390/foods11030379>.
- Spence, C. (2023): On the Manipulation, and Meaning(s), of Color in Food: A Historical Perspective, *J Food Sci* 88(S1), A5-A20. <https://doi.org/10.1111/1750-3841.16439>.
- Stevens, L.J., Kuczek, T., Burgess, J.R., Stochelski, M.A., Arnold, L.E., Galland, L. (2013): Mechanisms of Behavioral, Atopic, and Other Reactions to Artificial Food Colors in Children, *Nutr Rev* 71(5), 268–281. <https://doi.org/10.1111/nure.12023>.
- Stevens, L.J., Burgess, J.R., Stochelski, M.A. (2014): Amounts of Artificial Food Colors in Commonly Consumed Beverages and Potential Behavioral Implications for Consumption in Children, *Clin Pediatr* 53(2), 133-140.
- Vojdani, A., Vojdani, C. (2015): Immune reactivity to food coloring, *Altern Ther Health Med* 21, 52-62.

## POREMEĆAJI PREHRANE

Nikolina Pranić, Aleksandra Žigić Forić, Ivan Pokec, Zrinka Puharić\*

Veleučilište u Bjelovaru, Trg Eugena Kvaternika 4, 43000 Bjelovar, Hrvatska

*stručni rad*

### Sažetak

Poremećaji prehrane podrazumijevaju trajno narušen odnos prema vlastitom tijelu i hrani, što uzrokuje destrukciju mentalnog i fizičkog zdravlja pojedinca, kao i disfunkcionalne društvene i obiteljske odnose. Anoreksija i bulimija nervoza su najzastupljeniji poremećaji prehrane. Njihov kronični oblik je ujedno i najteži oblik bolesti. Obilježja anoreksije nervoze su izgladnjivanje, odbojnost prema vlastitom izgledu i zadržavanju normalne tjelesne mase, a obilježja bulimije nervoze su unos prevelike količine hrane u kombinaciji s kompenzatornim mehanizmima, kao što su povraćanje, prekomjerno vježbanje i primjena laksativa. Kompulzivno prejedanje je ozbiljan i iscrpljujuć poremećaj kada osoba unosi enormne količine hrane u kratkom vremenskom periodu, uz prisutan osjećaj gubitka kontrole. Točan uzrok nastanka nije u potpunosti poznat, iako se o poremećajima prehrane govori i istražuje još iz povijesnih vremena. Smatra se da nastaju kao spoj psiholoških, socijalnih i bioloških faktora. To uključuje emocionalnu nestabilnost, genetiku, poremećaje ličnosti, društveni i obiteljski pritisak. Unatoč tome što je uglavnom zahvaćen ženski spol (10-30 godina), bolesti su sve češće zastupljene i u muškoj populaciji. Poznato je kako samo se u samo 30 % slučajeva oboljeli odluče potražiti stručnu pomoć. U radu s oboljelima od poremećaja prehrane potrebno je teorijsko i praktično znanje, terapijska komunikacija i kontinuirana edukacija u svrhu poboljšanja zdravstvenog statusa, promjene negativnih zdravstvenih ponašanja i povećanja kvalitete života oboljele osobe te uključenost multidisciplinarnog tima (liječnik, medicinska sestra, psiholog, nutricionist, psihijatar, fizioterapeut, radni terapeut).

*Ključne riječi:* poremećaji u prehrani, anoreksija, bulimija, kompulzivno prejedanje, nutricionist, medicinska sestra

### Uvod

Uravnotežena i pravilna prehrana je esencijalna za optimalan razvoj i rast čovjeka. To podrazumijeva osiguranje optimalnog unosa i omjera hranjivih tvari (bjelancevina, ugljikohidrata, masti, vitamina i minerala) i tekućine. Uravnoteženost prehrane iznimno utječe na razvoj imunološkog sustava, raspoloženje, fizičko stanje, dostatnost sna, prevenciju različitih bolesti te stjecanje zdravih prehrambenih navika (Božić i Macuka, 2017). Znanost o prehrani je veoma dinamična, stoga stručnjaci neprestano pronalaze nove spoznaje na temelju kojih grade mišljenja i daju odgovarajuće smjernice. Pravilna prehrana podrazumijeva raznolik i balansirani unos nutrijenata sukladno spolu, životnoj dobi, građi osobe, radnoj okolini i klimatskim uvjetima (Božić i Macuka, 2017). Zdrave prehrambene navike se usvajaju već u ranom djetinjstvu, stoga je vrlo važno da roditelji i odgajatelji aktivno rade na razvijanju kvalitetnih prehrambenih navika koje se po uzoru na djetinjstvo nastavlja i u odrasloj dobi. U suprotnom se javljaju poremećaji u prehrani, koji u današnje vrijeme predstavljaju sve veći javnozdravstveni problem (Božić i Macuka, 2017; Duarte i sur., 2014). Poremećaji prehrane su kompleksni poremećaji ponašanja okarakterizirani snažnom potrebom za kontrolom nad tjelesnom težinom i hranom, a nastaju kao posljedica obiteljsko-socijalnih, razvojnih poremećaja ili su uzrokovani određenim biološkim čimbenicima (Duarte i sur., 2014). U Republici Hrvatskoj procjenjuje se da od poremećaja prehrane

boluje 35.000-45.000 osoba (Smink i sur., 2012). Pojedini faktori koji mogu utjecati na nastanak ovih bolesti su poremećaji osobnosti, emocionalni faktori, te obiteljski i kulturološki pritisak. Smatra se da je najugroženija dob od 10-30. godine života. U poremećaje prehrane ubrajamo čitav niz klasificiranih bolesti, od kojih kao glavne dijagnostičke skupine izdvajamo anoreksiju nervosus i bulimiju nervosus (Duarte i sur., 2014). Poremećaji prehrane prema DSM-V obuhvaćaju anoreksiju nervozus, bulimiju nervozus, poremećaj s prejedanjem i druge specificirane ili nespecificirane poremećaje hranjenja (Božić i Macuka, 2017). Sindrom kompulzivnog prejedanja, tzv. binge eating disorder, jedan je od nespecificiranih poremećaja prehrane, zbog toga što nema karakteristične kriterije za postavljanje dijagnoze anoreksije nervoze ili bulimije nervoze (Duarte i sur., 2014). Unatoč tome što se različito manifestiraju, zajedničko svim navedenim poremećajima je činjenica da zahtijevaju stručnu pomoć, nadzor i liječenje. O poremećajima prehrane ne govori se često zbog srama, straha od nerazumijevanja i osjećaja krivnje oboljele osobe (Božić i Macuka, 2017; Duarte i sur., 2014).

### Metode

Rad je pisan uz pomoć dostupnih domaćih i stranih literaturnih izvora s odgovarajućih platformi, kao što su Google Scholar, Portal hrvatskih znanstvenih i stručnih časopisa Hrčak, PubMed te korištenjem knjiga, doktorskih disertacija, članaka preuzetih ih

znanstvenih časopisa koji uključuju provedena znanstvena istraživanja. Ključne riječi za pretraživanje literature bile su: prehrana, poremećaji prehrane, anoreksija, bulimija i kompulzivno prejedanje.

## Rezultati i rasprava

### a) *Pravilna prehrana*

Pravilna i uravnotežena prehrana predstavlja neizostavni dio u životu svakog čovjeka. Povoljno utječe na zdravlje i smanjuje mogućnost razvoja kroničnih (kardiovaskularne bolesti, dijabetes) i malignih bolesti, te pojavu pretilosti, anoreksije i bulimije (Anestis i sur., 2009). Prehrana bogata hranjivim tvarima doprinosi boljem fizičkom stanju, manjem izlaganju stresu, boljem raspoloženju i očuvanju zdravlja. Prema podrijetlu hrana se dijeli na onu životinjskog i biljnog porijekla te soli koje spadaju u zasebnu skupinu. Nutrijenti mogu biti esencijalni i neesencijalni (Duarte i sur., 2014). U esencijalne nutrijente se ubrajaju aminokiseline, minerali, vitamini, neki ugljikohidrati i masne kiseline. Ljudski organizam nije sposoban sintetizirati esencijalne nutrijente, pa se oni osiguravaju ishranom. Neesencijalne nutrijente organizam proizvodi sam (Anestis i sur., 2009). Makronutrijenti se definiraju kao hranjive tvari koje razgradnjom omogućuju dotok energije u organizam (Božić i Macuka, 2017). Oni obuhvaćaju bjelančevine, masti, masne kiseline, prehrambena vlakna, ugljikohidrate i kolesterol. Zdrava odrasla osoba bi trebala unositi 45-65 % ugljikohidrata, 20-35 % masti i 10-35 % bjelančevina na dnevnoj bazi putem hrane (Anestis i sur., 2009). Voda je esencijalna supstanca za život. Bez dovoljnog unosa vode ne može se osigurati normalna probava, kao ni transport nutrijenata (eliminacija otpadnih tvari). Dnevni unos vode ovisi o dobi, tjelesnoj aktivnosti i tjelesnoj masi čovjeka (Dunkley i Grilo, 2007).

### b) *Poremećaji prehrane*

Poremećaji prehrane su kronične psihijatrijske bolesti, praćene različitim psihološkim, medicinskim i psihijatrijskim komorbiditetima. Oboljela osoba svakodnevno primjenjuje samoinicijativno izgladnjivanje ili prejedanje koje primarno uzrokuje iskrivljena slika vlastitog tijela te niska razina samopoštovanja (Anestis i sur., 2009). Poremećaji u prehrani predstavljaju vodeći javnozdravstveni problem današnjice, ali i skupinu psihičkih poremećaja sa izrazito visokom stopom smrtnosti (do 20 %). Najčešće se javlja kod osoba ženskog spola (90 %), što je očekivano s obzirom na to da su djevojke i

žene u većoj mjeri okupirane tjelesnom masom i izgledom te su sklone provođenju strogih dijeta koje uključuju izgladnjivanje (Dunkley i Grilo, 2007). Zastupljenost poremećaja se procjenjuje na 5 % unutar opće populacije. Najučestalije i najpoznatije dijagnoze iz ove skupine poremećaja su anoreksija nervoza, bulimija nervoza te kompulzivno prejedanje. Prevalencija anoreksije nervoze procjenjuje se na oko 1 % a bulimije nervoze 1-3 % (Smink i sur., 2012). Početni znakovi poremećaja prehrane pojavljuju se u mlađoj životnoj dobi i adolescenciji. Oboljela osoba nema zdrav pristup prema hrani, anksiozna je zbog mogućeg povećanja tjelesne mase, ima isključivo negativno mišljenje o vlastitom izgledu, kao i nisku razinu samopoštovanja. U dobi od 12-18 godina života kod djevojčica javlja se vrhunac anoreksije. Bulimija se u odnosu na anoreksiju češće javlja kod muškog spola, u završnoj fazi adolescencije i mlađoj odrasloj dobi (Dunkley i Grilo, 2007). U liječenju poremećaja prehrane ne sudjeluje samo bolesnik, već i njegova obitelj i njemu važne osobe. Važno je uspostaviti odnos povjerenja sa članovima obitelji te ih educirati o važnosti suradnje u terapijskom procesu. Multidisciplinarni tim mora posjedovati potrebno teorijsko i praktično znanje o poremećajima prehrane, kao i dobre komunikacijske vještine u svrhu zadovoljavanja svih bolesnikovih potreba, uklanjanja/smanjenja simptoma bolesti te povećanja kvalitete života (Anestis i sur., 2009; Harvard school of public health, 2008). Posljednjih desetljeća sve je više dostupnih informacija o poremećajima prehrane, kako u znanstvenim krugovima, tako i u općoj populaciji. Također je sve više studija koje potvrđuju povećanje broja oboljelih. Iako nema podataka o preciznoj etiologiji, opće je prihvaćeno da su poremećaji prehrane multifaktorijalan problem, što znači da je za njihov razvoj potreba interakcije psiholoških, socijalnih i bioloških faktora (Kelly i Carter, 2013).

### c) *Psihološki faktori*

Psihološki faktori imaju veoma važnu ulogu u etiologiji poremećaja prehrane. Najčešći psihološki faktori su anksioznost, depresija, poremećaji ličnosti, perfekcionizam i niska razina samopoštovanja. Nisko vrednovanje samog sebe znači da je osoba nesigurna u sve aspekte svog života, posebice u svoj fizički izgled. Nezadovoljstvo vlastitim izgledom je povod za "samokažnjavanje" koristeći se metodama mršavljenja u svrhu postizanja ljepote i zadovoljstva. Nisko samopoštovanje izrazito narušava mentalno zdravlje, budući da su osobe često tjeskobne, depresivne i nesretne (Kelly i Carter, 2013). Kod osoba s utvrđenom dijagnozom poremećaja prehrane

često se javljaju psihijatrijski komorbiditeti. Znanstveno je dokazano da oboljeli od anoreksije i bulimije boluju od još neke bolesti psihičke naravi (Harvard school of public health, 2008). Obično je to opsesivno-kompulzivni poremećaj ili depresija. Članovi obitelji oboljele osobe imaju veći rizik za razvoj depresije (Kelly i Carter, 2013). Ishod bolesti ponekad može biti fatalan (Sović i sur., 2013).

#### *d) Socijalni faktori*

Okolina ima veliki utjecaj na razvoj čovjeka i njegovo poimanje svjetovnog. Međutim, često nameće ideale i norme koje čovjek promatra i primjenjuje u vlastitom životu. Mišljenja društva, posebno vršnjaka je od velike važnosti u razdoblju adolescencije, kada dječaci i djevojčice nemaju u potpunosti razvijena stajališta. Tada je izrazito prisutan i nedostatak samopouzdanja, pa je normalno da socijalna sredina ima najveći utjecaj (Kelly i Carter, 2013; Sović i sur., 2013). Obitelj oblikuje pojedinca već od ranog djetinjstva. Stručnjaci smatraju da su poremećaji prehrane usko povezani sa specifičnim obiteljskim situacijama, odgojem i traumama iz djetinjstva (Sović i sur., 2013). Zbog toga je tijekom utvrđivanja dijagnoze poremećaja prehrane važno uključiti i članove obitelji bolesnika. Nedostatak emocionalne topline i pretjerana kontrola od strane roditelja povećavaju rizik za nastanak poremećaja prehrane. Neka istraživanja navode da bliskost s nesigurnom i anksioznom majkom uzrokuje nedostatak samopoštovanja i nesigurnost. Prihvatanje i ljubav koju obitelj pruža od rođenja doista utječe na izgradnju ličnosti i ponašanje u odrasloj dobi. Narušeni obiteljski odnosi ruše samopouzdanje i potencijalni su faktori za nastanak poremećaja prehrane (Repovečki i sur., 2020). Tijekom puberteta se ostvaruju nova iskustva i uspostavljaju nova prijateljstva. Svaki adolescent želi pripadati društvu i biti prihvaćen, pa fizički izgled ima bitnu ulogu u tome. Predstavlja zlatni standard za vrednovanje drugih i samovrednovanje u tom razdoblju. U stvaranju negativne slike o sebi intenzivno utječe vršnjačko zadirkivanje (Repovečki i sur., 2020). Kao društveno biće, čovjek ima potrebu za pripadnošću i interakcijom s drugim ljudima u zajednici, što je glavni razlog popularnosti društvenih mreža. Društvene mreže imaju brojne prednosti, ali ponekad još brojnije nedostatke. Imaju ogroman utjecaj na mentalno zdravlje korisnika, posebno mladih osoba koja se već osjeća nesigurno i nezaštićeno u svojoj okolini (Kelly i Carter, 2013; Obeid i sur., 2018). Normativ za osobe ženskog spola u virtualnom svijetu je mršavost i privlačnost. Osobe muškog spola u tom istom svijetu trebaju biti visoki, s velikim udjelom mišićne mase (Obeid i sur., 2018). Korisnici

društvenih mreža svakodnevno su zatrpani savjetima kako smanjiti tjelesnu masu i postati atraktivan ljudima. Brojne obrađene fotografije cirkuliraju internetom, s uvjerenjem da su realne. Sve je više osoba koje se uspoređuju s modelima na društvenim mrežama, a to dodatno spušta samopouzdanje. Istraživanja su dokazala da je izloženost ljudi, posebice adolescenata medijima i raznim popularnim časopisima povećala zabrinutost oko vlastitog izgleda i broj oboljelih od poremećaja prehrane (Repovečki i sur., 2020).

#### *e) Biološki faktori*

Biološki faktori također utječu na razvoj poremećaja u prehrani. Primjerice, anoreksija nervoza se u rijetkim slučajevima javlja prije razdoblja adolescencije ili kod žena starijih od 40 godina (Obeid i sur., 2018). Prosječna dob za pojavu anoreksije je 17 godina, dok je za pojavu bulimije prosječna dob 20 godina. Kod osoba ženskog spola specifično je povećanje udjela masnog tkiva u tijelu u adolescenciji, što rezultira i povećanjem tjelesne mase. Jedan od kritičnih bioloških faktora za nastanak poremećaja u prehrani, a posebice bulimije je pojava menstruacije u u dobi ranijoj od prosječne (Kelly i Carter, 2013; Marčinko i sur., 2013). Adolescencija je kritični faktor za razvoj ovih poremećaja zbog promjena u endokrinološkom sustavu. Istraživanja pokazuju da 40 % djevojaka i 25 % dječaka tijekom adolescencije započne neku vrstu dijete (Obeid i sur., 2018). Bitnu ulogu u razvoju poremećaja prehrane ima i spol. Žensko tijelo je biološki sklonije nakupljanju masnog tkiva u odnosu na muškarce. Ženski razvoj u pubertetu mnogo je kompleksniji od muškog, a to u kombinaciji s drugim rizičnim faktorima potencijalno predstavlja element ranjivosti (Marčinko i sur., 2013). Vaganje je najčešće korišten način utvrđivanja tjelesne mase. Neka istraživanja pokazuju kako vaganje ima niz negativnih učinaka na samopoštovanje i raspoloženje. Kada je osoba nezadovoljna svojom tjelesnom težinom, sklona je pokušajima raznih dijetnih režima te stječe nezdrave navike koje su zapravo temelj razvoja ozbiljnih poremećaja u prehrani. U posljednjih nekoliko godina znanost se u sve većoj mjeri okreće genetici i njezinoj ulozi u etiologiji psihičkih poremećaja. U medijima je zastupljen i stav koji uvijek naglašava osobe ženskog spola kada se govori o tjelesnoj masi, estetskim zahvatima i dijetama (Sambol i Cikač, 2015). Novija istraživanja tvrde da crijevna mikroflora može utjecati na nastanak ovih poremećaja jer ima bitnu ulogu u regulaciji metabolizma i tjelesne mase, ali je i povezana s depresijom i anksioznošću. Gastrointestinalne tegobe, dijabetes tipa 1, porođajne traume, prijevremeni porodi i perinatalne



komplikacije se također navode kao kritični biološki faktori za razvoj poremećaja prehrane (Gerard, 2016).

#### *f) Anoreksija nervoza*

Anoreksija nervoza pripada skupini najčešćih kroničnih poremećaja prehrane kod adolescenata. Češće se javlja kod ženskog spola, ali je zastupljena i u muškoj populaciji. Predstavlja životno ugrožavajuće stanje, čija je stopa smrtnosti vrlo visoka. Liječenje je teško i dugotrajno, a može biti i cjeloživotno (Schmidt, 2005). Oboljeli iskrivljeno percipiraju vlastito tijelo, odnosno smatraju da imaju prekomjernu tjelesnu težinu, iako je u potpunosti suprotno. Opsjednuti su odnosom hrane i tjelesnog izgleda, a radi izrazitog straha od debljanja prate radikalne dijeta i do iznemoglosti vježbaju (Schmidt, 2005). Kao posljedica izgladnjivanja javljaju se različite komplikacije, kao na primjer amenoreja (izostanak menstruacije), nesvjestica, vrtoglavice, dehidracija i lanugo dlačice (Mathisen i sur., 2018). Poremećena je cirkulacija, pa se često primjećuju plavičasti i hladni ekstremiteti. Osim toga, zna se javiti i akrocijanoza (plavičasto obojenje distalnih dijelova nosa i ušiju), koja nastaje kao rezultat hipotermije zbog toga što se krv iz distalnih dijelova premješta u središnji kako bi se očuvali organi koji su vitalni za život. Nerijetko su prisutne gastrointestinalne tegobe, posebice kod namjernog povraćanja (bol u želucu, žgaravica, erozija zubne cakline) (Dell Osso i sur., 2016). Zbog usporavanja bazalnog metabolizma dolazi do hipotermije. Smanjen je i srednji arterijski tlak, minutni volumen srca te je prisutna bradikardija. Poremećaj elektrolita i cirkulatorni kolaps hitna su stanja koja zahtijevaju hospitalizaciju (Mathisen i sur., 2018).

#### *g) Bulimija nervoza*

To je kronični psihički poremećaj kojeg prate epizode prejedanja, obično visokokalorične, nezdrave hrane u kratkom vremenu, nakon čega slijede epizode "čišćenja" povraćanjem ili upotrebom lijekova. Osoba koja duže vrijeme pati od bulimije s vremenom bez dodatnih podražaja nauči voljno povraćati. Čišćenje se može izvršiti i zloupotrebom laksativa i diuretika, iako se većina oboljelih odluči na povraćanje (Livazović, 2017). Oboljeli su normalne ili prekomjerne tjelesne mase, što otežava pravovremeno prepoznavanje bolesti. Specifični simptomi su: suhoća sluznice usne šupljine, grlobolja, erozija zubne cakline, natečeni obrazi, neugodan zadah, upala ždrijela, natečene žlijezde slinovnice na vratu i oko čeljusti, bolni i osjetljivi zubi, crvenilo očiju, to jest pucanje očnih kapilara zbog naprezanja uslijed čestog

povraćanja, disfagija, gastroezofagealni refluks, poremećaj elektrolita, hipotenzija i tahikardija (Castillo i Weiselberg, 2017).

#### *h) Dijagnostika poremećaja prehrane*

Utvrđivanje dijagnoze poremećaja u prehrani je vrlo težak posao, budući da većina oboljelih ne priznaje svoj problem. U početku odbijaju razgovor i bilo kakvu mogućnost liječenja. Prilikom sumnje na neki od poremećaja prehrane potrebno je obaviti razgovor sa članovima obitelji oboljele osobe, posebice ako je u pitanju maloljetna osoba (Vidović, 2009). Zatim je potrebno izvršiti određene pretrage kako bi se isključile neke organske bolesti (npr. Chronova bolest, anemija, celijakija, hipertireoza i slično). Ponašajni znakovi koji ukazuju na poremećaje prehrane mogu biti: paranoično brojanje kalorijskih vrijednosti hrane, provođenje restriktivnih dijeta, često vaganje, jedenje u samoći, skrivanje hrane, pretjerana fizička aktivnost. Psihološki znakovi koji ukazuju na poremećaje prehrane su: manjak samopouzdanja, perfekcionizam, depresija, anksioznost, suicidalnost, socijalna izolacija, manjak koncentracije, opsesivno-kompulzivni poremećaj. Fizički znakovi su: lomljivi nokti, pretjerana osjetljivost na hladnoću, amenoreja, gastrointestinalne tegobe, suhoća kože, problemi sa zubima (Tuerk i sur., 2018). Potrebno je napraviti laboratorijske pretrage koje obuhvaćaju kompletnu krvnu sliku, pretrage urina, radiološke pretrage (UZV i RTG), elektrokardiogram (EKG) radi utvrđivanja poremećaja u radu srca. Ako postoje opravdane sumnje na neki od poremećaja u prehrani, potrebno je napraviti fizički pregled osobe koji uključuje mjerenje visine i težine, provjeru vitalnih funkcija, stanje zubi i kože (Tuerk i sur., 2018).

#### *i) Liječenje poremećaja prehrane*

Postoje različiti oblici liječenja poremećaja prehrane. Bitno je da se svakom bolesniku pristupa holistički, odnosno cjelovito i individualno. Svaka osoba drugačije reagira na situacije, dijagnozu, lijekove, okolinu i intervencije koje se provode. Timski rad stručnjaka zahtijeva suradnju i kvalitetnu interakciju. Tim se sastoji od psihologa, psihijatra, nutricionista, liječnika, fizioterapeuta, radnog terapeuta i medicinske sestre. Liječenje poremećaja prehrane je kompleksno i dugotrajno uz česte relapse. Bitno je da se započne što je ranije moguće. Primarni cilj liječenja je poboljšanje općeg stanja, povratak na normalnu prehranu, kontroliranje neprirodnih obrazaca hranjenja i ponašanja, sprječavanje relapsa i sposobnost izražavanja vlastitih emocija (Tuerk i sur., 2018). Liječenje se obično provodi ambulantno ili u

sklopu dnevne bolnice, a u akutnom stanju potrebna je hospitalizacija. Ambulantno liječenje traje najmanje 6 mjeseci. U dnevnim bolnicama liječe se osobe koje su stabilnije i ne treba im strogi nadzor. Tu se odvijaju različiti programi unutar grupnih terapija kroz 1-3 mjeseca, 8-10 sati dnevno (Vidović, 2008).

## Zaključak

Važnost pravilne i uravnotežene prehrane neophodna je u svim životnim razdobljima. Poremećaji prehrane jedan su od vodećih javnozdravstvenih problema u 21. stoljeću, zbog različitih bioloških, psiholoških i socioekonomskih faktora. Zajedničko svim poremećajima u prehrani je nužnost stručne pomoći, hitno i adekvatno liječenje. U procesu liječenja ovih bolesti nerijetko se javljaju faze privremenih pogoršanja uz destruktivne misli i radnje. Pravovremeno otkrivanje poremećaja u prehrani od ključne je važnosti radi sprječavanja komplikacija i razvoja kroničnog oblika bolesti. Bolesnici uglavnom odbijaju potražiti pomoć jer su svakodnevno izgledniji, prejedanje i prekomjerna tjelesna aktivnost njihovi ukorijenjeni obrasci ponašanja. Teško im je pristupiti jer se često depresivni, asocialni i nezainteresirani za okolinu te preferiraju samoću. Budući da se radi o kroničnim psihičkim poremećajima, liječenje je vrlo kompleksno, najčešće dugotrajno, a ponekad i cjeloživotno. Ranim otkrivanjem bolesti moguće je prevenirati razvoj kroničnog oblika i pratećih komplikacija. Multidisciplinarni tim (liječnik, medicinska sestra, psiholog, nutricionist, psihijatar, fizioterapeut, radni terapeut) ima značajnu ulogu u liječenju, ali i prevenciji populacije pod rizikom.

## Literatura

- Anestis, M., Smith, A., Fink, E., Joiner. T. (2009): Dysregulated eating and distress: Examining the specific role of negative urgency in a clinical sample, *Cognitive Therapy and Research* 33(4), 390-97.
- Božić, D., Macuka, I. (2017): Uloga osobnih čimbenika u objašnjenju kompulzivnog prejedanja, *Hrvatska revija za rehabilitacijska istraživanja* 53(2), 1-16.
- Castillo, M., Weiselberg, E. (2017): Bulimia Nervosa/Purging Disorder, *Current Problems in Pediatrics and Adolescent Health Care* 47(4), 85-94.
- Dell Osso, L., Abelli, M., Carpita, B., Pini, S. i sur. (2016): Historical evolution of the concept of anorexia nervosa and relationships with orthorexia nervosa, autism, and obsessive-compulsive spectrum, *Neuropsychiatric Disorder Treatment* 12, 1651-60.
- Duarte, C., Pinto-Gouveia, J., Ferreira, C. (2014): Escaping from body image shame and harsh self criticism: Exploration of underlying mechanisms of binge eating, *Eating Behaviors* 15, 638-43.
- Dunkley, DM., Grilo, CM. (2007): Self-criticism, low self-esteem, depressive symptoms, and overevaluation of shape and weight in binge eating disorder patients, *Behaviour Research and Therapy* 45, 139-49.
- Gerard, P. (2016): Gut microbiota and obesity, *Cellular and Molecular Life Sciences* 73(1), 147-62.
- Harvard school of public health. Department of Nutrition 2008. Dostupno na: <https://www.hsph.harvard.edu/nutritionsource/2008/> (16.06.2023).
- Kelly, AC., Carter, JC. (2013): Why self-critical patients present with more severe eating disorder pathology: The mediation role of shame, *British Journal of Clinical Psychology* 52, 148-61.
- Livazović, G. (2017): Nezadovoljstvo tjelesnim izgledom i ponašanja povezana s poremećajima u prehrani u adolescenata, *Kriminologija i socijalna integracija* 25(1), 71-73.
- Mathisen, T., Bratland-Sanda, S., Rosenvinge, J., Friborg, O., Pettersen, G., Vrabel, K., Sundgot-Borgen, J. (2018): Treatment effects on compulsive exercise and physical activity in eating disorders, *Journal of Eating Disorders* 6(1), 43-52.
- Marčinko, D. i sur. (2013): Poremećaji hranjenja od razumijevanja do liječenja. Zagreb: Medicinska naklada.
- Obeid, N., Carlucci, S., Brugnera, A., Compare, A. i sur. (2018): Reciprocal influence of distress and group therapeutic factors in day treatment for eating disorders: A progress and process monitoring study, *Psychotherapy* 55(2), 170-78.
- Repovečki, S., Štrkalj Ivezić S., Bilić, V. (2020): Terapijski čimbenici u grupnoj psihoterapiji, *Psihoterapija* 34(2), 224-62.
- Sambol, K., Cikač, T. (2015): Anoreksija i bulimija nervoza-rano otkrivanje i liječenje u obiteljskoj medicini, *Medicus* 24(2), 165-71.
- Schmidt, U. (2005): Epidemiology and aetiology of eating disorders, *Psychiatry* 4(4), 5-9.
- Smink, FRE., Van Hoeken, D., Hoek, HW. (2012): Epidemiology of Eating Disorders: Incidence, Prevalence and Mortality Rates, *Current Psychiatry Report* 14, 406-414.
- Sović, J., Starčević, I., Katunarić, M. (2013): Erozivne promjene na tvrdim zubnim tkivima u osobe s poremećajem hranjenja-prikaz slučaja, *Medix* 14(104/105), 268-270.
- Tuerk, PW., Keller, SM., Acierno, R. (2018): Treatment for anxiety and depression via clinical videoconferencing: evidence base and barriers to expanded access in practice, *Focus (Madison)* 16(4), 363-369.
- Vidović, V., Majić, G., Begovac, I. (2008): Psihodinamski čimbenici u nastanku anoreksije nervoze i bulimije nervoze, *Petiadrlica Croatica* 52(1), 106-110.
- Vidović, V. (2009): Poremećaji hranjenja i jedenja u ranoj dojenačkoj dobi, djetinjstvu i adolescenciji, *Medicus* 18(2), 185-191.

## EATING DISORDERS

**Nikolina Pranić, Aleksandra Žigić Forić, Ivan Pokec, Zrinka Puharić**

Bjelovar University of Applied Sciences, Trg Eugena Kvaternika 4, 43000 Bjelovar, Croatia

*professional paper*

### Summary

Eating disorders imply a permanently disturbed relationship to body and food, which causes the destruction of an individual's mental and physical health, as well as dysfunctional social and family relationships. Anorexia and bulimia nervosa are the most common eating disorders. Their chronic form is also the most severe form of the disease. The hallmarks of anorexia nervosa are starvation, aversion to one's own appearance and maintaining a normal body weight, and the hallmarks of bulimia nervosa are the intake of excessive amounts of food combined with compensatory mechanisms, such as vomiting, excessive exercise, and the use of laxatives. Compulsive overeating is a serious and debilitating disorder when a person consumes enormous amounts of food in a short period of time, accompanied by a sense of loss of control. The exact cause of its occurrence is not fully known, although eating disorders have been discussed and researched since historical times. It is considered that they arise as a combination of psychological, social and biological factors. These include emotional instability, genetics, personality disorders, social and family pressure. Despite the fact that the female sex (ages 10-30) is mostly affected, the diseases are increasingly present in the male population as well. It is known that in only 30% of cases, sufferers decide to seek professional help. The process of patient health care includes the approach of discovering and solving the patient's problems in the field of health care. Working with patients with eating disorders requires theoretical and practical knowledge, therapeutic communication and continuous education in order to improve health status, change negative health behaviors and increase the quality of life of the affected person which include multidisciplinary team (doctors, nurses, nutricionists, psychologist, psychiatrist, physiotherapist, occupational therapist).

*Keywords:* eating disorders, anorexia, bulimia, compulsive overeating, nurse/technician, nutricionists

## **Instructions to authors**

Authors are kindly asked to read the following instructions while preparing the manuscript for publishing in the journal *Food in health and disease*.

*Food in health and disease* is a scientific-professional journal of nutrition and dietetics, published by the Faculty of Pharmacy, University of Tuzla with Co-Publisher Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek.

*Food in health and disease* publishes *original scientific papers, preliminary communications, scientific notes, reviews* and *professional papers*. All papers need to be written and submitted in English. All contributing manuscripts will be subjected to critical peer review.

Difference between *scientific* and *professional* papers is in the originality of methods, results and conclusions. Although a professional paper may imply more tangible applications it is generally not considered a new scientific contribution.

*Original scientific papers* report unpublished results of original research. They must contain significant and original observations to be critically evaluated. Experimental data should be presented in a way that enables reproduction and verification of analyses and deductions on which the conclusions are based.

*Preliminary communications* include short information on the results of scientific research which require immediate publication.

*Scientific notes* include reports on shorter but completed research or descriptions of original laboratory techniques (methods, apparatus etc.) and should be concise.

*Reviews* are original, critical and up-to-date surveys of an area in which, preferably, the author himself/herself is active. They should include recent references from international publications.

*Professional papers* present new possibilities of improvement within the area of food technology. The emphasis is on the application of known methods and facts as well as on broadening the knowledge in the particular area. The acquired knowledge is applied to the object of research.

## **Procedure**

All contributions are evaluated according to criteria of originality and quality of their scientific and professional content. All manuscripts received for consideration will be acknowledged by the Editorial office. All manuscripts are sent to at least two referees. Based on their opinion, the Editor and the Editorial Board bring a decision about the acceptance of the manuscripts. Contributions may be rejected without reviewing if considered inappropriate for the journal.

## **Copyright**

The authors bear the sole responsibility for the content of the contributions. The Editorial Board assumes that by submitting their papers the authors have not violated any internal rules or regulations of their institutions related to the content of the contributions and that they have not submitted the paper somewhere else. The acceptance of the paper obliges the authors not to publish the same material elsewhere.

## **Manuscript preparation**

The manuscript should consist of max. 15 type written pages including tables, graphs, schemes and photographs. It should be written with 1.5 spacing on one side of the paper and margins 2.5 cm. For the text should be used normal

plain font (Times New Roman, font size 12). The title of the manuscript and the title of the chapter should be short and written in bold. The title of subheading should be written in italic.

Under the title, author/s full name/s and surname/s should be written, with asterisk next to the name of the corresponding author. Footnote at the bottom of the first page should contain information about the corresponding author (address and e-mail). The affiliations for all authors must be given in the following sequence: University/Institution, Faculty/Department, Postal address, City, Country. When authors have different affiliations, should be used superscripted Arabic numbers after last name of the author.

Manuscript has to be written without spelling mistakes, impersonal style. It is the author's responsibility to ensure that papers are written in clear and comprehensible English. Authors whose native language is not English are strongly advised to have their manuscripts checked by an English-speaking colleague prior to submission.

The first word in the paragraph must not be retracted. Paragraphs have to be separated by clicking on enter key. Pages have to be numerated (on the bottom right). For decimal numbers in text and tables dot should be used.

Latin words, phrases and abbreviations, including generic and specific names, should be written in italic.

**Manuscripts should be submitted by e-mail, as attached document, to the Editor's office. The manuscripts should be sent to the following address:**

**journalFHD@gmail.com**

For clearness the paper should be divided into the following sections: **Summary**, *Keywords*, **Introduction**, **Materials and Methods**, **Results and Discussion**, **Conclusions and References**.

## **Summary**

Summary must not exceed 300 words and has to show relevant data, methodology, main results and conclusion. It should not contain abbreviations or references. After summary, authors are asked to list several keywords.

### *Keywords*

Keywords include the main topic of the paper and should not contain more than 5 words or phrases, which should be separated by commas.

## **Introduction**

Introduction should refer to previous research results and explain the purpose of the investigations.

## **Materials and methods**

Experimental part should be written clearly and in sufficient detail to allow the work to be repeated. Materials and Methods should indicate instruments, samples, subjects, chemicals, etc., giving enough details only if new methods and/or procedures and/or principles are used. For the well-known methods and techniques an adequate reference(s) citation will suffice.

## **Results and discussion**

The information given in tables and figures should not be repeated, and only relevant data discussed and explained. Combining the results with discussion can simplify the presentation.

Tables and figures should be completely understandable without reference to the text. For publishing reasons, they have to be delivered in graphical formats (\*.xls, \*.tif or \*.jpg) and at the end of the paper.

All illustrations (graphs, schemes, diagrams, pictures, etc.) should be named as figures. Refer to figures by the abbreviation "Fig.". All figures and tables should be cited in the text and numbered consecutively throughout. Preferred program for preparing figures and tables is Microsoft Office Excel.

Be sure to use lettering, data lines, and symbols sufficiently large and thick to be clearly legible when the figure is reduced to the normal published size. In graphs and charts, curves should be identified by using different symbols for points (•, ◊, ○, □, ■, ▲, etc.) and not by line width or colour. Several figures should be grouped in a plate on one page. Do not place figures into bordered frames. Figure caption and legend should be placed at the bottom of each figure, while table headings should appear above the tables. The text into the figures and tables should be written in the same language as the body text.

Whenever possible formulae and equations are to be written in one line, centred on the page, and consecutively numbered in Arabic numbers between round brackets at the right margin of the paper. Refer to equations by the abbreviation "Eq."

SI (System International) units should be used. Only symbols (not their subscripts, superscripts or description in brackets) of physical quantities should be written in italic. All physical quantities given in table columns or rows and corresponding table headings with units, or graphical plots and corresponding table headings with units, or graphic plots and corresponding axis labels should conform to the algebraic rules, i.e.

$$\text{physical quantity} / \text{unit} = \text{numerical value.}$$

It is preferred to write the measurement units as "kg/m<sup>3</sup>".

## Conclusions

Conclusions have to briefly explain significance of the research results.

## References

References should be selective rather than extensive (with the exception of review articles). Literature citations in the text should be referred by author's last name and year, in brackets, such as (Knowles, 2007), or with the last name of the author as part of the sentence, immediately followed by the year of publication in brackets, such as ("Smith (1963) reported growth on media."). If there are more than two authors, mention the first author and add et al., followed by the year.

In the reference list which has to be written at the end of the paper, all authors have to be listed (surname and name initials – capitalizing only the initial letters) in alphabetical order, and paper of the same author by chronological order. If there are more papers from the same author published in the same year, references have to be differentiated by letters in the text (a, b, c, d) behind the year of publishing. In case of multi author papers, in reference list all the authors have to be written (not the first author and mark "et al.").

Italicize only those words that were underlined or italicized in the original, such as names of microorganisms. Also titles of journals have to be written in italics.

For papers published on the web, it is necessary to write the source and the date when the paper was downloaded, besides basic information (title, author's name, etc.).

Abbreviations for periodicals should be in accordance with the latest edition of the Thomson ISI List of Journal Abbreviations (Thomson Scientific, USA). Full stop should be used after each abbreviation.

*Reference list should be written as shown:*

Journals:

Kopjar, M., Piližota, V., Hribar, J., Nedić Tiban, N., Šubarić, D., Babić, J., Požrl, T. (2008): Influence of trehalose addition on instrumental textural properties of strawberry pastes, *Int. J. Food Prop.* 11 (3), 646-655.

Books:

Doyle, M.P., Beuchat, L.R., Montville, T.J. (2001): *Food Microbiology: Fundamentals and Frontiers*, Washington, USA: ASM Press, pp. 572-573.

Chapter in book:

Varoquaux, P., Wiley, R.C. (1994): Biological and Biochemical Changes in Minimally Processed Refrigerated Fruits and Vegetables. In: Minimally Processed Refrigerated Fruits and Vegetables, Wiley, R.C. (ed.), New York, USA: Chapman, pp. 226-268.

Conference proceedings:

Babić, J., Šubarić, D., Ačkar, Đ., Kopjar, M. (2008): Utjecaj hidrokoloida na reološka svojstva voštanog kukuruznog škroba. In: 43rd Croatian and 3rd International Symposium on Agriculture, Pospišil, M. (ed.), Zagreb, HR, pp. 558-562.







