

Original Research



Dietary supplement use and its related factors among Chinese international and Korean college students in South Korea

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OPEN ACCESS

Received: Jul 26, 2021

Revised: Dec 24, 2021

Accepted: Jan 3, 2022

Published online: Sep 23, 2022

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Conflicts of Interest

The authors declare no potential conflicts of interests.

ABSTRACT

BACKGROUND/OBJECTIVES: The consumption of dietary supplements has shown an increase among young people in their 20s. We aimed to compare the use of dietary supplements and related factors between Chinese international and Korean college students living in South Korea.

SUBJECTS/METHODS: We conducted online surveys of 400 Chinese international students and 452 Korean college students from January to February 2021. We analyzed the factors related to the use of dietary supplements by these students using multi-group structural equation modeling and logistic regression analysis.

RESULTS: Approximately 65% of the Chinese international students and 93% of the Korean college students consumed dietary supplements at least once in the year preceding the survey. The common types of dietary supplements consumed by both groups of students were vitamin and mineral supplements, *Lactobacillus* products, and red ginseng products. Structural equation modeling showed that perception of the consumption of dietary supplements by family and friends positively influenced attitude toward dietary supplements. This effect was higher for Korean college students than for Chinese international students ($P < 0.01$). Attitude toward dietary supplements positively influenced their use, and this effect was higher for Chinese international students than for Korean college students ($P < 0.001$). Logistic regression analysis showed that the use of dietary supplements by Chinese international students was significantly associated with age, self-reported health status, interest in health, perception of and attitude toward dietary supplements, and length of residence in South Korea. Among Korean college students, it was associated with exercise frequency and attitude toward dietary supplements.

CONCLUSION: This study showed significant differences in the use of dietary supplements and related factors between Chinese international and Korean college students. Therefore, nutrition education programs on dietary supplements need to have differentiated content for each group. Such differences also suggest that the industry should consider the relevant characteristics of college students while developing and marketing dietary supplements.

Keywords: Functional food; dietary supplements; universities; perception; attitude

Author Contributions

Conceptualization: Huang L, Yoon J;
Methodology, Huang L, Yoon J; Formal
Analysis: Huang L; Investigation: Huang L;
Writing - original draft: Huang L; writing -
review & editing: Huang L, Yoo H-J, Abe S,
Yoon J. All authors have read and agreed to
the published version of the manuscript.

INTRODUCTION

In the era of cross-border education, international students have emerged as a new group of college students in South Korea. The number of international students taking degree courses or non-degree language courses in South Korea had increased from 91,332 in 2015 to 160,165 in 2019. Due to coronavirus disease 2019 (COVID-19), however, the number of international students in South Korea had fallen to 153,695 in 2020, of which 67,030 (43.6%) were Chinese international students [1].

International college students may experience a variety of challenges and difficulties in foreign countries due to language barriers, academic pressure, and cultural differences. Food and food habits are unique to the culture of every country. International students are likely to face drastic changes in their diet and eating environment in foreign countries. These changes could cause nutritional issues such as malnutrition, underweight, and obesity and have a negative impact on their health [2,3]. Therefore, they may consider using dietary supplements to improve their nutritional and health status.

In general, dietary supplements are intended to add to or supplement the diet and are different from conventional foods. Common dietary supplements include vitamins, minerals, botanicals or herbs, botanical compounds, amino acids, and probiotics [4]. Dietary supplements are available in various forms such as tablets, capsules, soft gels, gelpcaps, liquids, powders, or drinks for ease of use, and may help people to get adequate amounts of essential nutrients. Some dietary supplements may also help in the management of specific health conditions [5]. For example, calcium and vitamin D supplements are known to keep bones healthy and reduce bone loss.

Dietary supplements are more commonly referred to as 'Health Functional Foods' in South Korea. Health Functional Foods are defined and regulated by the Health Functional Foods Act [6], and the definition officially translated into English reads as follows: "foods (products) manufactured (including processing) using functional ingredients that are nutritious and helpful for our body" [7]. In China, dietary supplements are referred to as 'Health Foods'. Health Foods are defined as "food products that have specific health functions or supply vitamins and/or minerals" [8]. In the European Union (EU), the term 'Food Supplements' are used instead and defined as "concentrated sources of nutrients (i.e. mineral and vitamins) or other substances with a nutritional or physiological effect that are marketed in 'dose' form (e.g. pills, tablets, capsules, liquids in measured doses)" [9].

According to a market analysis report by the Grand View Research, Inc. published in 2021, the global market size of dietary supplements was valued at USD 140.3 billion in 2020 [10]. The market size of dietary supplements in South Korea was KRW 4,927.3 billion (USD 4.3 billion) in 2020 and grew 6.6% over the previous year [11]. The market size of dietary supplements in China has also been growing. It was approximately CNY 222.7 billion (USD 34.4 billion) in 2019 and was expected to exceed CNY 330.0 billion (USD 51.0 billion) in 2021 [12].

The use of dietary supplements by international students has been investigated in the United States. In a previous study on the eating habits of international college students [13], the reasons most frequently given for the use of dietary supplements were to get enough nutrition and to reduce fatigue. Another study on the use of dietary supplements by international and U.S. students [14] reported that the major reasons for using dietary

supplements in both groups were related to a belief that dietary supplements could prevent or cure specific medical conditions.

In South Korea, there were studies on the use of dietary supplements among Korean college students [15-18] along with cross-cultural studies on the dietary behavior and lifestyles of Chinese international and Korean college students [3,19]. However, very little is known about the differences in the use of dietary supplements between Chinese international and Korean college students. Therefore, the purpose of this study was to compare and analyze the use of dietary supplements and related factors between Chinese international and Korean college students living in South Korea.

SUBJECTS AND METHODS

Data collection

Two online surveys were conducted from January 18 to February 22, 2021, on Chinese international and Korean college students attending 4-year college in South Korea and aged 18 years and over. The survey of Chinese international students was conducted using the snowball sampling method. The uniform resource locator (URL) for the online survey was sent to WeChat (the Chinese instant messaging mobile app) individual or group chat rooms created by Chinese international students from several universities, namely, Busan University of Foreign Studies, Dankook University, Ewha Womans University, Hongik University, Inha University, Konkuk University, Kyung Hee University (Seoul and global campus), Seoul National University, Sungkyunkwan University (Seoul campus only), and Yonsei University (Seoul campus only). Responses were received from 469 Chinese international students, of which 400 were used for analysis, and 69 were excluded as being incomplete or having missing answers to some questions. The survey of Korean college students attending universities located in Seoul and Gyeonggi-do was conducted by Macromill Embrain Co. Ltd., an online research services company. The responses from 452 Korean college students were used for analysis. The study was approved by the Institutional Review Board of the Seoul National University (IRB No. 2012/001-021).

Study instrument

The questionnaire for this study was designed based on previous studies related to the use of dietary supplements by university students in South Korea [16,17] and other countries [20-24]. The questionnaire was originally written in Korean and then translated into Chinese. A pilot survey was administered to seven Korean graduate students majoring in food and nutrition in a university and ten Chinese graduate students from several universities in South Korea. Based on the results of this pilot survey, the questionnaire was modified to the final version in both Korean and Chinese. Instead of the term 'dietary supplements', the term 'Health Functional Foods' was used in the Korean questionnaire because the latter term is more commonly used in South Korea. On the other hand, the term 'Health Foods' was used in the Chinese questionnaire because this term is common in China.

The final version of the questionnaire comprised three main parts. The first part of the questionnaire was about perception of and attitude toward dietary supplements. The scale to measure the above comprised eight and seven items, respectively. Each item was measured by a 5-point Likert scale ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). Higher scores indicate more positive perception of or attitude toward dietary supplements.

The second part of the questionnaire was about the use of dietary supplements. Respondents were asked if they had consumed dietary supplements at least once in the year preceding the survey, and were then classified into users and non-users. The users were queried on their frequency of dietary supplement consumption, type of dietary supplements consumed, the reason for consuming dietary supplements, purchaser, place of purchase, and information source for dietary supplements. Non-users were asked the reason for their not consuming dietary supplements.

The last part of the questionnaire was about the general characteristics of the study subjects. The data sourced included age, gender, student classification, household type, monthly allowance, weight, height, smoking status, exercise frequency, self-reported health status, and interest in health. Chinese international students were also asked about their length of residence in South Korea. The self-reported health status and interest in health were measured respectively using a Likert-type scale ranging from 1 to 5 (self-reported health status: 1 = very poor, 2 = poor, 3 = neither good nor poor, 4 = good, 5 = very good; interest in health: 1 = very low, 2 = low, 3 = neither high nor low, 4 = high, 5 = very high).

Data analysis

Body mass index (BMI) was calculated using weight and height. The subjects were classified into underweight (BMI < 18.5), normal ($18.5 \leq \text{BMI} < 25.0$), overweight ($25.0 \leq \text{BMI} < 30.0$), and obese (BMI ≥ 30.0) groups based on the BMI classification of the World Health Organization (WHO) [25]. According to the self-reported health status, respondents were classified into three groups: the 'poor group' with 1 or 2 points, the 'moderate group' with 3 points, and the 'good group' with 4 or 5 points. According to the interest in health, respondents were classified into two groups: the 'low-interest group' who scored 3 or lower and the 'high-interest group' who scored higher than 3.

The results of the analysis were reported as means and standard deviations for continuous data, and frequencies and percentages for categorical data. The difference between Chinese international and Korean college students was tested for statistical significance using independent sample *t*-test, Pearson chi-square test, Fisher's exact test, and multivariate analysis of variance.

Confirmatory factor analysis was conducted to test the reliability and validity of the measurement variables concerning perception of and attitude toward dietary supplements. Multi-group structural equation modeling was used to test significant differences between Chinese international and Korean college students, in the relationships among perception of and attitude toward dietary supplements, and the use of dietary supplements.

Binary logistic regression analysis was used to examine the factors associated with the use of dietary supplements. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported. According to the perception of and attitude toward dietary supplements, respondents were classified into the 'low-positive group' (less than 3 points) and the 'high-positive group' (3 and higher than 3 points) based on an average of 3 points. For analyses, the significance level was set at *P*-values less than 0.05. All data were analyzed using the statistical package SPSS (version 25.0; SPSS Inc., Armonk, NY, USA) and AMOS (version 26.0; SPSS Inc.) software.

RESULTS

General characteristics of the survey respondents

Table 1 shows the general characteristics of the survey respondents. Dietary supplement use, student classification, household type, monthly allowance, smoking status, exercise frequency, and self-reported health status showed significant differences between the Chinese international and Korean college students. Approximately 65% of the Chinese international students and 93% of the Korean college students had consumed dietary supplements at least once in the year preceding the survey ($P < 0.001$). There was a significant difference in student classification between the two groups ($P < 0.001$) although seniors accounted for the largest proportion of students in both groups. The proportion of the Chinese international students who lived alone was more than those who lived with parents, while the proportion of the Korean college students who lived with their parents was more than those who lived alone ($P < 0.001$). The highest monthly allowances for the Chinese international students were KRW 500,000 and over, while that for the Korean college students was less than KRW 200,000 ($P < 0.001$).

There was a significant difference in smoking status between the two groups ($P = 0.011$) although non-smokers were more than smokers in both groups. There was a significant difference in exercise frequency between the two groups ($P < 0.001$) although the three times or less per month. Exercise frequency was highest in both groups. There was a significant difference in self-reported health status between the two groups ($P = 0.048$) although the moderate health status was high in both groups.

There was no significant difference in age, gender, weight status, and interest in health between the two groups. The mean age of each group was about 23 years. The proportion of female students (about 70%) was higher than that of male students in both groups. In terms of weight status, about two-thirds of the students in each group were normal. There were more students in the two groups with high interest in health than those with low interest. The highest length of residence in South Korea for Chinese international students was 4 or more years.

Use of dietary supplements

Table 2 shows the comparison of the use of dietary supplements between Chinese international and Korean college students. There was a significant difference in the frequency of dietary supplement consumption between the two groups ($P < 0.001$). The highest frequency of dietary supplement consumption among Chinese international students was one to three times per month, while the highest among Korean college students was daily. The most commonly consumed dietary supplements in both groups were vitamin-mineral supplements, followed by *Lactobacillus* products and red ginseng products. The most common reasons for consuming dietary supplements were nutritional supplementation, health improvement, and immunity boost.

There was a significant difference between the purchasers of dietary supplements in the two groups ($P < 0.001$). Most Chinese international students (85.3%) purchased dietary supplements on their own. On the other hand, about 60% (58.9%) of Korean college students purchased dietary supplements on their own while almost 40% (39.7%) of students said that their parents purchased the supplements on their behalf.

Dietary supplement use and related factors

Table 1. General characteristics of the survey respondents

Classification	Chinese students ¹⁾ (n = 400)	Korean students ²⁾ (n = 452)	χ^2 or t	P-value ³⁾
Dietary supplement use ⁴⁾			107.576	< 0.001
Yes	258 (64.5)	421 (93.1)		
No	142 (35.5)	31 (6.9)		
Age (yrs)	22.5 ± 2.50	22.8 ± 2.12	1.670	0.095
Gender			0.077	0.782
Male	116 (29.0)	135 (29.9)		
Female	284 (71.0)	317 (70.1)		
Student classification			21.258	< 0.001
Freshman	63 (15.8)	31 (6.9)		
Sophomore	67 (16.8)	94 (20.8)		
Junior	81 (20.3)	122 (27.0)		
Senior	189 (47.3)	205 (45.4)		
Household type			260.224	< 0.001
Living with parents	129 (32.3)	390 (86.3)		
Living alone	271 (67.8)	62 (13.7)		
Monthly allowance (KRW)			105.009	< 0.001
< 200,000	44 (11.0)	141 (31.2)		
200,000 to < 300,000	61 (15.2)	96 (21.2)		
300,000 to < 400,000	64 (16.0)	93 (20.6)		
400,000 to < 500,000	65 (16.3)	56 (12.4)		
≥ 500,000	166 (41.5)	66 (14.6)		
Weight status ⁵⁾			3.843	0.279
Underweight	89 (22.3)	79 (17.5)		
Normal	266 (66.5)	310 (68.6)		
Overweight	32 (8.0)	46 (10.2)		
Obese	13 (3.2)	17 (3.8)		
Smoking status			6.436	0.011
Smokers	63 (15.8)	45 (10.0)		
Non-smokers	337 (84.2)	407 (90.0)		
Exercise frequency			49.818	< 0.001
≤ 3 times/mon	274 (68.5)	201 (44.5)		
1–2 times/wk	67 (16.8)	128 (28.3)		
≥ 3 times/wk	59 (14.8)	123 (27.2)		
Self-reported health status ⁶⁾			6.083	0.048
Poor	47 (11.8)	73 (16.2)		
Moderate	233 (58.3)	228 (50.4)		
Good	120 (30.0)	151 (33.4)		
Interest in health ⁷⁾			1.191	0.275
Low	104 (26.0)	103 (22.8)		
High	296 (74.0)	349 (77.2)		
Length of residence in South Korea (yrs)		n/a	n/a	n/a
< 1	67 (16.8)			
1 to < 2	84 (21.0)			
2 to < 3	63 (15.8)			
3 to < 4	73 (18.3)			
≥ 4	113 (28.2)			

Values are presented as mean ± SD or number (%).

n/a, not available; BMI, body mass index.

¹⁾Chinese international students.

²⁾Korean college students.

³⁾By Pearson chi-square or t-test.

⁴⁾Response to the question of whether respondents consumed dietary supplements at least once in the year preceding the survey or not.

⁵⁾Underweight: BMI < 18.5 kg/m², normal: 18.5 kg/m² ≤ BMI < 25.0 kg/m², overweight: 25.0 kg/m² ≤ BMI < 30.0 kg/m², obese: BMI ≥ 30.0 kg/m²

⁶⁾Poor: 1 or 2 points, Moderate: 3 points, good: 4 or 5 points by a Likert-type scale.

⁷⁾Low: ≤ 3 points, high: > 3 points by a Likert-type scale.

There was also a significant difference in place of purchase between the two groups ($P < 0.001$). Most of the participants in both groups bought dietary supplements online, but the proportion of Chinese international students who bought dietary supplements in drugstores

Dietary supplement use and related factors

Table 2. Comparison of dietary supplement use between Chinese international and Korean college students

Classification	Chinese students ¹⁾ (n = 258)	Korean students ²⁾ (n = 421)	χ^2	P-value ³⁾
Frequency of dietary supplement consumption			44.843	< 0.001
Every day	46 (17.8)	149 (35.4)		
5–6 times/wk	18 (7.0)	29 (6.9)		
3–4 times/wk	44 (17.1)	73 (17.3)		
1–2 times/wk	48 (18.6)	92 (21.9)		
1–3 times/mon	80 (31.0)	59 (14.0)		
Very seldom	22 (8.5)	19 (4.5)		
Type of dietary supplements consumed (multiple responses)			n/a	n/a
Vitamin-mineral supplements	161 (62.4)	369 (87.6)		
<i>Lactobacillus</i> products	131 (50.8)	331 (78.6)		
Red ginseng products	82 (31.8)	230 (54.6)		
Squalene products	38 (14.7)	2 (0.5)		
Grape seed oil products	35 (13.6)	11 (2.6)		
β -carotene products	33 (12.8)	8 (1.9)		
EPA/DHA products	13 (5.0)	46 (10.9)		
Propolis products	11 (4.3)	53 (12.6)		
Others ⁴⁾	82 (31.8)	203 (48.2)		
Reason for consuming dietary supplements (multiple responses)			n/a	n/a
Nutritional supplementation	147 (57.0)	191 (45.4)		
Health improvement	113 (43.8)	214 (50.8)		
Immunity boost	81 (31.4)	140 (33.3)		
Digestion improvement	40 (15.5)	44 (10.5)		
Recovery from fatigue	29 (11.2)	130 (30.9)		
Disease prevention	29 (11.2)	51 (12.1)		
Others ⁵⁾	57 (22.1)	72 (17.1)		
Purchaser			78.753	< 0.001
Self	220 (85.3)	248 (58.9)		
Parents	26 (10.1)	167 (39.7)		
Friends	9 (3.5)	4 (0.9)		
Others ⁶⁾	3 (1.1)	2 (0.5)		
Place of purchase			127.880	< 0.001
Online	96 (37.2)	257 (61.0)		
Drugstore ⁷⁾	74 (28.7)	18 (4.3)		
Pharmacy	50 (19.4)	65 (15.4)		
Multi-level marketing company	13 (5.0)	1 (0.2)		
Mart	11 (4.3)	39 (9.3)		
Department store	10 (3.9)	9 (2.1)		
Home shopping on TV	1 (0.4)	26 (6.2)		
Others ⁸⁾	3 (1.2)	6 (1.4)		
Information source (multiple responses)			n/a	n/a
Family or friends (acquaintances)	164 (63.6)	317 (75.3)		
Internet	162 (62.8)	230 (54.6)		
Newspaper/magazine/TV	74 (28.7)	83 (19.7)		
Expert	31 (12.0)	59 (14.0)		
Journal	26 (10.1)	8 (1.9)		
Purchasing agent	15 (5.8)	15 (3.6)		
Others ⁹⁾	2 (0.8)	1 (0.2)		

Values are presented as numbers (%).

n/a, not available due to multiple responses.

¹⁾Chinese international students.

²⁾Korean college students.

³⁾By Pearson chi-square test (frequency of dietary supplement consumption and place of purchase) or Fisher's exact test (purchaser).

⁴⁾Spirulina products, apricot extract, γ -linolenic acid, chlorella, mushroom, fructooligosaccharide, lecithin, chitooligosaccharide products, ginseng products, glucosamine products, royal-jelly products, aloe products, etc.

⁵⁾Improve memory, improve skin, weight loss, sleep improvement, disease treatment, physical strength, etc.

⁶⁾Received as a promotion gift.

⁷⁾Drugstores such as Olive Young and Watsons without prescription.

⁸⁾Duty-free shop, gifts, unknown because dietary supplements were purchased by parents or family.

⁹⁾Hospital, college class.

and pharmacies was relatively higher than that of Korean college students. Family or friends (acquaintances) and the internet were most common sources of information on dietary supplements in both groups.

Table 3 shows the comparison between Chinese international and Korean college students of the reasons for not consuming dietary supplements. There was a significant difference in the reasons between the two groups ($P < 0.001$). Among Chinese international students, the major reasons were 'There is no need because I am healthy' (29.6%), 'I am concerned about their side effects' (20.4%), and 'I distrust their efficacy' (19.7%). Among Korean college students, the major reasons were 'I distrust their efficacy' (29.0%), 'The cost is high' (22.6%), and 'Exercise is all I need to be healthy' (16.1%).

Perception of and attitude toward dietary supplements

The results of confirmatory factor analysis on the perception of and attitude toward dietary supplements are shown in **Table 4**. Although the χ^2 value was significant in this study, other goodness-of-fit indices such as goodness of fit index, adjusted goodness of fit index, and comparative fit index were higher than 0.9, and root mean square residual was less than 0.05. Therefore, the model could be termed acceptable. The perception of dietary supplements encompassed three factors while the attitude toward dietary supplements was based on a single factor. There were three factors involved in the perception of dietary supplements which were termed 'Perception of the need for expert opinions,' 'Perception of the consumption of dietary supplements by family and friends,' and 'Perception of the functions of dietary supplements,' and the single factor of attitude was termed 'Attitude toward dietary supplements.'

Table 5 shows the comparison of the perception of and attitude toward dietary supplements between Chinese international and Korean college students. The mean score of 'Perception of the need for expert opinions' of Chinese international students was higher compared to that of Korean college students ($P < 0.001$). On the other hand, the mean scores of 'Perception of the consumption of dietary supplements by family and friends' and 'Perception of the functions of dietary supplements' of Korean college students were both higher than those of Chinese international students ($P < 0.001$). Also, the mean score of 'Attitude toward dietary supplements' of the Chinese international students was significantly lower than that of the Korean college students ($P < 0.001$).

Table 3. Comparison of the reasons for not consuming dietary supplements between Chinese international and Korean college students

Contents	Chinese students ¹⁾ (n = 142)	Korean students ²⁾ (n = 31)	χ^2	P-value ³⁾
Reason for not consuming dietary supplements			30.768	< 0.001
There is no need because I am healthy.	42 (29.6)	2 (6.5)		
I am concerned about their side effects.	29 (20.4)	1 (3.2)		
I distrust their efficacy.	28 (19.7)	9 (29.0)		
Three meals a day is all I need to be healthy.	15 (10.6)	2 (6.5)		
Exercise is all I need to be healthy.	11 (7.7)	5 (16.1)		
It is a waste of money.	9 (6.3)	2 (6.5)		
The cost is high.	8 (5.6)	7 (22.6)		
Others ⁴⁾	0 (0.0)	3 (9.7)		

Values are presented as numbers (%).

¹⁾Chinese international students.

²⁾Korean college students.

³⁾By Fisher's exact test.

⁴⁾Lazy to eat, forget to eat easily, etc.

Dietary supplement use and related factors

Table 4. Results of confirmatory factor analysis on perception of and attitude toward dietary supplements of Chinese international and Korean college students (n = 852)

Factor	Item	Standardized loading	t-value	Cronbach's α
Perception 1: Need for expert opinions	Expert opinions are needed when buying DS.	0.871	-	0.862
	Expert opinions are needed when consuming DS.	0.869	4.613***	
Perception 2: Consumption of DS by family and friends	Most of my friends consume DS.	0.607	-	0.656
	Most of my family consumes DS.	0.805	12.305***	
Perception 3: Functions of DS	DS can prevent chronic disease.	0.552	-	0.685
	DS can treat disease.	0.441	10.281***	
	DS have excellent efficacy.	0.484	11.020***	
	DS are healthful.	0.804	14.746***	
Attitude toward DS	I am usually interested in DS.	0.764	-	0.933
	I think favorably of DS.	0.870	27.185***	
	I prefer consuming DS.	0.845	33.152***	
	I try to consume DS for my health.	0.823	25.478***	
	I think the money spent on DS is worth it.	0.792	24.311***	
	I would recommend consuming DS to family or friends.	0.769	23.461***	
	I believe DS help to maintain health.	0.819	25.226***	

DS, dietary supplements.

Model fit: $\chi^2 = 362.375$ (df = 81, $P < 0.001$), root mean square residual = 0.039, goodness of fit index = 0.946, adjusted goodness of fit index = 0.919, comparative fit index = 0.960, root mean square error of approximation = 0.064.

*** $P < 0.001$.

Table 5. Comparison of perception of and attitude toward dietary supplements between Chinese international and Korean college students

Classification	Chinese students ¹⁾ (n = 400)	Korean students ²⁾ (n = 452)	F ³⁾
Perception 1: Need for expert opinions	4.06 ± 0.92	3.54 ± 0.82	74.894***
Expert opinions are needed when buying DS.			
Expert opinions are needed when consuming DS.			
Perception 2: Consumption of DS by family and friends	3.17 ± 1.03	3.44 ± 0.74	19.983***
Most of my friends consume DS.			
Most of my family consumes DS.			
Perception 3: Functions of DS	2.85 ± 0.75	3.20 ± 0.55	60.644***
DS can prevent chronic disease.			
DS can treat disease.			
DS have excellent efficacy.			
DS are healthful.			
Attitude toward DS	3.02 ± 0.99	3.59 ± 0.64	102.741***
I am usually interested in DS.			
I think favorably of DS.			
I prefer consuming DS.			
I try to consume DS for my health.			
I think the money spent on DS is worth it.			
I would recommend consuming DS to family or friends.			
I believe DS help to maintain health.			

DS, dietary supplements.

Values are presented as mean ± SD, scored by a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree).

¹⁾Chinese international students.

²⁾Korean college students.

³⁾By multivariate analysis of variance.

*** $P < 0.001$.

Fig. 1 shows the results of multi-group structural equation modeling that identified the relationships between the perception of and attitude toward dietary supplements, and the use of these supplements among Chinese international and Korean college students. 'Perception of the consumption of dietary supplements by family and friends' and 'Perception of the functions of dietary supplements' positively influenced 'Attitude toward dietary supplements,' while 'Perception of the need for expert opinions' did not influence attitude significantly.

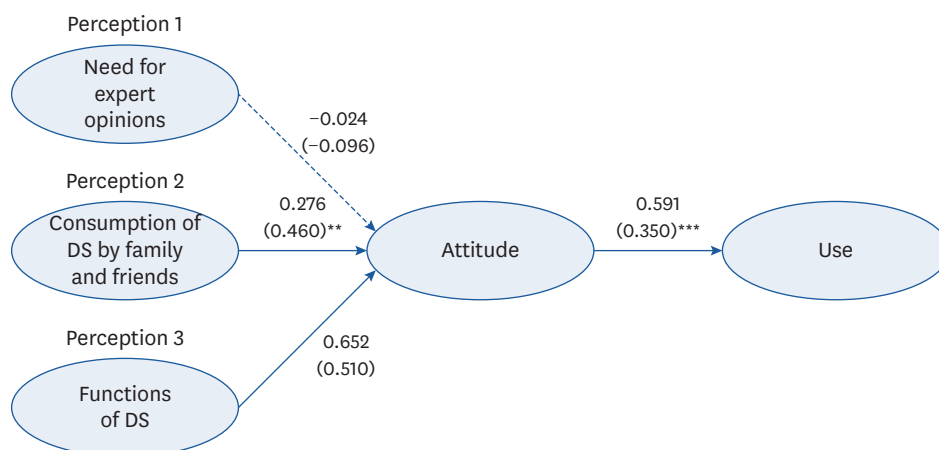


Fig. 1. Effect of perception of and attitude toward dietary supplements on dietary supplement use of Chinese international and Korean college students using multi-group structural equation modeling.

Note: Numbers on paths are standardized regression coefficients. Outside the brackets are the standardized regression coefficients for Chinese international students, and inside the brackets are the standardized regression coefficients for Korean college students. The dashed line indicates a non-significant path. The solid lines indicate significant paths.

DS, dietary supplements.

Model fit: $\chi^2 = 591.889$ (df = 194, $P < 0.001$), goodness of fit index = 0.940, Tucker-Lewis index = 0.925, root mean square error of approximation = 0.049.

** $P < 0.01$, *** $P < 0.001$ by multi-group structural equation modeling.

The effect of ‘Perception of the consumption of dietary supplements by family and friends’ on ‘Attitude toward dietary supplements’ was different between Chinese international and Korean college students. The effect of ‘Perception of the consumption of dietary supplements by family and friends’ on ‘Attitude toward dietary supplements’ was lower for the Chinese international students than for Korean college students ($\beta = 0.276$ vs. 0.460 , $P < 0.01$). However, the effect of ‘Perception of the functions of dietary supplements’ on ‘Attitude toward dietary supplements’ was not significantly different between the two groups. Lastly, ‘Attitude toward dietary supplements’ positively influenced the use of dietary supplements and this effect was larger for Chinese international students than for Korean college students ($\beta = 0.591$ vs. 0.350 , $P < 0.001$).

Factors associated with the use of dietary supplements

Table 6 shows the factors associated with the use of dietary supplements. In the Chinese international students’ group, older students were more likely to use dietary supplements (OR, 1.19; 95% CI, 1.03–1.37). Students who considered themselves to be in poor health status were more likely to use dietary supplements than those in good health (OR, 3.64; 95% CI, 1.24–10.69). In terms of interest in health, the high-interest group was more likely to use dietary supplements than the low-interest group (OR, 2.10; 95% CI, 1.13–3.87). It was also shown that perception of (OR, 2.02; 95% CI, 1.15–3.55) and attitude toward (OR, 9.04; 95% CI, 4.92–16.63) dietary supplements were significantly associated with their use. Students who had high-positive perception of or attitude toward dietary supplements were more likely to use them than the low-positive students. Students residing in South Korea for one to two years were more likely to be dietary supplement users than those for less than one year (OR, 2.55; 95% CI, 1.09–5.98).

For Korean college students, the use of dietary supplements was associated with their exercise frequency and attitude toward dietary supplements. Students who exercised three times or more per week were more likely to use dietary supplements than those who exercised three times or less per month (OR, 3.82; 95% CI, 1.07–13.61). Students who had high-positive attitude toward dietary supplements were more likely to use them than low-positive students (OR, 12.84; 95% CI, 4.92–33.50).

Dietary supplement use and related factors

Table 6. Comparison of the factors associated with dietary supplement use between Chinese international and Korean college students using logistic regression analysis

Classification	Chinese students ¹⁾ (n = 400)			Korean students ²⁾ (n = 452)		
	n (O/1)	β	OR (95% CI)	n (O/1)	β	OR (95% CI)
Age (yrs)	142/258	0.170	1.19* (1.03–1.37)	31/421	0.284	1.33 (0.98–1.80)
Gender						
Male	46/70		[Ref]	11/124		[Ref]
Female	96/188	0.529	1.70 (0.93–3.10)	20/297	0.591	1.81 (0.63–5.17)
Student classification						
\leq Junior	71/140	0.536	1.71 (0.85–3.46)	19/228	0.453	1.57 (0.51–4.86)
\geq Senior	71/118		[Ref]	12/193		[Ref]
Household type						
Living with parents	61/68		[Ref]	28/362		[Ref]
Living alone	81/190	0.528	1.70 (0.97–2.98)	3/59	0.416	1.52 (0.38–5.98)
Monthly allowance (KRW)						
$<$ 200,000	24/20		[Ref]	14/127		[Ref]
200,000 to $<$ 400,000	45/80	0.294	1.34 (0.54–3.34)	11/178	0.638	1.89 (0.72–4.96)
\geq 400,000	73/158	0.313	1.37 (0.57–3.30)	6/116	0.602	1.83 (0.59–5.69)
Smoking status						
Smokers	24/39		[Ref]	5/40		[Ref]
Non-smokers	118/219	-0.058	0.94 (0.46–1.92)	26/381	1.091	2.98 (0.78–11.44)
Exercise frequency						
\leq 3 times/mon	104/170		[Ref]	20/181		[Ref]
1–2 times/wk	20/47	0.330	1.39 (0.67–2.88)	7/121	0.411	1.51 (0.53–4.26)
\geq 3 times/wk	18/41	0.166	1.18 (0.52–2.71)	4/119	1.341	3.82* (1.07–13.61)
Self-reported health status ³⁾						
Poor	9/38	1.293	3.64* (1.24–10.69)	3/70	0.702	2.02 (0.44–9.33)
Moderate	91/142	-0.074	0.93 (0.49–1.75)	21/207	-0.400	0.67 (0.24–1.91)
Good	42/78		[Ref]	7/144		[Ref]
Interest in health ⁴⁾						
Low	46/58		[Ref]	14/89		[Ref]
High	96/200	0.740	2.10* (1.13–3.87)	17/332	0.427	1.53 (0.59–3.96)
Perception of dietary supplements ⁵⁾						
Low-positive	106/105		[Ref]	16/139		[Ref]
High-positive	36/153	0.702	2.02* (1.15–3.55)	15/282	-0.006	0.99 (0.41–2.44)
Attitude toward dietary supplements ⁵⁾						
Low-positive	123/87		[Ref]	23/76		[Ref]
High-positive	19/171	2.202	9.04*** (4.92–16.63)	8/345	2.552	12.84*** (4.92–33.50)
Length of residence in South Korea (yrs)						
$<$ 1	34/33		[Ref]	n/a		n/a
1 to $<$ 2	24/60	0.936	2.55* (1.09–5.98)			
2 to $<$ 3	21/42	0.699	2.01 (0.82–4.96)			
3 to $<$ 4	23/50	0.290	1.34 (0.53–3.37)			
\geq 4	40/73	0.390	1.48 (0.58–3.76)			

Dependent variable: use of dietary supplements (0 = non-use, 1 = use).

OR, odds ratio; CI, confidence interval; n/a, not available.

¹⁾Chinese international students: model $\chi^2 = 150.836$ ($P < 0.001$), Hosmer and Lemeshow test $\chi^2 = 5.953$ ($P = 0.652$).

²⁾Korean college students: model $\chi^2 = 61.487$ ($P < 0.001$), Hosmer and Lemeshow test $\chi^2 = 12.814$ ($P = 0.118$).

³⁾Poor: 1 or 2 points, Moderate: 3 points, good: 4 or 5 points by a Likert-type scale.

⁴⁾Low: \leq 3 points, high: $>$ 3 points by a Likert-type scale.

⁵⁾Low: $<$ 3 points, high: \geq 3 points by a 5-point Likert scale.

* $P < 0.05$, *** $P < 0.001$ by logistic regression analysis.

DISCUSSION

With the growing interest in nutrition and health, the use of dietary supplements has increased among young people in their 20s. We found that 64.5% of the Chinese international students and 93.1% of the Korean college students had consumed dietary supplements at least once in the year preceding the survey. The prevalence of dietary supplement use by Korean college students in the present study was higher than the

prevalence of 46.3% of adults in their 20s reported in the Korea Health Statistics 2020 [26]. This difference in the prevalence is mainly due to the fact that the questions used as part of the survey for this study and those used in the Korea Health Statistics 2020 survey were different. The question in this study was about the use of dietary supplements at least once in the year preceding the survey, while the question of the Korea National Health and Nutrition Examination Survey (KNHANES VIII-2) which formed the basis of the data shown in the Korea Health Statistics 2020 was about the use of dietary supplements for more than two weeks over the past year.

The most common types of dietary supplements consumed by Chinese international and Korean college students were vitamin-mineral supplements, followed by *Lactobacillus* products and red ginseng products. In previous studies [18,27,28], the types of dietary supplements that college students consumed the most were nutritional supplement products such as vitamins, minerals, and proteins, which was consistent with the result of this study. In addition, the results of this study showed that the main reasons for consuming dietary supplements were nutritional supplementation, health improvement, and immunity boost. This is similar to the findings of previous studies conducted on college students and the general population [17,20,29,30].

The positive effect of the perception of the consumption of dietary supplements by family and friends on the student's attitude toward dietary supplements was lower for Chinese international students than for Korean college students. This may be due to the fact that most international students leave their families behind in their home countries. The proportion of Chinese international students living alone (67.8%) was also much higher than that of Korean college students in this study. In addition, the positive effect of perception on attitude could be related to the fact that most Chinese international students (85.3%) purchased dietary supplements by themselves.

In the present study, gender, monthly allowance, and smoking status were not observed to be factors influencing the use of dietary supplements by either Chinese international or Korean college students. However, previous studies reported mixed results on the association between such variables and dietary supplement use. One study which assessed the use of dietary supplements by university students in Seoul and Chungnam province [16] reported that students who were female or with higher monthly allowances were more likely to use dietary supplements. There was no difference in smoking status among users and non-users of supplements in the study. Another study that analyzed the use of dietary supplements by Korean university students in Seoul [17] reported no difference in gender and monthly allowance between users and non-users. However, this study reported that non-smokers were more likely to use dietary supplements.

A few studies have been published on the use of dietary supplements by international students in other countries. One recent study in the United States [13] used the focus group method to investigate the eating habits of international students including their use of dietary supplements. Another study also conducted in the United States [14] examined the relationship between the extent of dietary supplement use and three behavioral and cognitive parameters, namely, changes in the use of dietary supplements following arrival in the university community, reasons for using dietary supplements, and the level of nutritional knowledge associated with the use of dietary supplements. The current study adds to the body of knowledge in the area of the use of dietary supplements by international

college students and focuses on factors such as demographic information, lifestyles, and the perception of and attitude toward dietary supplements that could influence their use by international college students.

This study is the first to investigate and compare dietary supplement use and related factors among Chinese international and Korean college students. Furthermore, this study is meaningful because it analyzed and compared various related factors, including the general characteristics of the use of dietary supplements by college students and their perception of and attitude toward dietary supplements.

This study has some limitations as follows. First, the survey of Korean college students was conducted only for students attending 4-year universities in Seoul and Gyeonggi-do. Thus, the survey respondents may not be representative of Korean college students in general. Second, some respondents could have faced some confusion about the definition of dietary supplements even though we had included an explanation of the definition of dietary supplements in the questionnaire. The subjects could have assumed that dietary supplements were similar to health foods or over-the-counter medicines. Lastly, we did not investigate the impact of the pandemic on the use of dietary supplements, although this study was performed during the COVID-19 outbreak. It was reported that the worldwide interest in dietary supplements such as vitamin C and zinc had increased since the beginning of COVID-19 [31,32]. Thus, the COVID-19 pandemic could have been a major influencing factor in the use of dietary supplements by Chinese international as well as Korean college students.

The present study found that the use of dietary supplements was significantly associated with age, self-reported health status, interest in health, perception of and attitude toward dietary supplements, and the length of residence of Chinese international students in South Korea. Meanwhile, for Korean college students, the use of dietary supplements was associated with their exercise frequency and attitude toward dietary supplements.

In conclusion, there were significant differences in the consumption of dietary supplements and related factors between Chinese international and Korean college students. This would necessitate a difference in the content and approach of dietary supplement-related nutrition education programs catering to Chinese international students and those for Korean college students.

Nutrition education for college students should focus on including content on information about the functions and selection of dietary supplements. According to the results of this study, Chinese international students who considered themselves to be in poor health or those who had a high interest in health were more likely to use dietary supplements. Thus, nutrition education that provides information about the functions and use of dietary supplements is important, especially for Chinese international students. In the same vein, Korean college students who exercised more frequently were more likely to use dietary supplements. Therefore, it is expected that there is a need for further education on dietary supplements related to exercise. For example, information about dietary supplements in the form of proteins that help muscle development could be highlighted.

Such differences also suggest that the industry should consider the relevant characteristics of college students when developing and marketing dietary supplements. Furthermore, understanding the factors related to the use of dietary supplements would help shape the appropriate use of these supplements by Chinese international and Korean college students.

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