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A cross-sectional study on dietary supplement use among university students who engage in physical activity

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ABSTRACT

Introduction: Dietary supplement (DS) use has increased across diverse populations. This study assessed prevalence and patterns of DS use among university students who engaged in physical activity and evaluated their perceptions and influencing factors. **Methods:** An online survey, based on content-validated questionnaire, was conducted over eight weeks targeting students at a Malaysian university. Participants were recruited using convenience sampling, with survey link distributed through widely used social media platforms, including Facebook, WhatsApp, and Telegram. **Results:** Out of 344 survey respondents, 77.6% were females, and 33.7% reported using DS in the past month. Users (*n*=116) generally had positive perceptions of DS, with vitamin C being the most commonly consumed (71.6%), followed by multivitamins (21.6%). Major sources of information for DS users included social media (52.6%) and pharmacists (43.1%). Most users obtained DS from pharmacies (69.8%), while 35.3% obtained from online platforms. Non-users primarily cited high costs as the main reason for not using DS (90.8% of non-users). Multivariate analysis showed that individuals who exercised less frequently (*aOR*=0.540, 95% *CI*=0.324–0.901) were less likely to use DS, while those who believed in the health benefits of DS (*aOR*=4.287, 95% *CI*=2.055-8.942) were more likely to use DS. **Conclusion:** Overall, 33.7% reported using DS in the past month, primarily for health maintenance. Social media served as the main source of information. Reliance of over a third of participants on online platforms for purchasing DS warrants attention.

Keywords: dietary supplement, physical activity, university student

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INTRODUCTION

Dietary supplements (DS) are products used to complement dietary intake, typically containing vitamins, minerals, amino acids, and plant-based substances, available in forms such as tablets, capsules, or liquids (Abd Wahab *et al.*, 2023). DS use has become widespread, particularly in Western countries, such as the United States and the United Kingdom, where adult usage ranges from 35% to 60% (Harrison *et al.*, 2004; Radimer *et al.*, 2004). While often associated with healthier lifestyles, the actual health benefits of many DS are not well-established. Moreover, excessive or unsupervised intake can pose health risks (Wahab *et al.*, 2022a).

In Malaysia, DS use has steadily increased over the past two decades (Salim *et al.*, 2008). Earlier national surveys reported rising consumption of multivitamin-mineral and food supplements (28%–34%), while recent studies showed prevalence rates ranging from 41.9% to 56.9% (Mohd Zaki *et al.*, 2018; Lim *et al.*, 2017; Abd Wahab *et al.*, 2023; Teow *et al.*, 2021; Wahab *et al.*, 2021). This rise is driven by marketing, accessibility, and the perception that "natural" products are inherently safe and effective – an assumption not consistently supported by evidence (Zamzuri *et al.*, 2024). Popular DS include honey, turmeric, and fish oil, often used to prevent or manage chronic conditions such as cancer, diabetes, migraines, and osteoarthritis (Wahab *et al.*, 2021).

DS use is especially common among women, older adults, and those with higher education levels who are more likely to have healthier behaviours (Harrison *et al.*, 2004; Abd Wahab *et al.*, 2023; Wahab *et al.*, 2021; Cheung, Wyman & Halcon, 2007). Physically active individuals frequently use DS to enhance performance, support recovery, or prevent nutrient deficiencies, although most guidelines suggest a balanced diet suffices in typical scenarios. Exceptions include severe weight-loss practices, energy-restricted diets, or elimination of food groups.

Commonly used DS among physically active individuals include multivitamins, calcium, vitamins C and D, protein supplements, and herbal products like *Panax ginseng* and *Ginkgo biloba*, which are commonly believed to improve endurance and strength (Martinovic *et al.*, 2021; Sellami *et al.*, 2018). Motivations for use include promoting general health, reducing illness risk, increasing muscle mass, reducing body fat, and accelerating recovery (Erdman, Fung & Reimer, 2006).

University students who engage in physical activity are a key demographic due to their increasing autonomy in health-related decision-making and frequent targeting by DS marketing (El Khoury *et al.*, 2020). Their participation in physical activities is often linked with health-conscious behaviours, making them a relevant population for understanding DS usage patterns and motivations (Erdman *et al.*, 2006).

However, Malaysian studies have mostly focused on adolescents or student athletes, with limited research specifically on physically active university students (Al-Naggar & Chen, 2011; Zakaria *et al.*, 2022; Hamzah *et al.*, 2023). Among studies involving university students, few have examined DS use in the context of physical activity. Usage patterns and motivations may differ in this subgroup.

Therefore, this study aimed to (1) investigate the prevalence of DS use among physically active university students in Malaysia; (2) assess their perceptions of DS; (3) identify predictors of DS use; (4) examine usage patterns and characteristics; and (5) explore reasons for non-usage among those who

do not consume DS. Findings will inform public health strategies and educational initiatives to support safe DS practices and guide future research.

METHODOLOGY

Study design and setting

This cross-sectional survey was conducted over eight weeks (1st April to 30th May 2023) using an online questionnaire targeting students at Universiti Teknologi MARA (UiTM), Puncak Alam campus. The campus is situated in Puncak Alam, a major suburban township in Kuala Selangor District of Selangor, Malaysia. The campus currently comprises eight faculties and has approximately 20,000 students. To minimise recall bias, this study defined DS use as consumption of any DS products within the past one month (Abd Wahab *et al.*, 2023; Wahab *et al.*, 2021). The study received approval from the UiTM Research Ethics Committee (REC[PH]/UG/036/2023).

Sample population

The study included students from UiTM Puncak Alam campus who could understand written Malay and had engaged in at least one physical activity per week over the past month. Participants with incomplete survey responses were excluded. The criterion of engaging in at least one physical activity per week over the past month was selected to minimise recall bias. This approach increases the likelihood of participants accurately recalling the occurrence of a weekly activity, as opposed to recalling the precise number of hours spent on physical activity. Furthermore, weekly physical activity is commonly used as a threshold in health and nutrition research (Altamirano *et al.*, 2018). The sample size was determined using Raosoft© sample size calculator. With an estimated campus population of 20,000 students, the recommended sample size was 267, providing a 5% margin of error and a 90% confidence interval, assuming a 50% response distribution. To account for possible incomplete responses or exclusions due to ineligibility, an additional 30% was anticipated, yielding an adjusted target sample of approximately 347 participants.

Survey instrument

The survey instrument comprised a questionnaire with four sections, developed by the authors based on relevant literature (Abd Wahab *et al.*, 2023; Wahab *et al.*, 2022b; Wahab *et al.*, 2021; Al-Naggar & Chen, 2011; Zakaria *et al.*, 2022; Hamzah *et al.*, 2023). Section 1 collected demographic details of respondents, including gender, ethnicity, height, weight, types of physical activity engaged in, and frequency of exercise per week. Section 2 contained ten items assessing respondents' perceptions of DS, using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Section 3 gathered data on DS usage in which users of DS provided information on the types of DS used, sources of information, sources of purchase, and reasons for use. Respondents who reported not using DS in the past month were directed to Section 4, where they were asked about their reasons for not using DS.

Six researchers specialising in social pharmacy reviewed the questionnaire items and rated each item's relevance using a scale of 1 (not relevant) to 4 (very relevant). The content validity index (CVI) was calculated for each item based on these ratings. Following Polit, Beck & Owen's recommendation, items with a CVI of ≥0.83 were retained (Polit, Beck & Owen, 2007). All items met this criterion and were included in the final questionnaire. The overall CVI for the questionnaire was 0.98. In response to

minor comments from the reviewers, some wording and clarity adjustments were made.

The survey was administered online using SurveyMonkey. The technical performance and clarity of the survey questions were pilot tested with a sample of 20 university students, including an equal number of participants with and without DS usage. The pilot test indicated that the online survey was practical and the questions were clear, with participants taking approximately five minutes to complete. Data from the pilot test were not included in the final data analysis.

Data collection

This study employed a convenience sampling method. The online questionnaire survey link was disseminated to UiTM students through widely used social media platforms, including Facebook, WhatsApp, and Telegram. Recipients of the survey link were encouraged to share it with others.

Upon accessing the online questionnaire, participants encountered an introductory section that outlined the study's objectives, estimated completion time, and assurances of anonymity and confidentiality regarding their responses. The list of investigators was also provided. Participants were informed that submission of the questionnaire implied consent to participate in the study.

Subsequent to the introductory section, a series of screening questions were presented to assess participants' eligibility. Those who did not meet the criteria were directed to the final page to conclude their participation. The survey was limited to one response per individual. No incentives were offered.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics for Windows version 28.0 (IBM Corp., Armonk, NY, USA). Categorical data were presented as frequencies and percentages. To identify predictors of DS use among students, univariate and multivariable logistic regression analyses were performed. The results were reported as odds ratios (*OR*s), with 95% confidence intervals (*CI*s). A *p*-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 672 individuals responded to the survey. However, 261 respondents were deemed ineligible because they were either non-UiTM students or did not engage in at least one physical activity per week over the past month. These respondents were excluded from the analysis. Among the 411 eligible participants who attempted the survey, 67 did not complete it, resulting in a final sample size of 344 participants. The completion rate among those who initiated the survey was 83.7% (344/411).

Table 1 presents the demographic characteristics of the respondents (*n*=344). The majority were females (77.6%) and Malays (95.6%), with 61.0% having normal body mass index. Regarding physical activity, 61.6% reported engaging in physical activity 1–2 times per week, while 38.4% participated in physical activity three or more times per week. Table 1 further illustrates the respondents' perceptions of DS. Most participants indicated that they believe DS marketed for performance enhancement may have side effects (66.3%), that these supplements do not replace the nutrients obtained from food (64.8%), and that they are generally regarded as safe (63.1%). Of all the participants, 33.7% used DS in the past month.

Among all participants, the most commonly engaged physical

Table 1. Socio-demographic characteristics and perceptions about DS among study respondents, and comparisons among DS users and non-users (*n*=344)

Variables	*All (n=344) n (%)*	*Non-DS Users (n=228) n (%)*	*DS Users [a] (n=116) n (%)*	*Univariate*		*Multivariate*	
				Odds Ratio (95% CI)	*p-value*	*Odds Ratio (95% CI)*	*p-value*
Demographic characteristics							
Gender							
Male	77 (22.4)	46 (20.2)	31 (26.7)	1.443 (0.855-2.435)	0.170		
Female	267 (77.6)	182 (79.8)	85 (73.3)	Reference			
Ethnicity							
Malay	329 (95.6)	217 (95.2)	112 (96.6)	1.419 (0.442-4.559)	0.556		
Non-Malay	15 (4.4)	11 (4.8)	4 (3.4)	Reference			
Body mass index categories [b]							
Underweight (<18.5 kg/m^2)	60 (17.4)	43 (18.9)	17 (14.7)	0.877 (0.415-1.850)	0.730		
Normal (18.5–24.9 kg/m^2)	210 (61.0)	134 (58.8)	76 (65.5)	1.258 (0.713-2.217)	0.428		
Overweight (25-29.9 kg/m^2)	74 (21.5)	51 (22.4)	23 (19.8)	Reference			
Frequency of exercise per week [c]							
1-2 times/week	212 (61.6)	150 (65.8)	62 (53.4)	0.597 (0.378-0.942)	0.027*	0.540 (0.324–0.901)	0.018*
≥3 times/week	132 (38.4)	78 (34.2)	54 (46.6)	Reference		Reference	
Perceptions about DS use [d]							
DS marketed for performance enhancement can have side effects.							
SA and A	228 (66.3)	149 (65.4)	79 (68.1)	1.132 (0.703-1.823)	0.610		
SD, D and U	116 (33.7)	79 (34.6)	37 (31.9)	Reference			
DS are not substitutes for the nutrients found in food.							
SA and A	223 (64.8)	136 (59.6)	87 (75.0)	2.029 (1.235-3.335)	0.005**	1.376 (0.781-2.425)	0.269
SD, D and U	121 (35.2)	92 (40.4)	29 (25.0)	Reference		Reference	
DS are generally safe.							
SA and A	217 (63.1)	123 (53.9)	94 (81.0)	3.647 (2.142-6.211)	<0.001***	1.384 (0.684-2.801)	0.367
SD, D and U	127 (36.9)	105 (46.1)	22 (19.0)	Reference		Reference	
DS can enhance energy levels							
SA and A	211 (61.3)	121 (53.1)	90 (77.6)	3.061 (1.842-5.087)	<0.001***	0.424 (0.174-1.034)	0.059
SD, D and U	133 (38.7)	107 (46.9)	26 (22.4)	Reference		Reference	

to be continued...

Table 1. Socio-demographic characteristics and perceptions about DS among study respondents, and comparisons among DS users and non-users (*n*=344) *(continued)*

Variables	*All (n=344) n (%)*	*Non-DS Users (n=228) n (%)*	*DS Users [a] (n=116) n (%)*	*Univariate*		*Multivariate*	
				Odds Ratio (95% CI)	*p-value*	*Odds Ratio (95% CI)*	*p-value*
DS can enhance endurance							
SA and A	203 (59.0)	113 (49.6)	90 (77.6)	3.523 (2.120-5.853)	<0.001***	1.082 (0.502-2.330)	0.841
SD, D and U	141 (41.0)	115 (50.4)	26 (22.4)	Reference		Reference	
DS can contribute to overall health.							
SA and A	195 (56.7)	99 (43.4)	96 (82.8)	6.255 (3.615-10.823)	<0.001***	4.287 (2.055-8.942)	<0.001***
SD, D and U	149 (43.3)	129 (56.6)	20 (17.2)	Reference		Reference	
DS can help increase strength.							
SA and A	201 (58.4)	108 (47.4)	93 (80.2)	4.493 (2.657-7.597)	<0.001***	2.356 (0.920-6.038)	0.074
SD, D and U	143 (41.6)	120 (52.6)	23 (19.8)	Reference		Reference	
DS can enhance training capacity.							
SA and A	186 (54.1)	101 (44.3)	85 (73.3)	3.448 (2.118-5.612)	<0.001***	0.989 (0.436-2.242)	0.978
SD, D and U	158 (45.9)	127 (55.7)	31 (26.7)	Reference		Reference	
DS can improve mental concentration.							
SA and A	177 (51.5)	91 (39.9)	86 (74.1)	4.316 (2.636-7.065)	<0.001***	1.674 (0.804-3.484)	0.169
SD, D and U	167 (48.5)	137 (60.1)	30 (25.9)	Reference		Reference	
DS can help individuals cope with pain from physical training.							
SA and A	172 (50.0)	93 (40.8)	79 (68.1)	3.099 (1.934-4.966)	<0.001***	0.925 (0.450-1.897)	0.831
SD, D and U	172 (50.0)	135 (59.2)	37 (31.9)	Reference		Reference	

DS: dietary supplement; SA: strongly agree; A: agree; SD: strongly disagree; D: disagree; U: unsure

[a] Defined as the use of DS in the past one month.

[b] Calculated using self-reported weight and height (formula: Body mass index (BMI) = weight (kg)/[height (m)]^2); BMI categories were defined according to Body mass index (BMI) classification standards.

[c] In the past one month

[d] Responses were based on a Likert-type scale ranging from 1 = strongly disagree; 2 = disagree; 3 = unsure; 4 = agree and 5 = strongly disagree

*p<0.05; **p<0.01: ***p<0.001

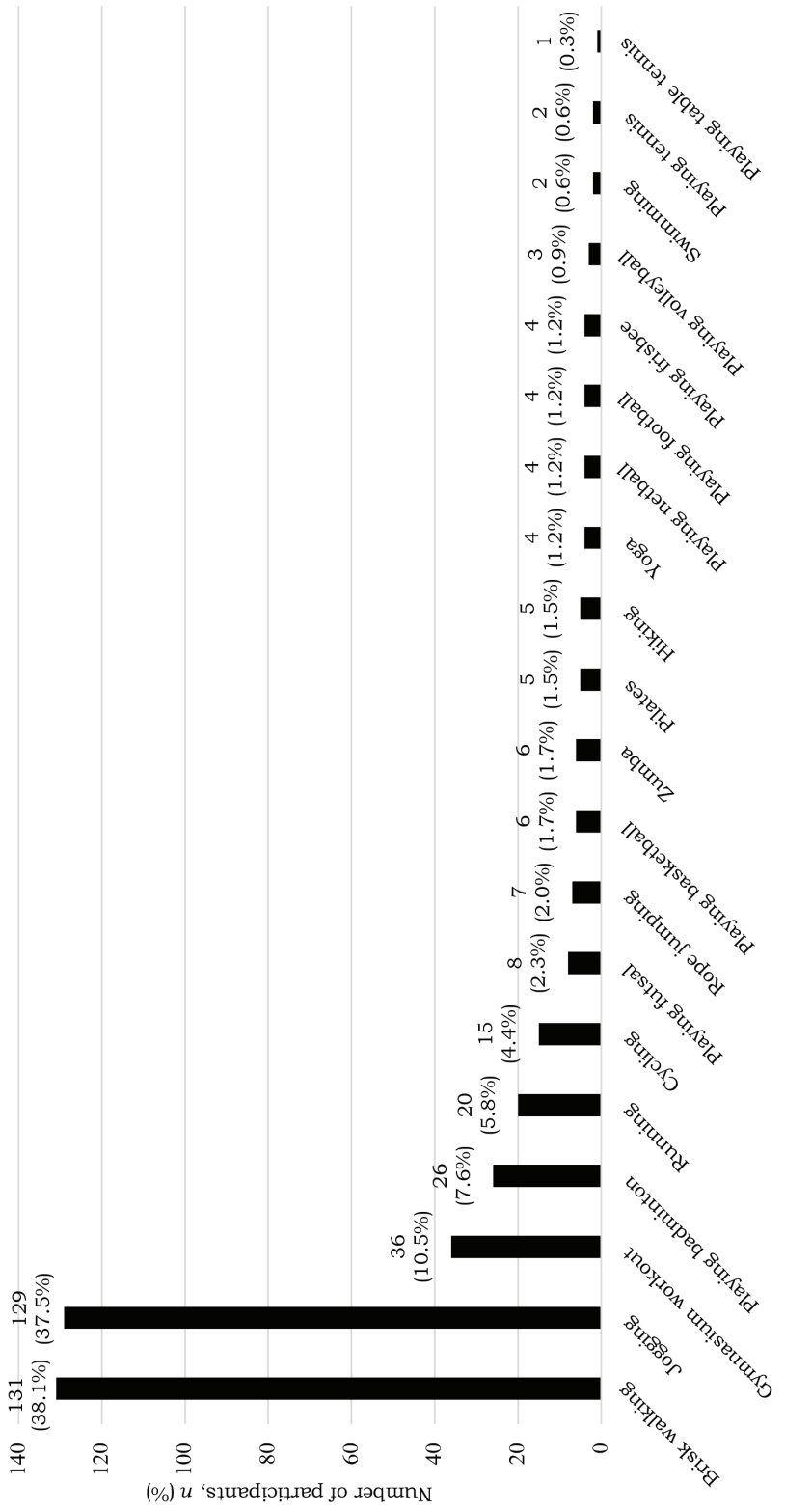

Figure 1. Types of physical activities engaged by participants (n=344)

Table 2. Distribution of DS use across different physical activities

Type of physical activity (n)	*Type of DS used (n, %)*					
	Vitamins	*Mineral*	*Proteins / Amino acids*	*Nutritional oil*	*Herbal products*	*Others*
Jogging (43)	• Vitamin C (32, 74.4%) • Multivitamin (6, 14.0%) • Vitamin A (3, 7%) • Vitamin D (3, 7%) • Vitamin E (2, 4.7%) • Vitamin B (1, 2.3%)	• Calcium (5, 11.6%) • Iron (3, 7%) • Magnesium (3, 7%) • Multimineral (1, 2.3%)	• Protein supplement (5, 11.6%)	• Omega-3 fatty acids (11, 25.6%) • Omega-6 fatty acids (1, 2.3%) • Flax seed oil (1, 2.3%)	• Garlic (3, 7%) • Ginseng (2, 4.7%) • Weight-loss herbal products (2, 4.7%) • Turmeric (2, 4.7%) • Green tea extract (2, 4.7%) • Gingko biloba (1, 2.3%)	• Caffeine (6, 14%) • Probiotics (2, 4.7%)
Brisk walking (42)	• Vitamin C (32, 76.2%) • Multivitamin (8, 19%) • Vitamin E (4, 9.5%) • Vitamin A (2, 4.8%) • Vitamin B (3, 7.1%) • Riboflavin (1, 2.4%)	• Iron (4, 9.5%) • Magnesium (3, 7.1%) • Calcium (1, 2.4%)	• Protein supplement (2, 4.8%) • N-acetylcysteine (1, 2.4%)	• Omega-3 fatty acids (5, 11.9%) • Omega-6 fatty acids (1, 2.4%)	• Green tea extract (8, 19%) • Ginseng (2, 4.8%) • Cranberry extract (2, 4.8%) • Weight-loss herbal products (1, 2.4%)	• Caffeine (2, 4.8%) • Probiotics (2, 4.8%) • Coenzyme Q10 (1, 2.4%) • Glucosamine (1, 2.4%)

to be continued...

Table 2. Distribution of DS use across different physical activities *(continued)*

Type of physical activity (n)	*Type of DS used (n, %)*					
	Vitamins	*Mineral*	*Proteins / Amino acids*	*Nutritional oil*	*Herbal products*	*Others*
Gymnasium workout (15)	• Vitamin C (10, 66.7%) • Multivitamin (4, 26.7%) • Vitamin B (1, 6.7%) • Vitamin D (1, 6.7%) • Vitamin E (1, 6.7%)	• Calcium (2, 13.3%)	• Protein supplement (3, 20%) • Arginine (1, 6.7%) • Creatinine (1, 6.7%)	• Omega-3 fatty acids (2, 13.3%)	• Ginseng (1, 6.7%) • Turmeric (1, 6.7%) • Cranberry extract (1, 6.7%)	• Caffeine (1, 6.7%) • Probiotics (1, 6.7%)
Playing badminton (10)	• Vitamin C (6, 60%) • Vitamin E (2, 20%) • Vitamin A (1, 10%) • Vitamin D (1, 10%) • Multivitamin (1, 10%)	None	• Protein supplement (1, 10%)	• Omega-3 fatty acids (1, 10%)	• Garlic (1, 10%) • Cranberry extract (1, 10%)	• Probiotics (2, 20%) • Caffeine (1, 10%)
Running (7)	• Vitamin C (5, 71.4%) • Multivitamin (3, 42.9%) • Vitamin A (1, 14.3%) • Vitamin B (1, 14.3%)	None	• Protein supplement (1, 14.3%) • Arginine (1, 14.3%) • Creatine (1, 14.3%)	• Omega-3 fatty acids (1, 14.3%)	None	• Probiotics (1, 14.3%)

activities were brisk walking (38.1%), jogging (37.5%), and gymnasium workouts (10.5%) (Figure 1). Among DS users, the five most frequently practised activities were jogging (37.1%), brisk walking (36.2%), gymnasium workouts (12.9%), playing badminton (8.6%), and running (6.0%) (Table 2).

Figure 2 shows the types of DS used among users (n=116). The most commonly consumed DS were vitamin C (71.6%) and multivitamins (21.6%), followed by omega-3 fatty acids (15.5%). Green tea extract (9.5%) and garlic (5.2%) were the most used herbal products.

An analysis of DS usage patterns among participants engaged in the top five most common physical activities revealed variations in DS consumption patterns according to the type of physical activity (Table 2). Notably, vitamin C was the most widely used DS across all physical activities, with particularly high usage among joggers, brisk walkers, and runners. Specifically, 74.4% of joggers, 76.2% of brisk walkers, 66.7% of gym-goers, 60.0% of badminton players, and 71.4% of runners reported using vitamin C.

Protein supplements were less commonly used by the participants. Among gym-goers, 20.0% used protein supplements, followed by 14.3% of runners, 11.6% of joggers, 4.8% of brisk walkers, and 10.0% of badminton players. Herbal products were moderately consumed. Green tea extract was used by brisk walkers (19.0%) and joggers (4.7%). Garlic was consumed by joggers (7.0%) and badminton players (10.0%). Ginseng usage was reported among joggers (4.7%), brisk walkers (4.8%), and gym-goers (6.7%). Caffeine was consumed by 14.0% of joggers, 6.7% of gym-goers, 4.8% of brisk walkers, and 10.0% of badminton players, while no caffeine use was reported among runners.

Table 3 presents the sources of information and procurement for DS, as well as reasons for using DS among DS users. The primary sources of information about DS were social media (52.6%), pharmacists (43.1%), and family members (39.7%). Most DS users obtained their DS from pharmacies (69.8%) and supplement stores (41.4%), with many also purchasing them online (35.3%). The main reasons for using DS included maintaining health (98.3%), preventing nutrient deficiencies (95.7%), and reducing fatigue (82.8%).

Univariate analysis revealed that gender (p=0.170), ethnicity (p=0.556), underweight body mass index (BMI) (p=0.730), normal BMI (p=0.428), and the perception that DS marketed for performance enhancement may have side effects (p=0.610) were not significantly associated with DS use. In contrast, frequency of exercise per week (p=0.027) and the other nine perception items (p<0.001) were significantly associated with DS use (Table 1).

Multivariate analysis identified two significant predictors of DS use: frequency of exercise and perception that DS contributes to overall health (Table 1). Specifically, individuals who exercised less frequently (*aOR*=0.540, 95% *CI*=0.324–0.901) were less likely to use DS, while those who believed in the health benefits of DS (*aOR*=4.287, 95% *CI*=2.055–8.942) were more likely to use DS.

Among participants who did not use DS (n=228), the most commonly cited reasons were high cost (90.8%) and concerns that the products might be unregistered or counterfeits (88.6%). Many DS non-users also indicated that they did not consider DS necessary (77.6%) or were afraid of potential adverse effects (71.9%). A substantial proportion (68.9%) believed that maintaining a balanced diet was sufficient, making

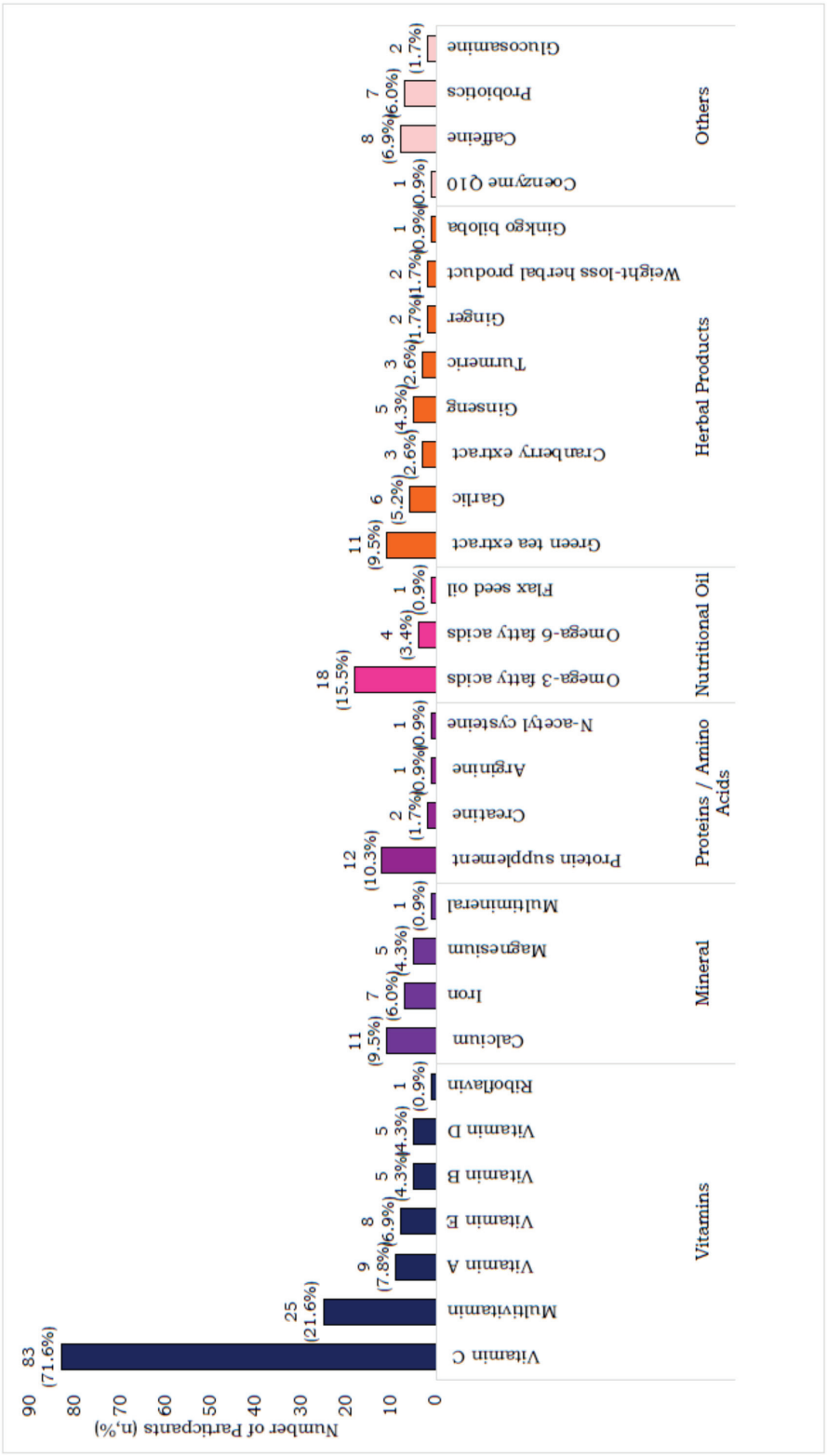

Figure 2. Types of DS used by participants (n=116)

Table 3. Sources of information and procurement for DS, and reasons for use among participants (*n*=116)

	n (%)[†]
Source of information	
Social media	61 (52.6)
Pharmacists	50 (43.1)
Family members	46 (39.7)
Online shopping platforms	38 (32.8)
Friends	30 (25.9)
Doctors	24 (20.7)
Nutritionists	14 (12.1)
Scientific journals	13 (11.2)
Television	13 (11.2)
Magazines	9 (7.8)
Dietitians	8 (6.9)
Sport coach	7 (6.0)
Newspapers	6 (5.2)
Sports teammates	2 (1.7)
Source of procurement	
Pharmacy	81 (69.8)
Supplement store	48 (41.4)
Online shopping platforms	41 (35.3)
Nutritionists	4 (3.4)
Doctors	6 (5.2)
Trainers	3 (2.6)
Sponsors	2 (1.7)
Dietitians	1 (0.9)
Reasons for using DS	
To maintain health	114 (98.3)
To prevent nutrient deficiencies	111 (95.7)
To reduce fatigue after physical activities	96 (82.8)
To enhance physical strength	96 (82.8)
To improve athletic performance	94 (81.0)
To enhance endurance	91 (78.4)
To accelerate recovery	81 (69.8)
To prevent muscle cramps	77 (66.4)
To treat injuries from physical activities	75 (64.7)
To reduce body fat	69 (59.5)
To increase muscle mass	68 (58.6)
To lose body weight	62 (53.4)
To increase body weight	49 (42.2)

DS: Dietary supplement
[†]Participants can provide more than one response and therefore responses do not add up to 100 %.

DS unnecessary. Social influences also contributed to non-usage, with some citing lack of encouragement from family members (50.0%) and friends (37.3%). In addition, a number of DS non-users reported not knowing how to use DS (43.0%) or being unaware of their benefits (35.5%). A smaller group (26.8%) expressed a lack of belief in the efficacy of DS.

DISCUSSION

This study is the first to examine DS use among Malaysian university students who engaged in physical activity. We found that 33.7% had used DS in the past month, with vitamin C and multivitamins being the most commonly consumed. A Canadian study reported a higher DS prevalence (43.4%) among non-athlete university students, which may be attributed to differences in physical activity definitions and overall activity levels (El Khoury *et al.*, 2020). In that study, 96.3% of participants were classified as physically active based on the International Physical Activity Questionnaire (IPAQ), compared to only 40% of participants in the present study who reported engaging in physical activity three or more times per week. The broader inclusion criterion in this study, which defined physical activity as participation at least once weekly, likely contributed to the lower overall DS prevalence observed.

Our findings reinforce previous evidence linking higher physical activity levels with increased DS use (Valentine *et al.*, 2018). Physical activity is widely recognised as part of a broader health-conscious lifestyle; thus, those who are more physically active may be more motivated to use DS for performance enhancement, recovery, and overall well-being (Wahab *et al.*, 2021).

Gender was not a significant predictor of DS use in this study. This contrasts with some studies that found a higher prevalence of DS use among males (El Khoury *et al.,* 2020; Valentine *et al.*, 2018) and others reporting higher use among females (Alfawaz *et al.*, 2020). The absence of gender differences in the present findings suggests that within this population, both male and female students may have similar attitudes and behaviours regarding DS use.

Patterns of DS consumption differed by type of physical activity. Vitamin C and multivitamins were consistently used across all groups, likely due to their accessibility and perceived benefits for immune support and general health (Cassa Macedo, Oliveira Vilela de Faria & Ghezzi, 2019). This widespread use aligns with previous studies and may reflect their over-the-counter availability, favourable safety profile, and strong consumer trust in their health-promoting effects (Alfawaz *et al.*, 2020). Gym-goers reported higher use of protein supplements, consistent with the way these products are typically marketed, namely for supporting muscle growth and facilitating post-exercise recovery (Solak & Akin, 2012). Similarly, the greater use of caffeine and omega-3 fatty acids among joggers may correspond with their frequently promoted roles in enhancing endurance and alleviating inflammation (Wall *et al.*, 2010). These findings suggest that the type of physical activity may be associated with specific DS usage patterns.

In contrast, herbal supplement use was relatively low. Among those who did consume herbal products, green tea extract and garlic were the most common. While such products are often perceived as safe, they have been associated with adverse effects, including liver toxicity and allergic reactions (Hu *et al.*, 2018). These risks underscore the need for professional guidance on herbal supplement use.

Notably, social media emerged as the primary source of DS information among participants. This finding is consistent with earlier studies documenting a shift towards digital platforms for health information. However, the quality of social media content is often commercially driven and lacks scientific accuracy. Thus, it is critical to address the risks of misinformation and commercially driven content. Promoting digital health literacy among university students could enable more critical evaluation of online DS claims. Educational interventions, such as integrating DS literacy into university wellness programmes or deploying short, evidence-based content on popular platforms, may empower students to make safer, more informed health decisions (Fallahi *et al.*, 2024; Neter & Brainin, 2012).

In addition, healthcare professionals and policymakers should consider more strategic engagement with digital platforms. This may include collaborations with trusted influencers, development of evidence-based content tailored for social media channels, and deployment of targeted campaigns to disseminate accurate DS information (de Lade *et al.*, 2021). Regulatory authorities also have a role in monitoring DS-related content online and implementing policies to minimise misinformation and unsubstantiated claims (Wahab *et al.*, 2022a).

Interestingly, although the majority of students purchased DS from pharmacies, only a minority sought advice from pharmacists. This finding indicates a missed opportunity to integrate pharmacists more meaningfully into the consumer decision-making process. Several factors may contribute to this gap. Pharmacists in retail settings are often preoccupied with dispensing duties, leaving limited time for proactive engagement with customers. Additionally, the public may perceive pharmacists primarily as medication experts rather than as reliable sources of nutritional or DS-related advice (Wahab *et al.*, 2022b).

The underutilisation of pharmacists stands in contrast to their potential role in DS counselling. Pharmacists are well-positioned to offer individualised, evidence-based guidance on DS use, including product selection, dosing, potential interactions, and safety considerations. To maximise this potential, pharmacists must adopt a more proactive approach in initiating DS-related discussions with consumers. Evidence suggests that many consumers are receptive to pharmacists' input but may not seek it unless prompted (Wahab *et al.*, 2022b). Strengthening the public health role of pharmacists through proactive counselling, targeted educational campaigns, and policy support from regulatory bodies could bridge this gap and promote safer DS use among university populations.

In addition, many pharmacies in Malaysia now employ or collaborate with nutritionists, whose expertise complements that of pharmacists. Nutritionists can contribute by providing in-depth dietary assessments, identifying nutrient gaps, and reinforcing non-pharmacological approaches to health. Collaborative counselling between pharmacists and nutritionists could enhance the quality of advice provided to consumers, ensuring a balance between evidence-based nutrition guidance and safe supplement use.

The increasing trend of online DS purchases among university students also raises important safety concerns. Online marketplaces allow consumers to bypass professional advice and access products that may not meet regulatory standards. Unsupervised purchases carry risks such as improper use, lack of quality assurance, and exposure to counterfeit or adulterated DS (Wahab *et*

al., 2022b). These challenges highlight the need for stronger regulatory oversight of online DS sales and broader public education on the importance of sourcing products from reputable providers.

Limitations of study

The limitations of this study warrant attention. Firstly, the data were collected using self-reported measures, which are inherently prone to biases such as recall bias. Additionally, there is a risk of social desirability bias. To minimise the risk of social desirability bias, anonymity was emphasised in the consent process by assuring participants that their responses would remain confidential and that no identifying information would be collected. Furthermore, the study sample predominantly comprised Malay female students, reflecting the demographic composition of the university but limiting the generalisability of findings. As health behaviours and DS use may differ across ethnic and gender groups, caution is warranted in extrapolating these results to the broader Malaysian university student population. Future studies should employ stratified sampling or include multiple universities to ensure more representative and diverse samples. Additionally, the study's cross-sectional design provided only a snapshot of DS usage at a single point in time, limiting the ability to draw causal inferences. Future research should employ longitudinal designs to more comprehensively investigate patterns of DS use over extended periods.

CONCLUSION

This study examined DS use among Malaysian university students engaged in physical activity, with one-third of participants reporting DS use in the past month. Individuals who engaged in physical activity more frequently and those who believed in the health benefits of DS were more likely to use DS. The prevalent use of social media as an information source for DS raises concerns, as the quality and reliability of information on these platforms may be questionable. Future research could enhance the understanding of DS use among university students by employing longitudinal designs, ensuring more representative samples, and expanding the scope to include multiple universities across Malaysia. As DS use continues to grow, it is crucial to strengthen public education and promote evidence-based guidance to ensure the safe and effective use of these products among university students and the broader population.

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Authors' contributions

Padil SNA, led the data collection and was involved in data analysis and interpretation, literature search, and drafting of the manuscript; Hamdan NEA, Hussin NSM, Sha'ari MS, Azlan S, and Taridi NS, contributed to data analysis and interpretation, conducted literature reviews, and participated in manuscript drafting and revision; Jamal JA, prepared the initial draft, contributed to data analysis and interpretation, and critically reviewed the manuscript; Wahab MSA, conceptualised and designed the study, contributed to the initial drafting, supervised the research process, participated in data interpretation and literature review, and critically revised the manuscript for intellectual content.

Conflict of interest

The authors declare that there are no conflicts of interest.

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