

# Assessment of dietary intake in patients with metabolic dysfunction-associated steatotic liver disease using the Ukrainian version of the EPIC-Norfolk Food Frequency Questionnaire: A cross-sectional study



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Metabolic dysfunction-associated steatotic liver disease (MASLD) is prevalent worldwide. Studies demonstrate a possible association between diet and MASLD. However, data regarding patients in Ukraine are lacking.

**Objective** – to study dietary habits and meeting recommended dietary intake in patients with MASLD.

**Materials and methods.** Adults with MASLD aged 18 years and older ( $n = 29$ ) receiving care in outpatient settings who fully completed the adapted and validated Ukrainian version of the EPIC-Norfolk Food Frequency Questionnaire (FFQ) were included in the analysis. Liver steatosis was confirmed by ultrasound examination, and diagnosis of MASLD was based on the criteria defined by the American Association for the Study of Liver Diseases. As a reference for recommended dietary intake, data from the Dietary Guidelines for Americans, 2020–2025 years were used. FETA software was used to calculate nutrient data from the FFQ. The one-sample t-test, t-test, the one-sample signed rank sum test, and Mann-Whitney test were used to assess the differences between the sample and the reference data. The chi-squared test was used to analyse categorical data.

**Results.** The mean age of participants was  $41.4 \pm 12$  years, 69 % of participants being female. The mean body mass index was  $35.4 \pm 7.9$  kg/m<sup>2</sup>. Participants consumed more protein, than recommended by current dietary recommendations. Women also tended to have higher energy intake and consume more fat, saturated fatty acids, and carbohydrates than recommended. The median fibre intake was 19.36 g (Q1; Q3: 13.29; 26.45), which is lower than the recommended 14 g per 1000 kcal ( $p = 0.0015$ ). Dietary intake of most vitamins and micronutrients was met. However, women and men consumed less than 600 IU of vitamin D daily. Among all patients with MASLD, sodium intake ( $3829.5 \pm 1559.3$  mg) was significantly higher than recommended (2300 mg,  $p < 0.0001$ ). Approximately 62 % of participants take dietary supplements, with vitamin D being the most popular choice.

**Conclusions.** Our study showed that patients with MASLD in Ukraine tend to exceed recommended protein and sodium intake and, at the same time, have low fibre and Vitamin D consumption. High energy intake and saturated fatty acids consumption are also of concern.

## Keywords:

dietary assessment, food frequency questionnaire, nutrient, MASLD, Ukraine.

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Metabolic dysfunction-associated steatotic liver disease (MASLD) is considered to become one of the most common chronic liver diseases, and its prevalence is expected to increase [5]. Multiple studies have investigated the role of dietary habits in the development and progression of MASLD. The data demonstrated an association between higher energy intake and MASLD [20]. Ultra-processed foods, sugar-sweetened beverages, and saturated fats

are also believed to be the main contributors [16]. Drug development addressing inflammation and fibrosis progression in MASLD remains a challenge. On 14 March 2024, the U.S. Food and Drug Administration (FDA) approved resmetirom for the treatment of adults with non-cirrhotic non-alcoholic steatohepatitis (NASH) with moderate to advanced liver scarring (fibrosis), to be used along with diet and exercise [6]. However, lifestyle changes remain an effective part of treatment and should be recommended for patients with MASLD [5, 7]. In Ukraine, the actual data on dietary intake in patients with MASLD and their meeting the recommended dietary intake (RDI) are still lacking. A better understanding of the dietary intake of patients with MASLD is needed to improve the care for this population group, making this study important and relevant.

**Objective** – to study dietary habits and meeting recommended dietary intake in patients with MASLD.

## Materials and methods

### Participants

It was a cross-sectional study involving patients with MASLD. Participants were recruited from outpatients who received medical care in two medical centres in Kyiv, Ukraine: private medical centre «Universal Clinic «Oberig» and KNE «Kyiv Municipal Consultative and Diagnostic Center» from July 2023 to June 2024.

The inclusion criteria for participation in the study were as follows: adult patients aged 18 years and older, liver steatosis confirmed by ultrasound imaging and the recent diagnosis of MASLD (in the last 6 months). The diagnosis of MASLD was based on the criteria defined by the American Association for the Study of Liver Diseases (AASLD), which are consistent with the EASL – EASD – EASO Clinical Practice Guidelines: hepatic steatosis identified by imaging or biopsy and at least one of five cardiometabolic risk factors: body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup> or waist circumference (WC)  $> 94$  cm (males) and  $> 80$  cm (females); fasting serum glucose  $\geq 5.6$  mmol/L or 2-hour post-load glucose levels  $\geq 7.8$  mmol/L or HbA1c  $\geq 5.7\%$  or type 2 diabetes or treatment for type 2 diabetes; blood pressure  $\geq 130/85$  mm Hg or specific antihypertensive treatment; plasma triglycerides  $\geq 1.70$  mmol/L or lipid-lowering treatment; plasma HDL  $\leq 1.0$  (males) and  $\leq 1.3$  mmol/L (females) or lipid-lowering treatment [5, 10].

The exclusion criteria were pregnancy, daily alcohol intake of more than 30 g per day for men and 20 g per day for women [5], acute or chronic liver diseases (hepatitis B, hepatitis C, etc.) other

than MASLD, recent changes of dietary habits. We measured weight and height with further BMI calculation. We also collected information about the place of residency, smoking status and physical activity level of the participants.

The study was conducted in accordance with the Declaration of Helsinki, and all participants gave informed consent. The study protocol was approved by the Ethic Committee of the Bogomolets National Medical University, Kyiv, Ukraine (Protocol No 152).

### Food frequency questionnaire and recommended dietary intake

Dietary intake was assessed using the Ukrainian version of the food frequency questionnaire «the EPIC-Norfolk FFQ», which we previously adapted and validated for Ukrainian adults [17]. As a reference for RDI, we used data from the U.S. Department of Agriculture and the U.S. Department of Health and Human Services, Dietary Guidelines for Americans [14]. We set recommended dietary intake for macro- and micronutrients for each participant based on their age and sex. Estimated Calorie Needs were chosen based on age, sex and physical activity levels of each participant. As the Acceptable Macronutrient Distribution Range (AMDR) for fat intake ranges from 10 to 35%, we used the highest value (35%) as the threshold and previously set Estimated Calorie Needs for calculating the acceptable energy obtained from fat, which was further converted from kcal to grams of fat using the approximation that 1 g of fat equals 9 kcal of energy [13]. We calculated the reference for fibre intake according to the recommendation of eating 14 g of fibre per 1000 kcal [14]. The upper limit for saturated fatty acids (SFA) was set as  $< 10\%$  of daily energy intake (kcal) [14].

### Statistical Analysis

Categorical variables were presented as the number of cases and percentages. Continuous variables were checked for normality using the Shapiro-Wilk test and histograms. Normally distributed continuous variables of the demographic data were presented as mean and  $\pm$  standard deviation (SD). As some continuous variables of nutrients did not follow a normal distribution, we expressed data for nutrients in the table as median with 25th and 75th percentile (Q1 and Q3). The one-sample t-test and the one-sample signed rank sum test (depending on whether data were normally distributed or not) were used to assess the differences between the sample data and the test value (one reference value for all participants according to guidelines the U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans)

[14]. Mann-Whitney test (for non-normally distributed data) and t-test (for normally distributed data) were used to assess the differences between the sample data and the reference data (calculated for each participant). The chi-squared test was used to analyse categorical data. The sample size was defined as at least 24 participants, as it was recommended by J. C. Hall [9] with power set as 80 %,  $p < 0.05$ , and the null hypothesis that the mean difference in calorie intake is 500 kcal or less. Initially data were entered and encoded in Google and Excel sheets, then we used FETA software to calculate nutrient data from the FFQ [12]. A  $p$ -value  $< 0.05$  was considered statistically significant. Data was analysed using MedCalc® Statistical Software 20.215.

## Results

Among 40 patients, who filled inclusion criteria, 34 agreed to participate in the study and were given the Ukrainian version of FFQ. Four participants did not return the filled form. The results of 30 filled FFQ were further entered into Excel sheets and encoded. Then we used the FETA software to calculate nutrient and food group data from the FFQs. One participant, who did not fill the FFQ properly leading to a total energy intake lower than 800 kcal/day, was excluded. As a result, 29 participants who fully completed FFQ were included in the following analysis. The mean age of participants was  $41.4 \pm 12$  years, with 69 % of participants being female. The mean BMI was  $35.4 \pm 7.9$  kg/m<sup>2</sup>. Table 1 summarizes the main socio-demographic and clinical characteristics of participants.

Both men (112.46 g vs 56 g,  $p = 0.01$ ) and women (127.68 g vs 46 g,  $p < 0.0001$ ) consumed more protein than recommended by current dietary recommendations [8]. Women also consumed more saturated fat than the threshold of 10 % of daily energy intake. Daily intake of fibre was lower in both women and men. The median of fibre intake was 19.36 g (Q1; Q3: 13.29; 26.45), which was lower than the recommended 14 g per 1000 kcal (median 31.74 g, Q1; Q3: 21.63; 36.33;  $p = 0.0015$ ). Dietary intake of most vitamins and micronutrients was met. However, women as well as men consumed less than 600 IU of vitamin D daily. Detailed data of macronutrient and micronutrient intake, meeting the dietary guidelines recommendation are summarised in Table 2. Patients with MASLD consumed higher sodium amounts than recommended. Among all patients with MASLD sodium intake ( $3829.5 \pm 1559.3$  mg) was significantly higher than recommended (2300 mg,  $p < 0.0001$ ). This finding can be also supported by the fact that approximately 90 % of participants always add salt during cooking their food and there were no differences between sexes. Nearly 52 % of

**Table 1.** The main socio-demographic and clinical characteristics of participants

Characteristics	Value
Age, years	41.4 ± 12
Female	20 (69 %)
Male	9 (31 %)
Smokers	9 (31 %)
Residence	
City/town	24 (82.8 %)
Village	5 (17.2 %)
BMI, kg/m <sup>2</sup>	35.4 ± 7.9
BMI category, kg/m <sup>2</sup>	
< 25	0
25 to < 30	9 (31 %)
30 to < 35	6 (21 %)
35 to < 40	7 (24 %)
≥ 40	7 (24 %)
Physical activity	
Sedentary	19 (65 %)
Light activity	8 (28 %)
Active	2 (7 %)

Note. Categorical variables are presented as the number of cases and percentage, while quantitative indicators are presented as Mean ± SD.

participants constantly or very often took dietary supplements, 10 % used them periodically, and 38 % did not take any. There was no difference between the sexes ( $p = 0.6337$ , chi-square test). The frequency of dietary supplement use depending on the living area is shown in Figure. Among patients who used dietary supplements, most (approximately 61 %) consumed at least two different supplements. Nearly 40 % of the participants reported the use of three different types of dietary supplements. Vitamin D was the most popular choice, which was mentioned by 83 % of participants, 39 % mentioned using marine fish oil and/or omega-3 fatty acids. The use of vitamin C, magnesium, zinc, and multivitamin complexes has also been reported.

## Discussion

Our results demonstrating higher energy intake by patients with MASLD are in agreement with those of other similar studies [1, 15, 20]. Stratified analysis shown higher carbohydrates, fat, saturated fat and sodium intake by woman than recommended. In contrast, the dietary recommendations for fibre intake were not met. Both women and men consumed significantly lower amounts of fibre which is consistent with the results of multiple studies in different countries [1, 2, 13].

**Table 2.** Daily intake of macronutrient and micronutrients in patients with MASLD

Indicator	All participants	Men		Women	
		RDI		RDI	
Energy, kcal	2267 (1545—2595)	2400	1655 (1386—2605)	1800	2377 (1705—2596)*
Protein, g	116.5 (73.5—150.1)	56.0	112.5 (65.5—156.6)**	46.0	127.7 (74.5—150.5)***
Fat, g	89.49 (64.41—124.2)	93.33	80.43 (57.92—94.15)*	70.00	92.85 (72.01—126.2)*
MUFA, g	36.58 (26.04—47.07)	–	32.29 (21.93—44.23)	–	38.01 (26.55—49.76)
PUFA, g	15.03 (10.18—18.53)	–	14.69 (9.85—17.05)	–	15.76 (9.90—20.28)
SFA, g	29.60 (20.90—44.76)	18.39	21.76 (19.01—34.21)	26.41	34.44 (25.27—45.16)**
Cholesterol, mg	467.1 (331.1—657.2)	–	467.1 (317.6—617.0)	–	492.4 (330.9—658.0)
Carbohydrates, g	220.3 (151.0—299.9)	130.0	237.5 (109.5—286.1)	130.0	217.6 (159.7—302.5)***
Fructose, g	17.24 (13.69—29.72)	–	14.53 (11.92—16.58)	–	22.20 (17.01—37.79)
Dietary fibre, g	19.36 (13.29—26.45)	23.17	16.00 (11.78—20.26)*	33.28	22.05 (13.72—31.50)*
Total sugars, g	92.8 (59.8—127.5)	–	58.4 (52.4—106.5)	–	97.4 (69.8—156.4)
Thiamine, mg	1.75 (1.22—2.16)	1.20	1.79 (0.88—2.46)	1.10	1.66 (1.28—2.10)***
Riboflavin, mg	1.92 (1.21—2.39)	1.30	1.40 (1.10—1.77)	1.10	2.02 (1.33—2.53)***
Niacin, mg	30.98 (20.05—38.50)	16.00	30.98 (19.56—46.71)**	14.00	30.57 (20.32—37.60)***
Pyridoxine, mg	2.51 (1.56—3.23)	1.30	2.28 (1.58—3.31)**	1.30	2.59 (1.50—3.27)***
Vitamin B <sub>12</sub> , mcg	8.58 (5.31—14.50)	2.40	8.58 (3.66—12.71)**	2.40	9.86 (6.56—14.75)***
Total folate, mcg	333.2 (220.7—443.5)	400.0	231.7 (194.1—313.8)**	400.0	392.8 (231.1—542.4)
Vitamin C, mg	145.35 (76.42—221.74)	90.0	75.70 (50.71—125.68)	75.00	174.57 (91.22—277.06)***
Vitamin D, mcg	3.35 (2.04—5.69)	15.00	2.79 (2.09—6.09)***	15.00	3.36 (2.04—5.24)***
Vitamin E, mg	12.30 (9.86—17.66)	15.00	10.24 (9.05—12.21)**	15.00	13.79 (10.41—20.32)
Iron, mg	13.98 (9.66—16.72)	8.00	11.94 (9.60—15.60)**	14.65	14.65 (9.66—17.50)
Calcium, mg	851.4 (516.0—1185)	1000	576.1 (421.1—855.6)	1000	1021.9 (746.0—1274)
Magnesium, mg	381.7 (237.5—438.2)	420.0	275.8 (237.5—438.2)	320.0	382.1 (254.2—449.5)
Zinc, mg	12.83 (7.95—14.78)	11.00	11.67 (8.38—15.70)	8.00	12.99 (7.88—14.41)**
Sodium, mg	4518 (2430—4949)	2300	3800 (2111—4765)	2300	4548 (2564—4967)***
Potassium, mg	3420 (2724—4877)	3400	3158 (2666—3783)	2600	3983 (2658—5169)**

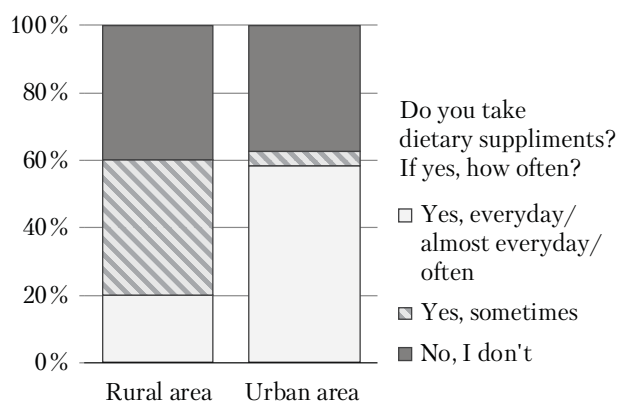
Note. Variables are presented as Median (Q1—Q3).

RDI is based on the US Department of Agriculture and US Department of Health and Human Services. Dietary Guidelines for Americans.

MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; SFA: saturated fatty acids.

Vitamin D RDI 600 IU = 15 mcg.

The difference from RDI is statistically significant: \*  $p < 0.05$ ; \*\*  $p \leq 0.01$ ; \*\*\*  $p < 0.001$ .



Timeline: within the past twelve months.  $p = 0.0425$ ,  $\chi^2$  test.

**Figure.** Dietary supplement usage frequency depending on living area in patients with MASLD

Our data demonstrating that low vitamin D intake is consistent with the results of a study conducted in Canada, which demonstrated that patients with MASLD vitamin D intake had a lower RDI in 100% of both men and women [1]. This is also supported by a meta-analysis showing that patients with MASLD have decreased serum 25(OH)D levels [4].

The role of high sodium intake and the onset of MASLD remains unclear. Even so, some studies have demonstrated a high sodium intake in patients with MASLD, which is in line with our findings [18]. In addition, a study conducted in Korea examined the sex-specific association between sodium intake and the risk of MASLD and found that the estimated 24-h urinary sodium excretion levels were positively associated with the incidence of MASLD in

all subjects. Furthermore, upon sex stratification, a significant relationship was observed in females but not in males [11].

Considering the relatively high rate of dietary supplement consumption among patients with MASLD, attention should be paid to the amount and type of supplements consumed. For example, additional vitamin D supplementation may seem reasonable in some cases as defined by the Endocrine Society [3]. However, large amounts of different dietary supplements pose a risk of drug-induced liver injury (DILI) development [8], making relevant questions about dietary supplement usage and reviewing them with the help of LiverTox (National Institute of Diabetes and Digestive and Kidney Diseases) as needed.

This study has some limitations. Despite our efforts to involve more men in this study, owing to the ongoing war in Ukraine, it was difficult to achieve. In addition, the total energy intake of men was lower than we expected. This may be explained by underreporting, which is considered a particular issue with self-reported data, especially among obese participants [19]. Nevertheless, our study has several strengths. To the best of our knowledge, this is the first study to use a validated FFQ to assess dietary intake in Ukrainian adults with MASLD. Furthermore, we investigated whether patients with MASLD met the current dietary recommendations for most nutrients. We detected increased

consumption of protein and sodium. At the same time, patients did not meet RDIs for fibre and vitamin D. Hence, these findings can be used in clinical practice to provide more precise recommendations for this category of patients.

### Conclusions

Our study showed higher protein and sodium intakes in patients diagnosed with MASLD in Ukraine. Women also tend to have a higher energy intake and consume more fat, SFA, and carbohydrates than those recommended by the current guidelines. In contrast, patients did not meet the daily requirements for fibre and vitamin D. Relatively high rates of dietary supplement consumption are also a concern. Finding opportunities to attract more males in similar research remains valid. These results can be used in clinical settings to advise patients with MASLD to pay attention to daily energy and macronutrient intake, reduce the amount of sodium consumed, and prefer foods with higher fibre and vitamin D contents.

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*Conflicts of interest: none.*

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## Оцінка харчування в пацієнтів з метаболічно-асоційованою стеатотичною хворобою печінки за допомогою української версії опитувальника EPIC-Norfolk Food Frequency Questionnaire: крос-секційне дослідження

**Метаболічно-асоційована стеатотична хвороба печінки (МАСХП), поширена в усьому світі. Дослідження демонструють можливий зв'язок між дієтою та МАСХП. Однак даних щодо пацієнтів в Україні бракує.**

**Мета** — вивчити харчові звички та дотримання рекомендованих дієтичних норм у пацієнтів з МАСХП.

**Матеріали та методи.** Проаналізовано дані 29 пацієнтів із МАСХП віком понад 18 років, які отримували медичну допомогу в амбулаторних умовах і повністю заповнили адаптовану й валідовану українську версію опитувальника the EPIC-Norfolk Food Frequency Questionnaire (FFQ). Стеатоз печінки підтверджено за допомогою ультразвукового дослідження, діагноз МАСХП встановлено на основі критеріїв Американської асоціації з вивчення захворювань печінки. Для визначення рекомендованих дієтичних норм використано дані з «Дієтичних рекомендацій для американців, 2020–2025 рр.». Дані щодо нутрієнтів з FFQ розраховано за допомогою програмного забезпечення FETA. Для оцінки відмінностей між вибіркою та референтними даними використовували t-критерій Стьюдента (для однієї вибірки та для двох вибірок), одновибірковий критерій знакових рангів Вілкоксона та тест Манна–Уїтні. Для аналізу категоріальних даних застосовували тест  $\chi^2$ .

**Результати.** Середній вік учасників становив  $(41,4 \pm 12,0)$  року, 69% учасників були жінками. Середній індекс маси тіла —  $(35,4 \pm 7,9)$  кг/м<sup>2</sup>. Учасники споживали більше білка, ніж рекомендовано сучасними дієтичними рекомендаціями. Жінки також мали тенденцію до вищого споживання енергії, жирів, насичених жирів і вуглеводів, ніж рекомендовано. Медіана споживання клітковини становила 19,36 г (міжквартильний розмах — 13,29; 26,45), що нижче рекомендованих 14 г на 1000 ккал ( $p = 0,0015$ ). Дієтичні норми споживання більшості вітамінів та мікроелементів були дотримані. Однак жінки та чоловіки споживали менше 600 МО вітаміну D на добу. У всіх пацієнтів із МАСХП споживання натрію ( $(3829,5 \pm 1559,3)$  мг) було значно вищим, ніж рекомендовано (2300 мг,  $p < 0,0001$ ). Близько 62% учасників приймали дієтичні добавки, найпопулярнішим з яких був вітамін D.

**Висновки.** Дослідження продемонструвало, що пацієнти з МАСХП в Україні зазвичай перевищують рекомендоване споживання білка та натрію, але мають низьке споживання клітковини й вітаміну D. Викликає занепокоєння висока калорійність раціону та споживання насичених жирів.

**Ключові слова:** оцінка раціону харчування, опитувальник частоти харчування, поживні речовини, МАСХП, Україна.

### ДЛЯ ЦИТУВАННЯ

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