Dietary supplement use among undergraduate male students in health and non-health cluster colleges of a public-sector university in Dammam, Saudi Arabia

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Abstract

Background: Dietary supplements (DS) are nutraceuticals that improve overall health and well-being of an individual as well as reduce the risk of diseases. Evidence indicates a rising prevalence of these products worldwide especially among college students. Studies have reported an increasing use of supplements among Saudi students. However, the scope of those researches was limited to prevalence data. Hence, the aim of our study was to document the prevalence, opinions, attitudes, reasons for use and monthly cost attributed to dietary supplement use.

Methods: A 3-month cross-sectional study was conducted to evaluate use of dietary supplement among health and non-health college students at a public-sector university in Dammam city, Saudi Arabia. It was conducted using Arabic version of the Dietary supplement questionnaire (DSQ-A). A total of 469 male students responded to the survey giving a response rate of 93.8%. The students were from ten colleges of the university. The data was analyzed by SPSS version 22. The study was approved by Institutional Review Board of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (IRB-UGS-2018-05-074).

Results: The overall prevalence of dietary supplement use in the university was 29.42%. In health cluster colleges, it was reported at 35.91% while in non-health cluster college it was 23.69%. Maintaining general health and well-being was the most common reason for use. Prevalence of multivitamins and whey proteins was approximately 23%. Average monthly cost of supplement was SAR 278.92 (USD 74.39). Cost was positively correlated ($p = 0.305$) with satisfaction score. Students preferred brand products (16.4%). 41.4% students opined that DS may prevent chronic illness if used regularly and agreed that they are good for health. Majority of students (65%) recommended DS use only upon physician’s recommendation. College clusters and study-year was associated ($p$-value < 0.01) with students’ opinion. Students in health cluster colleges were more likely to recommend supplements (OR 3.715, $p$-value < 0.0001).

Conclusion: Prevalence of dietary supplement use was lower than other local and international university students. Health cluster colleges had higher prevalence as compared to non-health cluster colleges. Multivitamins and whey protein were the most commonly used types of DS. Students preferred brand products, had positive opinions and attitudes towards dietary supplement. However, they recommended supplements use to others only upon a physician’s recommendation.

Keywords: Dietary supplement, Undergraduate students, Prevalence, Opinions, Attitudes, Cost, Saudi Arabia

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Background
Appropriate nutrition is essential for proper development and maintenance of the human body. Dietary supplement (DS) improves general health and well-being when used as recommended [1]. It includes multivitamins, minerals and, natural products extracts [2]. The use of DS is quite common in the developed world [3]. According to the 3rd National Health and Nutrition Examination Survey (NHANES), the overall prevalence of dietary supplement use in the United States (US) was 40% [3]. Evidence indicates that individuals may use a single or a combination of different dietary supplements as means to improve their nutrition intake, maintaining general health and well-being, as well as reduce risk of diseases [3]. Conversely, studies have reported adverse drug events and mortalities because of over dose, drug-drug and drug-disease interactions associated with supplement use [4]. For instance, excessive use of cholecalciferol, i.e., vitamin D, may adversely affect soft tissues and kidney functions [5]. Supplements may also interact with drugs for managing cardiovascular illnesses [6, 7].

Studies have reported a higher consumption of supplements in subgroups as compared to overall population and, several demographic determinants such as higher education, attitudes, etc., have been reported to be associated with a greater likelihood of dietary use [3, 8, 9].

Literature highlights that more than half (66%) of college students in the US used dietary supplements and students with a health study background used DS more regularly than students belonging to non-health study field [1, 10, 11].

The monetary value of dietary supplements in 2014 amounted to United States dollar (USD) 165.62 billion and was rising with a compound annual growth rate (CAGR) of 7.3%. The projected market worth is expected to touch USD 278.96 billion by 2021. Asia Pacific region has emerged as the second largest market for expected to touch USD 278.96 billion by 2021. Asia Pacific (CAGR) of 7.3%. The projected market worth is expected to touch USD 278.96 billion by 2021. Asia Pacific region has emerged as the second largest market for

College students studying in Saudi Arabia were more likely to use DS as compared to general population [10]. Although, a few studies reported that the use of supplements had increased in general population as well as undergraduate students of Saudi Arabia. However, the findings were limited to prevalence data [14, 16]. There is a scarcity of data that reports common supplements used by Saudi students. Moreover, the reasons as well as attitudes towards DS use have not been studied before. A study by Albusalih et al., conducted at this venue reported an increasing use of dietary supplement among students [16]. However, it established a mere prevalence of multivitamins. Hence, the aim of this study was to report the use of dietary supplements in students including its prevalence data, i.e., overall, college-wise and study year-wise prevalence as well as individual prevalence of each supplement. In addition, students’ opinion, attitudes, reasons for use as well as monthly cost attributed to dietary supplement use, was documented.

Methods
A cross-sectional study was conducted in undergraduate students studying in health and non-health cluster colleges at Imam Abdulrahman Bin Faisal University located in Dammam, Saudi Arabia.

Operational definitions

Dietary supplements
Dietary supplements are nutraceuticals and natural products extracts, that are available without prescription and are used by individuals in recommended dose for improving performance, general health and well-being as well as reducing the risk of diseases [1].

Dietary supplement prevalence (point prevalence)
The regular use of dietary supplements in a population over a defined time-period [1].

Brand and generic pharmaceutical products
A brand is a pharmaceutical product that is developed by a pharmaceutical company after years of research and financial investment. They are legally protected by patents granted from health regulatory agencies for several years. The patent gives the manufacturer the sole legal right to sell the product for the stated period of patent. After the expiry of the patent, other pharmaceutical firms may manufacture the product after approval from the health regulatory agency. These products are termed as generics and are cheaper than brands because they utilize...
the research of the parent brand drug and do not require investment of huge finances in research [15].

**Target population and inclusion criteria**

The study included male students studying in health and non-health colleges affiliated to IAU who were willing to participate. Health cluster included four colleges namely clinical pharmacy, medicine, nursing and applied medical science. Non-health cluster included six colleges namely sharia and law, architecture and planning, engineering, applied studies and community service, business and, science. Female students, students who had graduated from the university and non-consenting students were excluded. Female students could not be included as male and female students were segregated and studied in different campuses with separate and independent administration. The study included only male investigators and it was not possible to conduct the study in female campuses. This is mentioned as a limitation of our study.

**Sample size and procedure**

We employed purposive sampling methodology and selected most convenient time such as prayer and lunch breaks to approach students. Students from different health and non-health cluster colleges of university were invited to participate. Sample size was calculated based on number of undergraduate students studying in Saudi universities. According to official figures, there were 1597 students enrolled at IAU [17]. This figure was identified as target population. Sample size was calculated from online calculator [18]. The sample size calculated was 310. Our study gathered data from 469 students which was more than the required sample size.

**Research instrument and translation process**

A survey questionnaire developed by Naqvi and colleagues, known as the Dietary supplement questionnaire (DSQ) [1], was used after its translation into Arabic language that is the native language of Saudi students. The questionnaire contained multiple choice questions, few open-ended questions and a numeric rating scale.

The DSQ includes questions related to the demographic information of respondents such as age, college, year of study, residence status, number of siblings, presence of any major illnesses and if they had used a dietary supplement in the last month. Furthermore, the respondents were asked about the type of dietary supplement they used, what commercial product did they use, i.e., imported brand from foreign countries or a locally produced generic product, the reason for taking supplements and monthly cost attributed to its use. The respondents were also asked if they suffered from any adverse drug event that was related to their supplement use. The respondents were also inquired about their source of information and opinions about supplements. They were asked if they believed that dietary supplements were good for health and whether they would personally recommend supplements to others. Finally, they were asked to rate their satisfaction with supplement use on a rating scale [1].

The translation was carried out considering standard guidelines [19, 20]. The translation process included three Arabic speaking pharmacists whose second language was English. The initial translation was conducted in supervision of the inventors of DSQ to elaborate and clarify meaning in any DSQ item. The initial draft was reviewed by four academic professors specialized in medicine, pharmacy and physics whose first language was Arabic and second language was English. This was done to check for adaptability of the Arabic version (DSQ-A) for respondents belonging to health and non-health background. The three reviewers were kept unaware of the purpose of study to have a balanced review of the tool. DSQ-A was back translated by an academic professor of ethics with same language expertise in collaboration with tool inventors. The face validity and content validity were established and the Arabic version of DSQ was deemed fit to use at this point. The questionnaire is available as an Additional file 1.

**Pilot study and acceptability of the DSQ-A**

DSQ-A was subjected to pilot study in 100 students belonging to different colleges of the university. A total of 92 responses were received giving a response rate of 92%. No difficulty in understanding of the questionnaire was observed. The DSQ-A was deemed fit to use at this point.

**Data analysis**

The data was entered and analyzed using statistical software IBM SPSS version 22. Prevalence was calculated using Medcalc. Frequency counts (N), percentages (%) and descriptive statistics such as mean (X) and standard deviation (SD) were used. Prevalence was expressed in percentage (%) and 95% confidence intervals. Inferential statistics such as chi square (x²) test to observe associations between student characteristics, i.e., independent variables (IV) and DS study variables, i.e., dependent variables (DV) were performed. Spearman’s rank correlations (ρ) was employed to document any correlation among IV and DV. Regression analysis was conducted to report any predictors of DS use.

**Ethics approval and consent**

The study was approved by the Institutional Review Board of Imam Abdulrahman Bin Faisal University (IRB-UGS-2018-05-074). Students were informed about the study and its objectives. Students who consented to participate in the study were included. The participation was voluntary without any incentive. An informed written consent was sought from students before handing them
the questionnaire. Those who consented to participate in the study were handed DSQ-A.

Results
Of total 500 students who were approached, 469 students responded to the survey giving a response rate of 93.8%. The study included students from all study years. The mean age of the students was 21 years (X = 20.96, SD = 1.66). Majority of the students (N = 395, 84.2%) lived with their families and had 3–5 siblings (N = 262, 55.9%). Few students (N = 49, 10.4%) suffered from major illnesses. Of total 49 patients considered as 100% who suffered from illnesses, the proportions of patients were; hypertension (N = 3, 6.1%), diabetes mellitus (N = 5, 12.2%), sickle cell anemia (N = 7, 14.3%), thalassemia (N = 1, 2%), glucose 6 – phosphate dehydrogenase (G6PD) (N = 17, 34.7%), asthma (N = 6, 12.2%), rheumatoid arthritis (N = 1, 2%), psoriasis (N = 2, 4%), gastro esophageal reflux disorder (GERD) (N = 1, 2%), migraine (N = 2, 4%), obesity (N = 2, 4%) and epilepsy (N = 1, 2%). The summary of student information is presented in Table 1.

Table 1 Student characteristics

| College                      | N   | %   |
|------------------------------|-----|-----|
| Pharmacy                     | 70  | 14.9|
| Medicine                     | 92  | 19.6|
| Nursing                      | 22  | 4.7 |
| Sharia and law               | 39  | 8.3 |
| Applied medical sciences     | 36  | 7.7 |
| Architecture and planning    | 57  | 12.2|
| Engineering                  | 36  | 7.7 |
| Applied studies and community service | 27  | 5.8 |
| Business                     | 43  | 9.2 |
| Science                      | 47  | 10  |
| Study year                   |     |     |
| Prep year                    | 84  | 17.9|
| 2nd year                     | 138 | 29.4|
| 3rd year                     | 92  | 19.6|
| 4th year                     | 59  | 12.6|
| 5th year                     | 89  | 19  |
| 6th year                     | 7   | 1.5 |
| Residence                    |     |     |
| Living with family           | 395 | 84.2|
| Living alone (University accommodation) | 74  | 15.8|
| Siblings                     |     |     |
| Between 1 and 2 siblings     | 49  | 10.4|
| Between 3 and 5 siblings     | 262 | 55.9|
| Between 6 and 8 siblings     | 102 | 21.7|
| More than 8 siblings         | 50  | 10.7|
| No siblings                  | 6   | 1.3 |
| Any major illness            |     |     |
| Do not suffer from any illness| 420 | 89.6|
| Suffer from a major illness  | 49  | 10.4|
| DS use in the last month     |     |     |
| Daily                        | 62  | 13.2|
| Weekly                       | 24  | 5.1 |
| Once a month                 | 20  | 4.3 |
| Never                        | 300 | 64  |
| Not sure                     | 63  | 13.4|

Table 2 Types and prevalence of dietary supplement used

| Types of dietary supplements used | Alone | As combination |
|-----------------------------------|-------|----------------|
| Multivitamins                     | 44 (9.4) | 42 (9)          |
| Gingko biloba                     | 1 (0.2) | –              |
| Ginseng                            | –      | 3 (0.6)        |
| Glucosamine/omega 3 FA            | 3 (0.6) | 32 (6.8)       |
| Whey protein                       | 38 (8.1) | 38 (8.1)   |
| Calcium                            | 1 (0.2) | –              |
| Creatine phosphate                | –      | 1 (0.2)        |
| More than one supplement           | 64 (13.6) | –           |
| Not applicable                     | 318 (67.8) | –            |
| Cluster-wise prevalence            |       |               |
| All colleges                      | 29.4  | 25.3–33.8%     |
| Health cluster colleges           | 35.9  | 29.6–42.6%     |
| Non-health cluster colleges       | 23.7  | 18.5–29.5%     |
| College-wise prevalence           |       |               |
| Pharmacy                          | 34.3  | 23.4–46.6%     |
| Medicine                          | 39.1  | 29.1–49.9%     |
| Nursing                           | 18.2  | 5.2–40.3%      |
| Applied Medical Science           | 40    | 23.9–57.9%     |
| Sharia and law                    | 12.8  | 4.3–27.4%      |
| Architecture and planning         | 14    | 6.6–25.8%      |
| Engineering                       | 41.7  | 25.5–59.2%     |
| Applied studies and community service | 18.5 | 6.3–38.1%    |
| Business                          | 37.2  | 23–53.3%       |
| Science                           | 19.2  | 9.2–33.3%      |
| Study year-wise prevalence        |       |               |
| Prep year                         | 16.7  | 9.4–26.4%      |
| 2nd year                          | 24.5  | 17.6–32.5%     |
| 3rd year                          | 29.4  | 20.3–39.8%     |
| 4th year                          | 37.3  | 25–50.6%       |
| 5th year                          | 42.7  | 32.3–53.6%     |
| 6th year                          | 42.9  | 9.9–81.6%      |
Types and prevalence of dietary supplement use
Multivitamins were used alone or in combination by a tenth proportion of students, i.e., 9–9.4%. The overall prevalence of dietary supplement use was 29.4%. Health cluster colleges had an overall prevalence of 35.9% while non-health cluster college reported a prevalence of 23.7%. The summary of prevalence by group and individual colleges as well as study year is presented in Table 2.

The college-wise and study year-wise prevalence of multivitamins, glucosamine/omega 3 Fatty Acids (FA), whey protein, ginseng and gingko biloba was documented. The prevalence of ginseng was reported at 2.9% (0.4–9.9 for 95% CI) from pharmacy college. It was also reported at 1.1% (0.03–5.6 for 95% CI) and 1.7% (0.04–8.9 for 95% CI) in 3rd and 4th year students respectively. The prevalence of gingko biloba was reported in pharmacy college at 1.4 (0.04–7.7 for 95% CI) and at 1.7% (0.04–8.9 for 95% CI) in 4th year students respectively. The college and study year-wise prevalence are tabulated in Table 3.

Cost of dietary supplement per month
The average monthly cost attributed to dietary supplement use was reported at SAR 278.92 (USD 74.39) however, the median cost reported was SAR 220 (USD 58.67). Minimum cost incurred was reported at SAR 5 (USD 1.33) and maximum cost incurred on DS use per month was SAR 2170 (USD 578.74).

Reasons and types of dietary supplements used
Most students did not use DS (318, 67.8%). Almost a fifth proportion of students (N = 82, 17.5%) selected more than one reason for using dietary supplement.

Students’ experience from DS use
Some students (N = 77, 16.4%) used a brand product and a few (N = 51, 10.9%) did not know if it was a brand or generic product. A third of students (N = 142, 30.2%) did not suffer from an adverse reaction to dietary supplement.

Opinion and attitudes towards DS
More than 40% of students (N = 194, 41.4%) opined that DS may prevent chronic illness if used regularly followed by similar number of students (N = 185, 39.4%) who considered DS as harmless. Slightly less than half of students (N = 224, 47.8%) agreed to the notion that DS are good for health and more than half (N = 305, 65%) recommended use of DS to others, only upon doctor’s recommendation. Student rated their satisfaction with DS use on a scale of 0 (worst) to 5 (best). The average satisfaction score was reported to be almost 3 (X = 2.89, SD = 1.25). The details are presented in Table 4.

Association and correlation of independent and dependent variables
The dependent variable (DV) of student opinion towards dietary supplements, was significantly associated with;
college (p-value< 0.01), college type (p-value< 0.01) and study year (p-value< 0.001). However, there was no statistical significance between the variable of student opinion and demographic information, i.e., siblings (p-value> 0.05). Moreover, the association between student opinion and illness profile was insignificant (p-value> 0.05). The cross tabulation is presented in Table 5. The values presented in brackets are expected counts.

The IV of age and dietary supplement cost were positively correlated with satisfaction score (ρ = 0.12 and ρ = 0.305 respectively) and the correlation was significant at p-value< 0.01 (Figs. 1 and 2).

Multinomial logistic regression (MLR) was used to interpret the odds ratio for dependent variable (DV) of, ’encouraging dietary supplement use’. The discrete independent variable (IV) of, ‘age’ was considered as covariate and categorical IV of, ‘college type’ was fixed. Student attitudes towards encouraging DS use was taken as DV. The parameter of IV, i.e., ‘non-health cluster college’ was redundant and therefore, set to zero (0). Parameter of DV, i.e., ’not at all’ was considered as reference category. The regression analysis reported that keeping the categorical IV of ‘college type’ as constant, the odds of, ‘always recommending DS use’ increases with every year-wise increase in age (OR 1.303, p-value< 0.01). Similarly, keeping the IV of ‘age’ as constant, students studying in ‘health cluster colleges’ were more likely to, ‘recommend DS use’ as compared to students studying in ‘non-health cluster colleges’ (OR 3.715, p-value< 0.0001). The regression analysis is tabulated in Table 6.

Discussion
Dietary supplement use has been previously reported from this university by Albusalih et al., that highlighted the need to conduct a full-scale study to investigate their use including prevalence, cost attributed to DS use and students’ attitude and opinion towards it [16]. This study was conducted in ten colleges of the university. The sample size was 310 for 95% confidence interval (CI) however, we focused on gathering sample to satisfy 99% CI. The extensiveness of data collection in ten colleges, large sample size and a high response rate are major strengths of this study.

The average age of students was 21 years and most students lived with their families. Few students had major illnesses, i.e., cardiovascular diseases, endocrine and blood disorders, musculoskeletal diseases, gastrointestinal and central nervous system disorders. Previous studies conducted in this population have also reported similar student health profile [16, 21–23].

The overall prevalence of DS use at the university was 29.42%. This reiterates the findings of Albusalih et al.,

| Table 4 Reasons for use, experience with DS, opinions and attitudes towards dietary supplements |
|---------------------------------------------------------------|
| Reasons for use | Sample (N) | Percentage (%) |
| General Health and Well Being | 22, 31^a | 4.7, 6.6^a |
| Boost immunity | 2, 27^a | 0.4, 5.8^a |
| Weight gain | 2, 18^a | 0.4, 3.8^a |
| Doctor’s recommendation | 7, 17^a | 1.5, 3.6^a |
| Enhance memory | 3, 16^a | 3.4, 0.6^a |
| Increase performance/sports | 5, 24^a | 1.1, 5.1^a |
| Increase endurance/body building | 12, 47^a | 2.6, 10^a |
| Malnutrition | 9, 35^a | 1.9, 7.5^a |
| Energy source | 7, 29^a | 1.5, 6.2^a |
| More than one reason | 82 | 17.5 |
| Not applicable | 318 | 67.8 |
| Experience with DS use in last month | |
| Pharmaceutical category used | |
| Generic | 12 | 2.6 |
| Brand | 77 | 16.4 |
| Both | 11 | 2.3 |
| I do not know | 51 | 10.9 |
| Not applicable | 318 | 67.8 |
| Adverse reactions to dietary supplements | |
| I suffered from an adverse reaction | 1 | 0.2 |
| I suffered from an adverse reaction but sure if it was related to DS use | 8 | 1.7 |
| No, I did not suffer from any adverse effect | 142 | 30.2 |
| Not applicable to me as I did not use any supplements | 318 | 67.8 |
| Opinion about dietary supplements | |
| Necessary for all ages | 49 | 10.4 |
| They are harmless | 185 | 39.4 |
| Regular use of dietary supplement prevents chronic disease | 194 | 41.4 |
| Dietary supplements may prevent cancer | 26 | 5.5 |
| No opinion | 15 | 3.2 |
| Dietary supplements are good for health | |
| Agree | 224 | 47.8 |
| I don’t know | 173 | 36.9 |
| Disagree | 72 | 15.4 |
| Do you personally recommend use of dietary supplements to others | |
| Yes, I always recommend | 66 | 14.1 |
| Yes, only when doctors recommend | 305 | 65 |
| Not at all | 98 | 20.9 |

Legend: (\^a) = selected in combination with others
that reported a 30% prevalence of the same [16]. Though, that figure was reported in male and female students cumulatively. Our results are in the range of 26.31–35% as reported by Albusalih et al., [16]. Naqvi and colleagues reported a prevalence of dietary supplement use at 51% in male undergraduate pharmacy students of Pakistani universities [1]. Our finding was much lower than figures reported from American, Nigerian and South African university students [1, 14, 24, 25]. However, it was higher than that reported in Japanese students [26]. Our study further documented college-wise and study-year wise prevalence data as well. We tested the hypothesis that health students use such products more than non-health students. Studies have reported that students with a health background tend to use supplements more than their counterparts which could be due to better awareness and education that may shape their opinions in favour of using supplements [26, 27]. The prevalence of DS use in health cluster colleges was reported at 35.91% while it was 23.69% in non-health cluster. Similarly, highest prevalence of DS use was reported from applied medical science, medicine and pharmacy colleges. Students of engineering college, i.e., a non-health college, reported prevalence similar to that reported in students of applied medical science college. This reiterates the findings of Kobayashi et al., that prevalence was higher in students with health background compared to those with a non-health background [11, 26]. An inclining trend was evident while

| Independent Variable                  | Dietary supplements are good for health | P-value |
|--------------------------------------|----------------------------------------|---------|
|                                      | Agree | Do not know | Disagree |
| College                              |       |             |          |
| Clinical pharmacy                    | 49 (33.4) | 17 (25.8) | 4 (10.7) |
| Medicine                             | 62 (43.9) | 23 (33.9) | 7 (14.1) |
| Nursing                              | 7 (10.5) | 9 (8.1) | 6 (3.4) |
| Applied medical sciences             | 12 (17.2) | 14 (13.3) | 10 (5.5) |
| Sharia and law                       | 10 (18.6) | 23 (14.4) | 6 (6) |
| Architecture and planning            | 15 (27.2) | 32 (21) | 10 (8.8) |
| Engineering                          | 21 (17.2) | 9 (13.3) | 6 (5.5) |
| Applied studies and community service| 7 (12.9) | 13 (10) | 7 (4.1) |
| Business                             | 27 (20.5) | 11 (15.9) | 5 (6.6) |
| Science                              | 14 (22.4) | 22 (17.3) | 11 (7.2) |
| College cluster                      |       |             |          |
| Health                               | 130 (105.1) | 63 (81.2) | 27 (33.8) |
| Non-health                           | 94 (118.9) | 110 (91.8) | 45 (38.2) |
| Study year                           |       |             |          |
| Prep Year                            | 26 (40.1) | 39 (31) | 19 (12.9) |
| 2nd Year                             | 52 (65.9) | 63 (50.9) | 23 (21.2) |
| 3rd Year                             | 47 (43.9) | 32 (33.9) | 13 (14.1) |
| 4th Year                             | 35 (28.2) | 17 (21.8) | 7 (9.1) |
| 5th Year                             | 61 (42.5) | 19 (32.8) | 9 (13.7) |
| 6th Year                             | 3 (3.3) | 3 (2.6) | 1 (1.1) |
| Siblings                             |       |             |          |
| Between 1 and 2 siblings             | 28 (23.4) | 14 (18.1) | 7 (7.5) |
| Between 3 and 5 siblings             | 120 (125.1) | 103 (96.6) | 39 (40.2) |
| Between 6 and 8 siblings             | 54 (48.7) | 35 (37.6) | 13 (15.7) |
| More than 8 siblings                 | 22 (23.9) | 17 (18.4) | 11 (7.7) |
| No siblings                          | 0 (2.9) | 4 (2.2) | 2 (0.9) |
| Any major illness                    |       |             |          |
| Do not suffer from any illness       | 198 (200.6) | 156 (154.9) | 66 (64.5) |
| Suffer from a major illness          | 26 (23.4) | 17 (18.1) | 6 (7.5) |
Fig. 1 Correlation of student age with satisfaction score

Fig. 2 Correlation of cost of dietary supplement with satisfaction score
investigating prevalence data based on study year. This occurrence has been reported previously among university students in Japan. Hence, our findings are consistent with Kobayashi and colleagues [26].

Prevalence of some dietary supplements that were observed to be common amongst students in all colleges was also determined. These included multivitamins, glucosamine/Omega 3 fatty acids, whey protein, ginseng and gingko biloba extracts. Most notable figures were documented for whey protein use. The prevalence remained consistent throughout all colleges. Evidence indicates that protein supplementation is quite common among male university students as it improves physical performance [28, 29]. Multivitamin use prevailed in all colleges with highest prevalence in business college, i.e., around 23% and lowest in nursing college, i.e., 9.1%.

The use of glucosamine/Omega 3 fatty acids (FA) was more widespread in health cluster as compared to non-health cluster. Omega 3 FA may improve sleep quality, reduce depression and anxiety among students [30, 31]. Abbas et al., have reported that anxiety and depression due to academic studies may prevail in undergraduate students [32–34]. Prohaska reported improvement in sleep efficiency by omega 3 FA supplementation in clinically depressed undergraduate students [31]. Studies by Al Rasheed et al., and Al-Shagawi et al., have reported high academic stress and anxiety in Saudi undergraduate students studying medicine and allied health subjects [21, 22]. Hence, its prevalent use could be due to the stress and anxiety among health track students. Use of omega 3 fatty acids has been reported from other colleges in Saudi Arabia as well [14]. However, we could not conclude that high academic stress, depression and anxiety was the reason behind prevalent use of omega 3 FA in our sample.

The use of ginseng and gingko biloba was reported in very low percentages mainly from 3rd and 4th year pharmacy students. This is relevant as pharmacy students study natural products and alternative medicines as well as pharmacognosy courses that may increase their knowledge and awareness of natural products [23]. Use of ginseng and gingko biloba has also been reported from other Saudi universities [14].

| Table 6 Multinomial logistic regression analysis |
| Encourage dietary supplement use? | Coefficient | Odds ratio | 95% Confidence interval |
|--------------------------------------|-------------|------------|------------------------|
| Yes, I always recommend             | Age         | 0.265      | 1.303                  | 1.080 1.572 |
| Health cluster college              | 1.312       | 3.715      | 1.899                  | 7.266  |
| Non-health cluster college          | 0a          | –          | –                     | –  –   |
| Yes, only when doctor recommends    | Age         | 0.068      | 1.07                   | 0.93 1.231 |
| Health cluster college              | 1.133       | 3.104      | 1.868                  | 5.156  |
| Non-health cluster college          | 0a          | –          | –                     | –  –   |

*Reference category

Most common reason mentioned for using DS was maintenance of general health and well-being. Students in Pakistani universities mentioned physician’s advice as most common reason to use dietary supplement [1]. Furthermore, multivitamins were the most common type of DS used alone, as well as in combination. This occurrence has been reported by studies conducted in local and international academia [8, 14, 16, 26].

The average monthly cost attributed to dietary supplement use was reported at SAR 278.92, i.e., USD 74.39. No studies have been conducted in Saudi universities till date, that document cost attributed to DS use among students. A novel study conducted by Naqvi et al., in Pakistani universities reported average DS cost at USD 13.5 [1]. Hence, our findings highlight a relatively high spending trend among Saudi students. However, this may not be definite as there may be other determinants such as socio-economic status that may affect spending on supplements. We found that students preferred a brand over generic dietary supplement. This may be based on individual buying preference. Studies have demonstrated that an individual may prefer brands as brand products are believed to have better quality as compared to generics [15, 28]. Dwyer and colleagues have reported that poor quality of dietary supplements have resulted in adverse drug events (ADEs) and mortality [6]. Moreover, pharmaceutical packaging may also affect consumers’ preferences. Sabah and colleagues mentioned un-attractive packaging as a reason for low preference of brands. This may be a reason for high spending trend among students. However, this may not be definite as there may be other determinants such as socio-economic status that may affect spending on supplements. We found that students preferred a brand over generic dietary supplement. This may be based on individual buying preference. Studies have demonstrated that an individual may prefer brands as brand products are believed to have better quality as compared to generics [15, 28]. Dwyer and colleagues have reported that poor quality of dietary supplements have resulted in adverse drug events (ADEs) and mortality [6]. Moreover, pharmaceutical packaging may also affect consumers’ preferences. Sabah and colleagues mentioned un-attractive packaging as a reason for low preference of generics. This occurrence has been reported by Jamshed and colleagues from Pakistan’s health sector as well [36]. Studies report that brands are generally expensive than generics [15, 36].

Majority of the students opined that regular use of supplements prevented chronic diseases and agreed to the idea that DS were good for health. This was significantly associated with demographic variables of college, college cluster and study year. Students belonging to health cluster colleges agreed that DS were good for health however,
responses from non-health track students swayed between uncertainty and disagreement. Similarly, students in advance study years agreed with the notion. These findings agree with Kobayashi and colleagues [26]. Another confirmation of this phenomenon was the occurrence of significant positive correlation between age of students and DS satisfaction score. Most students mentioned that they would recommend DS only upon a physician’s recommendation. This finding contradicts the results of El Khoury et al., i.e., Lebanese students recommended use of supplements on relatives, friends and peers’ advice [37]. However, there is a plethora of evidence that indicates that dietary supplements may be harmful if not taken in recommended dose [4]. In some cases, over usage of multivitamins may exceed the permissible limits of certain vitamins such as cholecalciferol that may result in adverse effects [5, 6, 38].

Conclusion
The prevalence of dietary supplement was lower than other local and international academic institutions. Prevalence was higher in health cluster colleges as compared to non-health cluster colleges. Multivitamins were most commonly used dietary supplements among university students. Students were more inclined towards expensive brand supplements and had favourable opinion about them. Students had a positive attitude towards dietary supplement use however, they recommended it only upon physician’s recommendation. These findings were in line with previously reported literature.

This study used a validated questionnaire after its translation in Arabic language. The translated tool was piloted in students that enhanced understanding of the topic and improved its acceptability. This aspect was lacking in all previous researches.

The prevalence data derived from the study was very extensive. Predictive modelling applied to the data provided novel insights, i.e., prevalence, students’ attitudes and, monthly cost incurred on DS. Non-inclusion of female students could be a limitation in our study. Male and female students were segregated in different campuses with independent administration. Inclusion of female students would have helped the researchers to understand how DS use and its opinions differ gender-wise in the same population. The researchers recommend conducting the study in female population.

Additional file

Additional file 1: Dietary supplement questionnaire (DSQ) and the Arabic version of Dietary supplement Questionnaire (DSQA). (PDF 267 kb)

Abbreviations
CAGR: Compound annual growth rate; DS: Dietary supplement; DSA-A: Dietary supplement questionnaire – Arabic version; DSQ: Dietary supplement questionnaire; DV: Dependent variable; FA: Fatty acids; G6PD: Glucose 6 – phosphate dehydrogenase; IAU: Imam Abdulrahman Bin Faisal University; IV: Independent variable; KSA: Kingdom of Saudi Arabia; NHANES: National Health and Nutrition Examination Survey; SAR: Saudi Arabian riyal; SD: Standard deviation; USA: United States of America; USD: United States dollar

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Availability of data and materials
The data set generated from the study is an intellectual property of Research Committee, College of Clinical Pharmacy, Imam Abdulrahman Bin Faisal University. It is not available publicly however, will be available from the corresponding author on genuine requests.

Authors’ contributions
AAN conceived the idea, designed the study with RA, AWE, AHA and MJA. AAN wrote the introduction with RA, AWE, AHA and MJA. AWE, AHA and MJA conducted literature review. RA and AAN designed the data collection tool and wrote the abstract and methodology. The data was collected and entered in SPSS by AWE, AHA and MJA. AAN conducted statistical tests and wrote the results section. RA and AAN wrote the discussion and conclusion with assistance from AWE, AHA and MJA. AAN edited the final draft of the manuscript. The authors AWE, AHA and MJA contributed equally. All authors read and approved the manuscript.

Ethics approval and consent to participate
The study was approved by Institutional Review Board of Imam Abdulrahman Bin Faisal University ID # RB-UGS-2018-05-074. Furthermore, a written consent was sorted from volunteers.

Consent for publication
A written informed consent for publication was obtained.

Competing interests
The authors declare that they have no competing interests.

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