

A POST-PANDEMIC TREND IN THE CONSUMPTION OF DIETARY SUPPLEMENTS AMONG RESIDENTS OF LITHUANIA

Rokas Arlauskas, Donatas Austys, Rimantas Stukas

Department of Public Health, Institute of Health Sciences, Faculty of Medicine, Vilnius University, Vilnius, Lithuania

SUMMARY

Objectives: The consumption of dietary supplements might prevent the deficiency of necessary nutrients. On the other hand, in cases of overconsumption, adverse effects might occur. In Lithuania, the COVID-19 pandemic provoked an increase in the consumption of dietary supplements. The aim of this study was to reveal the post-pandemic trend of the consumption of dietary supplements among the working-age residents of Lithuania with respect to social and demographic factors and food selection criteria.

Methods: A cross-sectional observational study was performed. In total, using the same methods, 3,200 residents were surveyed: 1,600 in 2021 and 1,600 in 2022. Both samples were representative for Lithuania and included residents of Lithuania aged from 18 to 64 years. According to socio-demographic factors (sex, age, level of education, type of place of residence, marital status, number of family members, presence of children under 18 years old in the household, employment status, level of income), COVID-19 experience (presence of COVID-19 cases among friends or relatives, severeness of COVID-19) and food selection criteria (health strengthening, other) the prevalence of the consumption of dietary supplements was compared between the samples.

Results: The consumption of dietary supplements accounted for 78.1% and 71.6% of the respondents in 2021 and 2022, respectively ($p < 0.001$). After the COVID-19 pandemic, the prevalence of the consumption of dietary supplements decreased in the majority of social and demographic groups analysed in this article ($p < 0.05$). The consumption of dietary supplements remained unchanged among those who selected foods for health strengthening ($p = 0.098$).

Conclusions: The prevalence of the consumption of dietary supplements decreased after the COVID-19 pandemic in most social and demographic groups except those who selected foods for health strengthening.

Key words: dietary supplements; adults; Lithuania; COVID-19; food selection criteria

Address for correspondence: R. Arlauskas, Department of Public Health, Institute of Health Sciences, Faculty of Medicine, Vilnius University, M. K. Čiurlionio 21/27, LT-03101 Vilnius, Lithuania. E-mail: rokas.arlauskas@mf.vu.lt

<https://doi.org/10.21101/cejph.a8092>

INTRODUCTION

According to studies, in terms of social and demographic factors, nutritional habits of a large part of the population in many countries do not meet dietary recommendations (1–5). This may lead to the deficiency of necessary nutrients and subsequent health issues (5). Therefore, the consumption of dietary supplements may be beneficial in correcting micronutrient deficiency or maintaining adequate intakes (6). For example, the most prevalent dietary supplements from our previous study, vitamin C and vitamin D, which consumption significantly increased during the COVID-19 pandemic, are mainly known to be targeted to the strengthening of the immune system (7, 8). On the other hand, in cases of overconsumption, researchers emphasize the possible adverse effects of dietary supplements (9).

Our recent study (7), along with the studies conducted by other researchers, revealed a significant impact of the COVID-19 pandemic on the prevalence of the consumption of dietary supplements. During the COVID-19 pandemic, an increase in the prevalence of the consumption of dietary supplements was

observed (10, 11). On the other hand, there are studies stating a decrease in the prevalence of the consumption of dietary supplements (12). An increase in the prevalence of the consumption of dietary supplements targeted at strengthening the immune system of the human body was observed during the pandemic (7, 10).

A study published in 2021 revealed that the consumption of dietary supplements is determined by personal factors, including socio-demographic characteristics, perceived benefits of dietary supplements, history of illness, physiological conditions, and lifestyle factors; and also by socioeconomic factors including subjective norms, the price of food and commercial considerations of the sectors involved in the production and sale of dietary supplements (9). Other researchers claim that dietary supplements are most commonly taken by people with no clinical signs or symptoms of deficiency (6). Importantly, consumers of dietary supplements tend to have a better overall diet quality compared to those who do not use dietary supplements and their nutrient intake from foods mostly meets recommended intake levels (6, 13, 14). Taking into account the inequalities of the consumption of dietary supplements, and the changes in the consumption during the pandemic, it is important

to assess the prevalence of the consumption after the pandemic. In cases of an inadequate consumption of dietary supplements public health interventions should be taken.

The comparison of the prevalence of the consumption of dietary supplements before and during the COVID-19 pandemic was published by us in our previous publication (7). However, there is a lack of representative studies analysing the trends of the consumption of dietary supplements after the COVID-19 pandemic. Therefore, the aim of this study was to reveal the post-pandemic trend of the consumption of dietary supplements among the working-age residents of Lithuania with respect to the social and demographic factors and food selection criteria.

MATERIALS AND METHODS

Data Collection

The data for this study was collected after conducting two cross-sectional surveys during the COVID-19 pandemic – in October and November of 2021, and after the pandemic – in October and November of 2022. Two country-representative samples of adults aged from 18 to 64 years were formed. Both, male and female residents of Lithuania were included. The multi-stage stratified probabilistic sampling method was used to select participants for this study. It ensured an equal probability for every household in the country to be surveyed and, according to the target criteria (age, sex, level of education, place of residence), the sample represented the general population. Data was collected by conducting an internet-based survey.

The comparison with the pre-pandemic period findings of the data collected in 2021 had already been published (7). The current paper focuses on the post-pandemic period and the analysis of the prevalence of the consumption of dietary supplements with respect to the attitude towards nutrition which had not been covered in our previous paper.

Questionnaire

Both surveys, performed in 2021 and 2022, were carried out using the same questionnaire with a minimal adaptation for the post-pandemic period. An anonymous questionnaire included the questions about social and demographic characteristics of the respondents, COVID-19 experience, subjective assessment of personal health, nutrition, consumption of food supplements, and physical activity. The questionnaire was formed on the basis of the previously used questionnaire about the nutrition and consumption of food supplements (15) by adding additional questions related to the COVID-19 pandemic and its possible impact on nutrition, consumption of food supplements and physical activity. In this paper, we present the analysis of part of the questions included in the questionnaire (Table 1).

The questionnaire, used in this study, included questions about the consumption of specific dietary supplements. However, in order to define dietary supplements that contain multiple micro-nutrients and assuming that respondents might not know the exact ingredients of such dietary supplements, such terms as “complex of vitamins and minerals”, “complex of vitamins”, “complex of minerals” were included.

The questionnaire also included a group of questions about social and demographic factors. Two of those questions regarding the respondents' age and place of residence were open-ended. To achieve the unambiguous interpretation of the results, we transformed them into a binary format. Respondents were asked to identify the municipality they live in. Respondents from 5 municipalities with the largest number of residents were assigned to the “city” group, while all the rest respondents were attributed to the “towns and villages” group. The age was categorized by median to the range up to 41-year-olds and from 42-year-olds. All other questions were close-ended. Respondents with primary or secondary education and high school graduates were assigned to the “non-university education” group. Respondents with unfinished or finished university studies were assigned to the “university education” group. In terms of the employment status, the “employed” and “unemployed” groups were created. Heads of companies or the departments, office workers, civil servants, service sector employees, sellers, workers, and farmers were assigned to the “employed” group. Retirees, housewives, persons on parental leave, non-employed persons, and students were categorized to the “unemployed” group. The variable representing an income per member of a family was transformed into the binary format with “higher income” and “lower income” categories. With respect to a salary increase, the cut off point for those groups was 350 € in 2021, and 400 € in 2022. In addition to this, more binary variables were created such as the number of family members, marital status, with children under 18 years old. The categorization of the rest of the questionnaire is presented in Table 1.

Statistical Analysis

Normality of the distribution of variables was tested using the Shapiro-Wilk test. With respect to the results of this test, medians with interquartile range (Q1–Q3) were presented for variables with non-normal distribution, and averages with standard distributions were presented for variables with normal distribution. Pearson's chi-squared test (χ^2) was used to determine whether there was a statistically significant difference between the expected frequencies and the observed frequencies in one or more of the categories. Differences were considered statistically significant when the p-value was lower than 0.05.

RESULTS

In total, this study included 3,200 respondents: 1,600 in 2021 and 1,600 in 2022. Median age in both samples was 42 (29–54) years. The majority of the respondents were employed, married (or with partners), from small towns or villages, people with university education, without children under 18 years old. The samples were similar according to sex, age, education, place of residence, marital status, having children under 18 years old, employment status, income, and the severeness of COVID-19 among the respondents ($p > 0.05$). In 2022, the sample included relatively more single respondents, those who had personally suffered from COVID-19 or had COVID-19 cases either in their families or among friends ($p < 0.05$). In addition to this, this sample included more respondents who selected foods following other than strengthening of health criteria ($p < 0.001$). The distribution

Table 1. Questions about consumption of dietary supplements included in this study

Question	Categories with relevant response options ^a
Do you consume dietary supplements (vitamins, minerals, polyunsaturated fatty acids, plant-based preparations, etc.)?	Yes (yes, always / yes, more than 6 months per year / yes, 4–6 months per year / yes, 2–3 months per year / yes, 1 month per year / yes, but shortly or accidentally) No (no, I do not consume) Excluded from the analysis (I do not know / cannot answer)
What dietary supplements and what for have you taken over the last 12 months? ^b	For strengthening the immune system For disease prevention and the overall strengthening of the body / energy boosting / eye care / boosting memory / boosting the nervous system / strengthening the cardiovascular system / strengthening the joints, bones / better digestion / sleep regulation / for athletes / weight regulation / protection against the COVID-19 infection / other
What is most important to you when selecting food products?	Health strengthening (benefits to health) Other (taste / price / preferences of other family members / necessity of diet / other) Excluded from the analysis (I do not know / cannot answer)
Which of the dietary supplements have you consumed more under the impact of the COVID-19 pandemic? (the question used only in the 2021 survey) ^b	Complex of vitamins and minerals / complex of vitamins / complex of minerals / omega-3 fatty acids / plant-based / targeted to the immune system / targeted to the cardiovascular system / targeted to the nervous system / targeted to the general strengthening of the body / vitamin C / vitamin D / vitamins of the B group / iron / magnesium / potassium / calcium / selenium / coenzyme Q10 / other / I do not know
Which of the dietary supplements have you consumed/taken over the last 12 months? (the question used only in the 2022 survey) ^b	Complex of vitamins and minerals / complex of vitamins / complex of minerals / omega-3 fatty acids / fish oil / plant-based / targeted at the immune system / targeted at the cardiovascular system / targeted at the nervous system / targeted at the general strengthening of the body / vitamin C / vitamin D / vitamin A / vitamins of the B group / folic acid / other vitamins / iron / magnesium / potassium / calcium / zinc / selenium / other minerals / coenzyme Q10 / probiotics / other / I do not know
Please select the appropriate statements for you: (level of exposure to COVID-19)	I'm suffering (or suffered) from COVID-19 / there is (or was) a member in my family who is suffering (or suffered) from COVID-19 / my friends, acquaintances, neighbours are suffering (or suffered) from COVID-19 in their families / I do not know anyone who is suffering (or suffered) from COVID-19
Please select the most appropriate statement about your COVID-19 infection:	Suffered from the asymptomatic or mild form of COVID-19 (I had an asymptomatic form of this disease / I had a mild form of this disease) / suffered from a severe COVID-19 form (I had a severe form of this disease / I had a very severe form of this disease)

^aIn case of larger categories, the response options are provided in brackets; ^bselection of multiple answer options available

of the respondents by social and demographic factors is presented in Table 2.

In 2021, the consumption of dietary supplements was prevalent among 1,240 (78.1%) of the respondents. In 2022, the prevalence

of the consumption of dietary supplements was significantly lower and accounted for 1,131 (71.6%) of the sample ($p < 0.001$). Despite this, most of the purposes for the consumption of dietary supplements remained similar ($p > 0.05$) (Fig. 1).

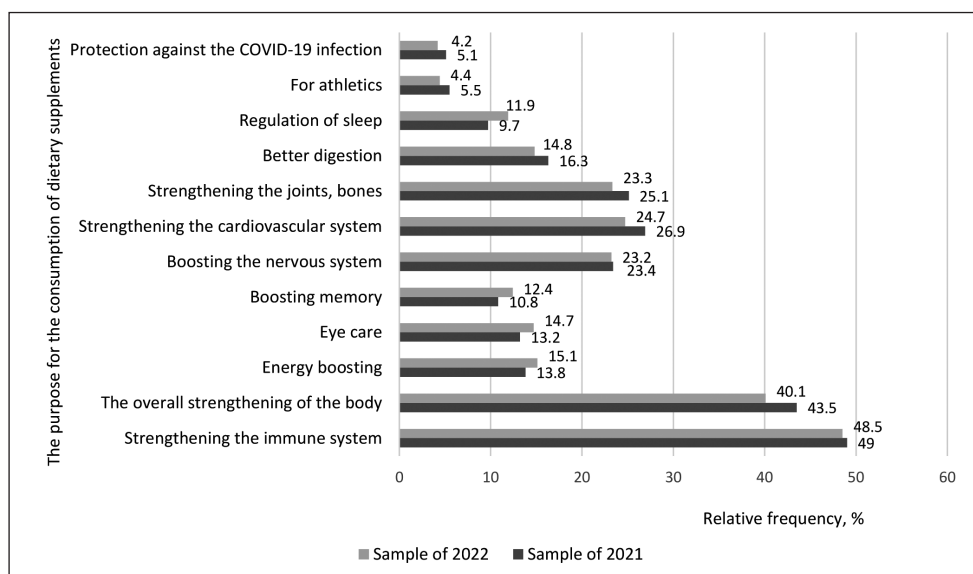


Fig. 1. Distribution of respondents by purpose of food supplements consumption and consumption within past 12 months in both samples.

No statistically significant difference was observed between the samples ($p > 0.05$).

Table 2. Distribution of respondents by social and demographic factors

Factor	Sample of 2021		Sample of 2022	
	n	Relative frequency (%)	n	Relative frequency (%)
Sex	1,600		1,600	
Male	792	49.5	800	50.0
Female	808	50.5	800	50.0
Age	1,600		1,600	
41 years old or younger	769	48.1	784	49.0
42 years old or older	831	51.9	816	51.0
Education	1,484		1,495	
Non-university education	474	31.9	495	33.1
University education	1,010	68.1	1,000	66.9
Place of residence	1,600		1,600	
City	678	42.4	686	42.9
Small town or village	922	57.6	914	57.1
Marital status	1,341		1,334	
Single	377	28.1	378	28.3
Married	964	71.9	956	71.7
Number of family members	1,600		1,600	
Two or more	1,408	88.0	1,370	85.6
One ^a	192	12.0	230	14.4
With children under 18 years old	1,600		1,600	
No	991	61.9	967	60.4
Yes	609	38.1	633	39.6
Employment	1,494		1,471	
Employed	1,174	78.6	1,135	77.1
Unemployed	321	21.4	336	22.9
Income	1,248		1,226	
Lower	412	33.0	437	35.7
Higher	836	67.0	789	64.3
COVID-19 among friends or relatives	1,600		1,600	
Does not know anyone who suffered from COVID-19	184	11.5	92	5.7
The respondent or his/her family members or friends suffered from COVID-19 ^a	1,416	88.5	1,508	94.3
COVID-19 among family members	1,600		1,600	
There were no COVID-19 cases in the respondent's family	970	60.6	393	24.6
The respondent or his/her family members suffered from COVID-19 ^a	630	39.4	1,207	75.4
Severeness of COVID-19	343		385	
Suffered from the asymptomatic or mild form of COVID-19	264	77.1	293	76.2
Suffered from a severe form of COVID-19	78	22.9	92	23.8
Food selection criteria	1,569		1,541	
Health strengthening	489	31.1	286	18.5
Other ^a	1,081	68.9	1,256	81.5

^aSignificantly larger part in the sample collected in 2022 ($p < 0.05$).

During the COVID-19 pandemic, in 2021, the consumption of dietary supplements was more prevalent among females, employed, respondents with higher income, university education, without children under 18 years old, from larger municipalities, respondents who suffered from COVID-19 by themselves or knew COVID-19

cases in their families or among friends, also among respondents who indicated the selection of foods for health strengthening ($p < 0.05$). The prevalence of the consumption of dietary supplements was not associated with age, marital status, number of family members, severeness of the COVID-19 ($p > 0.05$) (Table 3).

After the COVID-19 pandemic, in 2022, the consumption of dietary supplements was more prevalent among females, older, employed respondents, respondents with higher income, univer-

sity education, from larger municipalities, respondents who suffered from COVID-19 by themselves or knew COVID-19 cases in their families or among friends, also among respondents who

Table 3. Distribution of respondents by consumption of dietary supplements and social and demographic factors in both samples

Factor	Sample of 2021				Sample of 2022				p-value
	Did not consume		Consumed		Did not consume		Consumed		
	n	%	n	%	n	%	n	%	
Sex									
Male	192	24.5 ^a	591	75.5	253	32.2 ^a	533	67.8	<0.001
Female	155	19.3	649	80.7 ^a	195	24.6	599	75.4 ^a	0.011
Age									
41 years old or younger	180	23.7	580	76.3	238	30.8 ^a	535	69.2	0.002
42 years old or older	167	20.2	659	79.8	211	26.1	596	73.9 ^a	0.005
Education									
Non-university education	116	24.9 ^a	350	75.1	174	35.7 ^a	314	64.3	<0.001
University education	188	18.7	818	81.3 ^a	234	23.6	757	76.4 ^a	0.007
Place of residence									
City	124	18.5	548	81.5 ^a	168	24.8	510	75.2 ^a	0.005
Small town or village	223	24.4 ^a	691	75.6	280	31.0 ^a	622	69.0	0.002
Marital status									
Single	75	20.3	294	79.7	115	30.8	258	69.2	0.001
Married	223	23.2	740	76.8	268	28.3	678	71.7	0.010
Number of family members									
Two or more	313	22.4	1,082	77.6	396	29.3	957	70.7	<0.001
One	34	17.8	157	82.2	52	23.0	174	77.0	0.190
With children under 18 years old									
No	197	20.1	783	79.9 ^a	264	27.7	688	72.3	<0.001
Yes	150	24.8 ^a	456	75.2	184	29.3	443	70.7	0.070
Employment									
Employed	234	20.0	936 ^a	80.0 ^a	295	26.3	828	73.7 ^a	<0.001
Unemployed	87 ^a	27.7 ^a	227	72.3	109	32.8 ^a	223	67.2	0.157
Income									
Lower	102	24.9 ^a	307	75.1	144	33.2 ^a	290	66.8	0.009
Higher	162	19.5	670	80.5 ^a	205	26.2	577	73.8 ^a	0.001
COVID-19 among friends or relatives									
Does not know anyone who suffered from COVID-19	61	34.3 ^a	117	65.7	40	44.4 ^a	50	55.6	0.105
The respondent or his/her family members or friends suffered from COVID-19	286	20.3	1,122	79.7 ^a	409	27.4	1,081	72.6 ^a	<0.001
COVID-19 among family members									
There were no COVID-19 cases in the respondent's family	224	23.3	738	76.7	125	32.6 ^a	259	67.4	<0.001
The respondent or his/her family members suffered from COVID-19	122	19.6	502	80.4	324	27.1	872	72.9 ^a	<0.001
Severeness of COVID-19									
Suffered from the asymptomatic or mild form of COVID-19	60	23.1	200	76.9	75	26.0	214	74.0	0.435
Suffered from a severe form of COVID-19	11	14.1	67	85.9	29	31.9	62	68.1	0.007
Food selection criteria									
Health strengthening	84	17.3	401	82.7 ^a	63	22.2	221	77.8 ^a	0.098
Other	253	23.5 ^a	822	76.5	360	28.8 ^a	888	71.2	0.004

^aSignificantly larger part within the sample ($p < 0.05$).

Table 4. Distribution of respondents who indicated consumption of dietary supplements and selection of foods for health strengthening by social and demographic factors

Factor	Sample of 2021		Sample of 2022		p-value
	n	Relative frequency (%)	n	Relative frequency (%)	
Sex	401		221		0.168
Male	190	47.4	92	41.6	
Female	211	52.6 ^a	129	58.4	
Age	401		221		0.758
41 years old or younger	142	35.4	81	36.7	
42 years old or older	259	64.6	140	63.3	
Education	383		204		0.564
Non-university education	79	20.6	38	18.6	
University education	304	79.4	166	81.4	
Place of residence	401		221		0.901
Bigger municipalities	183	45.6	102	46.2	
Smaller municipalities	218	54.4 ^a	119	53.8	
Marital status	333		187		0.529
Single	79	23.7	49	26.2	
Married	254	76.3 ^a	138	73.8	
Number of family members	401		221		0.033
Two or more	341	85.0	173	78.3	
One	60	15.0	48	21.7	
With children under 18 years old	401		221		0.842
No	280	69.8	156	70.6	
Yes	121	30.2	65	29.4	
Employment	367		205		0.788
Employed	297	80.9	164	80.0	
Unemployed	70	19.1	41	20.0	
Income	324		164		0.273
Lower	78	24.1	47	28.7	
Higher	246	75.9	117	71.3	
COVID-19 among friends or relatives	401		220		0.252
Does not know anyone who suffered from COVID-19	36	9.0	14	6.4	
The respondent or his/her family members or friends suffered from COVID-19	365	91.0 ^a	206	93.6	
COVID-19 among family members	401		221		<0.001
There were no COVID-19 cases in the respondent's family	239	59.6 ^a	54	24.4	
The respondent or his/her family members suffered from COVID-19	162	40.4	167	75.6	
Severeness of COVID-19	83		52		0.813
Suffered from the asymptomatic or mild form of COVID-19	64	77.1	41	78.8	
Suffered from a severe form of COVID-19	19	22.9	11	21.2	

^aSignificantly larger part within the sample ($p < 0.05$).

indicated the selection of foods for health strengthening ($p < 0.05$). The prevalence of consumption of dietary supplements was not associated with marital status, number of family members, having children under 18 years old, severeness of the COVID-19 ($p > 0.05$) (Table 3).

After the COVID-19 pandemic, the prevalence of consumption of dietary supplements decreased among all social and demographic groups (Table 3), except one-person households, respondents with children under 18 years old, unemployed respondents, also among those who did not know anyone who suffered from

COVID-19, respondents who suffered from asymptomatic or mild form of COVID-19, and those who indicated the selection of foods for health strengthening ($p > 0.05$). On the other hand, the prevalence of selection of food for health strengthening among the consumers of dietary supplements significantly decreased after the pandemic ($p < 0.001$) (Table 3).

Among the respondents who indicated the selection of foods for health strengthening in 2021, the consumption of dietary supplements was more prevalent among females, residents from smaller municipalities, married respondents and those who personally suffered from COVID-19 or had COVID-19 cases among their family members or friends ($p < 0.05$). The consumption of dietary supplements was not associated with social and demographic factors among those who indicated the selection of foods for strengthening their health in 2022 ($p > 0.05$). In 2022, among the respondents who selected foods for health strengthening, the prevalence of the consumption of dietary supplements increased among single respondents and those who personally suffered from COVID-19 or had COVID-19 cases among their family members ($p < 0.05$). Sex, age, education, type of place of residence, marital status, having children, employment, income, COVID-19 cases among respondents or their friends, and COVID-19 severeness were not associated with changes in the prevalence of the consumption of dietary supplements among the respondents who selected foods for health strengthening (Table 4).

In both the samples, the top five purposes for the consumption of dietary supplements among the respondents who indicated the selection of foods for health strengthening were as follows: strengthening the immune system, the overall strengthening of the body, strengthening the cardiovascular system, strengthening the bones and joints, and boosting the nervous system. Among the respondents who indicated the selection of foods for health strengthening, the prevalence of consumption of dietary supplements in 2022 was similar to the prevalence in 2021 for all the purposes for the consumption except the energy boosting

($p > 0.05$). Among the respondents who indicated the selection of foods for health strengthening, the prevalence of the consumption of dietary supplements for energy boosting significantly increased ($p = 0.028$). In 2021, the respondents who indicated the selection of foods for health strengthening more frequently, compared to those who selected foods according to other criteria, indicated the consumption of dietary supplements for strengthening the immune and cardiovascular systems, also for digestion ($p < 0.05$). In 2022, the respondents who indicated the selection of foods for health strengthening more frequently, rather than those who selected foods according to other criteria, indicated the consumption of dietary supplements for strengthening the immune system ($p < 0.05$) (Table 5).

In 2021, the most frequently indicated dietary supplements the consumption of which increased during the COVID-19 pandemic were vitamin C and vitamin D. Other dietary supplements were indicated twice or more times less frequently. In 2021, among the respondents who selected foods for health strengthening, an increase in the consumption of omega-3 fatty acids, dietary supplements targeted at the immune system, vitamin C and selenium was more frequent than among those who selected foods for other purposes ($p < 0.05$). Respondents who indicated the selection of foods for other purposes than health strengthening more frequently indicated that they did not know or could not indicate the exact dietary supplements the consumption of which increased during the COVID-19 pandemic ($p < 0.05$) (Table 6).

In 2022, the most prevalent dietary supplement was vitamin D. Also, highly prevalent were complexes of vitamins and minerals, magnesium, vitamin C, omega-3 fatty acids, vitamins of the B group, and fish oil. Other dietary supplements were two or more times less prevalent. In 2022, among the respondents who selected foods for health strengthening, the consumption of omega-3 fatty acids, plant-based dietary supplements, targeted at the immune system, vitamin C, vitamin D, zinc, selenium and probiotics was more prevalent than among those who selected foods for other purposes ($p < 0.05$) (Table 7).

Table 5. Distribution of respondents^a by purpose of food supplements consumption during the pandemic (in 2021) and after it (in 2022)

Purpose of consumption of dietary supplements	Sample of 2021		Sample of 2022		p-value
	n	Relative frequency (%)	n	Relative frequency (%)	
Strengthening the immune system	216 ^b	53.8	123 ^b	55.7	0.668
Overall strengthening of the body	181	45.1	102	46.0	0.807
Energy boosting	50	12.4	42	19.0	0.028
Eye care	55	13.8	36	16.2	0.385
Boosting memory	49	12.3	35	16.0	0.206
Boosting the nervous system	94	23.5	57	25.8	0.513
Strengthening the cardiovascular system	139 ^b	34.7	64	28.8	0.146
Strengthening the joints, bones	108	26.9	54	24.3	0.497
Better digestion	78 ^b	19.5	36	16.3	0.329
Regulation of sleep	37	9.1	26	11.8	0.315
For athletics	28	7.1	13	6.0	0.597
Protection against the COVID-19 infection	25	6.2	12	5.6	0.685

^aOnly consumers of dietary supplements were included: in 2021 the sample size was 401, in 2022 the sample size was 221. The consumption of other than listed dietary supplements was indicated by less than 6.0% of the respondents in both samples. ^bStatistically significant difference in comparison with those who selected foods according to another criterion than health strengthening.

Table 6. Distribution of respondents by selection of foods and increase in consumption of exact dietary supplements during the COVID-19 pandemic in the sample of 2021 (N = 1,223)

Dietary supplements	Whole sample of 2021		Those who selected foods for health strengthening (n = 401)		Those who selected foods for other purposes (n = 822)		p-value
	n	Relative frequency (%)	n	Relative frequency (%)	n	Relative frequency (%)	
Complex of vitamins and minerals	91	7.4	35	8.7	56	6.8	0.231
Complex of vitamins	42	3.4	11	2.7	31	3.8	0.354
Complex of minerals	20	1.6	8	2.0	12	1.5	0.488
Omega-3 fatty acids	165	13.5	74	18.5	91	11.1	<0.001
Plant-based	34	2.8	12	3.0	22	2.7	0.752
Targeted at the immune system	128	10.5	61	15.2	67	8.2	<0.001
Targeted at the cardiovascular system	59	4.8	23	5.7	36	4.4	0.299
Targeted at the nervous system	45	3.7	14	3.5	31	3.8	0.807
Targeted at the general strengthening of the body	144	11.8	55	13.7	89	10.8	0.141
Vitamin C	377	30.8	141	35.2	236	28.7	0.022
Vitamin D	400	32.7	146	36.4	254	30.9	0.054
Vitamins of the B group	126	10.3	45	11.2	81	9.9	0.460
Iron	75	6.1	22	5.5	53	6.4	0.511
Magnesium	146	11.9	56	13.9	90	11.0	0.133
Potassium	62	5.1	16	4.0	46	5.6	0.226
Calcium	62	5.1	22	5.5	40	4.9	0.650
Selenium	46	3.8	22	5.5	24	2.9	0.027
Coenzyme Q10	21	1.7	10	2.5	11	1.3	0.146
Other	38	3.1	11	2.7	27	3.3	0.606
Did not know/could not answer	384	31.4	109	27.2	275	33.5	0.026

DISCUSSION

This study revealed the prevalence of the consumption of dietary supplements among the working-age residents of Lithuania during and after the COVID-19 pandemic with respect to social and demographic factors, COVID-19 experiences and food selection criteria. Despite the fact that nutritionists emphasize that it is recommended to gain the micronutrients with foods and use dietary supplements only in case of the under-consumption of micronutrients, this study brings to the light the behavioural changes of the society in case of the extreme situation – the COVID-19 pandemic (16).

Our results revealed that the prevalence of the consumption of dietary supplements decreased after the COVID-19 pandemic. This could have been foreseen after the study, which was conducted in Poland, during the pandemic. The Polish study revealed that the prevalence of the consumption differed between the waves of the pandemic and that the prevalence in the third wave was not greater than in the first. During the third wave, the prevalence of the consumption of dietary supplements was likely to decrease (10). Our study confirms this trend. On the other hand, in 2022, the

consumption of dietary supplements among residents of Lithuania was significantly higher than in 2017 (17).

The results of this study showed that the prevalence of the consumption of dietary supplements decreased among all social and demographic groups except one-person households, respondents with children under 18 years old, unemployed respondents, and also among those who did not know anyone who suffered from COVID-19, respondents who suffered from asymptomatic or mild form of COVID-19, and those who indicated the selection of foods for health strengthening. Therefore, we hypothesize that after the pandemic, the consumption of dietary supplements kept prevalent mostly among those who consumed dietary supplements deliberately and not impulsively. This could explain the fact that during the pandemic, in 2021, every third respondent could not answer/did not know what exact dietary supplements he/she used more frequently because of the COVID-19 pandemic, but after the pandemic, in 2022, there was less than 1 percent of the total sample of the respondents who did not know what dietary supplements they used in the past 12 months. With respect to the fact, that this question differed in the surveys and answers to it cannot be compared directly, such a big difference cannot be ignored and might

Table 7. Distribution of respondents by selection of foods and consumption of exact dietary supplements after the COVID-19 pandemic in the sample of 2022 (N = 1,110)

Dietary supplements	Whole sample of 2022		Those who selected foods for health strengthening		Those who selected foods for other purposes		p-value
	n	Relative frequency (%)	n	Relative frequency (%)	n	Relative frequency (%)	
Complex of vitamins and minerals	391	35.3	82	37.1	309	34.8	0.521
Complex of vitamins	88	7.9	11	5.0	77	8.7	0.069
Complex of minerals	30	2.7	5	2.3	25	2.8	0.659
Omega-3 fatty acids	327	29.5	83	37.6	244	27.4	0.003
Fish oil	278	25.1	52	23.5	226	25.5	0.555
Plant-based	91	8.2	29	13.1	62	7.0	0.003
Targeted at the immune system	150	13.5	40	18.1	110	12.4	0.026
Targeted at the cardiovascular system	109	9.8	17	7.7	92	10.3	0.235
Targeted at the nervous system	109	9.8	26	11.8	83	9.3	0.280
Targeted at the general strengthening of the body	106	9.6	27	12.2	79	8.9	0.133
Vitamin C	353	31.8	83	37.6	270	30.4	0.040
Vitamin D	535	48.2	134	60.6	401	45.1	<0.001
Vitamin A	66	6.0	17	7.7	49	5.5	0.214
Vitamins of the B group	285	25.7	68	30.8	217	24.4	0.054
Folic acid	71	6.4	16	7.2	55	6.2	0.570
Other vitamins	26	2.3	5	2.3	21	2.4	0.930
Iron	152	13.7	32	14.5	120	13.5	0.704
Magnesium	380	34.2	82	37.1	298	33.5	0.315
Potassium	162	14.6	41	18.6	121	13.6	0.063
Calcium	128	11.6	30	13.6	98	11.0	0.280
Zinc	180	16.2	51	23.1	129	14.5	0.002
Selenium	105	9.5	35	15.8	70	7.9	<0.001
Other minerals	20	1.8	6	2.7	14	1.6	0.250
Coenzyme Q10	57	5.1	15	6.8	42	4.7	0.208
Probiotics	105	9.5	38	17.3	67	7.5	<0.001
Other	38	3.4	6	2.7	32	3.6	0.516
Did not know/could not answer	8	0.7	0	0.0	8	0.9	0.157

indicate a low nutritional literacy and an inadequate consumption of dietary supplements in a large part of the consumers during the pandemic. Other researchers emphasize additional factors such as Russian-Ukrainian war that could impact the nutrition in the post-pandemic period which caused a socioeconomic crisis (18). Socioeconomic factors were presented as important determinants of the consumption of dietary supplements (9). On the other hand, our study showed that despite a general decrease in the prevalence of the consumption of dietary supplements, most of the purposes of the consumption remained similar in the post-pandemic period.

After the COVID-19 pandemic, in general sample, as well as among the respondents who indicated the selection of foods for health strengthening, the most prevalent dietary supplements were targeted at strengthening the immune system and the cardiovascular system. On the other hand, the group of respondents who indicated the selection of foods for health strengthening

more frequently consumed a higher variety of dietary supplements for strengthening the immune system and coping with infectious diseases while the general sample revealed a broader spectrum of dietary supplements. Other studies also show a high prevalence in the consumption of the same dietary supplements containing vitamin D, multivitamins, vitamin C, omega-3 fatty acids, probiotics, zinc (19). However, it seems that the consumption of dietary supplements in Lithuania and other countries of the world in most cases is not adequate and based on the actual deficiencies but rather highly determined by external factors such as advertising (20), socioeconomic factors (21), the improvement of health (22–24), and other factors (9). Concerns about the inadequate consumption of dietary supplements have been raised for quite long (25).

It remains questionable why the prevalence of the consumption of dietary supplements significantly decreased among the

respondents who suffered from a severe form of COVID-19 while among those who suffered from asymptomatic or mild COVID-19, the prevalence of the consumption of dietary supplements remained similar. It could be related with the studies stating that there is a limited evidence that high-dose supplements of micronutrients will either prevent severe disease or speed up the recovery (26, 27). On the other hand, this trend might indicate the tiredness of the pandemic or the false belief that the threat of COVID-19 has disappeared. In order to answer such questions, there is a need for studies about the prevalence of the consumption of dietary supplements in emergency situations like pandemic.

Limitations of the Study

We were able to assess only the subjective view of the respondents to the consumption of food supplements during and after the COVID-19 pandemic because of the cross-sectional design of the study. A longitudinal study would have possibly provided more accurate results. On the other hand, this study included two representative samples, sufficient to assess the consumption of dietary supplements among adult residents of Lithuania during and after the COVID-19 pandemic.

Also, assuming that respondents might use various dietary supplements with a different frequency we did not include the temporal analysis into this study. In addition, according to the limitations of the resources, this study included a question about food selection criteria without the additional questions about details of each criterion. Such data might have provided the brighter picture regarding the reasons of inequalities in the consumption of dietary supplements.

CONCLUSIONS

Among the working-age Lithuanian residents, the consumption of dietary supplements in most social and demographic groups decreased after the COVID-19 pandemic. After the COVID-19 pandemic, the selection of foods for health strengthening was associated with maintaining the same level of consumption as it was during the pandemic. Despite the decrease in the consumption of dietary supplements after the pandemic, the purposes for the consumption during and after the pandemic in the majority of cases remained similar with the leading purposes for strengthening the immune system and the general strengthening of the body.

The results of this study suggest the impulsivity and a lack of deliberation in the consumption of dietary supplements during the pandemic among the working-age residents of Lithuania. During and after the pandemic, the selection of foods for health strengthening was associated with a greater consumption of dietary supplements for strengthening the immune system and cardiovascular health. Additional studies regarding the adequacy of the consumption of dietary supplements are needed.

Conflicts of Interest

None declared

Adherence to Ethical Standards

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving study participants

were approved by the Vilnius Regional Ethics Committee for Biomedical Research.

REFERENCES

1. Kałucka S, Kaleta D, Makowiec-Dabrowska T. Prevalence of dietary behavior and determinants of quality of diet among beneficiaries of government welfare assistance in Poland. *Int J Environ Res Public Health*. 2019 Feb 11;16(3):501. doi: 10.3390/ijerph16030501.
2. Barzda A, Bartkevičiūtė R, Baltušytė I, Stukas R, Bartkevičiūtė S. [Actual nutrition and nutrition habits of adults and elderly of Lithuania]. *Visuomenės sveikata*. 2016 Mar 14;(1/72):85-94. Lithuanian.
3. Lorenzoni G, Azzolina D, Maresio E, Gallipoli S, Ghidina M, Baldas S, et al. Impact of the COVID-19 lockdown on psychological health and nutritional habits in Italy: results from the #PRESTOinsieme study. *BMJ Open*. 2022 Mar 4;12:e048916. doi: 10.1136/bmjopen-2021-048916.
4. Khan S, Fischer L, Ghaziani S, Jeremias T, Scherbaum V. Nutritional habits of asylum seekers living in communal accommodation in Stuttgart, Germany. *Ernahrungs Umschau*. 2018 Sep 6;66(2):18-25.
5. U.S. Department of Agriculture; U.S. Department of Health and Human Services. Dietary guidelines for Americans 2020–2025: make every bite count with the dietary guidelines [Internet]. Washington: U.S. Department of Agriculture; 2020 [cited 2023 July 5]. Available from: https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf.
6. Zhang FF, Barr SI, McNulty H, Li D, Blumberg JB. Health effects of vitamin and mineral supplements. *BMJ*. 2020 Jun 29;369:m2511. doi: 10.1136/bmj.m2511.
7. Arlauskas R, Austys D, Stukas R. COVID-19 pandemic and consumption of dietary supplements among adult residents of Lithuania. *Int J Environ Res Public Health*. 2022 Aug 4;19(15):9591. doi: 10.3390/ijerph19159591.
8. Bae M, Kim H. The role of vitamin C, vitamin D, and selenium in immune system against COVID-19. *Molecules*. 2020 Nov 16;25:5346. doi: 10.3390/molecules25225346.
9. Hoseini A, Dehdari T, Solhi M, Rahideh ST, Janani L. Qualitative exploration of the factors influencing the use of dietary supplements in Iranian women: introduction to areas of focus for developing interventions. *Heliyon*. 2021 Apr 3;7(4):e06672. doi: 10.1016/j.heliyon.2021.e06672.
10. Pušcion-Jakubik A, Bielecka J, Grabia M, Mielech A, Markiewicz-Żukowska R, Mielcarek K, et al. Consumption of food supplements during the three COVID-19 waves in Poland—focus on zinc and vitamin D. *Nutrients*. 2021 Sep 25;13(10):3361. doi: 10.3390/nu13103361.
11. Grebrow J. Peak dietary supplement sales leveling off during COVID-19 pandemic, but growth still remains strong over last year, market researchers report during webcast [Internet]. Cranbury: Nutritional Outlook; 2020 [cited 2023 Jun 30]. Available from: <https://www.nutritionaloutlook.com/view/peak-dietary-supplement-sales-leveling-during-covid-19-pandemic-growth-still-remains-strong>.
12. Monroe-Lord L, Harrison E, Ardakani A, Duan X, Spechler L, Jeffery TD, et al. Changes in food consumption trends among American adults since the COVID-19 pandemic. *Nutrients*. 2023 Apr 5;15(7):1769. doi: 10.3390/nu15071769.
13. Bailey RL, Fulgoni VL 3rd., Keast DR, Dwyer JT. Dietary supplement use is associated with higher intakes of minerals from food sources. *Am J Clin Nutr*. 2011 Oct;94(5):1376-81.
14. Harrison RA, Holt D, Pattison DJ, Elton PJ. Are those in need taking dietary supplements? A survey of 21 923 adults. *Br J Nutr*. 2004 Mar 9;91(4):617-23.
15. Stukas R, Arlauskas R, Butikis M, Dobrovolskij V. [Food supplements usage among Lithuanian residents in 2019]. *Visuomenės Sveikata*. 2019 Oct 7;(4/87):75-9. Lithuanian.
16. Directive 2002/46/EC of the European Parliament and of the Council of 10 June 2002 on the approximation of the laws of the Member States relating to food supplements. *Off J Eur Communities*. 2002 Jul 12;45(L 183):51-7.
17. Stukas R, Dobrovolskij V. [Food supplements usage and opinion about food supplements among Lithuanian residents]. *Visuomenės Sveikata*. 2018 Apr 25;(2/81):64-8. Lithuanian.
18. Galanakis CM. The “vertigo” of the food sector within the triangle of climate change, the post-pandemic world, and the Russian-Ukrainian war. *Foods*. 2023 Feb 7;12(4):721. doi: 10.3390/foods12040721.

-
19. Louca P, Murray B, Klaser K, Graham MS, Mazidi M, Leeming ER, et al. Modest effects of dietary supplements during the COVID-19 pandemic: insights from 445 850 users of the COVID-19 Symptom Study app. *BMJ Nutr Prev Health*. 2021 Apr 19;4(1):149-57.
 20. Karbownik MS, Paul E, Nowicka M, Nowicka Z, Kowalczyk RP, Kowalczyk E, et al. Knowledge about dietary supplements and trust in advertising them: development and validation of the questionnaires and preliminary results of the association between the constructs. *PLoS ONE*. 2019 Jun 24;14(6):e0218398. doi: 10.1371/journal.pone.0218398.
 21. Blumberg JB, Frei B, Fulgoni III VL, Weaver CM, Zeisel SH. Contribution of dietary supplements to nutritional adequacy by socioeconomic subgroups in adults of the United States. *Nutrients*. 2017 Dec 22;10(1):4. doi: 10.3390/nu10010004.
 22. Soukiasian P-D, Kyrana Z, Gerothanasi K, Kiranas E, Kokokiris LE. Prevalence, determinants, and consumer stance towards dietary supplements according to sex in a large Greek sample: a cross-sectional study. *Nutrients*. 2022 Dec 2;14(23):5131. doi: 10.3390/nu14235131.
 23. Bailey RL, Gahche JJ, Miller PE, Thomas PR, Dwyer JT. Why US adults use dietary supplements. *JAMA Intern Med*. 2013 Mar 11;173(5):355-61.
 24. Sicinska E, Madej D, Szmidt MK, Januszko O, Kaluza J. Dietary supplement use in relation to socio-demographic and lifestyle factors, including adherence to mediterranean-style diet in university students. *Nutrients*. 2022 Jun 30;14(13):2745. doi: 10.3390/nu14132745.
 25. Dickinson A, MacKay D, Wong A. Consumer attitudes about the role of multivitamins and other dietary supplements: report of a survey. *Nutr J*. 2015 Jul 2;14:66. doi: 10.1186/s12937-015-0053-9.
 26. James PT, Ali Z, Armitage AE, Bonell A, Cerami C, Drakesmith H, et al. The role of nutrition in COVID-19 susceptibility and severity of disease: a systematic review. *J Nutr*. 2021 Jul;151(7):1854-78.
 27. de Faria Coelho-Ravagnani C, Corgosinho FC, Sanches FFZ, Prado CMM, Laviano A, Mota JF. Dietary recommendations during the COVID-19 pandemic. *Nutr Rev*. 2021 Mar 9;79(4):382-93.

*Received December 4, 2023
Accepted in revised form August 21, 2024*