

ORIGINAL ARTICLE

Assessing Dietary Supplement Use, Health Status Perception, and Mediterranean Diet Adherence Among Young Adults: A Cross-sectional Study

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ABSTRACT

Introduction: Dietary supplement (DS) consumption has significantly increased, particularly post-COVID-19. However, the prevalence and determinants of DS intake among university students in Perak, Malaysia, remain underexplored. This study aimed to assess DS consumption, alongside knowledge, attitudes, and practices (KAP), and its association with perceived health status and Mediterranean diet adherence. **Methodology:** A cross-sectional study was conducted among students at Universiti Tunku Abdul Rahman (UTAR), Perak Campus. A validated questionnaire collected data on DS consumption patterns. Chi-square tests were used to examine differences between DS users and non-users across categorical sociodemographic variables. Logistic regression identified predictors of DS use, including knowledge, awareness of the Mediterranean diet, and perceived health status. **Results:** Among 278 respondents (25.9% male, 74.1% female), 38.8% reported DS use, with Vitamin C, fish oil, and Vitamin B complex being the most consumed. Poor knowledge (44.2%) and negative attitudes (61.2%) towards DS were common, regardless of usage. High-risk behaviours were exhibited by 50.9% of users. Significant associations were found between DS consumption and knowledge ($p=0.003$) as well as Mediterranean diet awareness ($p=0.016$), though no associations with gender, attitude, year of study, or education level were observed. **Conclusion:** Educational interventions are necessary to improve students' knowledge and awareness of DS, promoting safer consumption practices. Despite some awareness, the prevalence of high-risk behaviours highlights the need for professional guidance and monitoring.

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Introduction

Nutrition plays a vital role in maintaining optimal health and preventing chronic diseases. While a well-balanced diet remains the foundation for acquiring essential nutrients, dietary supplements (DS) have become an increasingly important means of complementing dietary intake [1]. According to the Dietary Supplement Health and Education Act (DSHEA) of 1994, DS are defined as non-drug, non-food products designed to supplement the diet, and not intended to treat, cure, or prevent disease [2]. These products may include vitamins, minerals, herbal extracts, amino acids, or a combination of these

components. The U.S. Food and Drug Administration (FDA) estimates that over 85,000 DS products are available in the United States alone [1]. Data from the National Health and Nutrition Examination Survey (NHANES) indicates that DS are widely consumed, with nearly half of U.S. adults and one-third of children using them regularly [3]. In Malaysia, findings from the 2014 Malaysian Adult Nutrition Survey (MANS) reported that 28.1% of adults used DS [4], with various studies indicating a potential rise in DS usage, particularly during the COVID-19 pandemic [5, 6].

Globally, the prevalence of DS consumption is on the rise, particularly among university students in regions such as Asia [6, 7], Canada [8], the Middle East [9], and Europe [10]. Despite the growing popularity of DS, concerns persist regarding the lack of knowledge, attitude

and good practice use of DS among young adults. The popularity of DS has surged, particularly among young adults, driven by aggressive marketing on social media platforms promoting the perceived health benefits of DS [11]. Previous studies have predominantly focused on specific populations, including the elderly [12, 13]. However, university students are often regarded as active and healthy but face unique challenges that can influence their future health. Therefore, it is important to explore this topic within this specific population.

Significant associations have been identified between healthy, active adults and a higher likelihood of DS consumption. For instance, studies from Japan and Saudi Arabia report a rising prevalence of DS use among university students, often motivated by the desire to improve physical strength, support weight loss, and ensure sufficient nutrient intake [14, 15]. The use of dietary supplements has become a significant aspect of modern health practices, driven by increasing awareness of nutrition's role in disease prevention and health promotion [16, 17]. Many young adults, however, lack adequate knowledge about DS, including potential interactions and side effects, and often fail to seek professional medical advice. This lack of awareness can lead to misconceptions, with some students erroneously perceiving DS as substitutes for food, despite their intended role as complementary rather than replacement components of the diet. Research shows that many students exhibit poor knowledge, attitudes, and practices regarding DS, relying on supplements as a replacement for a healthy lifestyle rather than prioritizing nutritious food [18]. Without proper knowledge, attitude, and good practice, this might lead to improper use of DS.

In Malaysia, only two quality studies assessed the knowledge, attitude, and practices of DS consumption at the university level [19, 20], and the results were not entirely consistent. Huong et al., [19] reported a generally low level of knowledge regarding nutritional health, especially concerning anaemia. Meanwhile, Mohd Radzi et al. [20] highlighted that the majority of students had a fair knowledge of DS, but their attitudes and practices were inconsistent. In addition, the lack of multivariate analysis in these studies presents a significant research gap. While these studies individually provide insights into knowledge, attitudes, and practices (KAP) related to dietary supplements (DS), none have examined external factors such as perceived health status or dietary adherence, particularly adherence to the Mediterranean diet, that may also influence DS consumption patterns. Therefore, this study aims to expand the existing body of knowledge by offering a more comprehensive understanding of the factors influencing DS use among young adults.

Additionally, this research incorporates unique external factors, such as perceived health status and adherence to the Mediterranean diet, in analysing dietary supplement

consumption patterns. Young adults with low adherence to the Mediterranean diet and poor perceived health status may seek supplements to fill perceived nutritional gaps. The Mediterranean diet was chosen for this study due to its widely recognized health benefits [21] and understanding adherence to this diet from a young age can provide valuable insights into its influence on DS consumption and overall health status among young adults. Exploring such relationship will offer valuable insights into how students' health perceptions affect their nutritional decisions and dietary behaviours.

Methodology

Study design

A cross-sectional, questionnaire-based study was conducted on a convenience sample from Universiti Tunku Abdul Rahman (UTAR) undergraduate students from November 2023 to February 2024. To ensure the study's objectives were met, specific inclusion and exclusion criteria were established for the study population. Ethical approval to conduct this study was obtained from the Research Ethics Committee of UTAR (U/SERC/310/2023) prior to the study.

Sample size calculation and study population

The sample size was determined using Cochran's formula [22], given a 95% confidence interval and an estimated proportion of 15.6% based on previous studies in a similar population and setting [23]. With a margin of error of 5.0% and considering a 10% non-response rate, the calculated total sample size was at least 223 participants.

The inclusion criteria for participants were undergraduate students at UTAR who were Malaysian nationals, between 18-30 years of age, and full-time university students. The exclusion criteria were pregnant and/or lactating females, individuals with chronic diseases, and individuals with eating disorders.

Study instrument

The questionnaire used for collecting data was divided into 5 parts. These parts included questions to collect the socio-demographic characteristics, background of dietary supplement intake, KAP related to dietary supplement, perceived health status and adherence to Mediterranean diet score.

Socio-demographic characteristics and anthropometry

This part of the questionnaire contained information on participants' sociodemographic characteristics (such as age, gender, education, faculty, and monthly pocket money) and lifestyle characteristics, including money spent on dietary supplements, smoking habits, and physical activity levels.

Body weight (kg), height (cm), and body fat percentage (%) were measured using a SECA-213 portable stadiometer (Seca Trading Co., Hangzhou, China) and

a Karada Scan Body Composition Monitor HBF-375 (OMRON HEALTHCARE Co., Kyoto, Japan). Weight and height were recorded to the nearest 0.1 kg and 0.1 cm, respectively, and the body mass index (BMI) of each participant was calculated using these measurements based on WHO criteria [24]. The body fat percentage cut-off points were based on gender-specific categories: a percentage greater than 20% is considered high for males, while a percentage greater than 30% is considered high for females [25].

Knowledge, attitude and practice (KAP) regarding the use of dietary supplement

This section of the questionnaire comprised 14 questions regarding the Knowledge, Attitudes, and Practices (KAP) related to the use of dietary supplements, adapted from a previous study by Elshahory et al., [26] which showed a good coefficient alpha result. The questions were divided into three domains: knowledge (six questions), attitude (four questions), and practice (four questions). Both dietary supplement users and non-users were required to complete the knowledge and attitude domains, while only dietary supplement users were required to complete the practice domain of the KAP questionnaire. A score of 1 was given to respondents who answered "Yes," and 0 points were given to respondents who answered "No" or "Not sure." The total marks were converted into percentages by dividing the total score of each section by the maximum possible score and then multiplying by 100.

The classification of KAP [26] was adapted based on previous study. For the Knowledge component, scores below 50% were categorized as "Poor," scores between 50% and 75% as "Fair," and scores above 75% as "Good." Similarly, Attitude scores were classified as "Negative" for those below 50%, "Neutral" for those between 50% and 75%, and "Positive" for scores exceeding 75%. Lastly, the Practice component was assessed based on risk levels, with scores below 50% indicating "High risk," scores between 50% and 75% indicating "Moderate risk," and scores above 75% classified as "Low risk" [26].

In the current study, the internal consistency was measured for knowledge (Cronbach's $\alpha = 0.84$), attitude (Cronbach's $\alpha = 0.66$), and practice (Cronbach's $\alpha = 0.74$). The overall internal consistency and reliability (Cronbach's $\alpha = 0.83$) were within the acceptable limits [27, 28].

3 Dietary supplement consumption pattern

To assess the dietary supplement consumption pattern, several questions were asked. These included questions about the types of dietary supplements used, the reasons for using dietary supplements, sources of information, the frequency of intake, and where the supplements were purchased. Non-dietary supplement users were required to answer the final question in this section, "Would they purchase DS in the future?" This question

was also answered by non-DS users only.

Perceived Health Status

The degree of perceived health status was measured using three questions adapted from a previous study [29]. The questions asked about the present perception of health, perceived health compared to others of a similar age, and perceived health over the past six months. The questionnaire used a 5-point Likert scale, with answers given 1 point for 'very bad' to 5 points for 'very good.' The range of the perceived health status scores was 3-15. A higher score indicates better health. The Cronbach's alpha coefficient measured in this study was 0.80.

Adherence to Mediterranean Diet

A new validated short Mediterranean Diet Adherence Questionnaire (excluding the alcohol category) was used [30]. The questionnaire is composed of eight questions representing eight food groups: cereals and cereal products, legumes, fresh vegetables, fresh fruit, dairy products, fish and fish products, meat and meat products, and olive oil. Within each food group, participants were asked to choose the portion size they consumed over the past month, with each question scored from 0 to 2 points. The total score ranges from 0 to 16, with 0 indicating the lowest adherence to the Mediterranean diet and 16 indicating the highest adherence. The Mediterranean diet adherence score of less than 9 indicates low adherence, 9.1–11.0 indicates moderate adherence, and 11.1–16.0 indicates high adherence [30]. The scoring details can be referred to in supplementary Table S1. The Cronbach's alpha coefficient of this questionnaire in this study was 0.61 which is considered acceptable [28].

Validity and reliability of the questionnaire

The supervisory committee conducted a content validity assessment in the Department of Allied Health Sciences at UTAR to ensure the appropriateness, clarity, and accuracy of each section of the questionnaire. As a result, several options were added to the dietary supplement pattern questionnaire, and graphic visuals were incorporated in the questionnaire to enhance understanding before proceeding with the pilot test.

The questionnaire was pre-tested among 30 students to determine its clarity, practicality, and relevance to the participants, as well as to identify any ambiguities that could compromise its validity and reliability. Participants were asked to respond to the questionnaire and provide feedback on its clarity and any suggestions they might have. After discussions with the supervisory committee, some sequences and wordings of the questionnaire were revised accordingly. The results from this pilot study were not included in the final analysis.

Data collection

The data were collected using a combination of

online and onsite methods. According to the planned schedule, face-to-face onsite sessions were conducted for anthropometric data collection and to explain the questionnaire. Subsequent data processing and analysis were performed online. The information sheet and informed consent were provided at the beginning of the study. Participation was voluntary, with no incentives offered. Participants could withdraw from the questionnaire at any time, and any incomplete responses would not be included in the study. Participants had the right to decide on their participation and could withdraw at any time if they felt uncomfortable with any items in the questionnaire.

Statistical test

Descriptive statistics were employed to describe the sample population, with continuous variables expressed as mean and standard deviation (SD), and categorical variables presented as frequencies and percentages (n, %). The chi-square test was used to determine whether the users differed from non-users in terms of categorical sociodemographic variables. Some category variables were recategorized prior to chi-square test to increase the rigor of the results. To identify factors associated with the use of dietary supplements, a univariate analysis was first conducted for each predictor variable. Variables with a p-value less than 0.25 were included in the binary logistic regression model, following the recommendation of Hosmer et al., [31], to ensure that important predictors were not excluded prematurely. Neither perceived health status nor Mediterranean diet score met the $p < 0.25$ threshold in the univariate analysis and were therefore excluded from the logistic regression model.

To check for multicollinearity among the independent variables, we calculated the Tolerance and Variance Inflation Factor (VIF). The predictor variables had tolerances ranging from 0.596 to 0.981, with a mean tolerance of 0.767. The VIF values ranged from 1.019 to 1.678, with a mean VIF of 1.332. Variables with tolerances greater than 0.1 and VIF less than 10 were considered to meet the assumption of no multicollinearity [32]. Additionally, logit linearity was evaluated for continuous predictor variables to ensure the validity of the model. All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS), Version 26.0 (IBM Corp., Armonk, NY). A significance level of $p < 0.05$ was used for all tests.

Results

Sociodemographic characteristics of study participants and Dietary Supplement Use

Table 1 presents the sociodemographic characteristics of the 278 study participants and their association with dietary supplement (DS) use. Among the participants, 74.1% were female, and 25.9% were male, with a significantly higher proportion of females using

DS compared to males ($p = 0.05$). The majority of participants were of Chinese ethnicity (94.6%), and 77.0% were pursuing a bachelor's degree. There was a significant difference in DS use by education level, with more DS users in the bachelor's program compared to foundation students ($p = 0.045$). Additionally, a significant association was found between the year of study and DS use, with Year 1 students less likely to use DS compared to those in Year 3 or higher ($p = 0.002$).

Table 1: Univariate analysis (chi-square test) of participants' socio-demographic characteristics with dietary supplement usage

Sociodemographic characteristics	Overall (n =278)	DS user (n =108)	Non-DS user (n =170)	p-value
Age (Years)	20.8 ± 1.6	20.9 ± 1.7	20.6 ± 1.5	
18-21	187 (67.3)	68 (63.0)	119 (70.0)	0.223
22 & above	91 (32.7)	40 (37.0)	51 (30.0)	
Gender				
Male	72 (25.9)	21 (19.4)	51 (30.0)	0.05*
Female	206 (74.1)	87 (80.6)	119 (70.0)	
Ethnicity				
Chinese	263 (94.6)	103 (95.4)	160 (94.1)	0.652
Indian	15 (5.4)	5 (4.6)	10 (5.9)	
Current education level				
Foundation	64 (23.0)	18 (16.7)	46 (27.1)	0.045*
Bachelor's degree	214 (77.0)	90 (83.3)	124 (72.9)	
Year of study				
Year 1	135 (48.6)	40 (37.0)	95 (55.9)	0.002*
Year 2	48 (17.3)	18 (16.7)	30 (17.6)	
Year 3	90 (32.4)	47 (43.5)	43 (25.3)	
Year 4 and above	5 (1.8)	3 (2.8)	2 (1.2)	
Exercise				
Less than 30 minutes per week	140 (50.4)	55 (50.9)	85 (50.0)	0.928
30 to 150 minutes per week	99 (35.6)	39 (36.1)	60 (35.3)	
151 to 300 minutes per week	19 (6.8)	6 (5.6)	13 (7.6)	
More than 300 minutes per week	20 (7.2)	8 (7.4)	12 (7.1)	
BMI (kg/m ²)	21.3 ± 3.8	21.3 ± 3.7	21.2 ± 3.8	
Underweight	69 (24.8)	27 (25.0)	42 (24.7)	0.997
Normal	168 (60.4)	65 (60.2)	103 (60.6)	
Overweight	30 (10.8)	12 (11.1)	18 (10.6)	

CONTINUE

Sociodemographic characteristics	Overall (n=278)	DS user (n=108)	Non-DS user (n=170)	p-value
Obese	11 (4.0)	4 (3.7)	7 (4.1)	0.465
Body fat percentage (%)	24.1 ± 6.4	23.3 ± 6.4	24.6 ± 6.3	
Low	26 (9.4)	13 (12.0)	13 (7.6)	
Normal	179 (64.4)	71 (65.7)	108 (63.5)	
High	50 (18.0)	16 (14.8)	34 (20.0)	<0.001*
Very high	23 (8.3)	8 (7.4)	15 (8.8)	
Awareness of Mediterranean Diet				
Yes	95 (34.2)	57 (52.8)	38 (22.4)	
No	183 (65.8)	51 (47.2)	132 (77.6)	

*Chi-square test significance level was set at $p < 0.05$. BMI: Body Mass Index; DS: Dietary Supplement. The Year of study was recategorized into three groups for the chi-square test (Year 4 was merged with Year 3).

Exercise habits and body fat percentage did not show significant differences between DS users and non-users. However, awareness of the Mediterranean diet was significantly higher among DS users (52.8%) than

non-users (22.4%), with a p-value of < 0.001 . Most participants fell within the normal BMI category (60.4%), with no significant differences in BMI between DS users and non-users ($p = 0.997$).

Comparison of Dietary Supplement (DS) Users and Non-DS Users on KAP, Perceived Health, and Mediterranean Diet Adherence

Table II provides a summary of the assessment of Knowledge, Attitudes, Practices (KAP), Perceived Health Status, and Mediterranean Diet Adherence among participants, comparing DS users with non-users. On average, DS users had a higher mean knowledge mean (64.4%) compared to non-users (38.1%). A significant portion of DS users had good knowledge (41.7%), while most non-users had poor knowledge (57.6%). These results indicate a statistically significant difference in knowledge levels between DS users and non-users ($p=0.001$). In terms of attitudes, DS users displayed more positive attitudes, with an average score of 43.3%, compared to 26.6% for non-users. Nearly half of the DS users (51.8%) had neutral or positive attitudes, while most non-users had negative attitudes (69.4%).

Table II: Assessment of Knowledge, Attitudes, Practices (KAP), Perceived Health Status, and Mediterranean Adherence Scores of Participants

Categorization	Overall (n=278)	DS user (n=108)	Non-DS user (n=170)	p-value
Knowledge (%)	48.4 ± 33.9	64.4 ± 30.7	38.1 ± 31.8	0.001*
Poor		123 (44.2)	25 (23.1)	
Moderate		86 (30.9)	38 (35.2)	
Good		69 (24.8)	45 (41.7)	
Attitude (%)	33.1 ± 33.9	43.3 ± 34.6	26.6 ± 31.8	0.002*
Negative		170 (61.2)	52 (48.1)	
Neutral		82 (29.5)	43 (39.8)	
Positive		26 (9.4)	13 (12.0)	
Practice (%)	44.4 ± 30.3			-
Low risk		-	14 (13.0)	
Moderate risk		-	39 (36.1)	
High risk		-	55 (50.9)	
Perceived Health Status	9.8 ± 1.8	9.8 ± 1.8	9.7 ± 1.8	0.556
Low		24 (8.6)	11 (10.2)	
Moderate		203 (73.0)	80 (74.1)	
High		51 (18.3)	17 (15.7)	
Mediterranean diet score	6.2 ± 1.7	6.1 ± 1.7	6.3 ± 1.7	0.805
Low adherence		264 (95.0)	103 (95.4)	
Medium adherence		13 (4.7)	4 (3.7)	
High adherence		1 (0.4)	1 (0.9)	

*Chi-square test significance level was set at $p < 0.05$. DS: Dietary Supplement. The Mediterranean diet score was recategorized into two groups for the chi-square test (high adherence merged with medium adherence).

The chi-square test revealed a significant difference in attitudes between DS users and non-users ($p=0.002$). When evaluating perceived health status, most participants (73.0%) rated their health as moderate, with no significant differences between DS users and non-users ($p=0.556$). Similarly, low adherence to the Mediterranean diet was prevalent among both DS users (95.4%) and non-users (94.7%). The Mediterranean diet score was recategorized into two groups for the chi-square test, but the analysis revealed no significant association between DS use and adherence to the Mediterranean diet ($p=0.805$). These results suggest that while DS use is significantly associated with higher knowledge and more positive attitudes, it does not appear to influence perceived health status or adherence to the Mediterranean diet.

Dietary supplement (DS) intake patterns among participants

Details of the DS intake patterns and sources of information among DS users ($n=108$) are shown in Table III. The majority (73.1%) consumed vitamins only, with fatty acids (10.2%) and multivitamins (8.3%) being the next most common supplements. Most users (57.4%) took only one type of DS at a time, though 31.5% used two types simultaneously, and 11.1% used three or more. Frequency of DS intake varied, with 27.8% taking supplements daily, while 28.7% consumed them less than twice a week.

Table III: Dietary Supplement (DS) Intake Patterns and Sources of Information Among Dietary supplement users of participants ($n=108$)

		N (%)
Main Dietary supplement (DS) consumed		
Vitamin(s) only	79	73.1
Fatty acid (omega 3)	11	10.2
Multivitamin	9	8.3
Others (e.g., antioxidants)	4	3.7
Mineral(s) only	3	2.8
Multimineral	1	0.9
Herbal supplement	1	0.9
Number of DS taken simultaneously		
1 type	62	57.4
2 types	34	31.5
3 or more types	12	11.1
Weekly Frequency of DS Intake		
Less than 2 times	31	28.7
2 to 4 times	33	30.6
5 to 6 times	14	13.0

CONTINUE

	N (%)	
Everyday	30	27.8
Location of purchasing DS		
Pharmacy/Drug store	78	72.2
Online apps (e.g. Lazada, shopee)	15	13.9
Electronic websites (e.g. official website)	9	8.3
Retail store/supermarket	6	5.6
*Main Information sources on DS		
Family	52	48.1
Pharmacy	22	20.4
Doctor	13	12
Social Media	10	9.3
*Main reasons of consuming DS		
Strengthen the immune system	45	24.2
Improve energy level	30	16.1
Reduce chronic disease	22	11.8
Inadequate dietary intake	20	10.8
Noticing Benefits from DS Use		
Yes	58	53.7
No	9	8.3
Maybe	41	38.0
Noticing Side Effects from DS Use		
Yes	24	22.2
No	66	61.1
Maybe	18	16.7
Awareness of DS Registration with the Ministry of Health		
Yes	74	68.5
No	34	31.5
Intention to purchase DS in the future		
Yes	63	58.3
No	5	4.6
When necessary	40	37.0

***Presents only the top four reasons for consuming dietary supplements (DS) based on participants' responses**

Pharmacies were the most common purchase location (72.2%), and family members were the primary source of information on DS (48.1%). The main reasons for DS consumption were to strengthen the immune system (24.2%) and to improve energy levels (16.1%). More than half of the users (53.7%) reported noticing benefits from DS use, and 61.1% reported no side effects. Additionally, 68.5% were aware of DS registration with the Ministry of Health, and 58.3% intended to purchase DS in the future, with 37.0% willing to do so when necessary.

Among the reasons cited for not consuming dietary supplements, cost was the most mentioned, with 26.5% (n = 45) of participants finding supplements

too expensive. Another 23.5% (n = 40) of respondents believed their diet was adequate, reducing the perceived need for supplementation. Additionally, 20.6% (n = 35) felt that taking supplements was unnecessary or a waste of money. For 17.6% (n = 30), the lack of advice from a healthcare professional played a key role in their decision not to take DS. In terms of future intentions regarding DS use, Table IV also reveals that 12.4% (n = 21) of non-users indicated a potential willingness to purchase supplements, whereas 17.6% (n = 30) had no intention to do so. However, the majority (70.0%, n = 119) reported that they would consider purchasing DS only when necessary.

Table IV: Reasons for Not Consuming Dietary Supplement (DS) and Future Purchase Intentions Among Non-Users (n=170)

		N (%)
*Main reasons for not consuming dietary supplement (DS)		
Supplements are expensive	45	26.5
Diet is adequate	40	23.5
No necessary or waste of money	35	20.6
Did not advise by health care professional	30	17.6
Intention to purchase DS in the future		
Yes	21	12.4
No	30	17.6
When necessary	119	70.0

***Presents only the top four reasons for not consuming dietary supplements (DS) based on participants' responses**

Multivariate analysis (logistic regression) to predict the dietary supplement (DS) usage among participants

The logistic regression analysis as shown in Table V revealed that awareness of the Mediterranean diet was a significant predictor of DS use ($p = 0.016$), with participants who were aware of the Mediterranean diet being more than twice as likely to use dietary supplements (OR = 2.120, 95% CI [1.150, 3.909]). Additionally, higher knowledge scores were associated

with an increased likelihood of DS usage ($p = 0.003$), with a 1.5% increase in the odds of DS use for each additional point on the knowledge score (OR = 1.015, 95% CI [1.005, 1.026]). Although attitude scores approached significance ($p = 0.067$), they did not reach the threshold. The other variables such as gender, education level, and year of study were not significant predictors of DS use in this model among the university students ($p > 0.05$).

Table V: Logistic regression results for dietary supplements intake (N= 278)

Variables		B	SE	Wald	Sig.	OR	95% CI for OR	
							Lower	Upper
Gender	Male	Ref	-	-	-	-	-	-
	Female	-0.539	0.312	2.990	0.084	0.583	0.317	1.075
Current education level	Foundation	-0.072	0.391	0.034	0.883	0.930	0.432	2.001
	Bachelor's degree	Ref	-	-	-	-	-	-
Year of study	Year 1	Ref	-	-	-	-	-	-
	Year 2	0.173	0.429	0.164	0.686	1.189	0.513	2.757
	Year 3 & above	0.588	0.354	2.767	0.096	1.801	0.900	3.603
Awareness of Mediterranean Diet	Yes	0.752	0.312	5.799	0.016*	2.120	1.150	3.909
	No	Ref	-	-	-	-	-	-
Knowledge score		0.015	0.005	8.609	0.003*	1.015	1.005	1.026
Attitude score		0.008	0.004	3.351	0.067	1.008	0.999	1.017

Ref = Reference category

*Logistic regression test significance level was set at $p < 0.05$.

Discussion

In an overview, the majority of respondents, particularly non-users of dietary supplements (DS), demonstrated poor knowledge and negative attitudes, while DS users engaged in higher-risk practices related to DS use. Notably, DS users exhibited significantly higher levels of knowledge and more positive attitudes compared to non-users. This study identified a significant association between DS use and knowledge of Mediterranean diet variables. However, DS use was not associated with perceived health status or adherence to the Mediterranean diet. A large proportion of participants, regardless of DS use, reported moderate perceived health status and low adherence to the Mediterranean diet. These findings highlight the need for further research to explore the complex relationships between DS use, health knowledge, behaviours, and overall health outcomes.

Over the years, dietary supplement (DS) consumption has been predominantly associated with older populations [12, 13]. Our findings highlight a significant shift in this pattern, with 38.8% of the younger population (university students) reporting DS use. This prevalence among younger adults indicates that DS use is no longer confined to older individuals but is becoming increasingly common among younger populations. These results are consistent with recent studies, which have documented a rising interest in DS use among younger adults, with reported prevalence rates ranging from 41.9% to 68.2% [5, 33, 34]. It is believed that the

rise in DS users has been further accelerated by the COVID-19 health crisis, driven by the expanding DS market and aggressive marketing strategies targeting younger consumers [16].

Our findings indicate that family members are the primary source of dietary supplement (DS) information (48.1%), followed by pharmacies (20.4%) and doctors (12%). These results align with prior studies, which also highlight the significant role of personal networks in influencing DS use. For instance, Mohammed et al., [6] found that 23.5% of respondents were influenced by friends and co-workers, while only 11% were swayed by media advertising. Additionally, research has shown DS users frequently seek information from social media or websites (66.7%), family members (45.2%), and friends (35.7%) for information [5]. In Malaysia, the majority of people obtained DS information from social media (18.8%), family or relatives (15%), and friends (9.8%) [20]. These findings suggest that personal networks, including family and friends, significantly influence DS consumption, often surpassing healthcare professionals like dietitians or nutritionists. This reliance on non-expert advice raises concerns about misinformation, as personal recommendations may lack scientific backing. Such practices may contribute to risky DS use, highlighting the need to raise public awareness about consulting qualified professionals to mitigate potential risks.

In this study, the primary reasons for DS consumption were to strengthen the immune system (24.2%) and

improve energy levels (16.1%), likely influenced by concerns from the COVID-19 pandemic. Similar findings were reported by Al Tamimi [35], where aesthetic reasons (45.6%) and enhancing health (42.4%) were common motivations. A national study in Jordan revealed that students primarily relied on information from the internet (56.3%), followed by friends (50.7%), sports coaches (38.6%), and family (37.3%) [26]. In Malaysia, general health (21.1%) and boosting immunity (12.2%) were cited as key reasons for DS use [20]. Our study also identified cost as the main barrier to DS use, suggesting that supplements may not be accessible to lower-income groups or students. Notably, 70.0% of non-users indicated that they would consider purchasing supplements, when necessary, although many perceived them as unnecessary or believed their diet was adequate. The findings suggest an opportunity for the DS market to address unmet needs, also emphasizing the importance of young adults obtaining information from reputable sources to ensure informed usage and meet their specific requirements.

Surprisingly, the relatively high awareness of dietary supplement (DS) registration with the Ministry of Health (68.5%) indicates a positive level of awareness regarding DS regulation. However, the fact that 31.5% of respondents remain unaware of this is concerning. Among current DS users, the willingness to continue using supplements (58.3%) or to use them when necessary (37.0%) reflects a sustained interest in supplementation, likely driven by perceived benefits. While existing research has identified common reasons for DS use, further exploration is needed to fully understand the underlying factors influencing DS consumption in this population. These insights could have significant implications for public health, particularly in terms of the role of DS in preventive health and the risks associated with over-reliance on supplementation.

Increased awareness of the Mediterranean diet was a significant predictor of dietary supplement (DS) use, suggesting that participants who are aware of this diet tend to be more health conscious. People with more health conscious tend to engage positive health behaviours, such as exercise [36], healthy eating lifestyle [37], and proactive health management through dietary supplements [38]. One study conducted among South Korean university students found that health-conscious individuals, particularly those with greater health involvement (e.g. pay attention on DS information), were more likely to consume dietary supplements to maintain or improve their health [33]. This health-conscious behaviour aligns with their intention to make future purchases of such supplements. However, while awareness of the Mediterranean diet is notable, it does not necessarily translate into practice, as adherence to the diet was not a predictor variable in our regression model in this study.

Our data revealed that 95% of young adults do not adhere to the Mediterranean dietary pattern, which aligns with findings from other studies conducted in various countries [39, 40]. This low adherence may be attributed to a lack of awareness about the diet, as evidenced by 65.8% of participants reporting that they were unfamiliar with the Mediterranean diet. This significant non-adherence highlights a potential public health concern, as the Mediterranean diet is associated with numerous health benefits [21]. Several determinants may influence adherence to healthy eating patterns, such as the Mediterranean diet, including a lack of self-control, busy schedules, easy access to unhealthy foods [41], and a positive attitude toward sugary drink consumption [42].

According to the hypothesis, increased adherence to the Mediterranean diet is associated with a higher likelihood of dietary supplement use among young adults [43], a phenomenon referred to as the inverse supplement hypothesis. Interestingly, our findings contrast with this hypothesis, as low adherence to the Mediterranean diet in our study was not associated with dietary supplement use. Furthermore, perceived health status also did not appear to influence DS consumption, as most participants (91.3%) reported not considering themselves to be in poor health yet still showed low rates of supplement use. This suggests that the motivations for supplement use may be influenced by factors beyond dietary adherence or self-perceived health, highlighting the need to explore the complex and distinct drivers behind DS use in young adults.

Knowledge of dietary supplements plays a critical role in shaping consumption decisions, as improper use can result in toxicity and health risks [44]. Notably, 44.2% of participants in our study displayed low DS knowledge, increasing their susceptibility to risky behaviours such as overuse or reliance on supplements instead of maintaining a balanced diet. Our findings revealed that higher knowledge scores on dietary supplements were significantly associated with DS use which is consistent with previous studies [26, 34, 45]. Participants who are well-informed about DS are likely to better comprehend their benefits, proper usage, and safety considerations, leading to a greater confidence in incorporating them into their daily routines. As indicated by DS users in this study, some engage in high-risk DS practices, which suggests that improving knowledge via health education could promote safer DS consumption and more informed supplement use [46].

Based on the current findings, attitude, gender, education level, and year of study were not significant predictors of dietary supplement (DS) use. This contradicts previous research among university students in Jordan, which found that factors such as weight status, education level, and family income were significantly associated with DS usage [26]. Similarly, a study conducted in

Tanzania revealed that gender plays an important role in DS consumption patterns in urban populations, with females being more likely to purchase DS [45]. In Kuwait, being female was identified as a significant predictor of higher dietary supplement usage [34]. Furthermore, a study in Malaysia using data from the Malaysian School-based Nutrition Survey indicated that females had a higher likelihood of purchasing dietary supplements, potentially due to greater awareness of health and wellness among women [47]. However, our findings differ from these studies, which may be attributed to the increasing trend of DS usage among both genders, as awareness of health and wellness has risen. This is supported by the chi-square p-value being on the borderline of significance (0.05), suggesting that both men and women now commonly use DS.

The absence of significant associations between attitude, education level, and year of study with DS use in our findings may be attributed to the homogeneity of the participants, who are all university students. University students, regardless of their year of study or educational attainment, often encounter similar environmental factors, such as access to campus health services, peer influence, and marketing campaigns targeted at young adults. These shared exposures may result in relatively uniform behaviour patterns regarding DS use, reducing the impact of academic seniority or education level. Moreover, while attitudes toward health products generally influence health behaviours, the growing accessibility and increasing popularity of dietary supplements [15] may have weakened this relationship. Research has shown that the primary motivation for supplement consumption among young adults is often driven by perceived benefits, social influence, or lifestyle habits, rather than scientific evidence [33]. Future research should explore these factors further to provide more comprehensive insights into DS consumption patterns.

This study is not without limitations. First, participants were selected based on availability, which may introduce selection bias and limit the generalizability of the findings. Second, the study population lacked diversity, as the sample predominantly consisted of females, which could skew the results and reduce representativeness. Third, the use of self-administered questionnaires could have introduced information bias, leading to potential inaccuracies in self-reported data. However, to mitigate this, anthropometric measurements were conducted by trained researchers, and detailed instructions were provided to participants before they completed the questionnaire. On the other hand, the Mediterranean diet questionnaire demonstrated moderate internal consistency, which may affect the robustness of our findings. However, given the multidimensional nature of the dietary patterns assessed and the diverse food groups involved, it is common for tools measuring such constructs to yield slightly lower internal consistency

values. Finally, the study was conducted within a single institution, limiting its broader applicability.

Despite these limitations, this study offers significant contributions. To the best of our knowledge, it is the first to explore the perceived health status and adherence to the Mediterranean diet in relation to dietary supplement use among young adults in Malaysia. This provides valuable insights into the factors influencing DS use in a rapidly evolving market. A reliable and validated questionnaire was specifically designed and rigorously tested to ensure accuracy in assessing the variables of interest. The sample size was statistically sufficient to ensure adequate study power and enhance the generalizability of the results. Additionally, the use of a stepwise selection method in our logistic regression analysis further strengthens the validity of our findings by identifying the most significant predictors of DS use.

Conclusion

This study highlights the prevalence of poor knowledge and negative attitudes towards dietary supplements (DS) among university students, with over half of DS users (50.9%) engaging in high-risk behaviours. The findings identify knowledge about DS and awareness of the Mediterranean diet as significant predictors of DS consumption, emphasizing the need for targeted educational interventions. Despite the link between awareness of the Mediterranean diet and DS use, this awareness does not necessarily lead to responsible DS practices, revealing a gap between health awareness and safe supplement use. To address this, educational programs should focus on enhancing knowledge about DS, while promoting informed, responsible supplement use and dietary adherence, given the high prevalence of DS consumption among young adults. Health professionals play a crucial role in providing accurate, accessible information to mitigate the risks associated with DS misuse and encourage healthier consumption habits among young adults. Promoting a well-balanced diet alongside safe DS practices can contribute to long-term health benefits. Future research should comprehensively explore various factors influencing dietary supplement consumption behaviours among young adults, focusing on larger and more diverse populations. A nationwide, multi-institutional study is recommended to improve the generalizability of the findings across different regions and demographics.

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Ethics statement

Ethical approval for the involvement of human subjects in this study was granted by the Institutional Review (U/SERC/310/2023).

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