

Construction and Reproducibility of a Questionnaire Aimed for Evaluation of Dietary Habits in Physically Active Individuals

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ABSTRACT

The aim of this study was to develop a comprehensive food frequency questionnaire (FFQ), and a complementary general questionnaire associated to it, specifically tailored for the assessment of dietary habits among athletes and other physically active individuals in Croatia, and to determine the reproducibility of the questions and nutrient intake estimations. The study included 83 students (42 males and 41 females) from the Faculty of Kinesiology, University of Zagreb. Construction of the initial version of the questionnaire was done according to the literature and the results of a pre-testing interview conducted on 15 subjects. The final version of FFQ consisted of 74 questions on usual consumption frequency of particular food and beverage items and usual food preparation methods. The final version of the general questionnaire consisted of 30 questions on age, gender, body height, body weight, energy expenditure, specific dietary regimen, general dietary habits, diet characteristics before, during and after training, and cigarette smoking habits. Reproducibility of the questionnaires was assessed by a repeated administration of the questionnaire after one month. Pearson correlation coefficients and proportions of agreement were used to present reproducibility of quantitative and qualitative data, respectively. In the sample of male students, Pearson correlations ranged from 0.51 for copper to 0.95 for alcohol, with an average correlation of 0.68. In the sample of female students, correlations ranged from 0.30 for alcohol to 0.78 for calcium, with an average correlation of 0.60. Average reproducibility of items in the general questionnaire was 0.83 and 0.86 for male and female students, respectively. In conclusion, the newly developed FFQ enables cost-effective assessment of dietary habits in Croatian athletes and other physically active individuals, as well as demonstrates acceptable reproducibility.

Key words: nutrition assessment, questionnaire design, food frequency questionnaire, general questionnaire, reliability, test-retest, Croatia

Introduction

Performance of both recreational and professional athletes can be considerably improved by adequate food and fluid intake. If athletes want to achieve optimal performance during competition and quick recovery after exercise sessions, they have to adhere not only to the training program, but also apply adequate eating strategies¹. Eating strategies include planning the diet, as well as the use of dietary supplements and ergogenic aids. In order to develop adequate strategies for improving athletes' diet, it is necessary to identify their current dietary habits. In epidemiological studies there are different methods for determining individuals' nutritional

intake, however in the recent years², food frequency questionnaires (FFQs) have become one of the most frequently used methods, probably because of their relatively low cost and applicability in large populations. Although measures of dietary composition obtained by such questionnaires are not perfect³, they are still satisfactory, which is why this instrument has become one of the key research methods in nutrition epidemiology⁴.

The food list in FFQ has to be specifically adapted to the diet of the target population^{5,6}, which in the case of athletes means the inclusion of supplements and ergo-

genic aids. Also, because of the differences in common food choice and food composition tables between the countries, FFQs developed in one country should be modified if it is to be used in another country⁴. Therefore, modification of the most common FFQs used in the USA such as Willett questionnaire⁷ and Block questionnaire⁸ would not be acceptable for surveys in Croatia. Moreover, even questionnaires developed within a single country should be continually modified because of changes in the patterns of food consumption, dietary composition⁹ and introduction of new types of food⁵. Although there is one FFQ recently developed in Croatia¹⁰, it could not be used for a complete assessment of dietary habits because it measures only calcium intake.

To the best of our knowledge, there is no FFQ that could be used for a complete assessment of dietary habits among athletes and other physically active individuals in Croatia. Therefore, the aim of this study was to develop such questionnaire and assess its reproducibility.

Subjects and Methods

Subjects

The study included 83 students (42 males and 41 females) from the Faculty of Kinesiology, University of Zagreb. Since the participation in obligatory classes at the Faculty requires between 7 and 10.5 hours of physical exercise per week, this sample of students had sufficiently high energy expenditure to be considered representative for the population of athletes and other physically active individuals. All students had signed an informed consent and participation in the study was voluntary.

Study design

The study protocol was approved by the Scientific and Ethics Committee of Faculty of Kinesiology, University of Zagreb. The study was conducted in 2004 through the following phases: 1. constructing the initial version of questionnaire; 2. pre-testing the initial version of questionnaire and defining the final version of questionnaire; and 3. determining the reproducibility of the final version of the questionnaire.

Construction of the initial version of questionnaire was done in accordance with the aim of the study, scientific facts from the literature and the authors' experience. The initial items of the questionnaire were defined through the following steps: 1. defining the parameters that will be assessed with the questionnaire; 2. making a list of food items that are usually consumed in Croatia; 3. collecting information on the specific characteristics of athletes' nutrition; 4. grouping the food items into homogenous groups; 5. determining the portion size for a particular food item or group of food items; 6. defining the number, content and order of questions in FFQ; 7. defining the number, content and order of questions in the general questionnaire; 8. formulating explanations for particular questions and instructions for the comple-

tion of the questionnaire; and 9. developing a computer application for the calculation of nutritive intakes on the basis of FFQ.

In order to evaluate and improve the initial version of the questionnaire, pre-testing study was conducted on 15 participants. After having fulfilled the questionnaire, participants were interviewed so that we could detect and clarify vague questions, determine if additional instructions and explanations are needed, complete the incomplete answers, determine the level of doubt and self-confidence when choosing an answer, estimate the time needed for completing the questionnaire, and detect other factors that might adversely influence the gathered data. The interview was conducted by a trained interviewer. Based on the results of pre-testing, certain questions, instructions and answers from the initial version were modified and additional information was added. The language of the final version of the questionnaire was edited by a language professional.

The reproducibility of the final version was assessed by a repeated administration to 83 subjects after one month. One-month interval was chosen because, it was shown that the optimal time for the repeated administration would be between 4 and 8 weeks, which is long enough that the participants forget what they had written before, but short enough for substantial dietary changes to occur¹¹. Because reproducibility coefficients are associated with gender¹², data were analyzed separately for males and females.

Questionnaire

The questionnaire contains 104 questions and is divided into FFQ and general questionnaire. FFQ consists of 74 questions and provides information on usual nutrient intakes. The FFQ contains questions regarding the usual consumption frequency of particular food and beverage items and usual food preparation methods. The portion size for each food and beverage item is predefined. Participants are asked to report the exact numerical frequency of consumption of every item. Beverage intake is assessed with 11 questions; cereals and cereal products with 8; nuts, fruit, vegetables and related products with 10; milk and dairy products with 6; eggs and related products with 2; meat, fish and related products with 12; confectionery with 4; sweeteners with 3; dietary supplements with 3; and food preparation methods with 15 questions. Food items included in each food group and dishes included in food preparation are additionally listed in the explanation for each question. Total number of food items and dishes is 304 and 28, respectively. General questionnaire consists of 30 questions and provides information on other aspects important for interpreting dietary habits of athletes, i.e., age, gender, body height, body weight, energy expenditure, specific dietary regimen (vegetarians, dieters, etc.), general dietary habits (number of daily meals, frequency of breakfast consumption, etc.), diet characteristics before, during and after training, as well as cigarette smoking habit. Data collected with the general questionnaire enable proper in-

terpretation and a more complete understanding of the usual nutrient intakes estimated by the FFQ. All questions refer to the previous 3 months.

Data analysis

Statistical analyses were performed by using STATISTICA software (StatSoft, Inc., version 5.0.). Means and standard deviations were calculated in order to describe general characteristics of the sample of students. Answers to the questions collected during the pre-testing interview were expressed as percentages. Reproducibility of qualitative and quantitative data was assessed using proportions of agreement and Pearson correlation coefficients, respectively. Within-person differences in nutrient intakes reported in the first and second administration of FFQ were expressed using Cohen’s d, i.e., the difference between two means divided by the pooled standard deviation for respective means. According to classical test theory the first and second administration of the questionnaire should be parallel tests and therefore should have equal means and standard deviations, so Cohen’s d for every nutrient intake is expected to be 0.

Body mass index (BMI) was calculated as the individual’s self-reported body weight divided by the square of their self-reported height. Basal metabolic rates were estimated using Mifflin-St. Jeor equation¹³. Nutrient intakes were calculated on the basis of food composition tables. The only Croatian food composition database¹⁴ does not contain all the items used in the questionnaire, so the data on missing items were obtained from USDA Nutrient Database for Standard Reference¹⁵. Nutrient intakes from dietary supplements were also included in calculations.

Results

Male and female students had on average 21 ± 1.58 and 20 ± 0.66 years, respectively (Table 1). There were 79% of male students and 93% of female students with normal BMI values (from 18.5 to 25), 5% of female stu-

dents were underweight (BMI from 16.5 to 18.5), while 21% of male students and 2% of female students were overweight (BMI from 25 to 30). Body weight of the majority of students remained almost unchanged between the two administrations of the questionnaire, i.e., in 88% of students it changed between -1 and 1 kilogram. Most students reported participation in additional sport or recreational activity beside obligatory classes at the Faculty of Kinesiology (88% of male and 68% of female students). Average training duration per week showed that male students were somewhat more active than female students (269 vs. 229 minutes per week, which is approximately 4.5 vs. 4 hours per week, Table 1). According to energy expenditure during training sessions and obligatory classes at the faculty, these students can be classified in a group of adults with high energy requirements. According to World Health Organization, physical activity level for adults with active and moderately active lifestyle is between 1.7 and 1.99¹⁶. Thereby, the product of average estimated basal metabolic rate and physical activity level, i.e., estimated energy expenditure for male and female students was 3048–3568 kcal and 2411–2822 kcal, respectively.

Table 2 shows the results of the pre-testing interview. In the general questionnaire, 60% of students were not always been able to find an appropriate answer. Despite evident incompleteness of certain answers, almost all students evaluated questions in the general questionnaire as completely clear (86%) and were quite certain or completely certain (74%) when answering. As expected, certainty for a given answers was somewhat lower for FFQ (27% partially certain, 27% quite certain, and 46% completely certain). Only 13% of students reported consumption of certain foods that were not on the FFQ’s list. The time required to complete the whole questionnaire was between 10 and 30 minutes for 80% of students. None of the students needed more than 40 minutes to complete the questionnaire.

Test-retest reproducibility coefficients for items in general questionnaire are shown in Table 3. Pearson correlation coefficients for self-reported body height, body

TABLE 1
GENERAL CHARACTERISTICS AND ENERGY EXPENDITURE PARAMETERS FOR MALE AND FEMALE STUDENTS

Parameters	males (n = 42)		females (n = 41)	
	\bar{x}	s	\bar{x}	s
Age (years)	21	1.58	20	0.66
Body height (cm)	180.4	6.31	168	6.19
Body weight (kg)	76.9	7.4	62.6	7.09
Body Mass Index (BMI) (kg/m ²)	23.62	1.62	22.15	1.86
Basal Metabolic Rate (BMR) (kcal)	1793	106.52	1418	103.83
Weekly training frequency (WTF)*	3	2.09	2	2.51
Average training duration (ATD) (min)*	72	42.57	58	49.88
Average training duration per week (ATDW) (min)*	269	203.89	229	269.36

* does not include activities of obligatory classes on Faculty of kinesiology

TABLE 2
PERCENTAGES OF ANSWERS TO THE QUESTIONS IN PRE-TESTING INTERVIEW

List of questions	Answer* percentage (%)				
	a	b	c	d	e
Do you consider some of the questions from the questionnaire too intimate?	7	93			
Were you always able to find an appropriate answer among the answers offered in the general questionnaire?	40	60			
Did you have difficulties in converting the intake of particular food items to the number of standard portion sizes offered in FFQ?	20	80			
Are there any food items that you frequently use but are not mentioned in the FFQ?	13	87			
How would you assess the instructions for completing the questionnaire and explanations for particular questions?	0	0	0	33	67
How would you assess the questions in the general questionnaire?	0	0	7	7	86
How would you assess the questions in FFQ?	0	0	0	27	73
With what certainty did you answer the questions in the general questionnaire?	0	0	27	27	46
With what certainty did you answer the questions in the FFQ?	0	7	27	39	27
How much time did it take you to complete the questionnaire?	7	47	33	13	0

* Available answers to the questions were as follows: questions 1–4 – a) yes b) no; questions 5–7 – a) completely unclear b) quite unclear c) partly clear d) quite clear e) completely clear; questions 8 and 9 – a) completely uncertain b) quite uncertain c) partly certain d) quite certain e) completely certain; and question 10 – a) less than 10 minutes b) 10–20 minutes c) 20–30 minutes d) 30–40 minutes e) more than 40 minutes

weight and corresponding BMI ranged between 0.95 and 0.99 (Table 3). Reproducibility of the estimated basal metabolic rate for both male and female students was 0.99 (Table 3). Reproducibility of average training duration per week was higher for female than for male students (0.92 vs. 0.73, Table 3). Proportions of agreement for qualitative questions in the general questionnaire were between 0.40 and 1 (Table 3). The highest reproducibility was determined for the questions on specific dietary regimen and cigarette consumption. Reproducibility coefficients for questions regarding general dietary habits were somewhat higher for male than for female students (0.71 vs. 0.63 for number of daily meals, 0.83 vs. 0.63 for breakfast consumption frequency, and 0.69 vs. 0.59 for fast-food consumption frequency, Table 3). Reproducibility coefficients for the questions regarding diet characteristics before, during and after training were similar for both genders (0.56–0.83 for male students and 0.56–0.81 for female students, Table 3). As expected, proportions of agreement were higher for questions with fewer available answers. Altogether, average reproducibility of the items in the general questionnaire was 0.83 and 0.86 for male and female students, respectively (Table 3).

Pearson correlation coefficients for nutrient intakes estimated at the first and second administration of FFQ (test-retest reproducibility) are presented in Table 4 and Table 5. In the sample of male students, Pearson correlations ranged from 0.51 for copper to 0.95 for alcohol, with an average correlation of 0.68 (Table 4). All correlations were statistically significant ($p < 0.05$). In the sample of female students, correlations ranged between 0.30 for alcohol and 0.78 for calcium, with an average correlation of

0.60 (Table 5). All correlations were statistically significant ($p < 0.05$), except for alcohol ($p = 0.057$). Reported mean intake was higher in the first than in the second administration of FFQ for almost all nutrients. Average Cohen’s *d* for male and female students was 0.16 and 0.32, respectively. According to Cohen’s criterion¹⁷, in the sample of male students differences between average intakes for 9 nutrients were classified as small and in the sample of female students 12 differences were classified as small and 3 differences as medium.

Discussion and Conclusion

In this study, we developed FFQ and an associated general questionnaire for evaluation of dietary habits in athletes and other physically active individuals and assessed the reproducibility of these questionnaires. The results suggest that newly developed questionnaires can provide reliable estimates of nutrient intakes and qualitative dietary habits.

Although FFQ allows easy usage and data analysis, if not designed and applied properly, it may not provide the required information⁴. Therefore, we tried to deal with various possible sources of error such as ambiguity of questions, explanations and available answers, incompleteness of the food list, number of questions, time required to complete the questionnaire, time frame for the assessment of diet, the range of frequency choices, within-person and between-person variability in portion sizes, etc. FFQs are designed to assess only dietary intake of energy and nutrients, and not other aspects of nutrition, such as food habits and eating behaviour¹⁸. Therefore, in

TABLE 3
TEST-RETEST REPRODUCIBILITY OF GENERAL QUESTIONNAIRE

List of parameters/questions	Reproducibility*	
	males (n = 42)	females (n = 41)
Age (years)	0.99	0.94
Body height (cm)	0.99	0.99
Body weight (kg)	0.99	0.99
Body mass index (BMI) (kg/m ²)	0.95	0.97
Basal metabolic rate (BMR)	0.99	0.99
Weekly training frequency (WTF)	0.79	0.87
Average training duration (ATD) (min)	0.70	0.86
Average training duration per week (ATDW) (min)	0.73	0.92
Who most frequently prepares your meals?	1	0.92
Are you a vegetarian?	1	0.98
Are you momentarily on some kind of popular diet?	1	0.98
If YES, which one?	1	0.98
How many meals do you have a day? (including main meals and snacks)	0.71	0.63
How often do you eat breakfast?	0.83	0.63
How often do you eat fast food?	0.69	0.59
Are you satisfied with your body mass?	0.95	0.95
Do you want to decrease your body mass?	0.92	0.97
Do you want to increase your body mass?	0.95	0.97
Do you take into account the nutritional value of the food items you eat?	0.79	0.80
Do you take care to insure adequate water intake before, during and after training sessions?	0.83	0.81
Do you eat immediately before the training session? (less than half an hour)	0.78	0.74
If YES, what food do you eat most frequently?	0.56	0.56
Do you eat immediately after the training session? (less than half an hour)	0.73	0.74
If YES, what food do you eat most frequently?	0.60	0.86
Do you feel a lack of energy during the training session?	0.78	0.82
Do you think that you recover fast enough from demanding training sessions?	0.78	0.95
Do you put extra salt in your food?	0.83	0.88
Do you add oil, grease, butter, margarine, or other types of fat into your food?	0.81	0.73
Do you smoke cigarettes?	0.95	0.98
If YES, how many a day?	0.40	0.70
Overall	0.83	0.86

* Reproducibility coefficients for age, body height, body weight, BMI, BMR, WTF, ATD and ATDW are presented as Pearson correlation coefficients. Reproducibility coefficients for other variables are presented as proportions of agreement.

addition to FFQ, we developed a general questionnaire to assess qualitative dietary habits and diet-related parameters which cannot be assessed with standard FFQ questions. By means of pre-testing we identified ambiguous questions or incomplete lists of answers. The majority of students answered the questions with high certainty, although they were not able to find an appropriate answer to some of the questions in the general questionnaire. Students mainly complained on the available answers to the questions on the intake of food items before or after the training session. Therefore, we added additional items on the food lists in these questions. Only a few students

reported consumption of foods that were not included on the initial FFQ food list, and each of such food items was added to the final version of FFQ. Further, the time required to complete the questionnaire was also determined in the pre-testing phase. Subsequent review of the questionnaires completed during the pre-testing revealed that students who took more than 20 minutes to fill in the questionnaire did not skip, or answer inaccurately, any of the questions. Accuracy in completing the questionnaire was obviously a consequence of careful reading of the instructions, questions and explanations. The time needed to complete the questionnaire was 20–40 min-

TABLE 4
TEST-RETEST REPRODUCIBILITY OF FOOD FREQUENCY QUESTIONNAIRE FOR MALE STUDENTS (n=42)

Parameters	Test		Retest		Cohen's d	Pearson r
	\bar{x}	s	\bar{x}	s		
Water (g)	2928.6	760.1	2718.7	831.5	0.26	0.62
Energy (kcal)	2818.3	817.2	2614.7	952.3	0.23	0.69
Protein (g)	101.9	34.1	97.5	42.1	0.11	0.67
Fat (g)	107.4	38.1	100	50.3	0.17	0.61
Cholesterol (mg)	388.5	183.1	359.1	203.9	0.15	0.69
Carbohydrates (g)	344.9	104.8	315.2	109.1	0.28	0.63
Dietary fiber (g)	23.7	7	21.6	8.7	0.27	0.60
Alcohol (g)	13.9	19.3	13.4	17.5	0.03	0.95
Sodium (mg)	4210.5	1277	3864.3	1602.4	0.24	0.61
Potassium (mg)	4576.1	1512.3	4169.8	1599.8	0.26	0.58
Calcium (mg)	1375.5	541.6	1386.1	731	-0.02	0.60
Magnesium (mg)	453.5	150.6	444.2	247.7	0.05	0.79
Phosphorus (mg)	1856.4	565.1	1792.6	725.6	0.10	0.60
Iron (mg)	19.6	7.6	18.4	8.1	0.15	0.69
Zink (mg)	16.6	6.6	16.4	9	0.03	0.56
Copper (mg)	2.6	0.9	2.4	1	0.21	0.51
Vitamin A (μ g retinol activity equivalents)	850.5	340.7	771.5	420.8	0.21	0.67
Thiamine (mg)	2.2	1.4	2	1.3	0.15	0.91
Riboflavin (mg)	3	1.9	2.8	1.9	0.11	0.91
Niacin (mg)	24.3	11.5	22.8	12	0.13	0.78
Vitamin B ₆ (mg)	5.9	2.4	5.6	2.5	0.12	0.72
Vitamin C (mg)	232.3	150	199.1	119	0.25	0.57

utes, which is in accordance with the recommended time reported in other studies¹⁹. While developing the questionnaire, we were aware of the fact that respondents might get fatigued and less cooperative if the questionnaire consisted of more than 150 items⁹. Therefore, we included 104 items in our questionnaire, which is in accordance with the majority of previously developed questionnaires⁶. Most of the studies using FFQ asked about participants' dietary habits in the period of previous 1 year⁴. We considered this period too long for accurate food intake recall and unnecessary when assessing dietary habits of athletes. Consequently, we used the time frame of previous 3 months. Further, in the majority of previously developed FFQs, participants were asked to rate the consumption frequency on an ordinal scale⁴, while our participants were asked to report the exact consumption frequencies. FFQs using ordinal scale enable easier adaptation to scanners and greater scanning efficiency but when validated against food records, FFQs using exact frequencies show higher correlation coefficients for most nutrients²⁰. Further, previously developed FFQs differed in the way portion sizes were specified. According to Cade et al., in 42% of the FFQs, portion sizes were specified in the questionnaire, in 36% of the studies they were specified by participants themselves,

and in 22% of the studies there was no recording of portion sizes⁴. Validity and reproducibility of FFQs were slightly higher when portion sizes were determined by participants than when the portion size was specified in the questionnaire⁴. On the other hand, introduction of separate questions on portion sizes for each of the food items would increase the number of questions and prolong the time required to complete the questionnaire. In addition, the within-person variability in portion sizes for almost all foods is much greater than between-person variability²¹. Therefore, we used constant, i.e., predefined portion sizes as proposed in some other studies²².

Errors in estimating nutrient intakes and other dietary habits are inevitable despite well-planned and precise development of the questionnaire. As reasons why inaccurate answers are given, Kohlmeier lists problems with memory, concentration level of the respondents, understanding of the communication by the respondent, or understanding of the respondent by the interviewer²³. In order to estimate the proportion of random error in the results of the newly developed questionnaire, we assessed test-retest reproducibility. Although many studies assessed reproducibility of different FFQs, there is a lack of data on the reproducibility of questions in the general

TABLE 5
TEST-RETEST REPRODUCIBILITY OF FOOD FREQUENCY QUESTIONNAIRE FOR FEMALE STUDENTS (n=41)

Parameters	Test		Retest		Cohen's d	Pearson r
	$\bar{\chi}$	s	$\bar{\chi}$	s		
Water (g)	2843.2	798	2404.6	830.4	0.54	0.71
Energy (kcal)	1884.1	608.9	1619	585.8	0.44	0.67
Protein (g)	66.4	21.5	60.1	22.9	0.28	0.77
Fat (g)	67.2	26.6	57.5	23.6	0.39	0.63
Cholesterol (mg)	222.2	96.6	193.9	94	0.30	0.63
Carbohydrates (g)	249.5	84.7	213.3	77.8	0.45	0.67
Dietary fiber (g)	22.5	7.4	18.5	7.1	0.55	0.63
Alcohol (g)	6	16.3	4.1	5.7	0.16	0.30
Sodium (mg)	3215.1	1045.5	2761.5	1010.5	0.44	0.73
Potassium (mg)	3894.1	1352.7	3238.3	1250.5	0.50	0.68
Calcium (mg)	1079.4	414.4	982.8	507	0.21	0.78
Magnesium (mg)	387	113	337.3	134.1	0.40	0.55
Phosphorus (mg)	1297.7	413.7	1178.4	491.1	0.26	0.76
Iron (mg)	16.8	8.3	15.2	9.9	0.18	0.40
Zink (mg)	13.3	7.7	12.7	8.5	0.07	0.45
Copper (mg)	2.2	1	2.1	1.1	0.10	0.40
Vitamin A (μg retinol activity equivalents)	739.6	306.5	609.3	273	0.45	0.68
Thiamine (mg)	1.8	1.1	1.5	1.1	0.27	0.52
Riboflavin (mg)	2.3	1.5	2.1	1.4	0.14	0.52
Niacin (mg)	19	12.9	17.5	13.8	0.11	0.63
Vitamin B ₆ (mg)	5.6	2.3	4.9	2.6	0.29	0.56
Vitamin C (mg)	262	168.3	194.6	109.5	0.47	0.52

questionnaire. Yaroch et. al. evaluated reliability of a modified qualitative dietary fat index questionnaire in African American adolescent girls and determined overall test-retest (2 weeks interval) reproducibility of 0.57²⁴. Turconi et. al. developed a dietary questionnaire on food habits, eating behavior and nutrition knowledge of adolescents and determined test-retest (1 week interval) reproducibility between 0.78 and 0.88¹⁸. Compared with these results, overall reproducibility of our general questionnaire was high. The only exceptions for males were the following questions: »What do you most frequently eat immediately before the training session?«; »What do you most frequently eat immediately after the training session?«; and »How many cigarettes do you smoke a day?«, and for females: »What do you most frequently eat immediately before the training session?« and »How often do you eat fast-food?«. Lower reproducibility of these questions could be partly explained by inconsistencies in these habits among students. In comparison with our study, the question »How often do you eat fast-food?« in the study by Turconi et al. had somewhat lower reproducibility (0.69 for males and 0.59 for females vs. 0.84 for both genders)¹⁸. Likewise, in the study by Turconi et. al. the average reproducibility of the group of questions regarding general dietary habits (group of questions »Heal-

thy and unhealthy diet and food«) was somewhat higher than in our study (0.78 for both genders vs. 0.74 for males and 0.62 for females)¹⁸. Lower reproducibility of these questions in our FFQ could be a consequence of a longer time period between test and retest (1 month vs. 1 week) and more available answers per question (5 vs. 4)¹⁸. Reproducibility of the group of questions regarding physical activity was similar in both studies (0.80 for males and 0.91 for females vs. 0.88 for both genders in study of Turconi et. al.)¹⁸. Altogether, most questions in our general questionnaire had satisfactory reproducibility, but future surveys, when interpreting the data gathered by this questionnaire, should take into account lower reproducibility of certain questions. Results of test-retest for nutrient intakes estimated with FFQ were also satisfactory. Cade et al. reported that correlation coefficients between two administrations of FFQ were usually between 0.5 and 0.7⁴. Therefore, the range of reproducibility coefficients for nutrient intakes estimated with our FFQ could be considered acceptable for both male (0.51–0.95) and female students (0.30–0.78). Low reproducibility for alcohol intake in female students (0.30) is likely to be a consequence of their inconsistent consumption of alcoholic beverages. Consequently, alcohol intake could not be considered as a short-term dietary

habit among female students and its reproducibility should be assessed with a longer recall time frame and a longer time period between test and retest. Besides, in the sample of female students, low reproducibility was determined for iron (0.40), zinc (0.45) and copper (0.40) consumption. Relatively low reproducibility for iron consumption in female respondents was found in other studies as well^{25,26}. Slightly higher average reproducibility of nutrient intakes in male (0.68) than in female students (0.60) was expected because reliability coefficients tend to be higher in men than in women¹². Altogether, reproducibility of most nutrient intakes in our FFQ was moderate-to-high and, therefore, satisfactory. However, future surveys on female athletes should take into consideration lower reproducibility of alcohol, iron, zinc and copper consumption.

Positive values of Cohen's *d* for almost all nutrients in both samples indicate underreporting in the second administration of FFQ. This is not a worrying finding because it has been reported that higher energy and nutrient intakes and greater frequencies of consumption are found in the first than in the subsequent administrations²⁷. Such underreporting was expected because respondents' motivation decreases at the second administration when the interval between the administrations is only 4–6 weeks²⁸. Because body weight of most students remained unchanged during test-retest period, overall

level of underreporting in FFQ could be assessed by comparing the estimated energy intake with total energy expenditure. Energy intakes estimated with our FFQ were considerably lower than total energy expenditure for both genders. This is not a surprising result since numerous studies show that self-assessed energy intake is underestimated in comparison with energy expenditure²⁹. Therefore, absolute differences between estimated energy intake and total energy expenditure were not used in order to calibrate FFQ. Calibration of FFQ should be done based on results of validation against more comprehensive dietary assessment method. For this purpose, validity of our FFQ should be assessed in future studies.

In conclusion, the newly developed FFQ enables cost-effective assessment of nutrient intakes and other dietary habits in Croatian athletes and other physically active individuals, as well as demonstrates acceptable reproducibility.

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KONSTRUKCIJA I POUZDANOST UPITNIKA ZA PROCJENU PREHRAMBENIH NAVIKA TJELESNO AKTIVNIH OSOBA

S A Ž E T A K

Cilj ovog istraživanja bio je razviti sveobuhvatni upitnik frekvencija za procjenu nutritivnih unosa (FFQ) i pripadajući opći upitnik, prilagođene prehrambenim navikama sportaša i ostalih fizički aktivnih osoba u Hrvatskoj te utvrditi pouzdanost pitanja i procjena nutritivnih unosa. Istraživanje je uključilo 83 studenata Kineziološkog fakulteta Sveučilišta u Zagrebu (42 studenta i 41 studenticu). Upitnik je osmišljen na osnovi podataka iz literature i rezultata dobivenih probnim testiranjem i intervjuiranjem 15 ispitanika. Konačna verzija FFQ-a sastoji se od 74 pitanja o uobičajenoj učestalosti konzumiranja određenih prehrambenih namirnica i o uobičajenim načinima pripreme hrane. Konačna verzija općeg upitnika sastoji se od 30 pitanja o dobi, spolu, tjelesnoj visini, tjelesnoj masi, potrošnji energije, posebnim režimima prehrane, općim prehrambenim navikama, unosu hrane prije, za vrijeme i nakon treninga, i pušenju. Pouzdanost upitnika je utvrđena test-retest metodom s periodom od mjesec dana između prve i ponovne primjene upitnika. Pouzdanost kvantitativnih varijabli je izražena Pearsonovim koeficijentima korelacije, a kvalitativnih proporcijama istovjetnih odgovora. Kod studenata su utvrđeni Pearsonovi koeficijenti korelacije od 0,51 za bakar do 0,95 za alkohol, s prosječnim koeficijentom 0,68. Kod studentica su utvrđeni Pearsonovi koeficijenti korelacije od 0,30 za alkohol do 0,78 za kalcij, s prosječnim koeficijentom 0,60. Prosječna pouzdanost pitanja u općem upitniku iznosila je 0,83 za studente i 0,86 za studentice. Može se zaključiti da novo konstruirani upitnik omogućava procjenu prehrambenih navika kod hrvatskih sportaša i ostalih fizički aktivnih osoba uz prihvatljive troškove i zadovoljavajuću pouzdanost.