Why Do Athletes Choose Dietary Supplements? Reliability and Validity of the Dietary Supplement Choice Questionnaire (DSCQ) among Japanese College Athletes

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Summary To assess the reliability and validity of the Dietary Supplement Choice Questionnaire (DSCQ) to capture dietary supplement choice motives among Japanese college athletes. The cross-sectional study was performed in 2014. This study recruited 1,451 college athletes from sports-oriented clubs at the University of Tsukuba, Japan. The participants completed the DSCQ, health literacy, and subjective economic status; part of the participants completed a test-retest (n=378). A sample of 975 participants (28.0% female) included in the analysis. The DSCQ was developed through factor analysis. Seven factors emerged, and were labelled “popularity,” “functionality,” “price,” “taste,” “convenience,” “antidoping” and “familiarity.” Mostly acceptable reliability was seen across seven DSCQ factors (the internal consistency, Cronbach’s α=0.62–0.85; the test-retest reliability coefficients, r=0.62–0.82), whereas convergent validity for price and antidoping factors was provided by significant associations with economic status and literacy (p<0.01). Findings showed reasonable evidence of reliability and validity of the DSCQ and provided the opportunity to comprehensively assess dietary supplement choice motives among Japanese college athletes.

Key Words sports, motivation, eating behavior, assessment, students

Dietary supplements are commercially available products that are intended to supplement the diet and may contain one or more dietary ingredients (https://ods.od.nih.gov/About/DSHEA_Wording.aspx). According to a meta-analysis that examined the prevalence of dietary supplement use among athletes, the overall prevalence of any type of dietary supplement use was about 60% (1). Furthermore, the prevalence rate of dietary supplement use among college athletes indicates a range from 76.8% to 89.0% (2–4).

Nutrition misinformation may interfere with the proper use of dietary supplements (5). Therefore, it is difficult for an athlete to use a dietary supplement properly regardless of whether they are an elite athlete or not. According to Petróczi et al., although few young athletes consider dietary supplements as unnecessary for competitive success, they have inconsistent habits such as using dietary supplements (6). Some studies have reported that there is significant incongruence between the rationale for supplement use and actual practice, especially in young athletes (7).

We can assume that the use of dietary supplements among some young athletes is driven by something other than correct understanding the physiological functions of supplements, for example the recommendation of friends, family, teammates, and coach (7). If we recommend that athletes properly use dietary supplements, we must have a comprehensive understanding of why they choose these products. As the scale to understand choice of a food, the Food Choice Questionnaire (FCQ) was developed from a sample of adults ranging in age from 18 to 87 y. Nine factors constructed the FCQ, and were labelled health, mod, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern. Although a comprehensive conceptualization of food choice motives is found in the FCQ (8), this scale concentrates on food choice in the everyday life of general people. Therefore, the present study aims at capturing a wide range of motives underlying dietary supplement choice and, subsequently, developing a concise questionnaire that allows for the comprehensive measurement and investigation of motives for dietary supplement choice among Japanese college athletes who belong to sports-oriented clubs at the University.

We conducted two studies to develop a concise ques-
tionnaire. In Study 1, the motives for dietary supplement choice among Japanese college athletes were identified through consideration of existing college athletes and dietitians interviews. Study 2 was designed to develop a new measure of motives for dietary supplement choice, to assess the validity and reliability of this measurement.

Data from the Canadian national survey provided evidence that supplement use was determined by household income and education and that adults of high economic or education status were more likely to take supplements (9). In addition, several studies have reported that motives for choosing foods and supplements is related to the characteristics, such as economic status and literacy. Differences in motives for food choice associated with income were described by Steptoe and coworkers (8). In the other hand, an investigation among UK athletes indicated that the lack of understand about supplement effects associated with the motives of supplement choice (10). The ability to access, understand, appraise, and apply health information is called health literacy (11). Therefore, we used economic status and healthy literacy as indicators of convergent validity of the instrument.

**MATERIALS AND METHODS**

**Study 1: Generating motives for dietary supplement choice**

Motives for dietary supplement choice were brought through interviews with college athletes, discussions with dietitians, and considerations by the authors. We recruited 15 college athletes (4 females, 11 males; mean age 20.7 y) from 5 sports-oriented clubs at the University of Tsukuba, Japan. The study was conducted after receiving approval from the ethics committee of Tsukuba (Tai26-49). This study was conducted in accordance with the Declaration of Helsinki.

We requested a survey of representatives of all 46 sports-oriented clubs at the University of Tsukuba that has a school of health and physical education, except for clubs at school medicine and medical science, and circles. A total of 1,451 college athletes belonged to the 46 clubs that requested the survey. These clubs compete with athletes of other universities in organized leagues. Athletes from a variety of sports disciplines, including individual sports (i.e., track & field, judo, tennis, swimming, gymnastics, and skiing) and team sports (i.e., football, baseball, rugby, American football, basketball, handball, and volleyball) were welcome to participate in the survey. We conducted the survey on 42 clubs that accepted the survey. There were four clubs that did not participate in the survey; two clubs were out of communication, one club has suspended its activities, and one club was near the convention. Participants in the survey were 1,043 college athletes (response rate: 71.9%). Written informed consent was obtained from all participants. Participants for whom data was missing, or who were aged over 23 y, were excluded (n=68). The present analysis includes 975 participants.

Between 2 to 3 wk after the survey was conducted, we asked 1,043 participants in the survey to participate the retest. Responses to a repeat questionnaire were obtained from 438 participants. Participants for whom data was missing, or who were aged over 23 y, were excluded (n=60). The test-retest analysis includes 378 participants.

**Procedure.** In the preliminary DSCQ, participants were asked to respond to the following statement: “It is important to me that for the supplements I choose usually ... for each of the 37 items by choosing among four responses: not at all important, a little important, moderately important, and very important, scored from 1 to 4. For those of you who do not usually take supplements, please assume that you intake and give your answer.” Participants who do not usually take supplements were asked to answer how important each item if you choose supplements to take yourself. Score for each factor were calculated by averaging scores of items included in each factor, with higher scores indicating greater motives about the factor. The participants were asked the following question: “Currently, how much frequency have you took dietary supplement?” The results were self-reported according to the following four categories: “never,” “rarely,” “often,” and “usually.”

To ensure that all participants would be able to distinguish dietary supplements, examples were given at the beginning of the questionnaire. Dietary supplements listed on the questionnaire included: vitamins, amino acids, protein, creatine, and minerals. We asked participants to comprehensively rate these dietary supplements for each item of the preliminary DSCQ.

Health literacy related to eating was assessed with the Healthy Eating Literacy (HEL) Scale (12). Health literacy defined as the competencies related to accessing, understanding, appraising and applying health information in the domains of healthcare, disease prevention and health promotion, respectively (11). The HEL can assess health literacy specialized in eating information. This
measure consists of five items concerning interactive and critical literacy related to eating for healthy life. Scores on the scale can range from 1 to 5, with higher scores indicating greater interactive and critical literacy. The scale has been shown to have reliability and validity among Japanese adults (12). The internal consistency (Cronbach’s α) score in the present sample was 0.821. This study showed the positively relationship between the HEL, and the stages of change as indicator of convergent validity (12).

Because it would be difficult to obtain exact figures of students’ annual household income, we assessed economic status using a subjective measurement of economic status with reference to the measurement used in the survey conducted by the Japanese Ministry of Health, Labour and Welfare (13), and validated by comparing the question with annual household income reported in another study (14). The participants were asked the following question: “Currently, how would you describe your economic status?” The results were self-reported according to the following six categories: “very comfortable,” “comfortable,” “normal,” “uncomfortable,” “very uncomfortable,” and “I don’t know.”

The survey required the participants to report their age, and sex.

Data analysis. To conduct both explore and confirm the factor structure of this new measurement, we first created a random split of the total sample (n=975) into two subsamples of 488 (subsample 1) and 487 (subsample 2) participants using the random sampling procedures of the SPSS. Exploratory factor analyses were conducted using maximum likelihood estimation on the data of subsample 1. Promax rotation, which allows factors to be correlated, was applied because previous data of subsample 1. Promax rotation, which allows factors to be correlated, was applied because previous data of subsample 1. To decide how many factors to retain, the scree test was conducted using maximum likelihood estimation on the data of subsample 1 and subsequently cross-validated data of subsample 2. Combining the results of the scree plot (17), Kaiser’s criterion (eigenvalues exceeding one) (16) and an inspection of the scree plot (17), the internal consistency of the measurement was calculated by using Cronbach’s α. Statistical tests were performed using SPSS Statistics (20, IBM Corp. Armonk, NY).

Confirmatory factor analyses were first performed on the data of subsample 1 and subsequently cross-validated in subsample 2 with SPSS Amos (22, IBM Corp). Model fit was assessed by the adjusted goodness-of-fit index (AGFI), the comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA) (18). A good fit is indicated by n AGFI ≥0.90, a CFI ≥0.90, and a RMSEA value <0.10 (18).

The participants were categorized into groups based in their economic status and the HEL. Subjective economic status groups included “low” (uncomfortable and very uncomfortable), “neither” (normal and I don’t know), and “high” (comfortable and very comfortable). The HEL was dichotomized according to medians. Analysis of variance and Tukey post-hoc tests were performed to compare means motives in relation to economic status and literacy on the entire sample of 975 participants. Test-retest reliability of the DSCQ scores was assessed with the intraclass correlation coefficient (ICC) both the scores of time 1 and time 2.

RESULTS

The present analysis includes 975 participants (273 females, 702 males; mean age 20.0 y; standard deviation 1.1 y; age range 18–22 y). Football, athletics, and rugby were represented as the three most common sports, with 123 (12.6%), 97 (9.9%), and 60 (6.2%), respectively. The majority of participants had taken some dietary supplements (n=594, 60.9%).

A first exploratory factor analysis with the set of 37 items from the subsample 1 yielded eight factors with eigenvalues greater than one. Additionally, the scree test of eigenvalues suggested the extraction of seven factors.

Ten items with insufficient psychometric characteristics such as low factor loadings (<0.40) or substantial cross-loading (>0.30) were deleted. A subsequent factor analysis with the remaining 27 items showed a seven-factor structure accounting for 64.2% of the variance, with eigenvalues ranging from 1.15 to 6.78 (Table 1). Factor 1 is composed of six items related to the recommendation by others, and is therefore labeled “popularity.” Factor 2 consists of five items related to the function of the supplement, and is labeled “functionality.” Factor 3 has five items associated with cost of supplement, and is labeled “price.” Factor 4 includes three items related to the taste of a supplement, and is labeled “taste.” Factor 5 is composed of three items associated with the risk of doping, and is labeled “antidoping.” Factor 6 consists of two items related to the use experience in the past, and is labeled “familiarity.” Factor 7 has four items concerned with the ease of purchase and preparation, and is labeled “convenience.” Scores on each factor were computed averaging unweighted ratings for individual items, and so could range from a minimum of 1 to a maximum of 4. The internal consistencies of the DSCQ were assessed by the Cronbach’s α coefficient (α=0.62–0.85) (Table 1).

As a result of confirmatory factor analysis, this seven-factor model for the DSCQ provided a good fit for subsample 1 (n=488, $\chi^2=856$, df=297, p<0.001; AGFI=0.85, CFI=0.89, RMSEA=0.062, and RMSEA 90% confidence interval=0.057–0.067) and subsample 2 (n=487, $\chi^2=772$, df=297, p<0.001; AGFI=0.86, CFI=0.90, RMSEA=0.057, and RMSEA 90% confidence interval=0.052–0.062). All factor loadings were significant (p<0.001).

Price was rated as less important by either neither or high economic status than low economic status (p=0.01) (Table 2). Functionality and antidoping were rated as more important by high literacy than low literacy (p=0.01 and p<0.01, respectively) (Table 2). Results of the test-retest are presented in the Table 3. Interclass correlation coefficients observed between time 1 and time 2 ranged from 0.62 to 0.82 (p<0.001), which indicated good to excellent reliability (19) except for familiarity (0.60, p<0.001).
**Table 1.** Supplement choice questionnaire, factor loadings, and internal consistency \((n=488)\).

| Factor | Cronbach’s alpha | Factor loading* |
|--------|------------------|-----------------|
| Factor 1—Popularity | 0.85 | |
| 25. It is recommended by seniors or juniors | 0.97 | |
| 26. It is recommended by friends | 0.89 | |
| 14. It is recommended by coaches | 0.59 | |
| 6. It is recommended by club members | 0.56 | |
| 24. It is recommended by the manufacturer-sponsored seminar | 0.54 | |
| 16. It is taken by famous athletes | 0.52 | |
| Factor 2—Functionality | 0.78 | |
| 12. It makes me feel the effects | 0.84 | |
| 11. It supplements insufficient nutrients in daily diets | 0.78 | |
| 18. It has a clear effect | 0.59 | |
| 10. It can be quickly taken anytime | 0.47 | |
| 5. It is easy to consume | 0.45 | |
| Factor 3—Price | 0.79 | |
| 21. It is cheap | 0.97 | |
| 17. It is not expensive | 0.67 | |
| 3. It is a good value for the money | 0.59 | |
| 27. It is of a price that can be continued to take | 0.51 | |
| 20. It has a special price | 0.45 | |
| Factor 4—Taste | 0.76 | |
| 1. It is easy to take and has taste | 0.92 | |
| 8. It is not bitter | 0.64 | |
| 7. It is easy to take | 0.54 | |
| Factor 5—Antidoping | 0.74 | |
| 22. It has an antidoping certified mark | 0.84 | |
| 4. It is not in a doping list | 0.75 | |
| 23. It contains no unnecessary components | 0.45 | |
| Factor 6—Familiarity | 0.78 | |
| 9. It is what I usually intake | 1.0 | |
| 2. It is what I have taken at least once | 0.63 | |
| Factor 7—Convenience | 0.62 | |
| 19. It can be taken without dissolving in water | 0.55 | |
| 15. It is packaged individually | 0.50 | |
| 13. It is convenient to carry | 0.41 | |

*All factor loadings are significant at \(p<0.001\). Exploratory factor analyses were conducted using maximum likelihood estimation. Promax rotation which allows factors to correlate.

**Table 2.** Motives for supplement choice in relation to economic status and literacy \((n=975)\).

| Economic status\(^a\) | Healthy eating literacy\(^b\) | \(p^c\) |
|------------------------|-----------------------------|--------|
| **Low \((n=171)\)** | **Neither \((n=500)\)** | **High \((n=304)\)** | **Low \((n=421)\)** | **High \((n=554)\)** |
| Population | 2.5 (0.7) | 2.5 (0.6) | 2.4 (0.6) | 0.89 | 2.5 (0.6) | 2.4 (0.6) | 0.46 |
| Functionality | 3.5 (0.4) | 3.5 (0.5) | 3.5 (0.5) | 0.32 | 3.4 (0.5) | 3.5 (0.4) | 0.009 |
| Price | 3.4 (0.5) | 3.2 (0.6) | 3.2 (0.6) | <0.001 | Low> Neither, High |
| Taste | 3.1 (0.6) | 3.1 (0.7) | 3.1 (0.6) | 0.95 | 3.2 (0.6) | 3.1 (0.7) | 0.14 |
| Antidoping | 3.4 (0.6) | 3.4 (0.6) | 3.4 (0.6) | 0.60 | 3.3 (0.6) | 3.5 (0.5) | <0.001 |
| Familiarity | 2.7 (0.7) | 2.6 (0.7) | 2.6 (0.8) | 0.26 | 2.6 (0.7) | 2.6 (0.8) | 0.85 |
| Convenience | 2.8 (0.6) | 2.7 (0.6) | 2.8 (0.7) | 0.43 | 2.8 (0.7) | 2.8 (0.6) | 0.35 |

Values are expressed as mean (standard deviation).

\(^a\) Groups include a “low” (uncomfortable and very uncomfortable), “neither” (normal and I don’t know) and “high” (comfortable and very comfortable).

\(^b\) The scale was dichotomized according to median (3.6).

\(^c\) Analysis of variance and Tukey post-hoc tests were performed.
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Table 3. Test-retest reliability of DSCQ (n=378).

|          | Time 1 | Time 2 | ICC   |
|----------|--------|--------|-------|
|          | Mean (SD) | Mean (SD) |       |
| Popularity | 2.6 (0.4) | 2.6 (0.4) | 0.74  |
| Functionality | 3.3 (0.4) | 3.2 (0.4) | 0.74  |
| Price    | 2.9 (0.5) | 2.9 (0.5) | 0.79  |
| Taste    | 3.2 (0.6) | 3.1 (0.6) | 0.82  |
| Convenience | 2.8 (0.6) | 2.8 (0.6) | 0.62  |
| Antidoping | 3.5 (0.5) | 3.5 (0.4) | 0.70  |
| Familiarity | 2.6 (0.7) | 2.5 (0.7) | 0.60  |

DSCQ indicates Dietary Supplement Choice Questionnaire. ICC indicates intraclass correlation coefficient. All correlations are significant <0.001 (2-tailed).

DISCUSSION

The current study developed a new measure to capture a wide range of motives underlying dietary supplement choice among Japanese college students and assessed the validity and reliability of this measurement. Although previous studies examined the motives of dietary supplement choice (3, 4), these measurements did not assess validity and reliability. The new measure developed in the current study allows for a comprehensive assessment of motives underlying dietary supplement choice among Japanese college athletes.

To generate wide range motives for supplement choice, we conducted study 1 that interviews with college athletes, discussions with dietitians, and considerations by the authors. Most of the interviewees were males and athletes in the individual sports category. Therefore, in discussions with dietitians and considerations by the authors, we considered generating mainly items that represent the motives for the entire supplement, while fitness supplements compared to the entire supplement. Finally, convergent validity was investigated to assess in relation to other measures; however, predictive validity was not assessed in relation to actual behavior. The relationship between consumption of supplements should therefore be investigated in a prospective study. To add evidence of DSCQ, further research needs to evaluate the supplement choice motives associated with the usage of supplements.

The results of this study suggest that the DSCQ has potential as a valid and reliable measurement for assessing the dietary supplement choice motives of Japanese college athletes. However, further research is required to involve athletes in a more diverse group and to assess the dietary supplement usage. Therefore, we recommend to assess the usage of supplements when evaluating the motives by DSCQ.

Nevertheless, the motives of dietary supplement choice may be an important target for athletes and their support personnel to promote that dietary supplement usage are being used efficaciously. The DSCQ provides for competitive athletes on which dope test is imposed. We have determined that the DSCQ can capture a wide range of motives underlying dietary supplement choice among college students.

Some instruments of food choice motives have been developed, such as FCQ (8) and the eating motivation survey (TEMS) (15). The internal consistencies of FCQ and TEMS were low to high (α=0.72–0.86, α=0.48–0.92, respectively) (8, 15). The test-retest correlation of FCQ was acceptable (r=0.71–0.83) (8). Compared with those instruments (8, 15), both Cronbach’s α assessing the internal consistency of the DSCQ (α=0.62–0.85) and the test-retest intraclass correlation coefficients (r=0.60–0.82) were mostly acceptable. The DSCQ has psychometric properties similar to those of other questionnaires designed to measure motives of food choice (8, 15). Convergent validity for the price and antidoping factors was provided by significant associations with economic status and literacy, respectively, similar to previous studies (8, 20). Confirmatory factor analyses showed good model fit. These results suggest that the DSCQ is a valid and reliable instrument for assessing the motives underlying dietary supplement choice among college students.

The present study has at least four considerable limitations. First, “familiarity” consisted of only two items. Since the internal consistency of this factor was not good either, it may be avoidable to use “familiarity” as well as the other factors. Second, because the measured self-reported motives may include skewed motives influenced by social desirability or self-presentation biases (21), self-reported motives might not always reflect accurately the actual underlying motives for food choice. Thus, complementary assessment of implicit motives should be subject to future research. Third, motives for dietary supplement choice had been evaluated without identifying the type of supplement. The DSCQ scores represent the motives for the entire supplement, while athletes may have different motives for specific supplements compared to the entire supplement. Finally, convergent validity was investigated to assess in relation to other measures; however, predictive validity was not assessed in relation to actual behavior. The relationship between consumption of supplements should therefore be investigated in a prospective study. To add evidence of DSCQ, further research needs to evaluate the supplement choice motives associated with the usage of supplements.
the opportunity to comprehensively assess motives perceived as relevant to dietary supplement choice.

Disclosure of State of COI

MO and IS are employees of Ajinomoto Co., Inc. The other authors have no conflicts of interest to declare.

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