

## ORIGINAL ARTICLE

# Beliefs and knowledge related to nutritional supplements among pharmacy students

## Názory a znalosti týkající se doplňků stravy mezi studenty farmacie

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### Summary

A variety of supplement-drug interactions has been identified, and therefore health scientists should be aware of the proper usage of nutritional supplements. The main aim of this study was to assess beliefs and knowledge related to nutritional supplements among pharmacy students. A cross-sectional study was conducted in order to assess beliefs and knowledge related to nutritional supplements among pharmacy students. A literature review on nutritional supplements was conducted in order to develop a 24-item questionnaire, and expert indications established its face and content validity. The sample was comprised of 142 pharmacy students in Cyprus, whose results are presented. The majority of the participants was receiving nutritional supplements (66.9%) and believed that nutritional supplements may interact and may have toxic effects. Those in the higher years of study scored higher in knowledge than those in the lower ones. The mean scores (mean  $\pm$  SD) on the knowledge about nutritional supplements by the years of study were  $9.14 \pm 2.67$ ,  $8.71 \pm 2.92$ ,  $9.91 \pm 2.08$ ,  $11.16 \pm 3.00$ , and  $15.76 \pm 2.67$  and compared using one-way ANOVA followed by Bonferroni correction. The level of statistical significance was set at  $p < 0.05$ . The study showed that pharmacy students are adequately informed about nutritional supplements and that this

subject is essential for the curriculum of pharmaceutical studies.

**Key words:** beliefs • knowledge • nutritional supplements • pharmacy students

### Souhrn

Byla zjištěna celá řada interakcí mezi doplňky stravy a léky, a proto by si zdravotníci měli být vědomi správného používání doplňků stravy. Hlavním cílem této studie bylo posoudit názory a znalosti týkající se doplňků stravy mezi studenty farmacie. Byla provedena průřezová studie s cílem posoudit názory a znalosti týkající se doplňků stravy mezi studenty farmacie. Byl zpracován přehled literatury o doplňcích stravy s cílem vytvořit 24položkový dotazník a na základě expertních indicií byla stanovena jeho zjevná a obsahová validita. Vzorek tvořilo 142 studentů farmacie na Kypru, jejichž výsledky jsou prezentovány. Většina účastníků užívala doplňky stravy (66,9 %) a domnívala se, že doplňky stravy se mohou vzájemně ovlivňovat a mohou mít toxické účinky. Osoby ve vyšších ročnících studia dosáhly vyššího skóre ve znalostech než osoby v nižších ročnících. Průměrné skóre (průměr  $\pm$  SD) znalostí o doplňcích stravy bylo  $9,14 \pm 2,67$ ,  $8,71 \pm 2,92$ ,  $9,91 \pm 2,08$ ,  $11,16 \pm 3,00$  a  $15,76 \pm 2,67$  pro jednotlivé ročníky studia a bylo porovnáno pomocí jednorozměrné ANOVA s následnou Bonferroniho korekcí. Hladina statistické významnosti byla stanovena na  $p < 0,05$ . Studie ukázala, že studenti farmacie jsou dostatečně informováni o doplňcích stravy a že tento předmět je nezbytný pro kurikulum farmaceutického studia.

**Klíčová slova:** názory • znalosti • doplňky stravy • studenti farmacie

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### Introduction

Over the last few decades, the usage of nutritional supplements (NS) has been increased. Among the US

marketplaces, there were about 4,000 NS products in 1994, which increased to 29,000 by 2000, and more than 85,000 in 2018<sup>1)</sup>. According to CRN's (Council for Responsible Nutrition) 2019 consumer survey, it is estimated that about 7 out of 10 adults in the USA take NS<sup>2)</sup>. This growing demand for NS could be attributed to the rapid increase of lifestyle-related diseases, such as cardiovascular diseases, cancer, etc.<sup>3–6)</sup>. People of every age and physical condition take NS in order to maintain health or prevent a possible deficiency. NS are formulations that contain in pure and concentrated form nutrients such as vitamins (multivitamin or single vitamins), minerals, amino acids, and herb supplements. Common reasons for NS consumption are good health maintenance, immune system boost, mental peace, weight management, and chronic diseases<sup>7,8)</sup>.

Although these products intend to supplement the diet, they are not always innocent, as a variety of supplement-drug interactions have shown in clinical trials. The NS could lead to serious interactions with other drugs and implications in some diseases or in special conditions, like pregnancy. Moreover, misled beliefs about the safety, toxicity, or interactions and inadequate knowledge about NS have been observed among not only consumers but also health care professionals<sup>9–11)</sup>. Thus, the understanding and application of the correct use of NS is a basic learning outcome of Pharmacy Schools<sup>4)</sup>.

Pharmacists, as healthcare professionals, must be informed and responsible for valid and safe consumer education on NS regarding their use and interactions<sup>12, 13)</sup>. A recent study reported that inadequate pharmacists' knowledge of NS was the main barrier to patients' counseling<sup>14)</sup>. The assessment of beliefs and knowledge related to nutritional supplements among health care professionals, and especially in pharmacy students, is essential for pharmacists' acknowledgment of NS and safety improvement. A valid and reliable assessment tool for the nutrition supplements, including multivitamins, minerals, herbal medicines, and their interactions, would be of critical importance for health care professional education and health care services development.

Up to the present, there is not enough literature for a validated assessment tool about nutritional supplements' beliefs and knowledge, reflecting safety acknowledgment and interaction prevention issues among health care scientists. Moreover, very little information is available about the usage and knowledge of NS in the Greek and Cypriot populations. The aim of this study was to determine beliefs and knowledge among pharmacy students regarding nutritional supplements.

## Experimental part

### Materials and Methods

#### Design

Literature on nutritional supplements was reviewed in order to develop beliefs and knowledge questionnaire<sup>7, 8, 15–19)</sup>. For the review were used the keywords

nutritional supplements, vitamins, herbal medicine, interactions, and questionnaire on the electronic database including Scopus, Google Scholar, and PubMed. A 35 item pool was developed and reviewed by two experts in the field, an experienced professional pharmacist and a Pharmacy University Professor, in order to clarify their ambiguity. This study was conducted on pharmacy students in Nicosia after the approval of the Ethics Committee. Pilot interviews with 20 participants, who were not included in the present study, were conducted to test the questionnaire for its comprehensibility and the appropriateness of its items. The results were used to determine the items of the final instrument and the qualitative feedback from the respondents.

The final questionnaire consisted of 24 items. Specifically, the questionnaire was divided into 3 parts, the demographic, the beliefs (4 items), and the knowledge part (20 items). The demographic part included personal details such as place of origin/residence, sex, year of study, and some attitudes towards the supplements, like the frequency of NS usage, the category they consume, and the source of advice on which they based their decision. The beliefs part was related to their safety and included 4 items on the Likert scale. The knowledge part included 20 multiple choice type items that cover the proper way NS should be taken and some of their common interactions. The total score of the knowledge part was assessed by adding all responses from 0 to 20; incorrect answers were given 1 point, and incorrect answers 0 points.

For the sample size, it is generally accepted to enroll 5 subjects for each question, for a sample > 100, in order to strengthen the instrument validity. Therefore, the number of sample for the current study was designed to be at least 120 subjects<sup>20–22)</sup>. A sample of 142 pharmacy students was interviewed in order to complete the questionnaire. Informed consent was obtained for all individuals who agreed to participate in the study. The participants had 15 min, sufficient time for completion of the questionnaire.

#### Data analysis

Descriptive statistics were used to assess demographic data. A two-sample t-test, as well as a non-parametric t-test, was used to investigate differences between the mean values of independent groups. Ordinal logistic regression was performed in order to investigate the association between ordinal and other explanatory variables. Furthermore, One-Way ANOVA and Kruskal-Wallis test were evaluated to determine the existence of differences in the mean values of the different levels of a categorical variable, while Tukey's test was used to check which groups actually differ. To adjust for multiple comparisons, a Bonferroni correction was applied. The reliability of the questionnaire was assessed separately in each category (beliefs and supplements) through Cronbach's alpha criterion. The level of statistical significance on all tests was set at  $p < 0.05$ , and

the analysis was applied using the statistical software R (www.r-project.org, v3.6.2).

## Results

The questionnaire includes three sections: i) Demographic details and attitudes toward NS; ii) Personal beliefs about the efficacy and safety of NS (part A) and iii) knowledge of the use and interactions of NS (Part B). Part A consists of 4 questions, while part B consists of 20. In order to be established face and content validity, an extensive bibliographic search took place, as well as the items were reviewed by experts and checked during pilot interviews. In the category of personal beliefs (part A), Cronbach's reliability index was 0.65, while in the category of knowledge (part B), the value was 0.67, both corresponding to acceptable questionnaire reliability levels based on the literature, indicating a high level of internal consistency<sup>23, 24)</sup>.

The participants were also divided into 2 groups, group I for the three first years of study (1<sup>st</sup>–3<sup>rd</sup> year) and group II for the last two years of study (4<sup>th</sup>–5<sup>th</sup> year). Construct validity was confirmed for each part by t-test. The total score in beliefs about NS appeared to be of borderline significance, whilst group II had better results than group I ( $t = -1.92$ ;  $df = 139$ ;  $p = 0.05$ ). On the other hand, the knowledge part gave a significantly higher mean total score for group II than group I ( $t = -7.21$ ;  $df = 77$ ;  $p < 0.001$ ).

The sample consists of 142 respondents (66 men and 76 women), while the number of participating students per academic year was about the same (29, 31, 32, 25, 25). 91.5% of the participants were from Greece, while 8.5% were from Cyprus. 43.7% of the participants lived in "major urban areas", 36.6% lived in "urban", 9.2% in "suburban" and 10.6% in "rural areas". Regarding the frequency of NS consumption, 33.1% of the participants answered that they have "never" received any, 16.2% "rarely", 27.5% "sometimes", 16.2% "often", while only 7% answered "always." Regarding the source of information about NS, participants could choose up to 2 possible answers. It came up that "health care professionals" were selected by 51.4% of the participants, "personal search" by 42.3%, "advertisements – mass/social media" by 25.4%, "University" by 19.7%, and "other" by 4.2%. Regarding the main reason for receiving NS, the participants could also choose up to 2 possible options. The "wellness and health maintenance" category was chosen by 69.7% of participants, "immune system boost" by 35.2%, "mental peace" by 12.7%, "other" by 9.9%, "slimming products" by 4.2%, while "special conditions" by 0.7% (Table 1).

Regarding the belief in NS safety, 4 items were answered by using a 5-point Likert-type scale. Questions 1 and 4 range from strongly disagree (1) to strongly agree (5), while questions 2 and 3 had the opposite meaning conceptually, so they range in the reverse order, from strongly agree (1) to strongly disagree (5). Lower scores represent acceptance feelings towards NS

safety and lack of toxicity symptoms, whilst the higher scores reflect concern and insecurity feelings about NS safety, interactions, and possible toxicity.

In the statement that "The nutritional supplements could cause serious interactions," most participants answered that they either agree (39%) or that they are neutral (32.6%); as for if "Vitamin and mineral products are always safe," participants mostly disagreed (48.6%) or were neutral (30.3%). Similarly, the majority of the participants (47.2%) disagreed with the belief that "Herbal supplements are always safe since they are derived from natural sources," while 52.1% agreed with the belief that "Nutritional supplements could be toxic."

Table 1. Participants' demographics and attitudes

Variable	N (142)	%
<b>Sex</b>		
male	66	46.5
female	76	53.5
<b>Year of study</b>		
1 <sup>st</sup> year	29	20.4
2 <sup>nd</sup> year	31	21.8
3 <sup>rd</sup> year	32	22.5
4 <sup>th</sup> year	25	17.6
5 <sup>th</sup> year	25	17.6
<b>Place of living</b>		
Major urban areas	62	43.7
Urban areas	52	36.6
Suburban areas	13	9.2
Rural areas	15	10.6
<b>NS consumption</b>		
Always	10	7
Often	23	16.2
Sometimes	39	27.5
Rarely	23	16.2
Never	47	33.1
<b>Source of information</b>		
Advertisements – mass/social media	36	25.4
Personal search	60	42.3
University	28	19.7
Health Care Professionals	73	51.4
Other	6	4.2
<b>Reasons receiving NS</b>		
Wellness and health maintenance	99	69.7
Immune system boost	50	35.2
Mental peace	18	12.7
Slimming products	6	4.2
Special condition	1	0.7
Other	14	9.9

The belief that “The nutritional supplements could cause serious interactions” did not appear to be related to the country of origin or place of stay. In addition, this belief does not differ by the frequency of NS consumption. Nevertheless, it does change significantly with gender ( $p = 0.04$ ) and year of study ( $p < 0.001$ ). More specifically, women had less chance to “Strongly disagree” compared to men, and students closer to graduation had fewer odds to “Strongly disagree” in comparison with 1<sup>st</sup> year.

The belief that “Vitamin and mineral products are always safe” was not related to the country of origin, year, gender, or frequency of NS consumption. However, the place of residence ( $p = 0.01$ ) was statistically significant. More specifically, participants who lived in “urban” and “rural areas” in comparison with others who lived in “Major urban areas” had fewer odds of strongly disagreeing, while participants who lived in “Suburban areas” in comparison with others who live in “Major urban areas,” had higher odds to “Strongly disagree”.

The belief that “Herbal supplements are always safe since they are derived from natural sources” was not related to the country of origin, place of residence, sex, or frequency of NS consumption. However, it was related significantly ( $p = 0.01$ ) to the year of study. All years of

study had higher odds of strongly disagreeing than the 1<sup>st</sup> year.

Finally, the belief that “The nutritional supplements could be toxic” was not significantly associated with any of the above variables.

The beliefs of study respondents about NS safety are presented in detail in Table 2. The total score in beliefs questions and mean scores per year of study is presented in Table 3, whilst the score per group (I and II) of students is presented in Table 4.

In the last section (knowledge part), each subject’s score was calculated as the total number of correct answers in order to calculate the average percentage. Respondents scored an average of 10.74 out of 20. The minimum score was 3, while the maximum score was 19 (Table 5). The country of origin ( $p = 0.05$ ) and gender ( $p = 0.07$ ) appeared to be of borderline significance, whilst students from Cyprus and women had better results. On the other hand, place of residence and frequency of NS consumption were not significant at all. Finally, the year of study was statistically significant ( $p < 0.001$ ), with students closer to graduation performing better. Scores in knowledge questions per group (I and II) of students are presented in Table 6.

After Bonferroni correction for multiple testing, most of the variables remain statistically significant.

Table 2. Participants’ beliefs about NS safety

Likert question	N	%	Mean
The nutritional supplements could cause serious interactions			3.58
Strongly agree	23	16.3	
Agree	55	39	
Neither agree nor disagree	46	32.6	
Disagree	16	11.3	
Strongly disagree	1	0.7	
Vitamin and mineral products are always safe			3.61
Strongly agree	0	0	
Agree	14	9.9	
Neither agree nor disagree	43	30.3	
Disagree	69	48.6	
Strongly disagree	16	11.3	
Herbal supplements are always safe, since they are derived from natural sources			3.81

Table 3. Total score in beliefs and mean scores per year of study

Variable	Min	Max	Median	Mean	1 <sup>st</sup> quantile	3 <sup>rd</sup> quantile	SD
Score in beliefs	2	5	3.75	3.74	3.25	4.25	0.60
Year	N			SD		Mean	
1 <sup>st</sup> year	29			0.54		3.47	
2 <sup>nd</sup> year	31			0.61		3.89	
3 <sup>rd</sup> year	32			0.6		3.65	
4 <sup>th</sup> year	25			0.67		3.8	
5 <sup>th</sup> year	25			0.63		3.95	

## Discussion

The study showed that pharmacy students are adequately informed about NS, and this subject is essential for the curriculum of their studies. The majority of the participants receives NS (66.9%) and believes that they may interact and have toxic effects. Those in higher years of study scored higher in knowledge than lower ones.

A limitation of this study was that the size of the sample was relatively small ( $n = 142$ ), due to the participation of only students who were present in the class, even if it fits the recommended instructions per item<sup>20–22</sup>.

There are some studies that examine attitudes, beliefs, and knowledge on NS, mainly focusing on nutrition and food-drug interactions<sup>17–19, 25</sup>. Our main aim was to identify the awareness about NS among pharmacy students by quantitative measurement of beliefs about NS safety and knowledge related to drug interactions from a pharmaceutical point of view. For this reason, a new valid and reliable questionnaire, with 24 items, was constructed to assess beliefs and knowledge among pharmacy students related to nutritional

supplements. The questionnaire was first tested for its comprehensibility and appropriateness of its items in order to establish reliability (internal consistency). According to the literature, each part of the questionnaire was assessed separately and found acceptable according to the literature<sup>23, 24</sup>. Specifically, on Cronbach  $\alpha$  reliability index for personal beliefs, the value was 0.65, and for the knowledge part, the value was 0.67. Construct validity was confirmed by a t-test comparing two students groups, divided by year of study.

Regarding demographic characteristics and attitudes of the study, some interesting findings were revealed. Since it is known from the literature, growing demand for NS consumption has been observed within the last decades. This study indicates a high percentage (66.9%) of participants who have received NS, which is in accordance with the bibliography (70% of young adults)<sup>2, 25–26</sup>. About the source of information, the results showed that pharmacy students trust health care professionals<sup>27</sup>, potentially related to their professional orientation. When participants were asked where they received information about NS from, over 50% chose health care professionals.

Table 4. Scores in beliefs questions per group of students

	Group I	Group II	P value
N (%)	92 (64.8%)	50 (35.2%)	
Mean	3.67	3.88	0.05582
Min	2	2.5	
Max	5	5	

Group I: 1<sup>st</sup>–3<sup>rd</sup>, Group II: 4<sup>th</sup>–5<sup>th</sup> year  
No data are missing in either group.

Table 5. Participants' knowledge about NS and mean scores by year of study

Variable	Min	Max	Median	Mean	1 <sup>st</sup> quantile	3 <sup>rd</sup> quantile	SD
Score in knowledge (score at 20)	3	19	10	10.74	8	12.75	3.61
Year	N			SD		Mean	
1 <sup>st</sup> year	29			2.67		9.14	
2 <sup>nd</sup> year	31			2.92		8.71	
3 <sup>rd</sup> year	32			2.08		9.91	
4 <sup>th</sup> year	25			3		11.16	
5 <sup>th</sup> year	25			2.67		15.76	

Table 6. Grades in knowledge questions per group of students

	Group I	Group II	P value
N (%)	92 (64.8%)	50 (35.2%)	
Mean	9.26	13.46	< 0.001*
Min	3	6	
Max	16	19	

Group I: 1<sup>st</sup>–3<sup>rd</sup>, Group II: 4<sup>th</sup>–5<sup>th</sup> year

\*p-value < 0.001

No data are missing in either group.



The more common reason for consuming NS was wellness and health maintenance (69.7%), followed by the immune system boost (35.2%). The most prevalent “other” option in males was protein supplements. These results are in accordance with similar studies in bibliography<sup>3, 7, 8, 28, 29</sup>.

Regarding the beliefs of the participants about NS safety, the majority of the respondents believe that nutritional supplements, including vitamins, minerals, and herbal products, are not always safe, as well as may induce drug interactions, and could be toxic. The question “The nutritional supplements could cause serious interactions” (mean of 3.58) gathered 55.3% of positive responses (agree and strongly agree), while the question “The nutritional supplements could be toxic” had a higher mean (3.95) and gathered totally positive responses 78.2% while the negative responses were less than 10%. On the contrary, the public tends to believe that NS consumption is harmless; thus, almost 9 out of 10 did not consider it important to inform their physician or pharmacist about their usage<sup>30</sup>. This is accentuated by the fact that more than 20,000 citizens in the USA visit the emergency department due to consumption of NS annually<sup>31</sup>. Many of these were related to unsupervised consumption of NS, indicating the necessity of counseling the pharmacist about supplement usage. Therefore, NS can be safe and effective only when they are taken correctly and when interactions are accounted for. The mean level for beliefs of students per year is presented in Figure 1.

The students in higher years of study, especially in the 4<sup>th</sup> and 5<sup>th</sup> year (group II), had higher scores in the beliefs part than the younger ones. It is known that non-healthcare professionals, especially older patients, perceive NS as safe, mainly due to their facile availability (many different shops to buy these products even without a prescription, etc.)<sup>32</sup>. Many serious or less serious adverse interactions have been reported in clinical practice, including St. Johns wort, Ginkgo biloba, Ginger, grapefruit, etc.<sup>33</sup>. The knowledge of these NS interactions is partially connected with beliefs about safety and toxicity.

The patients’ adherence to the medical treatment<sup>34</sup> as well as the pharmacists’ knowledge of serious interactions are of high importance, especially due to polypharmacy and NS overconsumption<sup>35</sup>. The students in higher years of their study also had higher scores in the knowledge part than the younger ones. The one-way ANOVA test showed statistical significance per year of study ( $F(4,137) = 30.13$ ,  $p\text{-value} < 0.001$ ). There was a significant difference between the scores of the first three years and the last two ( $p < 0.001$ ), while the scoring of the three first years did not vary significantly. 4<sup>th</sup> and 5<sup>th</sup>-year students gave the highest scores (11.16 and 15.76 respectively) in their knowledge of NS compared to the younger ones (Table 5). The mean level for knowledge of students per year is presented in Figure 2. These findings may lead to the assumption that the experience increases the rate of correct answers<sup>10, 11</sup>.

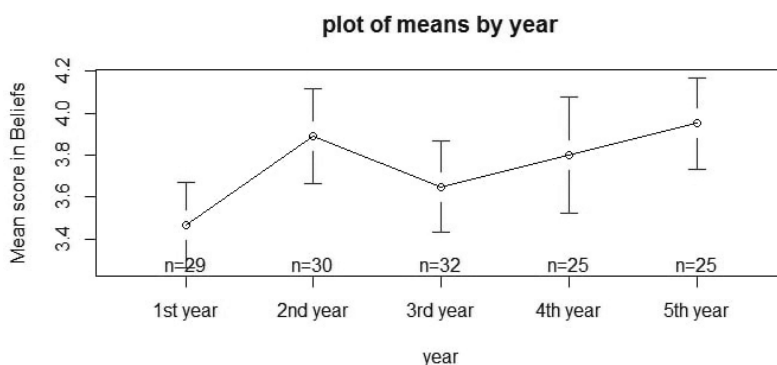


Fig. 1. Plot of mean scores in beliefs by year of study

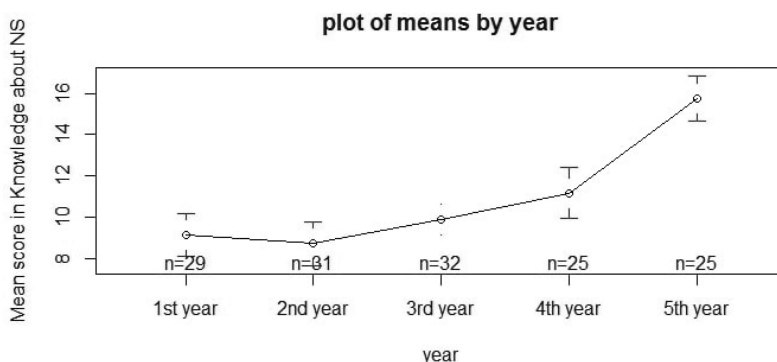


Fig. 2. Plot of mean scores in knowledge about NS by year of study

The belief and knowledge scores did not differ between participants who received supplements and those who did not ( $p$ -values  $> 0.05$ ). However, there has been a difference between years of study, indicating the role of University studies. The last two years of studies include most pharmaceutical courses such as pharmacology, pharmacognosy, and toxicology. The mean scores, both in beliefs and in knowledge, were higher in the 5<sup>th</sup> year of study, which could attribute to the clinical education on public or private pharmacies that is added to the last year of study. A correlation study took place by using Pearson's product-moment correlation. For group I, the correlation coefficient between beliefs and knowledge scores was 0.236, demonstrating no correlation ( $< 0.3$ ). On the other hand, the total sample and higher year of study (group II) showed a low correlation that the beliefs' score is increased by the improvement of knowledge, while the correlation coefficient was 0.337 and 0.399, respectively.

## Conclusion

Over the last decades, the consumption of nutritional supplements is increasingly expanded. It is crucial that vitamins, mineral products, herbal supplements, etc., should be recognized as an essential part of the curriculum of Pharmacy Schools. It is necessary to assess the beliefs and level of knowledge of health care students and professionals, providing advanced primary health care services in the institutional and the community area, addressing the matter of non-prescription supplementation intakes with a critical scope and up to date knowledge. This study showed that pharmacy students receive NS, having acknowledged their potential toxicity and interactions. This is of importance since the knowledge does not have only a sterile role, but is able to transform the beliefs of health care advisors, with potent linkage to an advance in the professional practice, intensifying their vocational role.

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## References

1. **Bailey R. L.** Current regulatory guidelines and resources to support research of dietary supplements in the United States. *Crit. Rev. Food Sci. Nutr.* 2020; 60(2), 100298–100309. <https://doi.org/10.1080/10408398.2018.1524364>
2. **Dietary Supplement Use Reaches All Time High.** CRN Consumer Survey on Dietary supplements available at: <https://www.crnusa.org/newsroom/dietary-supplement-use-reaches-all-time-high>. Accessed 20 January 2022.
3. **Bailey R. L., Gahche J. J., Miller P. E., Thomas P. R., Dwyer J. T.** Why US adults use dietary supplements.

*JAMA Intern. Med.* 2013; 173(5), 355–361. <https://doi.org/10.1001/jamainternmed.2013.2299>

4. **Axon D. R., Vanova J., Edell C., Slack M.** Dietary supplement use, knowledge, and perceptions among student pharmacists. *Am. J. Pharm. Educ.* 2017; 81(5), Article 92. <https://doi.org/10.5688/ajpe81592>
5. **Steyn N., Labadarios D., Nel J. H., Heidi-Lee R.** Development and validation of a questionnaire to test knowledge and practices of dietitians regarding dietary supplements. *Nutrition* 2005; 1(1), 51–58. <https://doi.org/10.1016/j.nut.2004.09.0086>
6. **Smith T., Kawa K., Eckl V., Morton C., Stredney R.** Herbal supplement sales in US increase 7.7% in 2016: Consumer preferences shifting toward ingredients with general wellness benefits, driving growth of adaptogens and digestive health products. *Herbal Gram J. Am. Bot. Counc.* 2017; 115, 56–65.
7. **Sharma A., Adiga S., Ashok M.** Knowledge, Attitude and practices related to dietary supplements and micronutrients in health sciences students. *J. Clin. Diagn. Res.* 2014; 8, HC10–HC13. <https://doi.org/10.7860/JCDR/2014/9329.4683>
8. **Owens C., Toone T., Steed-Ivrie M.** A survey of dietary supplement knowledge, attitudes, and use in a rural population. *J. Nutr. Food Sci.* 2014; 4(5), 1000304. <https://doi.org/10.4172/2155-9600.1000304>
9. **Enwerem N. M., Okunji P.** Knowledge, Attitudes and awareness of food and drug interactions among nurses with different levels of experience. *Int. J. Nurs.* 2015; 2(1), 1–9. <http://dx.doi.org/DOI:10.15640/ijn.v2n1a1>
10. **Jyoti M. B., Jayanthi M. K., Basavaraj R. T., Renuka M.** Knowledge and awareness of food and drug interactions (FDI): a survey among health care professionals. *IJPCS* 2012; 1(4), 97–105.
11. **Jakabovičová M., Ďurkovičová Z., Ondrejčovičová M., Faktorová X., Mojto V., Szántová M.** Hepatotoxic potential of nutritional and dietary supplements. *Prakt. Léč.* 2021; 101(2), 87–96.
12. **Boon H., Hirschhorn K., Griener G., Cali M.** The ethics of dietary supplements and natural health products in pharmacy practice: a systematic documentary analysis. *Int. J. Pharm. Pract.* 2009; 17(1), 31–38. <https://doi.org/doi:10.1211/ijpp.17.1.0005>
13. **Waddington F., Naunton M., Kyle G., Thomas J., Cooper G., Waddington A.** A systematic review of community pharmacist therapeutic knowledge of dietary supplements. *Int. J. Clin. Pharm.* 2015; 37(3), 439–446. <https://doi.org/doi:10.1007/s11096-015-0092-5>
14. **Medhat M., Sabry N., Ashoush N.** Knowledge, attitude and practice of community pharmacists towards nutrition counselling. *Int. J. Clin. Pharm.* 2020; 42(6), 1456–1468. <https://doi.org/doi:10.1007/s11096-020-01106-0>
15. **Homan E. M.** Dietary Supplements and College Students: Use, Knowledge, and Perception [MSc Thesis], Kent State University; 2018. Available at: [http://rave.ohiolink.edu/etdc/view?acc\\_num=kent1532083809853366](http://rave.ohiolink.edu/etdc/view?acc_num=kent1532083809853366). Accessed 20 January 2022.

16. **Farghali H., Kameníková L., Hodis J., Kutinová Cano-  
vá N.** Potential interactions between drugs and dietary  
supplements. *Čas. Lék. čes.* 2014; 2, 67–71.
17. **Yetley E. A.** Multivitamin and multimineral dietary  
supplements: Definitions, characterization, bioavailabi-  
lity, and drug interactions. *Am. J. Clin. Nutr.* 2007; 85(1),  
269S–276S. <https://doi.org/doi:10.1093/ajcn/85.1.269S>
18. **Sajid S. A., Sultana R., Masaratunnisa M., Naaz S.,  
Adil M. S.** A Questionnaire study of food – drug inte-  
ractions to assess knowledge of people from diverse  
backgrounds. *Asian J. Med. Health* 2017; 5(2), 1–9 (Ar-  
ticle no.AJMAH.33682). <https://doi.org/doi:10.9734/AJMAH/2017/33682>
19. **Agbabiaka T. B., Spencer N. H., Khanom S., Goodman  
C.** Prevalence of drug–herb and drug–supplement in-  
teractions in older adults: a cross-sectional survey. *Br.  
J. Gen. Pract.* 2018; 68(675): e711–e717. Available from:  
<https://doi.org/doi:10.3399/bjgp18X699101>
20. **Streiner D. L.** Figuring out factors: the use and misuse  
of factor analysis. *Can. J. Psychiatry* 1994; 39(3), 135–140.  
<https://doi.org/doi:10.1177/070674379403900303>
21. **Cattell R. B.** The Scientific Use of Factor Analysis in Beha-  
vioral and Life Sciences. New York: Plenum 1978.
22. **Gorsuch R.** Factor Analysis. 2<sup>nd</sup> ed. New Jersey: Lawrence  
Erlbaum Associates 1983.
23. **Taber K. S.** The Use of Cronbach's Alpha When Devel-  
oping and Reporting Research Instruments in Science  
Education. *Res. Sci. Educ.* 2018; 48(6), 1273–1296. <https://doi.org/10.1007/s11165-016-9602-2>
24. **Nunnally J. C.** Psychometric theory. New York: McGraw-  
Hill 1967.
25. **Alowais M. A., Selim M. A.** Knowledge, attitude, and  
practices regarding dietary supplements in Saudi Arabia.  
*J. Family Med. Prim. Care* 2019; 8(2), 365–372. [https://doi.org/10.4103/jfmpc.jfmpc\\_430\\_18](https://doi.org/10.4103/jfmpc.jfmpc_430_18)
26. **Wu C. H., Wang C. C., Kennedy J.** Changes in herb and  
dietary supplement use in the US adult population:  
a comparison of the 2002 and 2007 National Health In-  
terview Surveys. *Clin. Ther.* 2011; 33(11), 1749–1758. <https://doi.org/10.1016/j.clinthera.2011.09.024>
27. **See M., Butcher B. E., Banh A.** Patient literacy and  
awareness of medicine safety. *Int. J. Pharm. Pract.* 2020;  
28(6), 552–560. <https://doi.org/10.1111/ijpp.12671>
28. **Zezelj S. P., Tomljanovi A., Jovanovic G. K., Kresic  
G., Peloza O. C., Dragas-Zubalj N., et al.** Prevalence,  
knowledge and attitudes concerning dietary supple-  
ments among a student population in Croatia. *Int. J.  
Environ. Res. Public. Health* 2018; 15, 105. <https://doi.org/10.3390/ijerph15061058>
29. **Alhomoud F. K., Basil M., Bondarev A.** Knowledge,  
attitudes and practices (KAP) relating to dietary  
duplicates among health sciences and non-he-  
alth sciences students in one of the Universities  
of United Arab Emirates (UAE). *J. Clin. Diagn. Res.*  
2016; 10(9), JC05–JC09. <https://doi.org/10.7860/JCDR/2016/19300.8439>
30. **Samojlik I., Mijatovic V., Gavaric N., Krstin S., Bozin  
B.** Consumers' attitude towards the use and safety of  
herbal medicines and herbal dietary supplements in Ser-  
bia. *Int. J. Clin. Pharm.* 2013; 35(5), 835–840. <https://doi.org/10.1007/s11096-013-9819-3>
31. **Geller A. I., Shehab N., Weidle N. J., Lovegrove M. C.,  
Wolpert B. J., Timbo B. B., et al.** Emergency department  
visits for adverse events related to dietary supplements.  
*N. Engl. J. Med.* 2015; 373(16), 1531–1540. <https://doi.org/10.1056/NEJMsa1504267>
32. **Snyder F. J., Dundas M. L., Kirkpatrick C., Neill  
K. S.** Use and safety perceptions regarding herbal  
supplements: A Study of older persons in Southeast  
Idaho. *J. Nutr. Elder.* 2009; 28(1), 81–95. <https://doi.org/10.1080/01639360802634043>
33. **Borrelli F., Izzo A.** Herb-Drug Interactions with St  
John's Wort (*Hypericum perforatum*): an Update on Cli-  
nical Observations. *AAPS J.* 2009; 11(4), 710–727. <https://doi.org/10.1208/s12248-009-9146-8>
34. **Theodosios-Nobelos P., Asimakopoulou E., Rikkou-Ka-  
lourkoti M., Triantis C.** Adherence to medical treatment.  
Evaluation methods and enhance strategies. *Hellenic J.  
Nurs.* 2019; 58(4), 317–327.
35. **Loya A. M., González-Stuart A., Rivera J. O.** Prevalen-  
ce of polypharmacy, polyherbacy, nutritional supple-  
ment use and potential product interactions among  
older adults living on the United States-Mexico border:  
A descriptive, questionnaire-based study. *Drugs Aging.*  
2009; 26(5), 423–436. <https://doi.org/10.2165/00002512-200926050-00006>