

# DIETARY INTAKE IN ADULT FEMALE COELIAC DISEASE PATIENTS IN SLOVENIA

## PREHRANSKI VNOS ODRASLIH BOLNIC S CELIAKIJO V SLOVENIJI

Marija Aja KOCUVAN MIJATOV<sup>1\*</sup>, Dušanka MIČETIĆ-TURK<sup>2</sup>

<sup>1</sup>University of Primorska, Faculty of Health Sciences, Polje 42, 6310 Izola, Slovenia

<sup>2</sup>University of Maribor, Faculty of Medicine, Taborska 8, 2000 Maribor, Slovenia

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### ABSTRACT

**Objectives.** The aim of the study was to assess dietary intake of coeliac disease (CD) patients and to determine if they are meeting the dietary reference values for a balanced diet.

### Keywords:

coeliac disease,  
dietary intake,  
gluten,  
gluten-free diet

**Subjects/Methods.** 40 women with CD, aged from 23 to 76 participated in our study. Total daily intake was assessed by a three-day food diary. Resting metabolic rate (RMR) was calculated using Harris-Benedict equation. Considering physical activity level (PAL) 1.4, the recommended total energy expenditure (TEE) value was determined. The data was evaluated with professional evaluation software Prodi and statistically analysed.

**Results.** 40 participants returned the food diary. The average energy intake was significantly too low to ensure the meeting of all-day energy needs ( $p < 0.05$ ). The meals contained a recommended proportion of protein, but a statistically significantly higher proportion of fat ( $p < 0.05$ ), lower proportion of carbohydrates and a significantly lower intake of dietary fibre ( $p < 0.05$ ). Regarding macro-, micro- elements and vitamins, there was a significant lack in the intake of calcium and iodine, folic acid, vitamin D and vitamin A ( $p < 0.05$ ), meanwhile iron intake was at the lower limit of the recommended intake, whereas zinc, potassium and vitamin K intake were significantly higher according to the recommended values, but were comparable with the intake of the general population in the Central European area.

**Conclusion.** Even in subjects with adequate or low daily energy intake, their meals contained too much fat, too few carbohydrates and dietary fibre as well as inorganic substances. The patients with CD should get regular nutritional monitoring and education on the quality and balance of a gluten-free diet.

### IZVLEČEK

**Izhodišče.** Celiakija je sistemska imunsko pogojena bolezen, ki nastane kot posledica uživanja glutena pri genetsko disponiranih osebah. Bolnik s celiakijo mora iz prehrane izključiti vsa živila, ki vsebujejo gluten. Za zagotavljanje dnevnih potreb vseh pomembnih hranil ter vitaminov je pomembna prehranska kakovost brezglutenske diete.

### Ključne besede:

celiakija,  
prehranski vnos,  
gluten, dieta  
brez glutena

**Namen.** Z raziskavo smo želeli ugotoviti, kakšen je prehranski vnos odraslih bolnic s celiakijo v Sloveniji glede na veljavna priporočila za uravnoteženo prehrano in glede na Prehrabene navade odraslih prebivalcev Slovenije z vidika varovanja zdravja.

**Metode.** V raziskavo smo vključili 40 žensk s celiakijo, ki so uživale brezglutensko dieto in bile stare od 23 do 76 let. Za zbiranje podatkov o prehranskih navadah smo uporabili metodo prehranskega dnevnika, v katerega so preiskovanke tri poljubne dneve v tednu dosledno zapisovale vse, kar so zaužile tisti dan. Metabolizem v mirovanju (RMR) smo izračunali po Harris-Benedictovi enačbi. Za določitev celodnevni energetskih potreb (CEP) smo glede na poročanje o dnevnih aktivnostih RMR pomnožili z ustreznim faktorjem za fizično aktivnost (PAL). Podatke smo ovrednotili z računalniškim programom za strokovno načrtovanje prehrane Prodi 5.9, ki upošteva Referenčne vrednosti za vnos hranil D-A-CH. Dobljene podatke smo statistično obdelali.

**Rezultati.** Prehranski dnevnik je vrnilo 40 udeleženk. Ovrednoteni prehranski dnevniki kažejo, da je bil povprečen energetski vnos hranil statistično pomembno ( $p < 0,05$ ) prenizek za zagotavljanje priporočenih celodnevni energetskih potreb preiskovank. Bolnice s celiakijo so zaužile primeren delež beljakovin (14,2%), vendar statistično pomembno ( $p < 0,05$ ) prevelik delež maščob (36,4%) ter premajhen delež ogljikovih hidratov (48,2 %) in prehranskih vlaknin (18,9 g/dan).

Med makro-, mikroelementi in vitamini so preiskovanke v povprečju zaužile statistično pomembno ( $p < 0,05$ ) premalo kalcija in joda, folne kisline, vitamina D in vitamina A. Vnos železa je bil na spodnji meji priporočil, vrednosti cinka in kalija pa sta presegle priporočene vrednosti, vendar sta bili primerljivi z vnosom splošne populacije v srednjeevropskem okolju.

**Zaključek.** Rezultati kažejo, da brezglutenska prehrana bolnic s celiakijo v Sloveniji ne ustreza smernicam zdrave in uravnotežene prehrane glede na Referenčne vrednosti za vnos hranil D-A-CH. Ugotovili smo, da je tudi pri preiskovankah, pri katerih je bil dnevni energetski vnos hranil primeren ali celo prenizek, prehrana vsebovala prevelik delež maščob, premalo ogljikovih hidratov in prehranskih vlaknin ter anorganskih snovi. V prihodnosti bo treba narediti več na področju kvalitete prehrane in rednega prehranskega spremljanja bolnikov s celiakijo. Izobraževanja o brezglutenski prehrani bodo morala vključevati tudi nasvete, kako doseči priporočene dnevne vnose vseh pomembnih hranil in vitaminov.

\*Corresponding author: Tel: ++ 386 31 693 203; E-mail: [aja.mijatov@gmail.com](mailto:aja.mijatov@gmail.com)

## 1 INTRODUCTION

Coeliac disease (CD) is a chronic disease caused by an inappropriate immune response to the protein found in grains of wheat (gliadin), rye (secalin), barley (hordeins) and possibly oats (avenin), which are collectively known as prolamins. Patients with coeliac disease should eliminate all food containing gluten (wheat, spelt, rye, kamut, barley, oats), and all products containing listed grains or wheat starch from the diet (1). Gluten-free (GF) foods are foods that contain up to 20 mg/kg gluten (20 ppm). This applies to both natural GF products (e.g. corn, rice, buckwheat) and products consisting of one or more ingredients from wheat, rye, barley, oats or their crossbred varieties, which have been specially processed to remove gluten so that the gluten level does not exceed 20 mg/kg in total (2).

The disease can only develop in people with a genetic predisposition (HLA DQ2 and/or DQ8). The disease can present itself in various clinical forms, and it affects people of all ages. The diagnosis of overt coeliac disease is established by the presence of specific antibodies against tissue transglutaminase (t-TG), anti-endomysial antibody (EMA), deamidated gliadin peptide antibodies (DGP antibodies) and characteristic histological changes of the small intestine (3). If immunoglobulin A anti-tissue transglutaminase type 2 antibody titers are high (>10 times the upper limit of normal), then the option is to diagnose CD without duodenal biopsies by applying a strict protocol with further laboratory tests (3).

Various studies have determined that because patients with CD adhere to a strict GF diet, they have an unbalanced input of the main nutrients (proteins, fats, carbohydrates) and the lack of some macro- and microelements and vitamins (4,5). Predominantly, the patients lack a proper intake of dietary fiber, iron, unsaturated fatty acids, calcium, and certain vitamins (B12, A, D, E, K) (6). This is related to decreased mineral bone density and increased potential for obesity (4,7). Vitamin deficiency also increases the risk of developing cardiovascular disease in the same way as hypertension or hypercholesterolaemia (8).

With the advances in knowledge about the possibilities of improving the quality of GF diet in order to achieve the recommended daily intake of nutrients and vitamins, we could significantly influence the health status of CD patients (9).

According to the available data, nutrition instructions for coeliac disease patients in Slovenia focus only on allowed and probated foods.

The aim of this study was to determine whether the GF diet of adult female patients with coeliac disease in Slovenia meets the recommendations for a healthy and balanced diet.

## 2 METHODS

Adult CD patients were invited to participate in our study. Inclusion criteria were: being at least 21 years of age, having a biopsy proven coeliac disease and following a strict GF diet for at least one year, and being generally healthy individuals, except for having coeliac disease. We used convenience sampling. From the original available group of 48 CD patients, who met the criteria for inclusion, 40 adult female CD patients returned food diaries and were included in the study. All of them were members of the Slovenian Coeliac Disease Society, had a biopsy proven coeliac disease and followed a strict gluten-free diet for at least one year. Participants were between 23 and 76 years old (with the average of 51.5 years). Since they were following a strict gluten free diet and had no additional diseases, the participants were considered healthy women, and therefore the recommended values for a healthy population were taken into account. Participants responded to a questionnaire about their age, education, occupation, physical activity level, whether they were eating breakfast, the duration of CD and the time they followed a strict GF diet, whether they had any other allergies or intolerances to foods and the possible presence of symptoms in the last 6 months.

Patients having any other serious medical condition were excluded from the study. National Medical Ethics Committee of the Republic of Slovenia approved the study. All patients received written and oral information concerning the study before they gave their consent.

Investigators delivered a three day weighed food diary to all participants and provided them with exact instructions on how to complete the diary and how to use household measures. The participants were asked to choose any two days during the week and one day during the weekend. Any discrepancies in the data were resolved by direct communication.

The results were compared to Reference values for nutrient intakes D-A-CH (10) and to the data from the National study (NS): Dietary habits of adults in Slovenia in terms of health (11). This group is considered to be representative of the »general population« in Slovenia.

The Seca medical scale with a measuring rod for height was used to measure the weight and height of the participants. Measurements and interviews were always performed by one and the same investigator.

Body mass index (BMI) was calculated with the metric BMI formula - we divided weight in kilograms with height in meters<sup>2</sup>. Rest Metabolic Rate (RMR) was calculated with predictive Harris-Benedict equation, the coefficient of variation is about 8%:

$$\text{RMR women} = 655 + (9.6 \times \text{weight kg}) + (1.8 \times \text{high cm}) - (4.7 \times \text{age in years}) \quad (12).$$

Calculated RMR was additionally confirmed with bioimpedance measurements. For the bioimpedance measurements we used Bodystat® QuadScan 4000. All measurements were performed in the morning, before the subjects consumed any food. For the statistical analysis we used calculated RMR.

Additionally, the recommended total energy expenditure (TEE) value with considering physical activity level PAL 1.4, which indicates sedentary lifestyle or low activity level, was used (10). The proportion of total daily energy intake according to RMR was determined.

Three-day food diaries were evaluated with computer program for professional evaluation of diets, Prodi 5.9. A database of this program also includes gluten-free products from different manufacturers. All the results were statistically analyzed with SPSS (Statistical Package for the Social Science 20).

For each subject, all measured data, including their background information (gender, age, height, weight, education, physical activity level, body mass index, rest metabolic rate, total daily energy intake for each day, intakes of macro - and microelements and vitamins), were imported in one database and statistically analysed using the SPSS.

Descriptive statistics, the analysis of variance and tests of differences between variables (t-test for independent samples and chi-square) were calculated by standard SPSS

procedures, with significance of  $p < 0.05$ . Recommended values for body mass index, rest metabolic rate, total daily energy intake for each day, intakes of macro - and microelements and vitamins were added to the database as new variable values to the variables for each subject and tests of significance were performed on this extended database.

### 3 RESULTS

31% of participants had tertiary or university education, whilst the remaining 69% had primary or secondary education. 45% were employed, and the majority performed easy physical, intellectual, or secretarial work. 48% were retired and 7% were unemployed. 7% of all had an additional allergy or intolerance to food, mostly lactose intolerance. Most of the participants enjoyed breakfast and 3-5 meals a day, and reported sedentary lifestyle or low physically activity level.

#### 3.1 Daily Energy Intake

The characteristics of participants and the calculated RMR, TEE and energy content of meals consumed in an average day are shown in Table 1. Calculated RMR was additionally confirmed with bioimpedance measurements. The minimal (4773 kJ/day), maximal (7137 kJ/day) and average (6004 kJ/day) values were comparable with calculated values.

**Table 1.** The characteristics of participants and the calculated RMR, TEE and energy content of meals consumed in an average day.

	Age [years]	Body weight [kg]	Body height [cm]	BMI [kg/m <sup>2</sup> ]	RMR [kJ/day]	Total daily energy intake [kJ/day]	% total daily energy intake according to RMR [%]
Average	51.6	66.4	165	24.3	5669	6823	121.7
(min - max)	(23 - 76)	(41 - 109)	(152 - 174)	(17.3 - 38.2)	(4703 - 7492)	(3868 - 11093)	(64.1 - 220.8)
<b>*Recommended intake or the estimated value</b>				<b>18.5-24.9</b>	<b>5442*</b>	<b>7535-7953 *</b>	<b>140**</b>
<b>***Sig. (p&lt;0.05)</b>					<b>0.017</b>	<b>0.024</b>	

BMI - Body Mass Index, RMR- Rest Metabolic Rate, TEE - Total Energy Expenditure

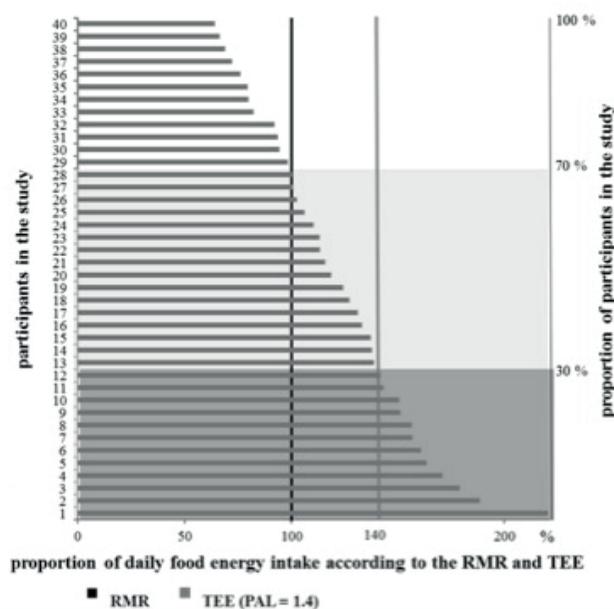
\* Recommended values according to the Reference values for nutrient intake (D-A-CH) for the Basal metabolic rate - BMR and TEE of the average values according to the age structure of participants in the survey (10).

\*\* For the recommended TEE, factors for physical activity PAL 1.4 were taken into account.

\*\*\* The difference of the average value of the recommended intake. The difference was considered statistically significant if  $p < 0.05$ .

Evaluated food diaries show that average total energy intake was 6823 kJ, or 1630 kcal significantly ( $p < 0.05$ ) too low to ensure the meeting of recommended daily energy needs (TEE) of the participants (kJ 7535-7953 or 1800-1900 kcal). Results from the proportion of total daily energy intake according to RMR show that the range of the proportion is from only 64.1% to 220.8%, in an average of 121.7%. These results indicate that the average of total daily energy intake was too low to ensure meeting total daily energy needs. The proportion of total daily energy intake in an average day, depending on the calculated RMR and TEE, is shown in the Figure 1.

Proportion of total daily energy intake according to the RMR and TEE



RMR: Rest Metabolic Rate, TEE: Total Energy Expenditure, PAL: Physical Activity Level

(We considered the factor of 1.4, because the majority of participants reported low/medium physical activity.)

Figure 1. The proportion of total daily energy intake in an average day, depending on the calculated RMR and TEE.

Taking into account the average PAL of 1.4, results show that as much as 70% of the participants did not meet recommended daily energy needs, 30% of participants exceed the TEE and 30% of participants did not meet the calculated energy needs for RMR (Figure 1).

### 3.2 The Daily Intake of Protein, Fat, Carbohydrate and Dietary Fibre in Women with Coeliac Disease

The average intake of the main nutrients in women with CD included a large, but adequate, proportion of protein (14.2%), a significantly higher proportion of fat (36.4%;  $p < 0.05$ ), and a too low proportion of carbohydrates (48.2%) and dietary fibre (18.9 g/day) in relation to the recommendations for a balanced diet (2). Only one CD patient in our study consumed a sufficient amount of dietary fibre.

The proportion of participants achieving the recommended daily intake of each main nutrient is presented in Figure 2.

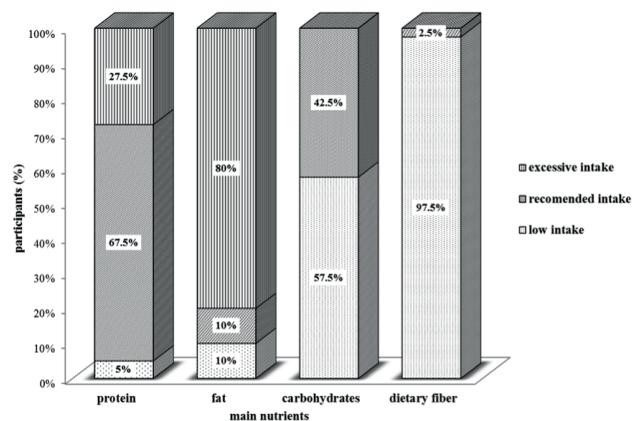
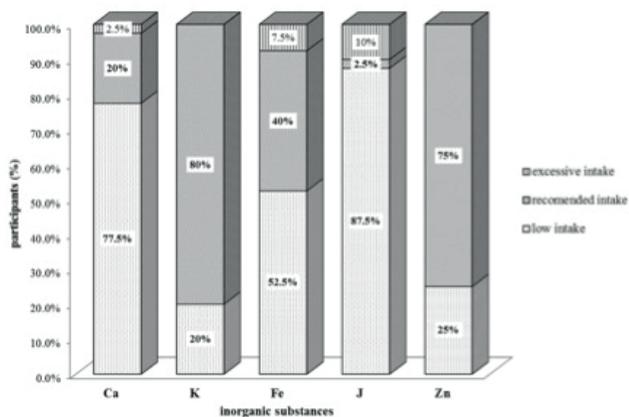


Figure 2. The proportion of participants achieving the recommended daily intake of each of the main nutrients.

### 3.3 The Daily Intake of Inorganic Macro-and Micronutrients in Women with Coeliac Disease

On average, the participants consumed significantly lower amounts ( $p < 0.05$ ) of calcium (760.7 mg/day) and iodine (96.2 mg/day), meanwhile the amount of iron (10.2 mg/day) was at the lower limit of the recommended intake, whereas the amounts of zinc (8.6 mg/day) and potassium (2716.6 mg/day) were beyond the recommended intake, but were comparable with the intake of the general population in Central Europe.

The proportion of participants achieving the recommended daily intake of each of the inorganic substance is shown in Figure 3.



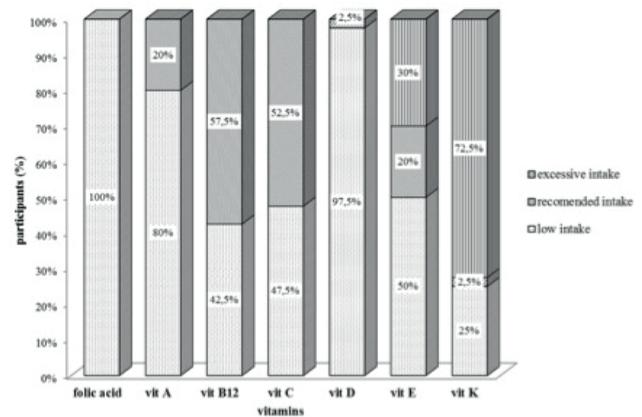
**Figure 3.** The proportion of participants achieving the recommended daily intake of each of the inorganic substance.

### 3.4 The Daily Intake of Vitamins in Women with Coeliac Disease

Among the vitamins analysed in our study, significant ( $p < 0.05$ ) and most prominent were folate (the average intake of 221.3 mg per day), because none of the participants on a strict GF diet did not reach the recommended value of folic acid (400 mg/day). On average, the entire group of participants had a significantly low intake of vitamin D (2.6 mg/day;  $p < 0.05$ ), according to the recommended intake. Considering the normal daily intake of vitamin D in adult diet, which is 2-4 mg, the results show that 30% of the participants in the survey reached normal daily intake of vitamin D, whereas 57.5% of the participants had a lower daily intake of vitamin D, and 12.5% of women with coeliac disease had a daily intake of vitamin D higher than 4 mg.

A large proportion of the participants had a low intake of vitamins A, C, B12 and E. Most participants had a higher intake of vitamin K than recommended (the average intake of 115.5 mg/day;  $p < 0.05$ ).

The proportion of participants achieving recommended daily intake of each of the vitamins is shown in Figure 4.



**Figure 4.** The proportion of participants achieving recommended daily intake of each of the vitamins.

## 4 DISCUSSIONS

The results of our study were interpreted with respect to the recommended values of individual nutrients and vitamins for women (10). Similar studies showed that results may be influenced by dietary changes during the management of a food diary as well as inaccurate or false reporting of all entered nutrients (11). This is particularly evident in the relationship between the reported daily energy intake and calculated RMR (8).

The average RMR was 5669 kJ (1354 kcal) and it is comparable to, or slightly higher than, RMR in comparable age and sex matched group Reference values for nutrient intake (D-A-CH ) (10). According to individual reports of daily physical activity level, PAL 1.4 that describes sedentary lifestyle with moderate activity was used to determine the recommended TEE (12). Taking this into account, the CD patients in this study would need to consume between 7535 and 7953 kJ (from 1800 to 1900 kcal) daily. The results show that the average total daily intake of our CD patients (6823 kJ or 1630 kcal) was significantly too low (in an average of 10-14 %) to ensure the meeting of daily energy needs. In addition, in 70% of CD patients, daily energy intake was too low to meet their recommended TEE.

It is also important to note that 40% of the CD patients had BMI equal to, or greater than, 25 kg/m<sup>2</sup>; similar results were published by Kopec et al.'s study (2009),

according to which 43,6% of CD patients had BMI equal to, or greater than, 25 kg/m<sup>2</sup> (13). It can be concluded that the reporting of food intake in certain CD patients is not realistic, which is consistent with the data from literature, where people with a higher BMI often reported lower food intake than the one actually consumed (8, 11). Upon evaluation of food diaries and identifying the main nutrient intake, we found that the GF diet is unbalanced in our population. The average daily intake included a large but adequate proportion of protein, a significantly higher proportion of fat, and a too low proportion of carbohydrates and dietary fiber in relation to the recommendations for a balanced diet (10). As previously observed in the study conducted at the Mayo Clinic (14), we also concluded that the reason for the unbalanced diet is improper food choice. Compared to the general population, patients with coeliac disease consume less pasta, bread and pizza but more eggs, meat and cheese to satisfy their desire and need for food (14). The average daily intake of protein in our study (14.2 %) coincides with the average protein intake in women (also accounted for 14.2%) from the survey data on the dietary habits of Slovenes (11). Of the 40 CD patients in our study, 17 (42.5%) consumed less than 0.8 g protein/kg body weight, which implies that, in the full-day diet (regardless if the proportion of protein in a ratio of fats and carbohydrates is suitable), the total daily energy intake of nutrients is low and thus confirms our results regarding the lack of all-day energy intake of nutrients.

An increased proportion of the daily intake of fats in our study (36.4%) coincides with the survey data on the dietary habits of Slovenes, according to which the average fat intake represents 38.8% of the daily energy intake in women (11), while Kinsey et al. (15), in their study, found that fat represented 31% of all-day energy intake in British patients with CD. The results indicate that the proportion of ingested fat in the diet is too high and the meals of CD patients in Slovenia were not balanced. A greater amount of fat in the diet increases the risk of obesity, and an excessive proportion of saturated fats and trans fats increases the risk of cardiovascular disease and certain types of cancer (16).

With regards to the data about the daily intake of carbohydrates, CD patients on average consume 193 grams of carbohydrates per day, which represents 48.2% of the energy intake. This is comparable with the results of an English study, according to which patients with coeliac disease consumed 213 grams of carbohydrates, or 49% of daily energy intake (15). This is slightly higher than the data about the dietary habits in Slovenia, where an average proportion of daily energy intake with carbohydrates, consumed by a Slovenian female, was 47% (11). More than half of the CD patients use the proportion of carbohydrates which is less than the recommended

amount. This coincides with an increased intake of fat in the overall dietary intake and with the data from the literature, according to which an insufficient intake of carbohydrates correlates with an increased consumption of fat and, thereby, increases the risk of chronic diseases (e.g. cardiovascular disease) (10, 11).

Only one CD patient in our study consumed a sufficient amount of dietary fibre. In a gender-comparable English study, dietary fibre intake among patients with coeliac disease was even lower, 12 g per day (in our study 18.8 g per day) (15).

Among macro-and microelements that were discussed in our study, calcium and iodine are particularly important. These are the two substances that our CD patients do not consume in big enough quantities. On average, CD patients consumed 760 mg of calcium per day (the recommended amount is 1000 mg/day (10, 12)), which meets only 76% of the daily calcium intake needs. The results are comparable with an English study, according to which the patients with coeliac disease consumed 797 g of calcium daily. An insufficient intake of calcium can lead to long-term health problems, such as osteoporosis, which is one of the most common diseases accompanying patients with CD (8,15). Intake of iodine is also a concern. On average, the CD patients consumed 96 mg of iodine daily, which satisfies only 53-64 % of the daily needs.

In contrast to the English study, according to which the CD patients consumed higher levels of iron than the recommended value (15), the average daily amount of ingested iron in our study and in a U.S. study is lower: 10.2 and 11 mg, respectively (10, 17). This was also found in Finland, where CD patients had significantly lower values of iron (18).

The average intake of zinc was 8.6 mg and was 22.8% higher than the recommended value of 7 mg/day (10). Regarding Central European diet, an average daily intake of potassium for adults is 2-3 g, which was confirmed in our study as well (10).

Upon evaluation of food diaries, we came to the conclusion that a large proportion of CD patients on a strict GF diet do not consume the recommended values of individual vitamins, which was also described in the study conducted by Hallert et al. (8).

Among the vitamins that were discussed in our study, folates are the most important, because none of the CD patients reached the recommended daily intake of folic acid. A Finnish study also confirmed a significantly low folate content (18). The second vitamin with a proven insufficient intake in almost all CD patients is the vitamin D. Normal daily intake of vitamin D in general population is ten to five times lower than the recommended intake, thus the recommended intake of vitamin D can only be achieved with dietary supplements (19). Pertaining to the

normal daily intake of vitamin D, we found that more than half of our CD patients had an insufficient intake, which is in line with the findings of other authors (8, 15, 20, 21). Good sources of vitamin D for patients with coeliac disease are oily fish, eggs and nutrients fortified with vitamin D, such as margarine, gluten free yogurts and gluten free cereal flakes. Because some yogurts and most cereals contain gluten, the CD patients consequentially consume less vitamin D than the general population (8). Our study also proved an insufficient intake of vitamin B12, which is consistent with the findings of other authors (8, 15). This indicates that the lack of vitamin B12 in the diet is prevalent for CD patients. Vitamin B12 is absorbed in the upper part of the small intestine, where, in the case of non-compliance with a strict gluten-free diet, damage to the villi occurs, which leads to the reduced absorption of nutrients and vitamins (8). CD patients, who enjoyed mussels, had an intake of 83.7 mg of the vitamin B12, but, due to the large deviations, these results were not included.

The only exception is vitamin K, with most of the CD patients consuming higher amounts than recommended. Depending on the selection of foods mentioned in food diaries, the patients with coeliac disease in Slovenia are knowledgeable of the allowed and prohibited food. As already mentioned, the food diaries evaluation may not fully reflect the real situation, especially in people who are overweight (8, 11). In our study, 40% of CD patients had BMI equal to or greater than 25 kg/m<sup>2</sup>, which could have the influence on the results and which, at the same time, proves that the obesity epidemic described in other studies has reached the patients with coeliac disease in Slovenia (13).

## 5 CONCLUSION

The research gives us a rough insight into the diet of adult coeliac disease patients in Slovenia. Gluten free diet of coeliac disease patients in Slovenia does not meet the guidelines for a healthy and balanced diet according to the Reference values for nutrient intakes D-A-CH. Because of an improper composition of the meals, the nutrition of patients with coeliac disease is unbalanced: it consists of an increased proportion of fat, and contains an insufficient intake of carbohydrates and dietary fibre, as well as inorganic substances, such as iron, calcium, iodine and folate, vitamin B12 and fat-soluble vitamins A, D and E.

As far as the selection of foodstuffs in the food diaries is concerned, we concluded that coeliac disease patients in Slovenia know very well which foods they can consume (gluten-free) and which foods they should not consume. In the future, more emphasis should be given to the balanced composition of foods, improving the quality of

a gluten-free diet in tandem with a regular nutritional monitoring of coeliac disease patients.

## CONFLICTS OF INTEREST

The authors declare that no conflict of interest exists.

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## ETHICAL APPROVAL

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