



Study of the Association between the Consumption of Dietary Supplements and Lifestyle Factors in a Population of Moroccan Academics during the COVID 19 Health Crisis

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Abstract

The objective of this study is to determine the prevalence of dietary supplement (DS) consumption by students, their perception of it during Covid 19 confinement, as well as the factors associated with it. A cross-sectional descriptive study was carried out online with a questionnaire, with a population of 350 students from Casablanca (Morocco), from March to May, 2020. The consumption pattern of DS, socio-demographic characteristics and lifestyle were collected. The association between the different factors was made by Pearson's correlation analysis. 69.4% of participants consume DS of which 32% are boys and 27.4% are girls. The most prominent reason for taking DS was to fight fatigue and combat stress (19.8%), and participants preferred to buy them in pharmacies and drugstores (55.5%), on medical prescription. (32.77%) or on the advice of a pharmacist (7.92%). 50.60% consumed vitamins, minerals and/or trace elements, 4.5% proteins/Amino acids and 4% fish oils. About a third (35%) consumed more than one type of supplement at the same time. 45.54% used them occasionally, 17.92% regularly and 6.08 frequently. 48.4% respected the recommended daily doses. Supplementation was significantly associated with body mass index, physical activity, socioeconomic level and is slightly conditioned by dietary practices. 32.5% think that

DS is harmless to health; 21.27% that regular consumption can prevent some diseases; 46.23% that excessive consumption can present health risks. These risks could be related to some components of DS. 21.78% of respondent's experience real satisfaction after consuming DS; 34.65% feel better; while 2.97% think they have no effect. Students seemed more likely to consume DS during confinement than the general population, which raises questions related to their impact on health. Thus, awareness campaigns for students on the risks and dangers of these substances are necessary. Strict regulations to ensure their job security are recommended.

Subject Areas

Public Health, Nutrition

Keywords

Dietary Supplements (DS), COVID19, Containment, Students, Lifestyle

1. Introduction

COVID-19 (SARS-CoV-2) is a disease caused by a new coronavirus, which affects the physical and mental health of individuals in different ways. The ongoing epidemic has been declared by the World Health Organization (WHO) as a global public health emergency [1]. This coronavirus presents a major global human threat that has turned into a pandemic. The latter to SARS-CoV-2 began in China in December 2019, then reached Morocco in March 2020 and has forced several countries, in addition to Morocco, to implement containment of their citizens. This confinement induces a state of significant stress in individuals [2]. Several effects of confinement have been studied by some authors: social isolation, stress, boredom, lack of sleep, anxiety, depression, suicidal and addictive behavior, as well as domestic violence [3]. It also has consequences on the eating habits which are found to be disturbed. Thus, and in the face of this pandemic, the nutritional status of individuals of both sexes, all age groups, in all countries affected by COVID 19, have seen changes and students were not excepted.

Some studies have shown that nutrition has a massive effect on the immune system [4], as well as other bodily systems, improving both the body's protection and the ability to fight the SARS-CoV-2 virus. Polamarasetti and Martirosyan, also noticed in 2020 [4] that some bioactive compounds and functional foods improve the body's immune function and prevent viral infection. These foods can also be recommended in the prevention and early management of chronic and infectious diseases such as SARS-Cov2 [5].

Since the 1980s, attention to meal balance, especially during confinement, has become a significant factor in food choice. Currently, eating behaviors are strongly influenced by the health and nutritional recommendations of physicians, in addition to the role of the media [6]. The subjects are also looking for ways to re-

duce fatigue and stress, prevent disease, and regain their well-being [7]. As a result, the development of products promising a health effect has also been observed [8]. Healthy foods include dietary supplements (DS). It is for these reasons that some people turn to them, especially those who eat unhealthily, for fear of developing some nutrition-related illnesses [9].

DS are defined according to Directive 2002/46/CE of the European Parliament, transposed by decree n° 2006-352 of March 20, 2006 [10], as “foods tuf DS the purpose of which is to supplement the normal diet and which constitute a concentrated source of nutrients or other substances, having a nutritional or physiological effect”. Currently, the promotion of physical and sporting activity for all and throughout life has encouraged subjects to do sport and fitness in sports halls, including wrestling, educating their customers about the new body discipline that encourages DS consumption [11].

The supply of DS has diversified a lot to meet the desires of consumers (compensate for an insufficient daily food intake (Nutrition), help accelerate weight loss or improve the capacity to gain weight and muscles [12] [13], or compensate for a particular condition (fatigue, illness, stress, tone, digestion, beauty, etc.) [8]. It also prevents disease, aim to strengthen health and maintain homeostasis [9]. These substances have increased dramatically in pharmacies, drugstores, organic stores, supermarkets, ... [14].

DS are a priori, healthy substances that present no danger to health. This suggests that each individual can consume them without risk. However, some authors, following studies of their physiological effects, have demonstrated their potentially harmful impact on the functioning of the body [8], especially in the absence of vitamin or mineral deficiencies. Thus, the amount of DS consumed must not exceed the maximum recommended levels. Any excess can be harmful to health [15], especially in the long term. Any supplementation must be under the supervision of a health professional and any intake without supervision may present health risks (overdose or overconsumption or concomitant intake of several DS [16]. In addition, many studies have shown correlations between different pathologies and excessive intake or insufficiency of nutrients [17]. These substances contain active ingredients that could cause side effects, especially when consumed in combination with other drugs or other DS [18], without the supervision of a doctor or pharmacist [19]. It exposes the subject to a risk of drug interactions. Thus, the constituents of DS are likely to increase or inhibit the effect of the drugs concerned. For example, for those intended for athletes aiming for muscle development, their association with analgesics or stimulants may delay the perception of fatigue. In this case, the workouts will be longer or more intense, which increases the risk of developing musculoskeletal disorders [20] and overtraining syndrome.

In Morocco, the placing on the market of DS is subject to control by the Ministry of Health and obeys the same rules as drugs. The DS market has evolved rapidly, especially with changes in lifestyles, the trend of physical well-being, the

decrease in physical activity which is the cause of the appearance of several diseases (arterial hypertension, diabetes, obesity, etc.), and containment during the COVID19 health crisis. Moroccans consume them either to protect themselves against diseases or health problems (stress, colds, heart attacks, osteoporosis, cancer, dental caries...), or to increase energy, improve physical performance and correct various deficiencies of lifestyle [21]. Thus, Jamal noticed in 2016 that 46% of Moroccans consume DS more or less regularly. In addition, Khalfaoui observed in 2018 [22], that 34.10% of Moroccan consumers are students; 33.8% are civil servants; 24.3% are executives and 7.8% have no profession.

Students have particular lifestyles. Student life is a dynamic phase of strong transition, during which the development of the person takes place. Some studies have shown that most of the habits developed by students during this phase determine their current and future state of health. Practices such as sleep deprivation [23], skipping breakfast [24], neglecting to eat meals at fixed and unbalanced times [23], and then compensating for this imbalance with DS, are fairly common practices among university students [25].

Despite the large market for supplements in Morocco, epidemiological studies on the consumption of DS by students are lacking, especially during confinement. Because students have different lifestyles, the use of these substances may differ from that of the general population. Thus, the objectives of the present study are to identify the potential effects of confinement on the consumption of SD by the participants, as well as the factors associated with it. This study will make it possible to develop recommendations.

2. Population and Methods

2.1. Study Context

Moroccan students are more and more attentive to their well-being and their health, especially during a period of containment put in place in Morocco in mid-March 2020, because of the COVID 19 pandemic. They are also aware of the link between health and food. Thus, they turn to DS to maintain their well-being and reduce the risk of disease.

The survey was carried out at the Ben M'Sik Faculty of Sciences, one of the 18 establishments of the Hassan II University in Casablanca. During the 2019-2020 academic year, it was attended by around 12,500 students from several prefectures in the city of Casablanca.

2.2. Online Survey Procedure

A cross-sectional, anonymous online descriptive study was carried out from March to May 2020, in accordance with the guidelines of the Helsinki declarations [26], with 350 students from the Ben M'Sik Faculty of Sciences, Casablanca (University Hassan II of Casablanca, Morocco), of different levels of study and background. An email invitation to participate in the survey and containing a link to the online questionnaire was sent to students, March 2020, to have a

random and non-discriminatory sample.

Inferred consent appeared on the first page of the questionnaire. Students had the right to accept or refuse participation on their own accord.

2.3. Collection of Data Survey

The questionnaire was developed and created using “GOOGLE FORMS”. The answers added to the questionnaires were collected automatically and organized clearly in a file which is then converted to Excel format.

A pilot study was carried out before the administration of the survey, to confirm the reliability and validity of the questionnaire, on a sample of 50 participants, following which modifications were made to some questions, in order to facilitate their understanding by the surveys.

The investigation gathered information on:

- General questions from the respondents, including socio-demographic information (sex, age, level and course of study, ...) And characteristics of the household (type of housing (luxury, traditional, modern, precarious), size of the household, occupation status (owner, co-owner or tenant)), professions of the parents (civil servant/manager, employee, retired or without profession), ...), anthropometric and lifestyle data (practice of physical activity, use of tobacco, alcohol and drugs, as well as food). Socioeconomic status (good to very good, average, poor) was self-rated by participants.
- The age has been classified into 4 classes: 17 - 21 years; 22 - 24 years old; 25 - 28 years old and over 28 years old. For the level of studies, the student had 3 choices: License (1st year, 2nd year or 3rd year), Masters or Doctorate.
- Anthropometric measurements: The height (height (cm) and weight (kg) of the participants were collected and the body mass index (BMI (kg/m²)) was calculated according to WHO recommendations [27] Participants with BMI between 18.5 and 24.99 were considered within the normal weight range, between 25.0 and 29.9 were considered overweight, and those with BMI over 30.0 were considered overweight been classified as obese.
- Regarding lifestyle factors, subjects were classified into 2 categories (yes or no), depending on the state of smoking, alcoholism, or drugs, and physical activity (PA). The intensity of PA expressed in MET (Metabolic Equivalent Task) was calculated by the short version of the international IPAQ questionnaire [28] and the level of PA was determined. This level is considered low if the activity is less than 600 MET-minutes/week; moderate if it is between 600- < 3000 MET-minutes/week and high if it is at least ≤ 3000 MET-minutes/week).
- Some student eating practices and habits (type of meals consumed, taking the time to prepare the meal, eating a typical meal (starter-main-dessert), eating balanced at the 3 meals of the day and skipping meals...) were studied through a questionnaire.
- The DS consumption mode section consisted of 20 questions. It discussed the different types of DS consumed by participants. These types have been grouped

into standardized categories (Vitamins/minerals/trace elements, fish oils (Omega 3), proteins/amino acids and DS from plants/plant extracts (Guarana, Ginger, Ginseng...)). In addition, the student use prevalence section had 3 response choices; participants who previously or currently used DS are considered consumers, while those who answered never are considered non-users. It also included questions on the method of consumption (regular, occasional or frequent), the duration of consumption (1 year, 2 years, 3 years or 4 years and more), the purchase recommendation (advised by a friend, medical prescription..) and places of purchase (Pharmacies, drugstores, ...), consumer expectations (fight against fatigue and fight stress, maintain health, balance diet, achieve an aesthetic goal, develop muscle mass, or to meet a need related to a PA), the quantities consumed (compliance with the recommended doses), as well as the products used concomitantly.

For students' beliefs about the efficacy and safeties of DS, participants were expected to answer 4 questions: the effectiveness of DS, their health benefits and risk, with excessive consumption, as well as the likely components induce toxicity.

2.4. Data Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) Version 25. Quantitative variables were expressed as means, while qualitative variables were expressed as percentages (Number of people with the studied modality/total population). The Chi-square test was used to assess significant differences for categorical characteristics, for example, the relationship between FS consumption and certain variables (sociodemographic, socioeconomic, and some student life factors). The p value < 0.05 is considered statistically significant.

3. Results

3.1. Sociodemographic and Lifestyle Characteristics

The socio-demographic and lifestyle data of the participants are presented in **Table 1**.

57.2% of study participants are girls and 42.8% are boys, about half of them aged between 17 and 21 (45.1%). 75.2% are in License, 12.7% in Masters and 12.1% are preparing for their Doctorate. 74% are studying in biology, 19.2% in physics, chemistry and 6.5% in computer mathematics.

72.28% live in apartments; 20.79% of modern housing; 4.95% in villas; 0.99% in small traditional houses while 0.99% in precarious housing. The participants came from families whose self-rated socioeconomic level showed good and very good for 8%, average for 82% while 10% are poor.

For the eating habits of the participants, almost half of the students (47.54%) prefer a healthy diet. Thus, 35.65%, declare consuming meals prepared at home and 11.89%, complete meals (starter, main course and dessert). 17.82% eat fast

Table 1. Characteristics of the study population.

Variables	Percentage (%)
Gender	
Female	57.2%
Male	42.8%
Age (years):	
17 - 21	45.1%
22 - 24	36.6%
25 - 28	12.1%
Over 28	6.2%
Level of studies:	
Licence	75.2%
Master	12.7%
PhD	12.1%
Study stream	
Biology	74%
Chemical Physics	19.2%
Computer science	6.8%
Parents' self-estimated socioeconomic level:	
Good and very good	8%
Way	82%
Poor	10%
Body mass index (kg/m²)	
Underweight (Below 18.49)	8.15%
Normal corpulence (18.5 - 24.9)	65.35%
Overweight (25.0 - 29.9)	22.69%
Obesity (Greater than 30)	3.81%
Practice of Physical Activity (PA) during the last 12 months	
No	30.7%
Yes	69.3%
- Low	22.7%
- Moderate	31%
- High	15.6%
Alcoholism	
Yes	3.2%
No	96.8%
Smoking	
Yes	14.5%
No	85.5%

Continued

Drugs		
Yes		1.5%
No		98.5%
Eating habits:		
-	Consumption of balanced meals	
	Breakfast	39.6%
	Lunch	35.64%
	Having dinner	38.6%
-	Type of meal consumed	
	Prepared at home	35.65%
	Complete meal (Starter, main course and dessert) prepared at home	11.89%
	Sandwich	30.69%
	Fast food	17.82%
-	Skipping meals	
	Never	6%
	Sometimes	43%
	Often enough	51%

food and 2.97% declare consuming several types of meal. Generally, the respondents are losing their nutritional balance. Approximately, a third of the population still consumes balanced and structured meals (39.6% at breakfast; 35.64% at lunch and 38.6% at dinner); half sometimes eat balanced meals (39.6% at breakfast; 54.5% at lunch and 47.5% at dinner), while the rest of the students never eat a balanced diet (20.8% at breakfast; 9.9% at lunch and 13.9% at dinner). The majority of respondents have poor eating habits, especially irregular meal consumption. Thus, 51% say they often skip meals and 43% from time to time (Table 1).

3.2. DS Consumption Mode

The characteristics of DS consumption by students are shown in Table 2.

Of the 350 participants in the survey, 69.4% reported consuming DS, with roughly similar consumption in both sexes (35.4% are boys and 34% are girls) ($\text{Khi}^2 = 2.37$; $p = 0.512$). The highest prevalence of consumption was observed among students aged 17 to 24 (41%) ($p = 0.001$; $\text{Khi}^2 = 4.68$). No association was observed between DS consumption and level of education ($\text{Chi}^2 = 3.505$; $p = 0.477$). On the other hand, the majority of consumers (51%) of these substances follow their studies in Life sciences, but without statistically significant difference between the different channels ($\text{Khi}^2 = 4.8$; $p = 0.09$).

This consumption is associated with the socio-economic level of the parents of the students. Thus, the participants who consume them the most are those

Table 2. Summary of the mode of DS consumption in the surveyed population.

Variables	Choice of answer	Percentage (%)
Consumption Dietary supplements	Yes	69.4%
	No	30.6%
Frequency of consumption	Occasional	45.5%
	Regular	17.92%
	Frequent	6.08%
Duration of consumption	4 years and over	11.88%
	3 years	4.95%
	2 years	7.92%
	1 year	26.83%
	Don't know how to answer	17.82%
Respect of the daily dose of dietary supplements consumed	Yes	48.4%
	No	21%
Purchase recommendation	On medical prescription	22.77%
	On the advice of a dietitian	1.98%
	On the advice of an athlete	0.99%
	On the advice of a pharmacist	20.79%
	On the advice of a friend or relative	7.92%
	Media, Advertising	4.95%
Place of purchase	At a nutritionist	1.99%
	In specialized stores	7.94%
	In pharmacies and drugstores	55.5%
	On the Internet	3.97%
Reason for consumption	Fight fatigue and combat stress	21.34%
	Balancing the diet	10.5%
	Maintaining health	3.96%
	To achieve an aesthetic goal	6.95%
	To build muscle mass	4.5%
	To fill a need related to a sports activity	4.23%
	Multiple reasons (maintenance of health, weight loss, beauty, disease prevention)	7.92%
Type of Dietary supplement	Vitamins/Minerals/Trace elements	40.6%
	Proteins/Amino acids	4.5%
	Fish oil (Omega 3)	4%
	DS Herbal/Herbal Extract	4.3%
	DS targeting a particular problem	6%
Non-consumers of DS	–	40.6%
Compliance with the daily dose of DS consumed	Yes	48.4%
	No	11%

whose parents have a good socioeconomic level ($K\chi^2 = 9.17$; $p = 0,014$). On the other hand, it is associated neither with smoking ($K\chi^2 = 2.35$; $p = 0.12$), nor alcoholism ($K\chi^2 = 0.79$; $p = 0.37$), nor with drugs ($K\chi^2 = 2.43$; $p = 0.11$). It is also slightly conditioned by dietary practices. It seems that the consumption of DS influence the type of meal consumed ($K\chi^2 = 17.81$; $p = 0.037$), and balanced eating ($K\chi^2 = 6.486$; $p = 0.039$). However, it does not influence the skipping of meals ($K\chi^2 = 3.23$; $p = 0.19$).

The frequency of DS consumption varies depending on the student. It was reported as once/day for 38%, 2 times/day for 10%, 3 times/day for 9.4%, or more than 3 times/day for 12% ($\chi^2 = 65.885$; $p = 0.023$). About half of the respondents (48.4%) respect the recommended daily dose. 45.54% are occasional consumers (consumption during the exam period or seasonal change); 17.92% consume them regularly and 6.08% frequently ($\chi^2 = 36.757$; $p = 0.000$).

The duration of DS consumption varies depending on the participants. About a third of students (26.83%) have been consuming DS for 1 year; 7.92% for 2 years; 4.95% for 3 years and 11.88% for 4 years and more and 17.82% could not answer because they don't no longer remember the date of the start of consumption of these substances, which probably exceeds the 4 years ($\chi^2 = 17.055$; $p = 0.004$).

30.6% of respondents do not consume these substances for several reasons. 16.73% say they do not feel the need for it; 5.94% because of the lack of confidence in these products; 3.96% because of their too high price; 0.99% because of their bad taste and 2.98% for multiple reasons.

The purchase of DS is influenced in 4.95% of respondents by the media and advertising; 20.79% buy them on the advice of a pharmacist; 32.77% on medical prescription; 7.92% on the advice of a relative or friend; 1.98% on the advice of a dietitian and 0.99% on the advice of an athlete (0.99% of boys) ($K\chi^2 = 35.82$; $p = 0.000$). 55.5% buy them in pharmacies and drugstores; 7.94% in specialized stores; 3.97% on the internet and 1.99% among nutritionists ($K\chi^2 = 32.219$; $p = 0.000$).

40.6% have preferences for Vitamins/Minerals/trace elements; 4.5% Protein/amino acids; 4% Fish oils (Omega 3); 4.3% the DS based on plants/plant extracts (Ginseng, Guarana, Biloba...) While 6% for those targeting particular problems (anti-aging, anti-stress, beauty, sleep, intestinal transit...), without statistically difference significant between the two sexes ($K\chi^2 = 17.42$; $p = 0.49$), nor as a function of age ($K\chi^2 = 68.09$; $p = 0.09$) (**Figure 1**). It was also observed that, 35% of participants consume more than one type of DS.

The percentage of consumers who took more than one type of supplement (35%), divided by the total number of consumers $\times 100$, is 50.43% (18% of men, 32.43% of women). Women are therefore more likely to take more than one type of dietary supplement than men.

21.78% of respondent's experience real satisfaction after consuming DS; 24.65% feel better; while 12.97% think they do not feel at all better ($\chi^2 = 2.217$; $p = 0.330$). The main reason for consumption is the fight against fatigue and the

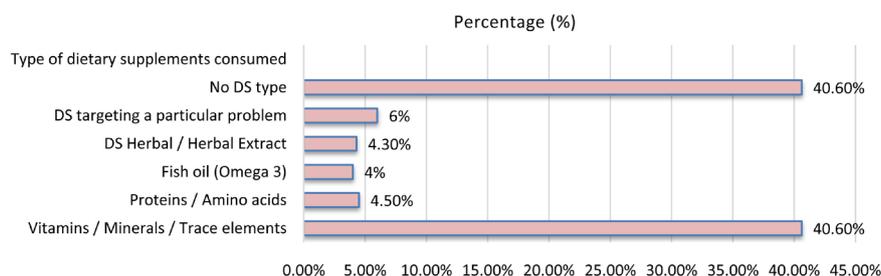


Figure 1. Distribution of participants according to the type of turnover consumed.

fight against stress (31.34%); 10.5% to balance the diet with nutrients; 6.95% to achieve an aesthetic goal; 4.5% to build muscle mass; 4.23% consume them to meet the need for sports activity, while 7.92% for multiple reasons (maintenance of health, weight loss, beauty, disease prevention) ($\text{Khi}^2 = 41.741$; $p = 0.002$) (**Figure 2**).

We observe that the majority of participants who consume DS to fight fatigue and combat stress and achieve an aesthetic goal are girls, while those who consume them to meet a need related to a sporting activity and develop muscle mass are practically all boys ($\text{Khi}^2 = 31.54$; $p = 0.041$).

Regarding participants' beliefs about DS, 32.5% think they are harmless to health, 21.27% that their regular consumption can prevent some diseases (deficiencies, chronic diseases, cancer, etc.) while for 46.23%, their excessive consumption can present health risks. According to the students, DS can cause potential harmful side effects such as bone problems (27.7%), hypervitaminosis (22.8%), with the development of some type of cancer (lung cancer) (15.84%), cardiovascular disorders (risk of cardiac arrest, etc.) (10.89%), renal dysfunction problems (9.9%), allergies (6.93%), hepatic dysfunction (3.96%), as well as the risk of mortality (1.98%) (**Figure 3**).

Participants believe that these health risks could be due to some components of these substances. Thus, a third of them (30%) think that the toxicity is linked to the food additives used in their manufacture, 21% to some vitamins (C, D, E or beta-carotene), 15% to antioxidants; 15% with several components (vitamins, minerals, plant extracts...); 10% to herbal products, while the remainder of the students think that minerals (2%), amino acids (5%) and proteins (2%) are very harmless (**Table 3**).

In the study population, 69.3% participated in sport. The level of PA is low for 22.7%; moderate for 31% and high for 25.6% (**Figure 4**). The most active are those aged between 17-21 years ($p = 0.000$). DS consumption was not just for athletes. Thus 11.3% of consumers are non-athletic and 54% have practiced physical activity during the past 12 months. Sport participation was associated with a higher probability of DS consumption ($\text{Chi}^2 = 13.16$; $p = 0.000$), as well as type of DS ($p = 0.007$). This consumption is also associated with the level of physical activity ($\text{Chi}^2 = 10.94$; $p = 0.0027$). It is more important when this level increases (**Figure 4**). Overall, those who are very physically active tended to prefer

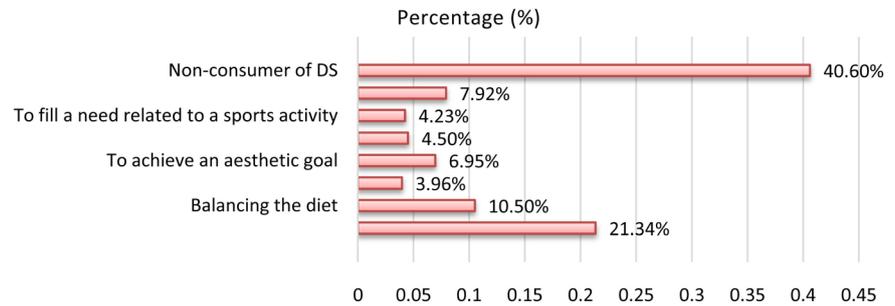


Figure 2. Distribution of the population according to the reason for consuming DS.

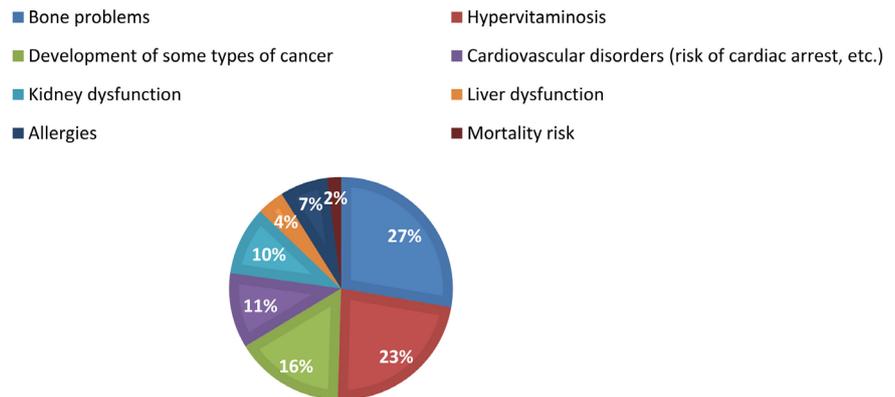


Figure 3. Beliefs of participants regarding the consumption of DS.

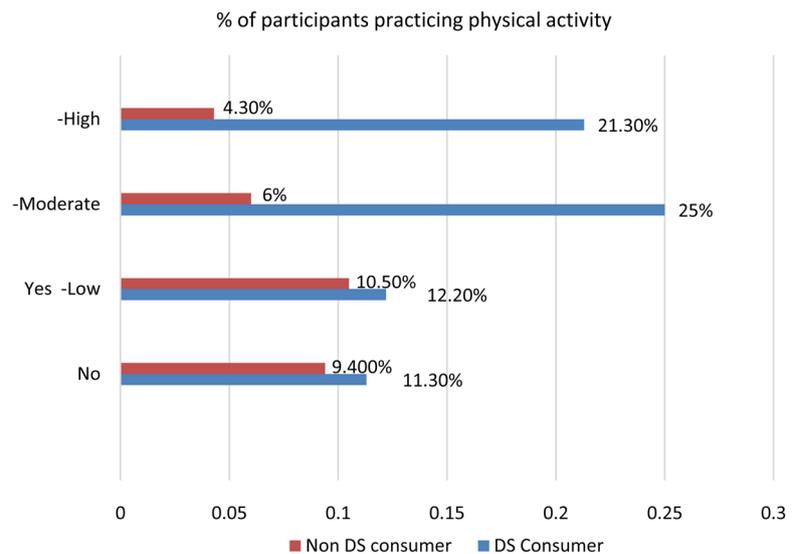


Figure 4. Distribution of participants according to DS consumption and level of physical activity (PA).

vitamins/minerals or trace elements. It also appears from this study that people who do not use tobacco, drugs or alcohol practically all consume DS.

The average BMI is $22.64 \text{ kg/m}^2 \pm 3.94$. 65.35% of respondents have a normal BMI (between 18 and 24.9 kg/m^2), 8.15% are underweight (less than 18.49), 22.69% are overweight (25.0 - 29.9) and 3.81% obesity (Greater than 30). BMI

Table 3. Student beliefs about some components of DS.

Components of DS	Percentage (%)
Some food additives	30%
Vitamins (C, D, E or beta-carotene)	21%
Minerals	2%
Products based on plant extracts	10%
Antioxidants	15%
Some amino acids (glutamine, arginine, etc.)	5%
Protein	2%
Several components (Vitamin C, D, E or beta-carotene), minerals, Antioxidants, some food additives, plant extract)	15%

varies according to sex ($p = 0.000$; $\text{Khi}^2 = 31.67$) and according to age groups ($p = 0.021$).

An association is observed between DS consumption and BMI ($\text{Chi}^2 = 21.88$; $p = 0.000$) (Table 4). Those who are underweight hardly consume DS. In contrast, the majority of those with a normal or overweight BMI consume DS (Figure 5).

For the perception of the general state of health (physical and mental), overall consumers of DS feel in better state of health than non-consumers, but without statistically significant difference between the two groups ($\text{Khi}^2 = 1.25$; $p = 0.60$).

4. Discussion

In students, good eating habits are essential for maintaining good health, good memorization and learning skills, as well as for meeting the body's nutrient needs. Inadequate food intake leads to vitamin and mineral deficiencies and can lead to the development of food-related illnesses. As a result, the consumption of DS is becoming more and more common to balance the diet and maintain good health [29]. Data on DS consumption by students in Morocco is very limited, especially during the lockdown period.

It appears from this study that 69.4% of participants consume DS, of which 35.4% are boys and 34% are girls, without significant differences between the two sexes ($\text{Khi}^2 = 2.37$; $p = 0.51$). These substances are therefore widely consumed by young Moroccans, because they take more and more care of their health and their diet. Nevertheless, the apparent overuse of these substances by participants is of particular concern, because many habits established during high school and higher education appears to be more persistent throughout life [30]. This result agrees with that of Sirico *et al.* [31], but it is higher than that observed by Jamal in 2016 (46%) and Khalfaoui in 2018 (57.1%) in Morocco [22], with higher DS consumption among girls. Several studies have shown this female predominance [32] [33]. On the other hand, Braun and Venter [34] found that higher education and young age were associated with supplement consumption and that gender was very influential.

Table 4. Summary of the association of DS consumption with some parameters studied.

Characteristics	DS consumers	Non DS consumers	Khi ² ; p Value
Age			
- 17 - 21 years	36%	17%	Khi ² = 4.68; p = 0.001
- 22 - 24	17.25%	3%	
- 25 - 28	8%	9%	
- Over 28 years	8%	1.6%	
Gender:			
Girls	54%	3.2%	Khi ² = 2.37; p = 0.512
Boys	12.8%	30%	
Education level			
- License	50%	27%	Khi ² = 3.505; p = 0.477
- Master	2%	1%	
- Doctorate	15%	5%	
Sector:			
Biology	49%	24%	Khi ² = 4.8; p = 0.095
Chemical Physics	13%	7%	
Mathematics Computer Science	5%	2%	
BMI Classes:			
- Underweight	2%	8%	Khi ² = 21.88; p = 0.000
- Normal build	42%	25%	
- Overweight	20%	0%	
- Obesity	3%	0%	
Socio-economic level:			
- Very Good	7%	1%	Khi ² = 9.17 p = 0.014
- Way	57%	25%	
- Poor	3%	7%	
Tobacco consumption:			
No	67%	32%	Khi ² = 2.35 p = 0.12
Yes	0%	1%	
Alcohol consumption:			
No	65%	31%	Khi ² = 0.79 p = 0.37
Yes	2%	2%	
Drug use:			
No	67%	31%	Khi ² = 2.43 p = 0.11
Yes	0%	1%	

Continued

Practice of physical activity:			
No	16%	20%	K χ^2 = 12.94 p = 0.000
Yes	51%	13%	
Type of meal consumed:			
- Prepared at home	26%	9.65%	K χ^2 = 17.81 p = 0.037
- Complete meal (Starter, main course and dessert) home made	9%	2.89%	
- Sandwich	17%	11.69%	
- Sandwich	12%	5.82%	
- Don't know how to remunerate	5.4%	0.55%	
Do you think you are eating a balanced diet:			
Always	26%	14%	K χ^2 = 17.80 p = 0.037
Sometimes	32%	16%	
Never	11%	3%	
Skipping meal:			
No	%	0%	K χ^2 = 3.23 p = 0.19
Sometimes	26%	17%	
Often	35%	16%	
Type DS:			
Vitamins/Minerals/Trace elements	40.6%	–	K χ^2 = 17.42 p = 0.49
Proteins/Amino acids	4.5%		
Fish oil (Omega 3)	4%		
DS Herbal/Herbal Extract	4.3%		
DS targeting a particular problem	6%		
Frequency of consumption:			
Occasionnelle	45.5%	–	K χ^2 = 65.885 p = 0.023
Régulière	17.92%		
Fréquente	6.08%		
Duration of consumption:			
1 year	26.83%	–	K χ^2 = 17.05 p = 0.004
2 years	7.92%		
3 years	4.95%		
4 years and over	11.88%		
Purchase recommendation:			
Media and advertising	4.95%	–	K χ^2 = 35.82 p = 0.000
Advice from a pharmacist	20.79%		
Medical prescription	32.77%		
Parent or friend advice	7.92%		
Dietitian Council	1.98%		
Sports advice	0.99%		

Continued

Reason for consumption:			
-	Fight against fatigue and combat stress	31.34%	-
-	Balance the diet	10.5	
-	Health maintenance	3.96	
-	To achieve an aesthetic goal	6.95	Khi ² = 60.28 p = 0.000?
-	To develop muscle mass	4.5	
-	To fill a need related to a sports activity	4.23	
-	Multiple reasons (maintenance of health. weight loss. beauty. disease prevention)	7.92%	
Place of purchase:			
-	At nutritionist	1.99%	-
-	In specialized stores	7.94%	Khi ² = 32.21 p = 0.000
-	In pharmacies and drugstores	55.5%	
-	On the Internet	3.97%	
Compliance with recommended doses:			
	No	21%	-
	Yes	48.4	Khi ² = 36.75 p = 0.000
Consumer satisfaction:			
	No	12.97%	-
	Feel better	24.65%	Khi ² = 2.217 p = 0.33
	True satisfaction	21.78%	
State of Health:			
	Poor	2%	0%
	Way	22%	11%
	Well	31%	12%
	Very good	14%	8%

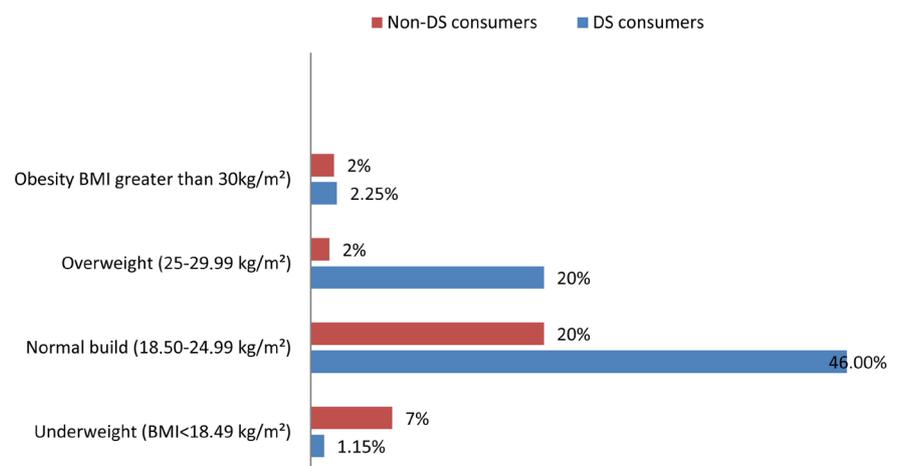


Figure 5. Distribution of participants according to DS consumption and according to BMI classes.

The highest prevalence of DS consumption is observed among students aged 17 - 24 (41%). $p = 0.001$ ($\text{Chi}^2 = 4.681$), so, a trend in DS consumption by the youngest participants. This result agrees with those observed by Sirico *et al.* [31] among Italian students, Dubecq *et al.* [35], CREDOC [32], as well as that of Khalfaoui [22], which found in Morocco that heavy users of these substances were between 20 and 30 years old (51%). It should also be noted that the participants who consume DS occasionally (to solve health problems during exams, to combat stress, and to achieve an aesthetic goal) are all girls, while those who consume them to meet their needs. A need related to sports activity and to increase muscle mass are all boys. This shows the difference in consumption between the two sexes. Several studies have shown this difference in the acquisition, preparation and consumption of food, between food choices and nutritional strategy. There are therefore reciprocal interactions between sex and food, which are conditioned by physiological, psychological and socio-cultural factors. Women show more confidence in a healthy diet and a greater uncontrollable commitment to body weight [36].

48.4% of the population declares that they comply with the recommended daily dose; this reflects the importance of the recommendations mentioned in the prospectuses. An underdose will have no effect on health, while an overdose may lead to unwanted effects, such as disturbance of body homeostasis, with side effects [37].

30.6% of participants do not consume DS, of which 16.73% do not feel the need, 5.94% do not trust these products and 3.96% because of their high price. The majority of non-consumers therefore believe that a healthy diet is capable of meeting their nutritional needs; Indeed, Bonillo [38] found that 42% of non-consumers of French DS doubt the usefulness of DS. Also, the prices of these substances are so exorbitant that they prohibit their purchase by students, the majority of whom do not have stock exchanges and whose financial means are very limited.

This consumption is not associated with smoking ($\text{Khi}^2 = 2.35$; $p = 0.12$), alcoholism ($\text{Khi}^2 = 0.79$; $p = 0.37$), and drugs ($\text{Khi}^2 = 2.43$; $p = 0.11$), but it is associated with the socio-economic level of the parents of the participants ($\text{Khi}^2 = 9.17$; $p = 0.014$). The respondents who consume them the most are those whose parents have good incomes. Khalfaoui (2018) [22] also noted that Moroccan supplement consumers were more educated and had a higher socio-economic status. In contrast, Al-Johani *et al.* [39] found no association between substance use and social status among students from Saudi Arabia.

This consumption of DS is also slightly conditioned by dietary practices. Thus, the consumption of DS influences the type of meal consumed ($\text{Khi}^2 = 17.81$; $p = 0.037$), and balanced eating ($\text{Khi}^2 = 6.486$; $p = 0.039$). However, it does not affect skipping meals ($\text{Chi}^2 = 3.23$; $p = 0.19$). Changes in the eating behavior of students have also been observed by Agathe in France [40]. Good eating habits among young people and especially students are determining factors for learning capacities.

It appears from this study that 40.6% have preferences for vitamin and mineral type DS, of which 7.92% are boys and 34.65% are girls. Indeed, the consumption of vitamins and minerals is a fairly common attitude among young people, especially among people who are very concerned about their overall health [31] [41]. Similar results were observed by Sirico *et al.* [31] among Italian students. This type of DS claims to provide the energy and the ability to engage in typical daily activities without getting tired, a concept closer to mental than physical energy or caloric intake [42]; O'Connor [43]. Vitamins and minerals play an essential role in the body, improve stress, have a positive effect on mood, help fight infections by strengthening the body, intervene in the repair of damaged tissues, prevent aging premature and the appearance of some diseases (cancers, etc.). Trace elements are also involved in many biochemical and metabolic reactions. They are widely used as anti-stress and to reduce fatigue.

Very few students (4.5%) consume DS made from proteins and amino acids, most of which are boys who want to increase muscle mass and improve physical performance. 4.5% consume Omega 3 and 4.3% of plant-based DS. Omega 3 plays a role in the protection of the cardiovascular system, skin, hair and nails and is very important in cell renewal. It is necessary for normal brain function and mental health, and is involved in the regulation of blood pressure. Omega 3 improves stress, either alone or when combined with trace elements, antioxidants that prevent their degradation and maximize their effects, or with vitamins [44]. Plants or plant extracts are used as energizers (Ginseng...), but also to increase muscle mass (proteins/amino acids) or to lose weight. Currently, the use of herbal extracts as adjuncts to weight loss diets is a growing practice. However, more often than not, the clinical efficacy of these supplements is still unsure [45]. These are usually substances of plant origin, which moderate appetite and which may help reduce the feeling of "appetite suppressant" hunger. This type of supplement also has the particularity of reducing the activity of digestive enzymes, and therefore reducing the intestinal absorption of sugars. Thus, they inhibit hyperglycemia and postprandial insulinemia, and consequently induce the reduction of "pecks" [14]. For all these reasons, the use of these substances should be under the guidance of a healthcare professional.

Regarding the frequency of DS consumption, 45.54% are occasional consumers (of which 25.74% consume them from time to time very irregularly), while 17.92% regularly and 6.08% frequently. Quite often, occasional consumption takes place during exam periods, (to combat fatigue, intense stress, combat memory loss and improve concentration), or during the period of seasonal changes in the form of cures. In France, the cure takes place in winter for 54% of adult consumers and 70% of children [46]. This occasional DS consumption by our participants is lower than that observed by Khalfaoui (79.5%) in 2018 [22] and Jamal in 2016 (84.1%) in Morocco [11], as well as by Devaux and Brisard in France in 2016 (43%) [47].

For the duration of DS consumption, it varies according to the participants, but 26.83% have consumed them for 1 year; 7.92% for 2 years. So the majority

have been consuming them for a long time, because they need them. To be able to assimilate new data every day, students must have a healthy brain system and therefore need to eat balanced. However, during some periods of student life, students think that food intake is insufficient and they encounter difficulties in balancing their diet, and therefore try to fill them by turning to DS, especially during confinement. Indeed, in addition to our diet, each human being has a psychological background that will have a major influence on feelings such as stress, anxiety or weariness [48].

Participants mainly consumed more than one type of DS (35%). Braun and Venter [34] found that most students took vitamin, mineral and plant based DS. Self-administration of several DS can have serious side effects, caused by the activity of some constituents of DS with those of other DS or other drugs, also interactions between drugs and herbs [31]. For example, with ginkgo, antiplatelet or anticoagulant effects have been observed by Ulbricht *et al.*, [49]. In addition, excessive consumption of vitamins and herbal supplements can interfere with the absorption of other nutrients by the body and thus lead to an unhealthy imbalance of the body's systems [50].

For consumer expectations, the main ones are fighting fatigue and stress [31] [43], solving health problems during exams and balancing diet. This result was confirmed by the observation of an association of the consumption of AC with eating habits ($Khi^2 = 17.81$; $p = 0.037$) as well as with the type of meal consumed ($Khi^2 = 7.81$; $p = 0.037$). About a third of students (35.65%) prefer a healthy diet, thus, 30.69% report consuming meals prepared at home in advance (30.69%); 17.82% eat fast food sandwiches, 39.24% eat healthy. Students therefore need to eat well to maintain general well-being or to improve mental and cognitive performance. They also want to improve athletic performance. This is not the case for Saudi students from Riyadh, 32.3% of whom took supplements mainly for cosmetic reasons (for example, hair and skin health) [51]. Currently, the concept of body image is becoming a trend that continues to increase with the influence of the media. Thus, young people are increasingly aware of their appearance [52]. To achieve the desired body image, it is essential to have a good diet and to be physically active [53]. Eating a balanced diet strengthens the immune system. Some studies have shown that the effect of vitamin supplements on the immunity of individuals is difficult to measure and may also affect one component of the immune system but not another. In contrast, the main way to strengthen immunity against infections, including COVID 19, is to maintain good personal hygiene, healthy lifestyle and adequate nutritional intake [54] [55].

Most consumers say they buy DS in pharmacies and drugstores (55.5%), on medical prescription (32.77%) or on the advice of a pharmacist (20.79%). The preference for purchasing these substances from pharmacies and drugstores is due to the confidence of students in traditional distribution places which are managed by specialists. These results are close to those observed by the INCA2 study (2006-2007) [56] and Khalfaoui in 2018 in Morocco [22], which noted that the consumption of DS is quite often recommended by a doctor (46,7%); and

purchased from pharmacies and drugstores. Japanese university students also reported buying DS mainly from pharmacies [57]. In contrast, Balzo *et al.* [58] reported in Italy that doctors ranked second after sports coaches.

21.78% of participant's experience real satisfaction after consuming DS, and 34.65% feel they feel better. Khalfaoui, (2018) [22] and Jamal, (2016) [11] also noticed that respectively 27.8% and 31.6% are clearly satisfied. ALTamimi (2019) [51] also found that more than half of students in Riyadh, (Saudi Arabia) reported health benefits. In addition, 84.6% of Italian students declared that DS are very beneficial for health [58].

69.3% of respondents have practiced physical activity during the past 12 months. The most active are those over 28 years old. These results are encouraging especially for this subpopulation. Managing stress and sleep through sport is also very important, especially during confinement. It helps you concentrate better; it is a natural antidepressant. Exercise improves mental health and cognitive function, and also plays a role in the management of depression and anxiety [59]. Our results also showed that boys engaged in more physical activity than girls. Similar results were observed by Mestaghanmi *et al.* in 2019 [23], who found that 65% of academics in Casablanca practiced physical activity, with a significant difference between the two sexes and that girls are less active than boys.

During confinement, the PA level is low at 22.7; moderate for 31% and high for 25.5. Student sports enthusiasts train at home. Moreover, in Morocco, during this period of confinement, the purchase of sports articles and equipment has increased sharply [60]. Thus, several students have started to practice individual sports and to follow sports lessons given by coaches, *via* social networks (instagram...).

Sports practice was associated with a higher probability of consuming DS ($\text{Chi}^2 = 13.16$; $p = 0,000$). Consumption is also associated with the level of PA ($\text{Chi}^2 = 10.94$; $p = 0.027$) and it is greater when the level of PA increases. Similar results have been observed by several authors [61] [62] [63]. Playing sports is generally considered a healthy habit. In this regard, some studies have indicated that DS users were more likely than non-users to participate in sports, suggesting that the consumption of these substances is part of a desire for a healthy life [64]. The main reason given, according to statements by athletes, is to improve sports performance, well-being as well as health [65].

Regarding the anthropometric parameters of our population, the average BMI is $22.64 \text{ kg/m}^2 \pm 3.94$; 65.35% have a normal build of which 50.49% are girls and 14.86% are boys. 8.15% are underweight and all of them are girls; 22.69% overweight; 3.81% obesity. Many of the participants present a normal build and even thinness, because generally, girls pay more attention to their appearance and their figure than boys [66]. Girls are also more likely than boys to be fat (overweight and obesity). Several factors could be at the origin of this weight gain. This could be related to diet and physical inactivity. In fact, obesity in college students is usually caused by an imbalance in energy intake and expenditure.

This imbalance leads to an accumulation of reserves stored in fatty tissue, which can lead to many complications (type 2 diabetes, heart disease and cancer). A statistically significant association was observed between BMI classes and DS consumption [67].

For the use of substances posing a health risk (tobacco, alcohol and drugs), it is very rare in the study population. This could be explained by the desire of respondents to promote overall health by adopting healthy habits, especially since the majority of respondents are biologists [68]. Our results are different from those of Khelafa [69], who found that 17.5% consume alcohol and 9.8% cannabis and 24.6% tobacco in Fez, with a predominance of boys. Zerrouk [70] also observed, among young people in public establishments in the Center-North region of Morocco, higher frequencies of consumption. The prevalence of experimentation (use over the whole life) of all psychoactive products combined was 9.35%, while the prevalence rates of recent use (in the last 12 months) and use current (over the past 30 days) were 7.48% and 6.28% respectively. Generally, the use of psychoactive products by students between the ages of 18 and 25 is much higher [71]. Alcohol and drugs are substances the consumption of which can also represent serious risks for the physical and psychological health and development of young people [72].

For students' beliefs, vis-à-vis DS, 32.5% think they are harmless to health, 21.27% that regular consumption can prevent some diseases, while for 46.23%, heavy drinking can pose a health risk. DS have been reported to be needed at all ages, are essentially harmless, and their regular consumption may prevent cancer and chronic disease [31].

DS could cause potential harmful side effects such as bone problems (27.7%); hypervitaminosis (22.8%); the development of some types of cancer (15.84); cardiovascular disorders (risk of cardiac arrest, etc.) (10.89%); renal dysfunction problems (9.9%); allergies (6.93%), liver dysfunction (3.96%), and 1.98% believe that these substances increase the risk of mortality. Hypervitaminosis is often caused by self-medication and consumption without reading the labels and interacting with other substances. Intake of excessive amounts of vitamins and minerals can have harmful effects on health [73]. The use of some allergenic substances in the manufacturing process can affect hypersensitive people, which shows the importance of reading the labeling of these substances before use. Regular consumption of some DS has been reported in epidemiological and clinical trials to be associated with increased morbidity and mortality [74]. It can also cause significant damage, including side effects such as liver damage, cancer, heart attack or stroke [75]. Neurological disorders and hepatic toxicity have also been observed by Haller *et al.* [76]. In addition, most cases of renal and hepatic dysfunction associated with DS are due to supplementation intended for athletes and doping [77]. A number of deaths of apparently healthy young individuals have been attributed to the use of some DS. In-depth reviews of the literature have also shown that adults who do not consume vitamin and mineral supplements are quite often healthy [78]. Although the role of DS in preventing nutri-

tional deficiencies is well established, there is insufficient evidence for that in preventing death from cardiovascular disease and cancer [79].

The toxicity of DS could be linked to some of their component. Thus, 30% think it is related to food additives used in their manufacture, 21% to some vitamins, 15% to antioxidants; 15% multi-component; 10% to herbal products. Since the start of the Covid19 pandemic, many people have tended to store DS and drugs in order to protect themselves against Covid19 and strengthen their immune system [80]. The role of some micronutrients as support agents in the treatment and prevention of respiratory tract infection has been demonstrated by several studies [81]. Although the use of vitamins in doses higher than those recommended is safe, moderate consumption is desirable. Vitamins and minerals are involved in the strengthening of the immune system and participate in many biochemical processes and in well-being [82]. An appropriate intake of micronutrients is therefore essential at each stage of growth, and particularly in some physiological conditions (stressful situations and deficiencies, advanced age). Some studies have reported the deleterious effects of excessive supplementation of antioxidants and especially synthetics (A, E, C and β -carotene) which are often used in many preventive and long-term therapeutic medical applications. However, they can lead to hypervitaminosis and even a potential toxic effect. [83]. For herbal supplements or herbal extracts, they can be toxic when used for improper indications, or in an inappropriate manner, excessive or for a prolonged period. For example, excessive doses of vitamin D cause hyperkalemia; similarly, excessive and prolonged vitamin A intake can lead to osteoporosis and hepatotoxicity [84]. Constituents of some herbal products can increase the risk of side effects and induce toxicity [85]. Some weight loss DS contain several alkaloids, which can cause high blood pressure, increase the risk of arrhythmias, heart attacks and stroke [86]. In addition, other constituents can lead to doping (caffeine...) especially in athletes, with excessive consumption, especially for strength sports (such as body building, weight lifting...) are harmful to consumer health, rather than improving it [87].

Several substances of plant origin may also contain androgenic steroids [16]. The presence of anabolic and exogenous androgens in DS, are converted into testosterone, above normal levels. They are likely to promote muscle mass, but also suppress testicular testosterone production and exert negative control over the release of pituitary gonadotropins [88]. Excess circulating testosterone is converted to estradiol, providing feedback to the pituitary gland. High estrogen concentrations can cause estrogenic side effects [89]. At the end of a supplementation cycle, testosterone levels in the body can be very low.

5. Conclusions

Academics in Casablanca consume a lot of DS during the COVID 19 pandemic. These substances help supplement the normal diet and prevent disease, but uncontrollable use can be ineffective in the absence of vitamin or mineral deficiency.

cies and can also be harmful. Drugs and DS used together can cause many unwanted side effects that can lead to serious complications.

It is therefore advisable to raise awareness among students through TV spots and to include specific courses in university study programs for health sectors, covering the indications, interactions and potential adverse effects of DS.

Students must also be encouraged to adopt a healthy lifestyle; a diversified diet is balanced, with physical activity, which is essential for the preservation of good health.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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