



## The knowledge and attitudes of pharmacists related to the use of dietary supplements: An observational study in northeastern Italy

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### ARTICLE INFO

#### Keywords:

Dietary supplements  
Patient safety  
Pharmacists  
Nutrition  
Counselling

### ABSTRACT

Inappropriate use of dietary supplements can be potentially harmful to patients, especially given the uncontrolled information on the Internet and social media. The role that pharmacists play in advising citizens and purchasing these products can help improve their safer use, but the knowledge, attitudes, and practices of these professionals on this topic are still largely unknown.

Pharmacists in the Italian Region of Friuli-Venezia Giulia (FVG) were surveyed from September 2020 to February 2021 using a 54-item online questionnaire. The questions were related to knowledge, attitudes, and practice. Data on gender, age, work experience, degree, and function in pharmacy were also collected.

232 questionnaires were completed, predominantly by women (71 %). The majority of respondents had a degree in Pharmacy (77 %) and were employed in a pharmacy (66 %) where they had worked for at least 10 years (61 %). Pharmacists' knowledge was rated as low, with one-third of participants above the median; knowledge was higher among more experienced pharmacists. Larger knowledge gaps were noted regarding the potential carcinogenicity of multivitamin misuse and the undesirable presence of unlabeled ingredients in dietary supplements. Employees were more likely than owners to report purchasing dietary supplements at the direct request of patients ( $p < 0.05$ ).

The low level of pharmacists' knowledge about the use of dietary supplements is unsatisfactory, with concerning impact on patient safety. Young professionals in particular would benefit from continuous education to better advise patients. Nevertheless, the European regulatory framework for the manufacture, sale and post-marketing surveillance of dietary supplements needs to be strengthened.

### 1. Introduction

A dietary supplement, as defined by the Food and Drug Administration (FDA), is a product intended to supplement the diet by increasing the total daily intake, or an extract, metabolite, concentrate, constituent, or combination of at least one of the following dietary ingredients: vitamins, minerals, herbs or other botanicals, amino acids (FDA, 2022).

At the European level, the use of vitamins and minerals in dietary supplements and their addition to food is regulated by the latest European Community text (EC) 1170/2009, which amends Directive 2002/

46/EC and Regulation 1925/2006 of EC. According to the Italian Ministry of Health, vitamin supplements should not be used as food substitutes but as a dietary supplements with the aim of optimizing nutritional intake, providing substances of nutritional interest with protective or trophic effects, or improving metabolism and physiological functions of the organism (Epicentro, 2022). The list of substances and herbal preparations that may be used in dietary supplements, as well as the information on the requirements that must be observed for the safety and protection of consumers, are regulated by law. Dietary supplements are usually available in pre-measured forms such as capsules, tablets,

*Abbreviations:* FDA, Food and Drug Administration; EC, European Community; CENSIS, Italian Centre for Social Studies and Policies; FVG, Friuli Venezia Giulia; KAP, knowledge, attitudes, practices; EU-GDPR, European General Data Protection Regulation; SD, standard deviation.

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<https://doi.org/10.1016/j.pmedr.2022.101986>

Received 6 May 2022; Received in revised form 5 September 2022; Accepted 17 September 2022

Available online 19 September 2022

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liquids in ampoules or bottles with dropper caps.

Currently, the dietary supplement industry is one of the fastest growing industries. In 2018, 32 million Italians consumed dietary supplements, most of whom were adults (about 63 %) and women (60 %). In 2018, this sales volume led to a growth in market value of 3.3 billion (+126 %) and employment in the sector, which increased by 44 % in three years (CENSIS, 2019). Factors that have contributed to this consumption growth include an ageing population (ISS, 2020), greater awareness of the causal relationship between disease and nutrition, and the importance of preventive health measures to protect individuals' health (Marra and Boyar, 2009). However, improper use of dietary supplements can have potentially harmful effects, such as an increased risk of bleeding with vitamin E overdose, and the occurrence of ataxia, alopecia, hepatotoxicity, and teratogenicity with chronic vitamin A overdose. In addition, significant drug-drug interactions can occur with certain classes of drugs, such as between vitamin K and oral anticoagulants (Eichhorn et al., 2011; Kroll, 2004). Although the efficacy of dietary supplements in certain clinical conditions, e.g., oncohematologic diseases (AIMAC, 2019), is undisputed, their improper use has recently led to public health hazards, such as in the case of hepatotoxicity associated with the use of turmeric as a dietary supplement (Menniti-Ippolito et al., 2020). For these reasons the Italian Institute of Health (ISS, Istituto Superiore di Sanità) published a special report explaining the ineffectiveness of dietary supplements as treatments for COVID-19 (ISS, 2020).

According to the European regulation, dietary supplements may only be marketed by food business operators. In Italy, the purchase of dietary supplements is possible in pharmacies and specially authorised stores, called parapharmacies (Epicentro, 2022). According to the 2019 report of the Italian Centre for Social Studies and Policies (CENSIS), 95 % of dietary supplements are sold in pharmacies (86 %) and in parapharmacies (9 %) (CENSIS, 2019). The same report confirms the key role of pharmacists in advising citizens on the purchase and use of these products, as 82 % of Italians were advised on the purchase of dietary supplements by either a doctor or a pharmacist (CENSIS, 2019). However, a 2016 survey of Italian pharmacists found that 26 % of respondents reported a lack of information on how to choose the most appropriate product for the consumer, on possible side effects, or on interactions with other products (FederSalus, 2018). In this context, in 2018, the Scientific Association of Italian Pharmacists proposed that dietary supplements for health purposes and nutraceuticals should be subject to stricter legislation to prevent possible misuse while reducing the current confusion and lack of orientation of both pharmacists and citizens (ASFI, 2018).

Considering these findings, and the strategic role that the Italian Region of Friuli Venezia Giulia (FVG) assigns to pharmacies for public health, improvements in the existing gaps in dietary supplement advice are desirable. The aim of this study is to assess the knowledge, attitudes and practice of pharmacists working in the FVG Region regarding dietary supplements.

## 2. Methods

### 2.1. Study design

A cross-sectional observational study was conducted with the aim to assess the knowledge, attitudes, and practices of pharmacists working in both public and private licensed pharmacies in the FVG Region regarding dietary supplements.

### 2.2. Eligibility criteria

All 1,600 pharmacists in the FVG Region were eligible to participate in the survey. Only pharmacists working in hospital pharmacies were excluded because their role in counselling inpatients about dietary supplements was considered too specific to compare with counselling

the general public. Participants gave informed consent to participate. All procedures performed in this study were in accordance with relevant guidelines and regulations. The study protocol was approved by the Institutional Review Board of the University of Udine, Italy.

### 2.3. Instrument

The online survey with 54 questions was developed by a multidisciplinary group of public health professionals, pharmacists, and a clinical pharmacologist. The survey was developed after consultation of the available scientific literature, particularly in light of similar surveys conducted by Shilbayeh et al. and Ghosn et al. (Ghosn et al., 2019; Shilbayeh, 2011); some specific items were modified to take into account the Italian regulatory framework for the sale of dietary supplements. Homoeopathic or herbal remedies were not included in the survey.

The survey included two sections: 1) the KAP section -knowledge, attitudes, practices - with a total of 47 questions (1.1 to 1.20: true/false/no knowledge; 2.1 to 2.23: 5-point Likert scale from 1-strongly disagree to 5-strongly agree); and 2) the sociodemographic section with seven multiple-choice questions. A translated English version of the survey administered to FVG pharmacists is shown in Table 1.

### 2.4. Dependent variables

The dependent variables considered were the individual knowledge, attitude, and practice and the overall level of knowledge, considered as the presence of more than 11 (that is the median value) correct answers for the part of the questionnaire testing knowledge (20 questions).

### 2.5. Independent variables

Sociodemographic data, including age, gender, educational background, years of work experience, public or private pharmacy as workplace, function in the pharmacy (owner or employee), were considered as independent variables.

### 2.6. Data collection

In collaboration with the four professional associations of pharmacists of the provinces of Gorizia, Pordenone, Trieste and Udine of the FVG Region and with the support of the regional office of the Italian Federation of Pharmacists (Federfarma), pharmacists were invited to participate in the survey by e-mail. Pharmacists were informed about the survey, the reasons for the study and its objectives. Remind e-mails were sent to encourage participation during the survey period. The anonymous online survey was developed using the European platform EUSurvey and was available online from September 2020 to February 2021; participation was completely free and without any reimbursement. After reading all the information, participants gave their informed consent to participate and proceeded with the compilation by following the link to the survey. Data collection and management was in accordance with the European General Data Protection Regulation (EU-GDPR).

### 2.7. Data analysis

Assuming that 50 % of the target population was knowledgeable about dietary supplements and considering a confidence level of 90 %, the required sample size was estimated to be 232 participants.

Descriptive analyses were performed by calculating absolute numbers and relative frequency distributions for categorical variables and median, mean, and standard deviation (SD) for numerical variables with normal distribution. Statistical analyses were performed using the Chi-square test, the Shapiro-Wilk test for normal distribution, and the Mann-Whitney test as a nonparametric test. A p-value < 0.05 was

**Table 1**  
English version of the survey administered to FVG pharmacists.

Question code	Text of the question					
<b>Section 1: Knowledge</b> (true/false question)						
1.1	A balanced provision of nutrients is guaranteed by the adoption of a varied diet rather than by using multivitamin supplements					
1.2	Multivitamin supplements may contain unlabeled toxic ingredients					
1.3	Increasing evidence supports the hypothesis that some types of cancer are caused by the abuse of multivitamins (commonly used as antioxidants)					
1.4	Some lifestyles can reduce the absorption of vitamins or cause their complete depletion					
1.5	The chronic use of some drugs can cause a significant deficit of vitamins					
1.6	Important drug interactions and side effects can be enhanced by the concomitant intake of vitamin supplements					
1.7	The recommended daily allowance (RDA) of vitamin C for an adult woman (19–50 years old) is 70 mg					
1.8	The recommended daily dose of vitamin K is 90 µg					
1.9	Excessive intake of Vitamin D (higher than the RDA) can cause loss of appetite, vomiting and increased urination frequency					
1.10	The recommended daily allowance (RDA) for folic acid in a man adult is 400 µg					
1.11	The recommended daily allowance (RDA) in men and women between 51 and 70 years for Vitamin D is 400 IU					
1.12	Excessive intake of Vitamin E can increase the risk of hemorrhagic stroke, development of skin hematomas, bleeding and headache					
1.13	The presence of cracks in the corners of the mouth may indicate a deficit of Vitamin B12					
1.14	The presence of dandruff may indicate a Biotin deficiency					
1.15	Conjunctival dryness can indicate a Vitamin A deficiency					
1.16	Poor ability to concentrate can indicate a Vitamin B12 deficiency					
1.17	The intake of high doses of antioxidant vitamins (A, C, E) can interfere with the effectiveness of some chemotherapy drugs					
1.18	The administration of branched-chain amino acids and acid eicosapentenoic (EPA) can help reducing loss of weight and muscle mass in cancer patients					
1.19	Beta-hydroxy-beta-methylbutyrate (HMB) is an active metabolite of leucine which could help reduce muscle loss, which is frequently observed in oncological disease					
1.20	Pharmacists can dispense all vitamin supplements without prescription					
<b>Section 2: Attitudes, practices</b> (strongly agree/agree/neither agree or disagree/disagree/strongly disagree)						
2.1	Providing information about vitamins to patients and citizens is part of the pharmacists' professional responsibility because:					
2.1.1	pharmacists are professionals specifically trained for this aim					
2.1.2	vitamins are not always over the counter (OTC) drugs					
2.1.3	there is a lack of other trained professionals on this topic					
2.2	Before recommending a food supplement, the medical history of the single consumer should be investigated to exclude any contraindications upon hiring					
2.3	I have enough information about the recommendations for the use of vitamins supplements in specific population target groups					
2.4	Pharmacists play a fundamental role in supporting an appropriate nutrition in oncologic patients, by providing oral nutritional supplements, modular supplements and nutraceuticals					
2.5	It happens to receive pressures from manufacturers of food supplements to increase their sale					
2.6	Each consumer should always be counselled about natural sources of vitamins intake					
2.7	Pharmacists should provide updated information and dedicated seminars to other healthcare professionals					
2.8	I have enough information about adverse effects of vitamins if assumed at dosages higher than recommended					
2.9	Pharmacists should be responsible for security only regarding vitamins supplements dispensed in their pharmacy					
2.10	Consumers should be individually counseled about dosage and via of administration of food supplements					
2.11	Vitamin supplement products should be sold only in pharmacy settings					
2.11.1	because they are drug					
2.11.2	because it is safer for patients					
2.11.3	to have more control on pricing and cost					
2.12	I am informed enough regarding their contraindications in specific groups of patients (i.e. diabetics, epileptics, having anticoagulant therapy).					
2.13	I recommend food supplements to all consumers, being confident of their safety and effectiveness					
2.14	I have enough knowledge about dosage and administration of vitamins as dietetic supplements					
2.15	It is recommended to update periodically about scientific evidence concerning vitamin supplements on paper supports or official/institutional websites					
2.16	The choice of food supplement should be dictated by both economic and effectiveness evaluations					
2.17	I have enough knowledge about interactions between drugs and food supplements					
2.18	It is necessary to report any adverse effects (related upon the hiring of food supplement and reported from the patient) to the qualified Health Authority					
2.19	I believe that pharmacists are often induced to encourage the consumption of vitamin supplements					
2.20	It is necessary to inform the single consumer about possible adverse effects of the vitamin supplements					
2.21	As a pharmacist, I recommend consumers about a healthy lifestyle and food supplements consumption, particularly:					
2.21.1	checking the vitamin intake with food to avoid overdose from contemporary hiring of vitamin supplements					
2.21.2	recommending appropriate way of storage and cooking of fruits and vegetables					
2.21.3	recommending an adequate daily water intake					
2.21.4	banning on alcohol consumption					
2.21.5	banning on smoke habit					
2.22	I often sell vitamin supplements because of a specific request of a patient, even if supplementation is not necessary					
2.23	It is necessary to check if a particular food supplement interacts with any medications hired from the single patient					
<b>Section 3: Sociodemographic information</b> (multiple choice questions)						
Gender	Male	Female				
Age (years)						
Degree	Pharmacy	Chemistry and Pharmaceutical Technologies				
Further training (multiple choice)	Master in Food Sciences	Specialization in Food Sciences	Other courses	None		
Years of work experience	< 1	1–5	6–10	11–15	16–20	> 20
Pharmacy type	Public	Private				
Function	Owner	Employee				

considered statistically significant. To compare knowledge, the prevalence of questionnaire with at least 11 correct answers was calculated and a Chi-square test was performed for each dichotomous characteristic (gender, type of degree, years of experience, function). To compare the attitudes for each characteristic (type of degree, years of experience, function, and number of correct responses), the normality of the distribution was assessed with the Kolmogorov-Smirnov test, followed by a Mann-Whitney or *T*-student test.

### 3. Results

We collected 232 questionnaires, 164 (70.7 %) from women and 68 (29.3 %) from men. 179 respondents (77.2 %) had a degree in Pharmacy, and the remaining 53 (22.8 %) in Chemistry and Pharmaceutical Technologies. The majority (142; 61.2 %) had more than 10 years of work experience, 39 (16.8 %) between six and 10 years, 44 (19.0 %) 1–5 years, and only seven (3.0 %) less than one year. Almost all (188, 81.0 %) worked in a private pharmacy, and most (152, 65.5 %) of the respondents were employees, while the other 80 (34.5 %) were owners of the activity.

#### 3.1. Knowledge of dietary supplements

Table 2 summarizes the overall results for the 20 knowledge questions. Only seven of the 20 questions had a rate of correct answers of at least 75 %, with in particularly high knowledge scores for vitamin deficiencies due to chronic drug therapies (97.4 %), lifestyle effects on reduced vitamin absorption (97.0 %), and the role of a balanced diet in ensuring adequate nutrient intake (94.0 %). Overall accuracy was below 50 % for eight questions, with less than one-third of pharmacists knowing the recommended daily allowance (RDA) for vitamin K (20.7 %), increasing evidence of the carcinogenic role of multivitamin abuse (21.1 %), and the possibility that multivitamins contain unlabeled toxic ingredients (11.2 %). Analysis of data on pharmacist characteristics revealed that the largest difference between groups was due to professional experience, with the more experienced pharmacists knowing more about the RDA for vitamin C (52.1 vs 34.4) and D (66.9 vs 50.0) and the potential use of amino acids to reduce weight loss in cancer patients (48.6 vs 31.1). The presence of signs of vitamin B12 deficiency was better recognized by women (80.5 vs 61.8) and employees (80.9 vs 63.8), while owners were better informed about the RDA for vitamin C (53.6 vs 39.5). There was no difference by respondent's type of degree for any of the knowledge questions.

Analysis of the answers given by individual participants showed that the median number of correct answers was 11 out of 20 (QI 25–75: 10; 14). Thus, considering more than 11 correct answers as the minimum standard, we found that the only characteristic that has a statistically significant impact on knowledge is professional experience: 30 out of 90 respondents (33.3 %) with 10 or less years of professional experience reached the minimum standard, while among respondents with 11 or more years of professional experience, the percentage of questionnaires with more than 11 correct answers was 55.6 % (79/142).

#### 3.2. Attitudes and practices toward dietary supplements

Table 3 summarizes the mean Likert score for each question, stratified by respondents' main characteristics and by minimum knowledge level (12 correct answers). In terms of attitudes and practices, pharmacists generally appear to perform their counseling role by providing tailored information about dietary supplements to patients and citizens (individual counseling, median 4.9), taking safety into account by, for example, checking for possible drug-drug interactions (median 4.8), asking patients about their medical history to avoid contraindications (4.8), and informing users about the possible adverse effects of dietary supplements (4.8). Women were more likely than men to recognize the need to report adverse effects to the health authority (4.79 vs 4.49) and

**Table 2**  
Pharmacists' knowledge about food supplements.

Question	Overall knowledge, expressed as % of questionnaires reporting the correct answer
1.1 A balanced provision of nutrients is guaranteed by the adoption of a varied diet rather than by using multivitamin supplements	94.0
1.2 Multivitamin supplements may contain non-labeled toxic ingredients	11.2
1.3 Increasing evidence supports the hypothesis that some types of cancer are caused by the abuse of multivitamins (commonly used as antioxidants)	21.1
1.4 Some lifestyles can reduce the absorption of vitamins or cause their complete depletion	97.0
1.5 The chronic use of some drugs can cause a significant deficit of vitamins	97.4
1.6 Important drug interactions and side effects can be enhanced by the concomitant intake of vitamin supplements	85.8
1.7 The recommended daily allowance (RDA) of vitamin C for an adult woman (19–50 years old) is 70 mg	45.3
1.8 The recommended daily dose of vitamin K is 90 µg	20.7
1.9 Excessive intake of Vitamin D (higher than the RDA) can cause loss of appetite, vomiting and increased urination frequency	50.0
1.10 The recommended daily allowance (RDA) for folic acid in a man adult is 400 µg	51.3
1.11 The recommended daily allowance (RDA) in men and women between 51 and 70 years for Vitamin D is 400 IU	60.3
1.12 Excessive intake of Vitamin E can increase the risk of hemorrhagic stroke, development of skin hematomas, bleeding and headache	32.3
1.13 The presence of cracks in the corners of the mouth may indicate a deficit of Vitamin B12	75.0
1.14 The presence of dandruff may indicate a Biotin deficiency	62.5
1.15 Conjunctival dryness can indicate a Vitamin A deficiency	67.2
1.16 Poor ability to concentrate can indicate a Vitamin B12 deficiency	79.3
1.17 The intake of high doses of antioxidant vitamins (A, C, E) can interfere with the effectiveness of some chemotherapy drugs	62.9
1.18 The administration of branched-chain amino acids and acid eicosapentenoic (EPA) can help reducing loss of weight and muscle mass in cancer patients	41.8
1.19 Beta-hydroxy-beta-methylbutyrate (HMB) is an active metabolite of leucine which could help reduce muscle loss, which is frequently observed in oncological disease	34.9
1.20 Pharmacists can dispense all vitamin supplements without prescription	76.7

to advise patients to avoid alcohol consumption (4.66 vs 4.38), while men were more likely to recognize their role in the nutritional status of oncology patients (3.76 vs 3.30) and to review patients' vitamin intake to avoid overdoses (4.56 vs 4.29); these differences were statistically significant. Among the least frequently but still reported attitudes and

Table 3

Pharmacists' attitudes and practices: mean Likert score for each question, stratified by respondents' main characteristics and by the minimum standard of knowledge.

Question	Mean value	Type of degree		Years of experience		Function		Number of correct answers	
		Pharmacy n. 179	Chemistry and pharmaceutical technology n. 53	≤ 10 n. 90	greater than 11 n. 142	Employee n. 152	Owner n. 80	≤ 11 n. 118	greater than 11 n. 114
		Mean value		Mean value		Mean value		Mean value	
Providing information about vitamins to patients and citizens is part of the pharmacists' professional responsibility because: pharmacists are professionals specifically trained for this aim	4.0	4.1*	3.7*	3.9*	4.1*	4.0*	4.2*	3.9	4.2
(...) vitamins are not always over the counter (OTC) drugs	4.4	4.4	4.3	4.3	4.4	4.4	4.4	4.3	4.5
(...) there is a lack of other trained professionals on this topic	3.3	3.2*	3.7*	3.3	3.3	3.4	3.1	3.4	3.2
Before recommending a food supplement, the medical history of the single consumer should be investigated to exclude any contraindications upon hiring	4.8	4.8	4.6	4.8	4.7	4.7*	4.8*	4.7	4.8
I have enough information about the recommendations for the use of vitamins supplements in specific population target groups	3.3	3.4	3.3	3.2*	3.5*	3.2*	3.6*	3.0*	3.7*
Pharmacists play a fundamental role in supporting an appropriate nutrition in oncologic patients, by providing oral nutritional supplements, modular supplements and nutraceuticals	3.4	3.5	3.2	3.0*	3.7*	3.3*	3.7*	3.3*	3.6*
It happens to receive pressures from manufacturers of food supplements to increase their sale	2.2	2.2	2.2	2.3	2.2	2.3	2.1	2.3	2.2
Each consumer should always be counselled about natural sources of vitamins intake	4.7	4.7	4.7	4.0	4.8	4.7	4.7	4.7	4.7
Pharmacists should provide updated information and dedicated seminars to other healthcare professionals	3.9	3.9	3.8	4.7	3.9	3.8	4.0	3.7*	4.1*
I have enough information about adverse effects of vitamins if assumed at dosages higher than recommended	3.2	3.3*	2.9*	3.9	3.3	3.2	3.3	3.0*	3.5*
Pharmacists should be responsible for security only regarding vitamins supplements dispensed in their pharmacy	2.8	2.9	2.7	3.1	2.9	2.8	2.9	2.9	2.7
Consumers should be individually counseled about dosage and via of administration of food supplements	4.9	4.9*	4.8*	2.8	4.9	4.9	4.9	4.8*	4.9*
Vitamin supplement products should be sold only in pharmacy settings: ...because they are drug	3.6	3.7	3.5	4.8	3.6	3.6	3.8	3.6	3.7
(...) because it is safer for patients	4.5	4.5	4.6	3.7	4.5	4.5	4.6	4.5	4.6
(...) to have more control on pricing and cost	2.9	2.9	2.9	4.5	2.8	3.0	2.8	3.0	2.8
I am informed enough regarding their contraindications in specific groups of patients (i.e diabetics, epileptics, having anticoagulant therapy).	3.2	3.3	2.9	3.0	3.2	3.1	3.3	2.9*	3.4*
I recommend food supplements to all consumers, being confident of their safety and effectiveness	2.6	2.5	2.7	2.4	2.6	2.4*	2.8*	2.6	2.5
I have enough knowledge about dosage and administration of vitamins as dietetic supplements	3.3	3.4*	3.1*	3.2*	3.5*	3.2	3.5	3.2	3.5
It is recommended to update periodically about scientific evidence concerning vitamin supplements on paper supports or official/institutional websites	4.8	4.9*	4.7*	4.9	4.8	4.8	4.8	4.8	4.8
The choice of food supplement should be dictated by both economic and effectiveness evaluations	3.6	3.5	3.6	3.5	3.6	3.5	3.6	3.6	3.5
I have enough knowledge about interactions between drugs and food supplements	3.3	3.4	3.1	3.2	3.4	3.3	3.4	3.0*	3.6*
It is necessary to report any adverse effects (related upon the hiring of food supplement and reported from the patient) to the qualified Health Authority	4.7	4.7	4.7	4.7	4.7	4.8	4.6	4.6	4.8
I believe that pharmacists are often induced to encourage the consumption of vitamin supplements	2.9	2.7*	3.3*	3.0	2.8	3.0*	2.6*	2.9	2.8
It is necessary to inform the single consumer about possible adverse effects of the vitamin supplements	4.8	4.8	4.6	4.7	4.8	4.7	4.8	4.8	4.8
As a pharmacist, I recommend consumers about a healthy lifestyle and food supplements consumption, particularly: ... checking the vitamin intake with food to avoid overdose from contemporary hiring of vitamin supplements	4.4	4.5*	4.1*	4.2*	4.5*	4.3	4.5	4.2*	4.5*
(...) recommending appropriate way of storage and cooking of fruits and vegetables	4.4	4.5	4.3	4.3	4.5	4.4	4.5	4.3*	4.5*
(...) recommending an adequate daily water intake	4.8	4.8	4.7	4.7*	4.9*	4.8	4.8	4.8	4.8
(...) banning on alcohol consumption	4.6	4.6	4.6	4.5	4.6	4.5	4.7	4.5	4.6
(...) banning on smoke habit	4.8	4.8	4.8	4.7*	4.8*	4.8	4.8	4.7	4.8
I often sell vitamin supplements because of a specific request of a patient, even if supplementation is not necessary	3.4	3.3	3.5	3.5	3.3	3.6*	3.0*	3.4	3.3
It is necessary to check if a particular food supplement interacts with any medications hired from the single patient	4.8	4.8	4.8	4.9	4.8	4.8	4.9	4.8	4.9

\* Statistically significant difference,  $p < 0.05$ .

practices were the phenomena of pharmacists being led to encourage patients to take dietary supplements (2.9), recommending dietary supplements to all consumers because they know the safety and efficacy profile (2.6), and being pressured by manufacturers to sell these products (2.2).

When analyzing the effect of the independent variables, it was found that knowledge (the number of correct answers) was the variable that most influenced attitudes and practices, followed by type of degree, years of work experience, function in the pharmacy, and gender. The questions for which the greatest heterogeneity in attitudes and practices occurred between groups related to the role of pharmacists in supporting the nutritional status of oncology patients (2.4), the need to review vitamin intake to avoid overdose (2.21.1), recognition of being specifically trained to counsel patients on vitamins (2.1.1), and confidence in having enough information for specific patient groups when using vitamin supplements (2.3).

#### 4. Discussion

As far as we know, this is the first study to investigate the knowledge, attitudes, and practices of pharmacists in the Friuli Venezia Giulia region regarding dietary supplements. In general, this study has shown that pharmacists' knowledge of dietary supplements is low, with only one third of pharmacists above the level considered the minimum standard. These results seem to confirm what was already found in a review on this topic, where the median knowledge score was 64 % (Waddington et al., 2015), but contrast with the high level of knowledge recently reported by Croatian colleagues (Bukic et al., 2021). The main knowledge gaps were related to the RDA for vitamin K, the increasing evidence for the carcinogenic role of multivitamin misuse, and the possibility that multivitamins contain unlabeled toxic ingredients. Professional experience appears to be associated with significantly better knowledge levels, particularly regarding the RDAs for vitamins C and D and the potential use of amino acids to reduce weight loss in oncology patients. Small differences in knowledge levels were found in relation to gender and pharmacy role, while no difference was found in relation to type of degree. These results partially confirm those previously reported by Bukic et al, with the exception of work experience which in their case made no difference in knowledge level (Bukic et al., 2021).

In general, however, pharmacists were very aware that vitamin deficiencies may be related to chronic drug therapy and that a proper lifestyle with a balanced diet positively influences nutrient intake. This belief seems to be confirmed in their attitudes and practices, particularly with regard to counseling patients about natural sources of vitamin intake and healthy lifestyles, including diet, drinking, alcohol consumption, and smoking, whose importance in maintaining health and well-being and preventing noncommunicable diseases is undisputed. Although dietary supplements are an important complementary source of essential nutrients (Epicentro, 2022; FederSalus, 2018), their widespread and inadequately regulated use raises concerns about potential adverse effects (ISS, 2020), which may be exacerbated by the incomplete or falsified information available on the Internet and social media (Al Khaja et al., 2018; Molin et al., 2019; Adams et al., 2020) and by the ease of purchasing dietary supplements available over-the-counter.

Individual and systemic actions need to be taken to ensure consumer protection from health risks associated with dietary supplements. At the individual level, patients and citizens should receive appropriate and tailored counseling to ensure that all risk-related clinical conditions, drug and food interactions are considered in a risk-benefit assessment. Colleagues in the Netherlands have recently reported that information provision in drugstores and health food stores is often inconsistent and unreliable (Lenssen et al., 2021). Healthcare professionals, particularly pharmacists, would be a safer and more reliable choice, as they themselves have already recognized (Ghosh et al., 2019), although gaps in knowledge remain to be addressed (Harnett et al., 2019; Ng et al., 2021), for example, regarding the potential association between cancer and

multivitamin misuse, the possibility that dietary supplements contain unlabeled toxic ingredients, and the appropriate daily intake of vitamins. Further consideration needs to be given to whether pharmacists should be specifically trained to counsel patients with oncohematologic disease regarding the use of dietary supplements, because to date, this expertise has likely grown primarily in acute care hospitals and is therefore provided by hospital pharmacists, who were excluded from this study. In general, however, pharmacists seem to fulfill their responsibilities in advising patients, believing that their role is central and that the pharmacy is the safest place to sell these products. This belief reflects the Italian context, where 92 % of vitamin products are actually sold by pharmacies, which generate more than 10 % of their income from them (CENSIS, 2019). Nevertheless, some concerns remain regarding ethical issues already raised by Boon et al. (Boon et al., 2009), in particular regarding a potential conflict of interest for pharmacists arising from the profit motive associated with the sale of these products, as also emerged from our study.

At the system level, a uniform and strict regulatory framework, marketing legislation, and postmarketing surveillance at the European level would be recommended (Ailkanjari, 2021; Harnett et al., 2019; Menniti-Ippolito et al., 2020; Ng et al., 2021; ISS, 2020) to protect vulnerable subgroups of patients, such as pregnant women, but also patients on concomitant therapies, whose numbers are increasing day by day (OsMED, 2019), and provide a safer public health experience.

##### 4.1. Limitations and strengths of the study

To our knowledge, this is the first study to investigate the knowledge, attitudes and practices of pharmacists in the Friuli Venezia Giulia region, and the first experience in this sense also at the national level regarding dietary supplements. Although no validated instrument was used to study the subject, we took into account previously published works to allow some comparisons. In addition, the design of our study, covering only one Italian region, is certainly a limitation, as the representativeness of our results could be affected by this choice. For this reason, we would like to extend this experience to other national and international networks. Finally, we did not include hospital pharmacists, which might have biased the knowledge about certain groups of patients usually treated in hospitals.

#### 5. Conclusion

In conclusion, pharmacists' knowledge of dietary supplements is low and young professionals in particular need to continue their training to ensure safe and effective advice to patients about these products. In addition, an improvement of the European regulatory framework for the manufacture, authorization and post-marketing surveillance of these products would be recommended.

#### 6. Declarations

##### 6.1. Ethics approval and consent to participate

Pharmacists gave their informed consent for participation. The study protocol was approved by the Institutional Review Board of the University of Udine, Italy. All procedures performed in this study were in accordance with relevant guidelines and regulations.

##### 6.2. Consent for publication

Not applicable.

##### 6.3. Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Authors contributions

LB, LA, LC, PC designed the research; Md'A and GM collected data; GM, Md'A, LB, LA discussed investigation methodology and contributed to result interpretation; LA performed data analysis; LB, LA supervised the study conduction; Md'A, GM, LB wrote the original draft; MP revised contents; all authors revised the paper and agreed with the final version of the manuscript.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

Data will be made available on request.

### Acknowledgements

The Authors would like to thank the four provincial offices of the professional associations of pharmacists of Gorizia, Pordenone, Trieste and Udine, and the regional office of the Italian Federation of Pharmacists (Federfarma) for their support in the design of the study and data collection.

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