

Exploratory Data Analyses Indicate an Overuse of Dietary Supplements among Male Gym Users in Germany

Explorative Datenanalyse deutet auf einen übermäßigen Konsum von Nahrungsergänzungsmitteln bei männlichen Fitnessstudiosbesuchern in Deutschland hin

Summary

- **Background:** Dietary supplements (DS) are very popular with the general population, physically active people and professional athletes are often taken without professional advice. Adverse effects on consumer health are increasingly being reported and there are concerns about overdoses of certain nutrients. There are initial indications that some groups of people have a higher affinity to DS than others. It appears that the type of sport and possibly gym membership could have an influence on consumer behaviour. Therefore, this study aimed to identify high consumer groups of DS among the general population in Germany.
- **Methods:** The consumption of DS was assessed using an online questionnaire including information about physical activity, gym membership and the consumption and intake doses of DS. Completed questionnaires were returned by 244 participants (m=153, f=91; 30.7±10.4 years SD). The answer options were valued, and subjects were categorized in low, average and high consumers (indicating overdosing). A configural frequency analysis was performed using the independent variables gender, gym membership, consumption. The configurations were tested with an exact binomial test and the p-value was corrected according to Bonferroni (0.05/12=0.0042).
- **Results:** Three significant configurations were found (p<0.0042). The configuration, 'male-gym member-average consumption' as well as 'male-gym member-high consumption' were significantly overrepresented. Male gym members with low consumption behaviour were significantly underrepresented.
- **Conclusion:** This analysis suggests that male gym users in the German population have a higher risk of excessive DS consumption than other subgroups. Awareness campaigns regarding the risk of intake and overconsumption of DS can be targeted to high-risk groups. Due to the small sample size and the different types of fitness gyms, further studies are needed to make clearer statements and identify more precise risk groups.

KEY WORDS:

Supplement Use, Dosage, Nutrition, Health, Risk, Athletes, Physical Activity, Consumption, Questionnaire

Introduction

The use of dietary supplements (DS) has become increasingly popular. It now broadly seems to be perceived as a vital part of a healthy lifestyle. Motives for DS use are diverse, but most commonly 'overall health/ wellness', 'fill nutrient gaps in diet', 'energy provision' and 'immune health' have been reported (45). The motivations among gym members and athletes apparently resemble those of the general population. As expectable, additional intentions such as 'building muscle', 'improve performance in sport', 'gain strength' and 'better recovery' can be found (11, 24, 31, 36).

Furthermore, various position papers show that DS such as multivitamin preparations, creatine, bicarbonate or caffeine can have a positive effect on health and performance (3, 9, 18, 20). In addition, a very low risk of side effects was also found for individual DS (3, 9, 27).

Based on the increasing amount of scientific evidence of the positive effects of DS, consumer behaviour has risen continuously worldwide. The annual turnover in the United States (US) increased from 27 billion US\$ in 2009 to 52 billion US Dollar (\$) in

2019 (25, 43). Accordingly, consumer surveys detected an increase in the consumption of DS among US adults from 64% to 76% between 2008 and 2017 (46). Supplements most commonly used among US adults are vitamins/minerals, speciality supplements such as omega-3-fatty acids, probiotics and others, herbals and botanicals, sports nutrition supplements and supplements for weight management. In European countries such as Denmark, Netherlands and Sweden, an increasing consumption of DS can be observed (26, 34, 37). In Germany, a more moderate consumption behavior than in the USA was observed, although the intake motivations of DS appear similar. In a survey 47.1 % of 13,615 women and 41.3 % of 11,929 men reported regular consumption of dietary supplements (40).

Competitive athletes also regularly consume DS. When DS use among professional athletes was compiled by sport, sex, age and supplement type, there was a high variability in the prevalence of consumption among the athletes (25, 31). In the meta-analysis of Knapik et al. (2016) 159 unique studies concerning the DS consumption of athletes were analyzed (25). >

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The prevalence of DS use among all 159 studies was 62% for male athletes and 58% for female athletes. Elite athletes appeared to use dietary supplements to a greater extent than non-elite athletes. Supplement use was also positively associated with higher levels of training and performance. In addition, a correlation between age and consumer behaviour was found. Older athletes consumed more DS than younger athletes (25, 31, 40). Vitamin and mineral supplements, protein, amino acids and creatine were most commonly used. The type of supplements was similar for men and women with the exceptions of iron (higher intake among female athletes), creatine, protein and vitamin E (all three showed a higher intake among male athletes) (25). Younger athletes are also prone to regular consumption of dietary supplements. Approximately 70% of youth athletes under the age of 18 have consumed dietary supplements (13). Braun et al. found that 80% of 164 young elite athletes (age 16.6±3.0) used at least one dietary supplement in the previous 4 weeks. Among this group minerals and vitamins were the supplements most often used (6). In addition, recent investigations indicate that the consumption behaviour of athletes also depends on the type of sport. A higher consumption behaviour of DS can be observed particularly in sports in which a conditional ability, such as strength or endurance, is dominant. In particular, male athletes from strength-dominant sports such as weightlifting, powerlifting or American football have a significantly higher consumption behaviour than other athletes (23). These observations are supported by studies in fitness gyms. Initial studies by Morrison et al. found that 84.7% of the members surveyed regularly consume DS (36). Similar consumption behaviour was also found by Mettler et al and Mazzili et al. (32, 35). Even if the consumption of supplements is associated with a higher level of education (2, 47) and an overall healthier lifestyle (45), supplements are often consumed without a previous consultation of a nutritionist, medical doctor or research staff. Tsitsimpikou et al. found that only 17.1% of recreational athletes who regularly consumed DS had previously consulted a physician or nutritionist (47). These observations are confirmed by Heikinnen et al in Finnish Olympic athletes (21).

Regarding the quality of DS, several studies have demonstrated, that a considerable amount of supplements contain prohibited substances, which are not clearly identified on the label (16, 30, 38). For recreational athletes negative health effects are possible consequences of the consumption of substances such as anabolic steroids, however, for professional athletes the consumption of banned substances might additionally lead to a positive doping test and a suspension from competition along with a severe image loss. In spite of the difficulty to estimate the number of positive doping tests due to contaminated supplements, estimations range from 6.4 – 8.8% (38). Unless an athlete does not really suffer from nutrient deficiency, supplementation of DS is rather discouraged to minimize the risk of getting contaminated DS (15, 31).

Contaminations can occur either due to poor manufacturing practices or intentionally by unconscionable manufacturers (30). DS are concentrated sources of nutrients or other substances with a specific physiological or nutritional effect and are classified as a subcategory of food (12). Therefore, manufacturers are not required to provide evidence of product safety or efficacy. In contrast to pharmaceuticals, DS do not require approval from regulatory authorities before being marketed due to legal frameworks (12, 15). Supplements are commonly regulated on a national level. In the European Union, supplements are regulated by the European Food Safety Authority (EFSA). The harmonized rules on DS are comprised in the Directive

2002/46/EC (12) for consumers' protections. Consumers should be protected against potential health risks from dietary supplements and from misleading information coming from wrong labeling or from unduly aggressive marketing strategies. Among other rules, labelling and appearance of supplements are not allowed to attribute the prevention, treatment or healing of any human diseases to those products. Food supplements must be safe and upper intake levels (UL) of vitamins and minerals shall not be reached with proper administration of supplements (12). Due to the lack of controls, tests of safety, purity, and quality of ingredients of DS were failed. This creates potential health risks and serious adverse effects have been reported from the use of some dietary supplements (30, 39).

Due to the limited data available on potential subgroups with an increased affinity for DS in general and in Germany, the aim of this study was to get first insights with an explorative analysis. Based on previous studies, it appears that male strength athletes and gym users have a higher affinity for DS than other subgroups (23, 32, 35, 36), therefore possible influencing factors such as gym membership and gender on consumption behaviour were analysed. Due to the lack of data on excessive consumption of DS, an exploratory data collection was carried out, focusing on compliance with the recommended daily doses, regardless of the different concentrations of the various providers. This work primarily serves to formulate hypotheses for subsequent studies.

Materials and Methods

Data Collection and Exclusion Criteria

All participants were informed about the study design and the project before the survey started and agreed to participate in the survey. All data were anonymized and comply with the Declaration of Helsinki. The consumption of DS was determined using an online questionnaire. The questionnaire was accessible via the online platform [surveymonkey.de](https://www.surveymonkey.de) for 14 days. Following the snowball principle, the survey link was distributed via Internet platforms, such as Facebook and Instagram, and shared in various forums at the University of Cologne, the German Sports University Cologne, sports companies and fitness studios in western (the region around Düsseldorf Cologne) and southern (the region around Heidelberg and Karlsruhe) Germany. In addition, the questionnaire was distributed in a German high school in Cologne. In total, more than 100,000 people were reached.

Questionnaire and Rating

The self-developed questionnaire was previously tested in a preliminary study according to the guidelines of Bühner et al. (8) to obtain the necessary information specifically on consumer behavior and to carry out a possible calculation of dosage behavior. It consisted of three different parts: general information, physical activity in the gym and consumption behavior of DS. The general information included age, gender and occupation. In the parts 'physical activity' and 'consumption behavior of DS' closed questions were used. The different types of supplements were also divided into five categories:

- nutrition and health supplements (vitamin C, magnesium etc.)
- regeneration promoting supplements (protein shakes or bars etc.)
- pre-workout booster (beta-alanine, caffeine, taurine etc.)
- performance supplements (creatine, ecdysterone etc.)
- weight loss supplements ("fatburner" such as L-carnitine).

In the lack of standardized guidelines on the concentrations of different DS and their form of consumption (powder, capsules, pills), different response options were given depending on the category. In the category nutrition and health supplements, it has been determined that the first response option, one pill / day corresponded to the recommended daily dosage, whereas in the category regeneration-promoting and performance-enhancing DS, the response option 1-2 scoops / day corresponded to the recommended daily dosage. In addition, the scoops were defined according to the category of the average daily recommended dose. Consequently, the responses were transcribed into an ordinal scale. The answer option "No" indicated no intake of the respective supplement and was coded with 0 points in questions 5 to 10. With increasing intake doses the answer options were valued accordingly with "1", "2", "3" etc. The coding "1" corresponded to the recommended daily intake of the supplement. The coding "2", "3", etc. corresponded to double, triple etc. of the recommended daily intake of the supplement. For detailed information about the quality of supplements, respondents were able to provide more specific information at the end of each question. The complete questionnaire can be found in the supplemental material online.

Data Analysis

Raw data were pre-processed by summing up the scores for each participant as the total supplemental score (SUP Score). The new variable SUP score exhibited an approximately tri-modal distribution. Local minima, which show an intersection of the distribution of the participants, could be recognized at scores >3 and >8. All subjects were assigned to one of the three levels of consumption. The range for a low consumption behavior (lo) of DS was 0-3 points, average consumption (av) was in a range of 4-8 and a high (hi) consumption was determined when ≥ 8 points were reached. The factor 'consumption' was combined with the two factors 'sex' and 'gym' to constitute a three-dimensional (3 x 2 x 2) contingency table.

Statistical Analysis

The frequencies of the corresponding factor combinations were analyzed by a configural frequencies analysis (CFA) according to Lienert (28) and to Bortz (5). The current CFA algorithm is based on log-linear models fitted to multidimensional contingency tables (33). Assuming mutual independence of the factors, the standardized residuals of the regression model are χ^2 -distributed. Unusually high or low frequencies can initially be identified by the comparison to critical quantiles of the χ^2 -distribution function. Conspicuous combinations of given factor levels were re-tested by exact binominal tests. Presence of so-called 'types' or 'anti-types' (preference or avoidance) were trusted ex-post at a Bonferroni-corrected p-value, i.e. <0.0042 (=0.05/12, with 12 the number of parallel tests). R statistical software package version 3.4.3 (R Core Team, 2017) was used for statistical analysis. The confreq library (version 1.5.1) was employed to perform the CFA.

Results

Two hundred and eighty-three questionnaires were returned. After the exclusion of 39 incomplete questionnaires, 244 questionnaires were used for analysis. Ninety-one women (30.8±10.7 yrs) and 153 men (30.7±9.8 yrs) between the age of 14 to 68 yrs participated in the study. Gender and gym member distribution is shown in table 2. The flow chart of the included participants and their distribution by sex and age (figure S3) can be found in the supplementary material online.

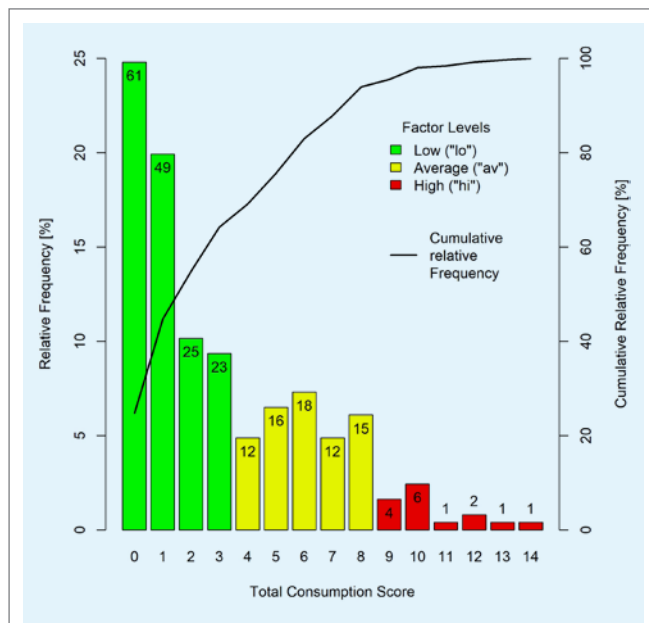


Figure 1

Histogram of the total consumption score. The integers within or above the bars indicate absolute frequencies. For subsequent analysis the variable was converted to a factor featuring the three levels „lo=low“, „av=average“, and „hi=high“ according to the breaks indicated by the different colors.

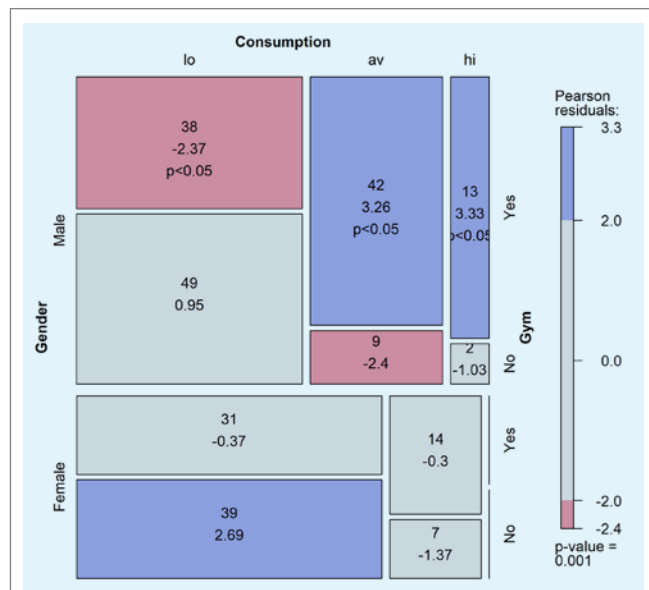


Figure 2

The Mosaic plot shows the absolute frequencies of all possible combinations. Overrepresentation is illustrated by blue and underrepresentation by red backgrounds. Sig. differences between fe and fo are additionally marked with Type (overrepresented) and Anti-Type (underrepresented). lo=low; av=average; hi=high; m=male; f=female; sig. dif.=significant difference.

Figure 1 shows the distribution of the total consumption scores and of the defined ranges of the factor 'consumption' (lo, av, hi). Low consumption is defined with a low affinity to consume DS. An average score means that there is a medium affinity for the consumption of DS and a high score generally indicates a strong affinity and increased consumption of DS. The frequency is significantly skewed and a low consumption behavior was found among 65% (n=158) of the participants with scores ≤3. 6% of the participants showed a SUP score >8, indicating a high consumption of DS.

Table 1

Gender and gym member distribution of all participants. Descriptive data of the participants.

N=244	SEX		GYM MEMBER	
	MEN	WOMEN	YES	NO
Absolute	153	91	139	105
Percentage (%)	62.7	37.3	57.0	43.0
Age (years)	30.7±10.4			

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

Figure 2 shows a mosaic plot of the data. Blue backgrounds indicate frequencies significantly larger than expected (Type!) ($\chi^2 > 2$, $p < 0.05$), red backgrounds indicate frequencies significantly lower than expected (Anti-Type!) ($\chi^2 > 2$, $p < 0.05$). The configuration female, no-gym-member and low consumption behavior (g0-f-lo) is overrepresented ($p = 0.005$) and the combination male, no-gym-member and average consumption behavior is underrepresented (g0-m-av) ($p = 0.005$). No other significant differences between observed frequencies and expected frequencies could be observed. Following Bonferroni correction ($p^* < 0.0042 = 0.05/12$), three configurations still tested significant by exact binomial tests:

1. Anti-type: g1-m-lo. f_o : 38. f_e : 55.7. $p = 0.003$.
2. Type: g1-m-av. f_o : 42. f_e : 25.5. $p = 0.001$.
3. Type: g1-m-hi. f_o : 13. f_e : 5.3. $p = 0.003$.

The global χ^2 for the three-dimensional contingency table tests highly significant ($\chi^2 = 49.95$, $df = 7$, $p < 0.001$). Significant association of the three factors (sex, gym, consumption) can be assumed.

The CFA confirmed the results of the global χ^2 -test. When comparing the expected frequencies (f_e) to the observed frequencies (f_o) (table 2) three configurations showed a significant result ($p \leq 0.0042^*$) (table 2). The configuration, male-gym member-average consumption and the configuration male-gym member-high consumption behavior (g1 m av; g1-m-hi) are

significantly over-represented. Male gym members with low consumption behavior (g1-m-lo) are significantly underrepresented.

Discussion

The evaluation of 244 questionnaires showed differences in consumption and dosage behavior between gym members and non-gym members as well as men and women. The increased consumption behavior of male gym members is reflected in the overrepresentation and underrepresentation of individual possible combinations of the actual distributions (table 2). Male gym members in the surveyed population tend to take dietary supplements. The combination g1-m-av and g1-m-hi are overrepresented indicating that a gym membership is positively associated with a higher use of dietary supplements. A high SUP score represents either the simultaneous consumption of several supplements or an overconsumption of individual products. If the SUP score is greater than five, at least supplementation of one category exceeds intake recommendations. The influence of a gym membership on the consumption behavior of supplements cannot be observed in women.

The distribution of consumption behaviors can be divided into three groups (figure 2). Forty-five percent (110 of 244 of respondents) did not use DS or consumed them appropriately within the recommended intake doses. Depending on the category, these are one pill or 1-2 scoops of the respective DS. A low consumption behavior was determined depending on the local minimum with a score of zero up to three different DS. No consumption of any DS was indicated by 61 of the 244 respondents (25%). Similar observations can be found by Morrison et al., who observed that 15% of the respondents did not consume any DS (36). In contrast, Tsitsimpikou et al. reported that 60% of the respondents did not take any DS (47). Morrison et al. and Tsitsimpikou et al. collected their data in different regions of the US and Greece (36, 47), indicating differences between regions and nations regarding the consumption behavior of DS. These observations can be corroborated by further investigations of different countries (10, 14, 46). Darvishi et al. observed that almost every second male collegiate athlete (45% of $n = 192$) in Iran takes dietary supplements regularly (10). Froiland et al. even found almost 90% of Division I athletes ($n = 203$) in the US

Table 2

Possible combinations of independent variables. Configural frequencies analysis (CFA) of the investigated variables. Sig. difference between f_o (observed frequencies) and f_e (expected frequencies) were calculated with $p \leq 0.05/12 = 0.0042$ and marked with *. lo=low; av=average; hi=high; m=male; f=female; sig. dif.=significant difference.

GYM	SEX	USE	FO	FE	SIG. DIF.
0	m	lo	49	42.768	0.167
0	m	av	9	19.613	0.005
0	m	hi	2	4.086	0.223
0	f	lo	39	25.437	0.005
0	f	av	7	11.665	0.100
0	f	hi	0	2.430	0.087
1	m	lo	38	55.679	0.003*
1	m	av	42	25.534	0.001*
1	m	hi	13	5.320	0.003*
1	f	lo	31	33.116	0.389
1	f	av	14	15.187	0.443
1	f	hi	0	3.164	0.041

had used or use dietary supplements (14). Gender-specific differences in the selection of supplements could be identified. According to his observations female athletes tend to use supplements for health reasons, whereas men use them primarily for 'building muscle mass' and 'improvement of power and agility'. Tian et al. came to similar conclusions and found more than 75% of collegiate athletes (n=82) in Singapore to be using DS (46). The results of our survey are within the ranges stated in literature. Seventy-five percent of the respondents of the present study use DS. Considering the literature stated above a range of 45-90% of gym members and athletes consuming DS can be identified depending on different regions and population groups. Even though the majority of the participants did not take a DS or took it within the recommended daily dosage, almost 20% of the respondents had a SUP score of 2 and 3. However, it is not clear from the SUP score whether the participants took double or triple the doses of one DS or used one dose of several different products. Subjects with the categorization 'average consumption' took either more than the triple recommended daily dosage of one supplement or were using more than three supplements within daily recommendations. Seventy-three of 244 (30%) were classified as average consumers. However, it can be clearly established that if a SUP score is greater than 5, at least one category is consumed above the recommended daily dose. Consequently, for participants with a SUP score between 2 and 5, it cannot be clearly determined whether individual categories are consuming above the recommended daily intake.

Five percent of the respondents even had a SUP Score of 9 or above. This subgroup is considered to have a very high affinity for the consumption of DS and participants within this group are categorized as a 'high consumer'. This observation can be supported by the results of Willers et al. who examined the intake of minerals from food supplements among the German population (48). They found 105 of 5,586 (2%) of the German consumers were above the recommended dosage for magnesium, zinc or calcium.

In view of the objective of this study, the aim is to identify potential risk groups that are prone to an increased consumption of DS. Considering sex and gym membership, their influence on consumer behavior is present. The combinations g1-m-av ($p=0.001$) and g1-m-hi ($p=0.003$) show a significant overrepresentation expressing a higher appearance than expected (table 1). In contrast, the combination g1-m-lo is significantly underrepresented ($p=0.003$) expressing a lower appearance than expected. No significant results, but a trend can be seen in the combination of g0-m-av (underrepresented) (figure.2). Those results indicate a considerable positive influence of the factors 'gym membership' and 'male' on the consumption behavior of DS. It can be suggested that due to the overrepresentation of the groups g1-m-av and g1-m-hi and with a score of 6 or higher, mainly male gym visitors tend to increase their consumption of DS and consume it above the recommended daily dose.

Contrary, the influence of 'gym membership' cannot be observed in women. Women, who don't have a gym membership are overrepresented in the low-intake use of DS ($f_o = 39$; $f_e = 25.437$; $p=0.005$). No or very few DS are consumed by females if no gym membership is present. No woman, whether gym member or not, could be assigned to the group of high supplementation. As a result, a sex difference in supplementation behavior can be identified.

Increased consumption of DS and a dosage above the recommended daily dosage can lead to potential side effects. For example, increased consumption of caffeine or creatine supplements can lead to discomfort, diarrhea and high blood pres-

sure (4, 7, 17, 19, 29, 41, 42, 44). Men are more likely to consume creatine supplements than women (16, 30, 39), the side effects may also be more likely to occur in men than women. Increased consumption of DS can therefore be associated with a higher risk of adverse effects of these DS. A similar consumer behavior and risk tolerance among men could also be observed in the consumption of fast food products and alcoholic beverages. Hull et al (2016) showed that women go to fast food restaurants less often ($m=61.97\%$ vs. $f=53.33\%$, $X=15.021$, $p=0.02$), drink less alcohol ($m=47.55\%$ vs. $f=27.50\%$, $X^2=24.725$, $p=0.001$) and have a better knowledge of nutritional periodization than male athletes (22). Increased consumption of fast food and alcoholic beverages can lead to a variety of diseases such as obesity, diabetes or liver damage. Consequently, it can be assumed that men have a higher risk of side effects than women when it comes to the consumption of recreational products and non-essential substances such as DS. Therefore, it can be hypothesized that men who are registered at the gym are a potential risk group who consume DS at an increased rate, which can lead the consumption above the recommended daily intake. This hypothesis must be confirmed by further investigations.

Limitations

In addition to the new findings, this study also has some limitations. Based on the sample size and the recruitment and collection of the questionnaires, it is not possible to draw clear conclusions about the entire German population. Even if more than 100,000 people can be reached, there may be a bias in the recruitment process. There are clear differences in Germany with regard to the type of fitness studio. There are some gyms that focus more on health and others more on performance. Consequently, the clientele in these studios differs. It is therefore all the more important to include the type of sport in this context. Previous studies have clearly shown that male strength athletes in particular, as well as performance-oriented gym members, have a high affinity to DS (23, 35, 36). Based on this, it can be assumed that the gyms included also had more of a performance-oriented focus and less of a health-oriented focus. In addition, the data must be collected more systematically and not on a snowball principle. People from all age groups and social classes should be included. The unsystematic distribution of the questionnaire could have created a bias, whereby the results obtained should only be interpreted as an initial indication. Furthermore, no data on food intake or potential deficiencies were collected in this study. In addition to the mentioned risks of DS, DS also have some positive effects to compensate for nutrient gaps or even improve performance (3, 27). The decisive factor in this context is the quality of the supplements. In Germany and Europe, the quality of product safety can still be improved to further reduce the risk of side effects or contamination. Besides, no final statements can be made about dosage behavior of individual supplements, especially of those with a low SUP score. Only initial presumptions and possible hypotheses about the dosage behavior can be formed. With a SUP value of 2 or 3 („low consumption“), no general statement can be made about the dosage behavior. The score can be achieved by either consuming different DS within the recommended intake dosage or by overconsuming one individual DS. A high overconsumption of a certain DS, such as protein shakes, cannot be ruled out even with a low SUP score. With a SUP score of six or above, at least one DS of the five categories is certainly overdosed. A three to fourfold overdose of individual dietary supplements such as protein shakes, vitamins or creatine cannot be ruled out >

due to the overconsumption of g1-m-hi. There is an increased probability that individual DS will be overconsumed, especially by male gym members. Another important aspect is the different concentrations of the capsules or pills of each DS. Because there is no uniform regulation for the various preparations, it is hardly possible to determine consumer behavior based only on the number of capsules, scoops and pills. For example, a vitamin C capsule can contain about 2000 mg or “only” 500 mg. Therefore, it is crucial to define the concentration per tablet as well as the number of tablets. However, the stated concentrations of many products do not correspond to actual concentrations (1). Often the products contain a lower concentration than stated, so that the actual amount taken is only a hint. Although, these observations are also known among athletes and gym members, so that they may be consciously consuming DS at an increased level based on this assumption. Nevertheless, if the concentrations are underestimated, potential side effects may occur due to higher doses than recommended. In this context, however, it must be mentioned that potential side effects can vary greatly between different DS. For example, no clearly noticeable side effects have been reported from overconsumption of protein products. In contrast, side effects such as hypertension, malaise and diarrhea have been reported with creatine and caffeine products. Therefore, the DS must be considered with a differentiated view. The different categories of DS should be examined separately. Additionally, further studies need to analyse the consumption behavior of different sports in order to identify risk groups

Conclusions

This study provides a first insight into the consumption and the respective dosage behavior of DS in men and women depends on gym membership in certain areas of Germany. A gender-specific difference of the consumption behavior can be seen depending on the gym membership in the surveyed population. This data is used exclusively to identify potential risk groups and to create hypotheses. No definitive statements can be made. Further research in Germany is needed to confirm and refine the observed results. But it is necessary to conduct a detailed analysis of the consumption and nutrition behaviour to be able to make clearer statements. Especially studies on the consumption and dosage behaviour of different types of athletes in the different DS categories are necessary. ■

Conflict of Interest

The authors have no conflict of interest.

Ethical Approval

As we were dealing with an anonymised questionnaire, we did not submit a specific ethics application at the time. At no time can the questionnaire be traced back to individual participants. However, we have an ethics vote for a similar survey of athletes, which would also cover this survey (Ethics Committee of the IST University of Applied Sciences, 02/2020 and date of approval: 18 February 2020). All participants were informed and informed about the project before the survey and gave their written consent. This research project is in accordance with the Declaration of Helsinki.

Summary Box

- Currently there is no data to potential subgroups with an increased affinity for DS in general and in Germany. Therefore, as an initial exploratory data analysis, this survey aimed to identify potential relationships between gender, gym membership and dietary supplement consumption behaviour and to generate hypotheses.
- A total of 244 questionnaires were analysed and the results indicate that male gym-users in particular have an increased affinity for DS. This could not be established for women. However, further research is needed to confirm this.

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