RESEARCH

A cross-sectional study of self-reported dietary supplement use, associated factors, and adverse events among young adults in Kuwait

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Abstract

Background Dietary supplements (DS) are commonly used to improve overall health status and correct nutritional deficiencies. However, with the global rise in DS use, there is an increased risk of misuse and/or excessive use leading to toxicity and adverse events (AE). Research on DS use and DS-related AE is limited in Kuwait. This study aimed to explore the prevalence of DS use, its associated factors, and reported AE in a population of young adults.

Methods A cross-sectional study was carried out using an online self-administered questionnaire. Non-probabilistic sampling was used via multiple social media platforms. Logistic regression analysis was performed to assess the association between sociodemographic, lifestyle characteristics and health status with DS use and AE.

Results The prevalence of DS use was 68.24%. DS use was found to be associated with age (odds ratio [OR] = 1.07, 95% confidence interval [CI] 1.03–1.13; p-value [p] = < 0.001) and being female (OR = 1.55, 95% CI 1.01–2.41; p = 0.047). AE related to DS use were found to be associated with having respiratory disorders (asthma) (OR = 2.09, 95% CI 1.07–4.05; p = 0.029) and digestive disorders (OR = 3.22, 95% CI 1.24–8.35; p = 0.016).

Conclusion The study findings provide valuable insights into current DS use in young adults in Kuwait, which may enable the strategic development of targeted interventions and health promotion awareness campaigns. Furthermore, they emphasize the necessity of implementing regulations and policies to effectively manage DS use and monitor AE reporting in Kuwait.

Keywords Dietary supplement use, Dietary supplement misuse, Adverse events, Young adults

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Introduction

Dietary supplements (DS) include a wide range of products containing various dietary ingredients, such as single and multivitamins, minerals, botanicals, probiotics, prebiotics and amino acids [1]. Vitamins and minerals are often used to correct specific micronutrient deficiencies, botanicals are valued for their unique health benefits, probiotics and prebiotics support gut health, and amino acids are popular for enhancing athletic performance. Despite their widespread use to address nutritional deficiencies, promote overall health and prevent diet-related diseases, there is a global trend of DS use, along with an increase in DS-related misuse and adverse events (AE) [1–3].

DS misuse due to improper dosage, duration of use, and/or manufacturing processes, pose a risk of toxicity and adverse events ranging from mild gastrointestinal discomfort to life-threatening complications [4]. Moreover, given the dose-dependent nature of DS on health and its potential interaction with medication, accurate DS product labelling is empirical [4, 5]. Regulations and monitoring of DS production and use has become a pressing public health challenge, exacerbated by varying regulatory frameworks across countries. Hence, ensuring adherence to safety and transparency in reporting AE is crucial [6].

Population-based estimates of DS use in the Arabian Gulf region are limited and prevalence of DS use varies widely. For instance, in Qatar one study reported that half (49.6%) of university students used health supplements (HS) whereas in the United Arab Emirates (UAE) 38.7% reported HS use [5, 7]. Moreover, while another study in the UAE reported a prevalence of DS use (39%), and further reported that the main motivator was to maintain good health (58%) and to ensure adequate nutrition (43%) [8]. In Saudi Arabia, 63.2% of the general population were found to be either currently using or previous users of DS [9]. In Kuwait, 71.4% of Kuwaiti nationals were reported to use natural health products (NHPs) [2], and 37% Kuwaiti university students were reported to use DS [10].

Kuwait's Department of Registration and Control of Medicinal and Botanical Drugs in the Ministry of Health oversees the registration and approval of DS, ensuring compliance with international standards to safeguard consumer health [11]. Despite regulatory efforts, there is limited population-based data and no current reporting or surveillance of AE. Therefore, this study aims to investigate the prevalence of DS use, explore its associated factors, and reported AE in a population of young adults. Findings may contribute to the development of public health initiatives aimed at the regulation of DS use and prevention of DS-related AE.

Research methods

Study design and participants

A cross-sectional study was conducted between February 9, 2022 and April 11, 2022. Non-probabilistic sampling was used to recruit a sample of young adults aged between 18 and 35 years old. The sample size was calculated based on a previously published study in the UAE that investigated the prevalence of DS use and associated factors among college students [12]. Based on this study's proportion, 95% confidence interval, and 5% margin of error, the minimum sample size required was 353. Considering non-responders, the sample size was increased by 20%, and thus resulting in a total required sample size of 424.

Inclusion and exclusion criteria

The study included young adults aged between 18 and 35 of any nationality residing in Kuwait, including both males and females. Participants younger than 18 or older than 35 years, and those not living in Kuwait were excluded.

Data collection

A validated self-administered questionnaire available in Arabic and English was used [5]. In line with public health measures to maintain social distancing, the questionnaire was disseminated online using a widely used platform; SurveyMonkey (San Mateo. Ca). A link to the study information, informed consent and questionnaire was advertised on social media platforms.

Measures

The questionnaire included six sections. '*Demographic factors*' included age, gender, nationality, area of residence (governorate), highest attained educational level, employment status, and income. '*Health and Lifestyle*' included self-reported weight (kilograms) and height (meters), and questions related to physical activity, smoking habits, and general medical health status. '*Dietary supplement use*' included questions related to DS definitions, self-reported duration and frequency of DS use, as well as reasons for purchasing DS. '*Information about Dietary Supplement Products*' included questions related to advice to use DS, and duration and dose of prescriptions from health care practitioners. Given the importance of product labeling, participants were also asked to describe the information on the label of DS products, whether these labels were useful, their concerns regarding DS labels, and if they follow the recommended dose of DS. '*Adverse Events Related to Dietary Supplement Use*' included a definition of AE, questions on whether self-reported AE related to DS use were ever experienced, self-reported severity of the AE (mild, moderate, severe, life threatening), and frequency of AE (once, occasionally,

Table 1 Characteristics of the study population, (*n*=529)

	All (*n*=529)	
Age, *yr**	*22*	*[7.00]*
Gender, n (%)		
Male	116	(21.93)
Female	413	(78.07)
Nationality, n (%)		
Non-Kuwaiti	82	(15.50)
Kuwaiti	447	(84.50)
Governorate, n (%)		
AlAhmadi	51	(9.64)
Capital	136	(25.71)
Farwaniya	77	(14.56)
Hawalli	145	(27.41)
Jahra	55	(10.40)
Mubarak AlKabeer	65	(12.29)
Highest Educational Level		
High school	157	(29.68)
Undergraduate	299	(56.52)
Postgraduate	73	(13.80)
Employed, n (%)		
No	342	(64.65)
Yes	187	(35.35)
Monthly Income[a], n (%)		
< 500 KD	16	(8.56)
500–1000 KD	55	(29.41)
> 1000–2000 KD	94	(50.27)
> 2000 KD	22	(11.76)
Body Mass Index, *kg/m^2**	*24.24*	*[6.32]*
Body Mass Index, kg/m^2, n (%)		
Underweight	32	(6.05)
Normal weight	259	(48.96)
Overweight	160	(30.25)
Obese	78	(14.74)
Physically Active, n (%)		
No	224	(42.34)
Yes	305	(57.66)
Diseases[b], n (%)		
Asthma	83	(15.69)
Skin disorder	33	(6.24)
Disease of the digestive system	30	(5.67)
Hypertension	11	(2.08)
High cholesterol	20	(3.78)
Diabetes	15	(2.84)
Thyroid issues	20	(3.78)
Anemia	6	(1.13)
Current Smoker, n (%)		
No	440	(83.18)
Yes	89	(16.82)

Data presented as number (frequency) for categorical variables and *Median [Interquartile range] for not normally distributed continuous variables, [a]Employed only (*n*=189), [b]Can choose more than one answer.

frequently). *'Reporting Adverse Events'* included questions on informing physicians of the DS use, and how participants report AE. Questionnaire used in the study (Additional file 1).

Analysis plan

All data was analyzed using STATA (Software for Statistics and Data Science) version 16.0. Descriptive statistics was used to summarize the demographic characteristics. Median (Interquartile range) and frequencies (percentages) were used for DS use and reported AE. The normality of continuous data was assessed using Shapiro-Wilk test. Chi-square test was used for categorical variables and Mann-Whitney-U for continuous variables were used to test the difference between subgroups of the sample. Univariate simple logistic regression analysis was performed to assess the association between DS use and independent variables, as well as between adverse events and independent variables. Variables with a p-value ≤ 0.1 in the univariate analysis were included in backward stepwise elimination to identify the variables that were adjusted for in the multivariate analysis. The multivariable logistic regression model was used to identify the factors associated with DS use and factors associated with experiencing adverse events. Statistical significance was set at p-value ≤ 0.05 with 95% confidence intervals (CI) for all analyses.

Results

A total of 649 participants agreed to participate, with 529 completing the survey, yielding a completion rate of 81.5%. The median age was 22 years, predominantly females (78.07%) and Kuwaiti nationals (84.50%). Most participants resided in Hawally governorate (27.41%) and the Capital governorate (25.71%), with more than half holding an undergraduate degree (56.52%). The majority were unemployed (64.65%), and half of the employed participants earned between 1000 and 2000 KD (Table 1).

Lifestyle characteristics and health status

The median body mass index (BMI) was 24.29 kg/m^2 and nearly half (48.96%) were of normal weight, 30.25% were overweight, 14.74% were obese, and 6.05% were underweight. More than half were physically active (57.66%), and the majority were non-smokers (83.3%). Commonly reported chronic conditions include asthma (15.69%), skin disorders (6.24%), and digestive disorders (5.67%) (Table 1).

Dietary supplement use

Among all respondents, 68.24% reported ever using DS, with 33.65% being past users and 34.59% current users. Among the past-users, the main reason for stopping was because they did not need them anymore (20.42%).

Table 2 Dietary supplement use among study population, (*n* = 529)

	n	(%)
DS Use		
Never	168	(31.76)
Yes, in the past	178	(33.65)
Yes, currently	183	(34.59)
Ever (current/past)	361	(68.24)
Reasons for stopping DS[a]		
Availability	13	(2.46)
Cost	16	(3.02)
Adverse events	12	(2.27)
Do not need	108	(20.42)
Irregular use	17	(3.21)
Reasons for using DS[a]		
Deficiency	181	(34.22)
Hair loss	176	(33.27)
Anemia	91	(17.20)
Digestive	33	(6.24)
Energy booster	54	(10.21)
Immune health	44	(8.32)
Pregnancy and breastfeeding	35	(6.62)
Weight management	81	(15.31)
Other	57	(10.77)
Purchasing of DS[a]		
Pharmacy	248	(46.88)
Clinic	52	(9.83)
Nutrition shops	89	(16.82)
Supermarket	15	(2.84)
Online stores	80	(15.12)
Type of DS[a]		
Vitamins	290	(54.82)
Minerals	113	(21.36)
Herbal	39	(7.37)
Weight loss	37	(6.99)
Sport nutrition	75	(14.18)
Form of DS[a]		
Tablet/capsule	277	(52.36)
Powder	79	(14.93)
Chews/gummies	68	(12.85)
Liquid/drops/sprays/lozenges	29	(5.48)

DS; Dietary Supplements, [a]Can choose more than one answer.

Ever-users predominantly used DS for a diagnosed deficiency (34.22%), hair loss (33.27%), anemia (17.20%), and for weight management (15.31%) (Table 2). The majority of respondents (64.31%) were daily DS users and 55.64% used 1 to 2 types of DS in their lifetime. Nearly half of the respondents (46.61%) reported that they used or currently use DS for more than one month but less than a year, 28.91% reported that they used DS for one to five years, and 17.11% used DS for less than a month. Vitamins were the most used DS (54.82%), followed by minerals (21.36%), and sport nutrition products (14.18%), with

Table 3 Information about dietary supplement products among study population, (*n* = 529)

	n	(%)
No. of times DS prescribed		
Once	104	(32.1)
Twice	56	(17.28)
Several times (more than twice)	111	(34.26)
Never	53	(16.36)
Advised to take DS[a]		
Self-recommendation	105	(19.85)
Friends/Relatives	93	(17.58)
Healthcare professional	200	(37.81)
Internet (social media)	64	(12.1)
Seek info on DS[a]		
Pharmacy	126	(23.82)
Physician	167	(31.57)
Internet	174	(32.89)
Relatives/Friends	58	(10.96)
Describe Info. on DS		
Very informative	82	(25.31)
Somewhat informative	193	(59.57)
Not informative	17	(5.25)
Don't read the label	32	(9.88)
Think info. on DS is useful		
No	33	(10.19)
Yes	291	(89.81)

DS; Dietary Supplements, [a]Can choose more than one answer.

the preferred form being tablets or capsules (52.36%) often purchased from a pharmacy (46.88%) (Table 2).

Information about Dietary Supplement products
Among the ever-users, 83.64% had been prescribed supplements by a health care practitioner at least once in their lifetime. The majority received advice on DS use from health professionals (37.81%) or decided to independently use DS (19.85%) (Table 3). Information was primarily obtained from internet sources (32.89%) and physicians (31.57%), followed by pharmacists (23.82%) and relatives/friends (10.96%). Most users found supplement labels somewhat informative (59.57%) and useful (90%), with 92.28% adhering to recommended label information (Table 3).

Adverse events related to DS Use and the reporting adverse events (AE)
Most participants (80.56%) did not experience any AE related to DS use. Among those reporting AE (19.44%), the majority reported mild AE, mild low blood pressure (4.8%), mild anxiety (4.8%), mild chest pain (5.1%), mild skin reactions (3.2%), and mild vomiting (4.8%). No patients reported severe or life-threatening AE. Additional Table 1 displays the severity of adverse events reported (Additional file 2). Approximately 86.67% reporting AE had informed a clinic or hospital, with

67.81% believed that AE surveillance would be beneficial (Table 4).

Associations of DS Use and experiencing adverse events

Univariate and multivariate logistic regression are presented in Table 5 for DS use. Age was significantly associated with greater odds of DS use (OR=1.07, 95% CI 1.03–1.11; $p<0.001$) and following adjustment for age and gender, the association remained significant (adjusted odds ratio [AOR]=1.07, 95% CI 1.03–1.13; $p<0.001$). At univariate analysis, there was no association between DS use and gender, however following adjustment, it was found that females had higher odds of using dietary supplements (AOR=1.55, 95% CI 1.01–2.41; $p=0.047$). Having a postgraduate degree and being employed were significantly associated with DS; however, were no longer significant following adjustment.

Univariate and multivariate logistic regression for experiencing adverse events is presented in Table 6. Predictors significantly associated with greater odds of experiencing adverse events include asthma, digestive disorder, and high cholesterol. After adjustment, asthma (AOR=2.09, 95% CI 1.07–4.05; $p=0.029$) and an existing digestive disorder (AOR=3.22, 95% CI 1.24–8.35; $p=0.016$) remained statistically significant.

Table 4 Adverse events related to dietary supplement use, ($n=529$)

	n	(%)
Ever experienced AE		
No	261	(80.56)
Yes	63	(19.44)
Frequency of AE		
Once	21	(33.87)
Occasionally	32	(51.61)
Frequently	9	(14.52)
Informed Physician of DS use		
No	21	(33.87)
Yes	41	(66.13)
Reported AE related to DS use		
No	32	(51.61)
Yes	30	(48.39)
Place reported AE		
Pharmacy	1	(3.33)
Clinic, Hospital	26	(86.67)
Seller helpline	3	(10.00)
Establishment of AE surveillance		
Definitely beneficial	217	(67.81)
Somewhat beneficial	53	(16.56)
Not sure	44	(13.75)
Not beneficial	5	(1.56)
Definitely not beneficial	1	(0.31)

DS; Dietary Supplements, AE; Adverse Events

Discussion

Dietary Supplements (DS) have gained popularity worldwide for a variety of reasons [13, 14]. Nevertheless, DS misuse and/or excessive use is also a rising public health problem [6]. The present study is the first study to explore the prevalence of DS use, its associated factors, and reported AE related to DS among young adults in Kuwait. In this study, the prevalence of ever using DS was 68.24%. Although there is a wide variation in prevalence of DS use worldwide, ranging from 17 to 66% among Japanese [15], Italian [16], US [17], and Croatian [18] young adults and university students. Our findings are comparable to some regional studies within the Arabian Gulf region and international studies. Regionally, the prevalence of DS use was also found to range from 32% in Qatar and 39% in UAE to 76.6% in Saudi Arabia among university students [7, 8, 19]. Our findings are comparable to a study in Saudi Arabia, where 63.2% of the general adult population were found to have previously used or currently use DS [9]. Moreover, whilst similar to a previous a study in Kuwait, where 71.4% of Kuwaiti nationals were found to use natural health products [2], another study among university students reported a lower prevalence (37%) of DS use [10]. Nevertheless, our findings are also in line with other studies carried out internationally. For instance in Malaysia, DS use among university students was similar to our study, ranging between 71.9% and 66.8% [20, 21]. Likewise, in the United States, data from the National Center for Health Statistics reported that 57.6% of adults were using DS [22]. However, it was slightly higher than others [7, 8, 23], for example a study in Poland among university students found that only 41% of students used DS within the last 6 months [23]. Differences in the prevalence of DS use could be attributed to differences in study populations, study design (e.g., duration of use and recall period) and the types of DS investigated. Thus, these discrepancies may influence reported prevalence rates, and hinder accurate comparisons.

Age and gender were found to be associated with DS in our study, whereby older students and females had a greater odds of DS use. These findings are similar to other studies regionally and internationally [5, 24, 25]. A recent study that compared the use of DS across six Arab countries found that out of the 64% of DS users, females were 2.5 times more likely to use DS, which is comparable our study [26]. Moreover, consistent with our findings, other studies carried out in the United Arab Emirates, United States, and Korea found a higher frequency of DS use among females compared to men [5, 22, 24]. The similarity in prevalence of DS use could be a result of higher level of health consciousness among females and greater health awareness, and motivation to maintaining good health and overall wellbeing compared to males. However, although previous studies found that DS use was

Table 5 Risk factors of Dietary supplement use among young adults in Kuwait

	Univariate (Crude)		Multivariate (Adjusted)	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Age, yr*	1.07 (1.03, 1.11)	**< 0.001**	1.07 (1.03, 1.13)	**< 0.001**
Gender, n (%)				
Male	1		1	
Female	0.66 (0.43, 1.02)	0.066	1.55 (1.01, 2.41)	**0.047**
Nationality, n (%)				
Non-Kuwaiti	1		1	
Kuwaiti	0.93 (0.55, 1.55)	0.788	0.84 (0.49, 1.44)	0.533
Governorate, n (%)				
AlAhmadi	1		1	
Capital	1.20 (0.60, 2.39)	0.604	1.08 (0.53, 2.18)	0.823
Farwaniya	0.98 (0.46, 2.07)	0.96	0.97 (0.45, 2.08)	0.950
Hawalli	0.97 (0.49, 1.92)	0.952	0.84 (0.42, 1.69)	0.644
Jahra	1.33 (0.58, 3.06)	0.498	1.22 (0.52, 2.85)	0.640
Mubarak AlKabeer	1.04 (0.47, 2.28)	0.907	0.78 (0.35, 1.75)	0.552
Highest Educational Level				
High school	1		1	
Undergraduate	1.22 (0.81, 1.82)	0.335	0.95 (0.62, 1.46)	0.840
Postgraduate	2.70 (1.36, 5.34)	**0.004**	1.61 (0.76, 3.38)	0.206
Employed, n (%)				
No	1		1	
Yes	1.92 (1.28, 2.89)	**0.001**	1.32 (0.77, 2.27)	0.298
Monthly Income[a], n (%)				
< 500 KD	1		1	
500–1000 KD	2.78 (0.85, 9.04)	0.088	1.82 (0.51, 6.43)	0.348
> 1000–2000 KD	2.87 (0.95, 8.68)	0.061	1.65 (0.49, 5.59)	0.810
> 2000 KD	3.50 (0.8, 15.16)	0.094	1.98 (0.40, 9.83)	0.840
Body Mass Index, kg/m^2*	1.03 (0.99, 1.07)	0.066	0.18 (0.98, 1.06)	0.289
Body Mass Index, kg/m^2, n (%)		*0.066*		
Underweight	1		1	
Normal weight	0.83 (0.38, 1.84)	0.663	0.72 (0.32, 1.61)	0.428
Overweight	1.06 (0.46, 2.40)	0.888	0.88 (0.38, 2.04)	0.769
Obese	1.41 (0.56, 3.50)	0.457	0.99 (0.38, 2.52)	0.985
Physically Active, n (%)		0.888		
No	1		1	
Yes	0.86 (0.59, 1.25)	0.434	0.81 (0.55, 1.21)	0.323
Diseases[b], n (%)				
Asthma	1.25 (0.74, 2.11)	0.389	1.28 (0.75, 2.18)	0.361
Skin disorder	0.53 (0.26, 1.09)	0.085	0.48 (0.23, 1.01)	0.052
Disease of the digestive system	1.29 (0.56, 2.97)	0.538	1.08 (0.46, 2.55)	0.854
Hypertension	2.12 (0.45, 9.93)	0.339	1.60 (0.32, 7.85)	0.561
High cholesterol	2.71 (0.78, 9.40)	0.114	1.87 (0.52, 6.69)	0.335
Diabetes	1.28 (0.40, 4.11)	0.668	0.98 (0.29, 3.32)	0.983
Thyroid issues	2.71 (0.78, 9.40)	0.114	2.25 (0.64, 7.96)	0.205
Anaemia				
Current Smoker, n (%)				
No	1		1	
Yes	1.25 (0.77, 2.02)	0.352	0.91 (0.52, 1.57)	0.732

Data presented as frequency (percentage) for categorical variables and * mean (standard deviation) for continuous variables. DS; Dietary Supplements, OR; Odds Ratio, [b]Employed only (*n* = 189), [c]Can choose more than one answer, [#]Adjusted for Age and Gender, Statistical significance set at < 0.05

Table 6 Risk factors of Dietary supplement related adverse events among young adults in Kuwait

	Univariate (Crude)		Multivariate (Adjusted)	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Age, *yr**	1.01 (0.96, 1.05)	0.606	1.01 (0.96, 1.05)	0.606
Gender, n (%)				
Male	1		1	
Female	0.79 (0.38, 1.62)	0.524	0.79 (0.38, 1.62)	0.524
Nationality, n (%)				
Non-Kuwaiti	1		1	
Kuwaiti	1.43 (0.63, 3.21)	0.384	1.43 (0.63, 3.21)	0.384
Governorate, n (%)				
AlAhmadi	1		1	
Capital	1.5 (0.54, 4.13)	0.433	1.5 (0.54, 4.13)	0.433
Farwaniya	0.85 (0.25, 2.82)	0.792	0.85 (0.25, 2.82)	0.792
Hawalli	1.32 (0.47, 3.65)	0.588	1.32 (0.47, 3.65)	0.588
Jahra	0.27 (0.05, 1.46)	0.129	0.27 (0.05, 1.46)	0.129
Mubarak AlKabeer	0.95 (0.28, 3.17)	0.94	0.95 (0.28, 3.17)	0.94
Highest Educational Level				
High school	1		1	
Undergraduate	1.55 (0.77, 3.09)	0.211	1.55 (0.77, 3.09)	0.211
Postgraduate	1.95 (0.82, 4.59)	0.127	1.95 (0.82, 4.59)	0.127
Employed, n (%)				
No	1		1	
Yes	1.16 (0.67, 2.03)	0.58	1.16 (0.67, 2.03)	0.58
Monthly Income[a], n (%)				
< 500 KD	1		1	
500–1000 KD	1.6 (0.17, 14.9)	0.68	1.6 (0.17, 14.9)	0.68
> 1000–2000 KD	2.61 (0.3, 22.44)	0.381	2.61 (0.3, 22.44)	0.381
> 2000 KD	2.18 (0.81, 15.1)	0.531	2.18 (0.81, 15.1)	0.531
Body Mass Index, *kg/m²**	0.99 (0.19, 25.02)	0.826	0.99 (0.19, 25.02)	0.826
Body Mass Index, kg/m², n (%)				
Underweight	1		1	
Normal weight	0.69 (0.21, 2.29)	0.548	0.69 (0.21, 2.29)	0.548
Overweight	0.87 (0.25, 2.94)	0.825	0.87 (0.25, 2.94)	0.825
Obese	0.81 (0.22, 2.98)	0.754	0.81 (0.22, 2.98)	0.754
Physically Active, n (%)				
No	1		1	
Yes	1.1 (0.63, 1.92)	0.729	1.1 (0.63, 1.92)	0.729
Diseases[b], n (%)				
Asthma	2.34 (1.23, 4.47)	**0.01**	2.34 (1.23, 4.47)	**0.01**
Skin disorder	1.95 (0.65, 5.85)	0.229	1.95 (0.65, 5.85)	0.229
Disease of the digestive system	3.78 (1.49, 9.58)	**0.005**	3.78 (1.49, 9.58)	**0.005**
Hypertension	0.51 (0.06, 4.15)	0.529	0.51 (0.06, 4.15)	0.529
High cholesterol	3.13 (1.14, 8.60)	**0.026**	3.13 (1.14, 8.60)	**0.026**
Diabetes	0.45 (0.05, 3.63)	0.455	0.45 (0.05, 3.63)	0.455
Thyroid issues	2.41 (0.77, 7.47)	0.126	2.41 (0.77, 7.47)	0.126
Current Smoker, n (%)				
No	1		1	
Yes	1.52 (0.75, 3.07)	0.237	1.52 (0.75, 3.07)	0.237

Data presented as frequency (percentage) for categorical variables and * mean (standard deviation) for continuous variables. OR; Odds Ratio, [b]Employed only (*n* = 189), [c]Can choose more than one answer, [#]Adjusted for Asthma and disease of the digestive system, Statistical significance set at < 0.05

positively associated with higher educational level, physical activity, and higher income [19, 24, 27], this study found no association. For instance, a study in France, found that DS use was higher in postgraduate students compared to undergraduate students, and suggested that older students are likely to be more health conscious of dietary recommendations and the benefits of using DS to rectify deficiencies [27]. The lack of such association in

this study could be due to sociodemographic differences in the current study population where participants were predominantly young, unemployed, and undergraduate university students.

Numerous studies have highlighted the increased risk of AE associated with dietary and health supplement use [28]. Previous studies show that up to 10% of DS users experience related AE, which vary from mild to severe requiring medical intervention [28, 29]. For instance, one study reported that emergency department visits due to DS-related AE are notably high, posing a significant public health issue. This highlights the critical need for monitoring supplement use and implementing proper regulations to reduce the risks associated with these products [28]. This risk is particularly significant for herbal supplements, which are more susceptible to contamination with heavy metals and pesticide residues [30, 31]. Furthermore, the lack of regulation for some dietary and health supplements results in an absence of transparency about their precise ingredients, potentially increasing the likelihood of AE [30–32]. In the current study, 19.44% reported experiencing adverse events due to DS use. This is notably higher than the 2.9% reported in UAE [5] and 8.2% in Saudi Arabia [33]. Conversely, in another study among undergraduate female students in Bangladesh 31.9% were found to have experienced AE-related to DS use [34]. Studies also reported that 5 to 8% of participants experienced nausea, vomiting and diarrhea [33, 34]. Adverse events reported in this study primarily (5%) included mild symptoms of such as low blood pressure, skin reactions, and vomiting. However, the severity of these AE is unclear, and require further exploration such that participants may not be able to accurately self-report AE without clinical investigation. Therefore, findings must be interpreted cautiously considering potential confounding such as preexisting health conditions and participants health literacy. Nevertheless, the study highlights potential concerns regarding DS safety in Kuwait and calls for rigorous monitoring and policies to regulate DS use and associated AE.

Strengths and limitations

To our knowledge, this is the first study that explored AE related to DS use in Kuwait. Our findings provide valuable insight into the current situation regarding DS use safety. The focus on young adults is particularly relevant given that they constitute the majority of DS users, and are often targeted through marketing and social media which is not regulated [35]. Nevertheless, it is key to note the limitations of this study. Firstly, the use of non- probabilistic sampling does not ensure that all participants had an equal chance of being included in the study leading to a non-representative sample and limits the generalizability of the findings beyond the study sample. Secondly, participants were selected based on their availability, raising a risk of selection bias, which may have influenced the study findings, making them less applicable to the general population. Thirdly, participants were primarily recruited in a university setting, and thus convenience bias may have influenced and biased the findings, such that there is an overrepresentation of university students and female participants, which in turn restricts the generalizability of the study findings. Fourthly, the use of self-reporting measures may have introduced information bias, leading to potential misreporting of DS use and AEs, and therefore it is difficult to infer whether DS use is the main reason for experiencing AE, or whether it was due to preexisting health conditions. Moreover, due to the self-reporting nature of this study, DS use is subjective to individuals' perception. This could potentially limit the interpretation of findings, as we cannot accurately estimate DS use in this population. For instance, participants may have been inclined to provide socially desirable responses related to DS use. Lastly, given that the study depended on self-reported AE associated with DS use, the findings should be interpreted cautiously since participants' health literacy could have impacted their awareness and comprehension of these AE, and their personal experiences might have influenced their reporting. To objectively determine whether DS caused the reported AEs, future studies should utilize clinical reporting.

Conclusion

This study provides comprehensive investigation into factors associated with DS use and related AE. The prevalence of DS use aligns with regional and international studies, highlighting its significance in the context of public health. It also emphasizes the importance of conducting larger population-based cohort studies to better understand the association between determinants of DS use and adverse effects. To effectively address the challenges posed by DS use, there is a need to establish a robust surveillance system for DS-related AE. Such system will enhance our understanding of DS-related AE and facilitate the development of targeted interventions and regulatory policies aimed at mitigating potential risk. Potential interventions may include the development of online platform integrating comprehensive information about DS, along with mechanisms for online consultations linked with the Ministry of Health.

Abbreviations

DS   Dietary Supplements
AE   Adverse Events
FDA   Food and Drug Administration
UAE   United Arab Emirates

Supplementary Information

Supplementary Material 1

Supplementary Material 2

Author contributions
All authors conceptualized the research, DT and ZS methodology and statistical analysis. All authors contributed to writing, reviewing, and editing of the article. All authors accept responsibility for the conduct of the study and for the analysis and interpretation of the data.

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Data availability
All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

Declarations

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Ethical approval and consent to Participate
The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Health Sciences Center, Kuwait University and the Ethics Committee of the Ministry of Health (2nd February 2022). All study participants consented for participation in this study. There were no risks in this research and participation was voluntary with freedom to withdraw at any time.

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