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The Effect of Nutrition Knowledge on Dietary Intake among Croatian University Students

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ABSTRACT

The aim of this study was to examine the relationship between nutrition knowledge and dietary intakes among university students. The students (264 males and 741 females) were asked to answer a validated General Nutrition Knowledge Questionnaire and to fulfil a Food Frequency Questionnaire. Gender, university status (freshmen, juniors, seniors) and eating arrangements (home, restaurants, self-cooking) were used as predictors of the relationship between nutrition knowledge and dietary intake. The findings indicated that women ($p=0.008$), senior students ($p<0.001$) and those who prepare food for themselves ($p=0.038$) have higher nutrition knowledge scores. The assessment of nutrition knowledge had parallels in dietary intake, and adherence to the dietary recommendations was significantly associated with nutrition knowledge scores ($p<0.001$). Regression analysis showed differences in daily intakes of grains ($p<0.001$), meat and beans group ($p<0.001$), vegetables ($p<0.001$), fruits ($p=0.002$) and oils ($p<0.001$) in relation to all predictors. However, nutrition knowledge acted as a modifier of the influence of eating arrangements. Logistic regression has shown that students with the highest nutrition knowledge are twelve times more likely to have a diet in accordance to recommendations compared to students with the lowest level of knowledge ([OR]=12.03, 95% [CI]=6.64–21.79, $p<0.001$). The results support the value of including nutrition knowledge in health education campaigns targeting the student population with the aim of improving their dietary intake.

Key words: *dietary intake, nutrition knowledge, university students*

Introduction

The importance of nutrition knowledge in shaping dietary patterns is often underestimated although a true assessment of knowledge is the basis for the further determination of nutrition-related behaviours. The place of nutrition knowledge is somewhere among the set of perceptions a person may hold about a food and the behaviours they might have in relation to that food[1]. Studies investigating the relationship between nutrition knowledge and eating habits or dietary intake reveal inconsistent results. Some researchers have shown that nutrition knowledge was highly and positively related to behaviour toward nutrition[2–4]. Other researchers, however, found little correlation between nutrition knowledge and healthy food choices[5–7]. The major explanation for these inconsistencies is the possibility that knowledge is being poorly assessed because of the limited efficacy of questionnaires and their lack of adequate validity and reliability[8]. However, as reviewed, in researches, which use sophisticated statistical techniques in order to investigate the association between knowledge and food intake, it was indicated that if knowledge is established with a very well constructed and validated questionnaire, it is an important factor in explaining variations in food choice of the adult population[1]. One of the questionnaires with these advantages, which were also used in our research, is the one developed by Parmenter and Wardle[8] and which has recently been used in several other studies[9–12]. This questionnaire differs from previous assessments of knowledge because it incorporates a broad range of nutrition concepts, including knowledge of dietary recommendations, healthy food choices, nutrient sources and some diet-disease relationships.

Starting university often represents the first time many young adults take the responsibility for choosing

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and preparing their meals, and their eating habits and dietary intake become particularly influential. The diet of the population of university students in different countries is often categorized as being unhealthy, low in fruit and vegetables with irregular patterns of daily meal consumption and a high frequency of fast food selection[13–16]. This is of special concern since dietary habits established in this period of life can have a considerable effect on the health of individuals in the long term[17]. Although some data are available on the daily food intake of Croatian university students[18], it is not known if they adopt new guidelines and to which extent are their everyday food choices related to their nutrition knowledge. Efforts should be made to identify factors which influence eating habits and healthy lifestyle practices among this population and to ensure wide and deep diffusion of new dietary guidelines and recommendations for healthy eating, making it possible to reach healthier dietary choices and to plan targeted educative interventions to bridge the gaps. Among the major factors which are shown to determine the food choices of university students are cost, convenience, taste, physical and social environment, gender, weight concern, attitudes and beliefs[19–21]. Another aspects possibly impacting on dietary intake yet to be explored are the impact of university status, and living and eating arrangements. In this context, it has been shown that once they start university, the diets of students living away from the family home change in a less healthy direction compared to those who still live with their families[22]. Additionally, some studies recently have examined the differences in dietary intake of students related to the year of study[23,24]. At this time, no study determines the combined effect of nutrition knowledge, eating arrangements and year of study on dietary intake of this population. In this study, to test the relationship between dietary intake and nutrition knowledge, the following predictors of student dietary intake have been chosen: eating arrangements (with the aim to investigate the influence of home, restaurants and self cooking) and university status (in order to distinguish freshmen, junior and senior students), in addition to gender-related differences.

In view of the above, the purpose of this manuscript was fourfold: 1) to characterise and quantify overall dietary intake and adherence to the recommendations among this population, 2) to estimate their level of nutrition knowledge and compare the differences in adherence to recommendations regarding the level of nutrition knowledge, 3) to establish the strength of association between nutrition knowledge and dietary intake, 4) to test the possibility of nutrition knowledge being an effect modifier in the relationship between gender, eating arrangements and dietary intake. We hypothesized that better nutrition knowledge would be associated with a daily diet more in adherence with recommendations, independently of previously mentioned factors that influence food choice. In other words, we assume that the association between gender, eating arrangements, year of study and dietary intake could be mediated with nutrition knowledge. We used sophisticated forms of statistical analysis, which covered not just the strength of association but also the size of effects (i.e. logistic regression). To the best of the authors' knowledge, no prior studies consider the interaction between nutrition knowledge, dietary intake and the previously mentioned predictors by using logistic regression among university students, so this research will add to the limited research data.

Materials and Methods

The target sample for this cross-sectional nutrition assessment study consisted of 1005 university students (264 males and 741 females, with a mean age of 21.7±2.3 years) randomly drawn from the University of Rijeka, Croatia, a medium-sized university with student representation from the entire country. We used a convenience sample because the goal was to enrol as many students as possible. Students were told that their participation was voluntary, but they were not informed about the specific objectives of the research, with a view to minimising bias. The instrument was administered during class time, and one of the researcher's was present at all times to answer questions and ensure the clarity of answers.

A three-part instrument was used, consisting of: demographic data, a test of general nutrition knowledge, and food intake data. Demographic data included gender, year of study and questions about living arrangements and the place where they consume their meals at least three times per week. According to the responses to that question, participants were divided into the following categories: live at home and eat meals prepared by home members (home), live away from home and eat at student restaurants (student restaurants), and live away from home and prepare daily meals by themselves (self-cooking). According to the year of study at the time of data collection, participants were divided into: freshmen, juniors and seniors.

Respondents of each gender were also asked to classify themselves as one of the types of physical activity levels as indicated in My Pyramid Food Guidance System[25], as this was necessary for counting personal daily recommendations. Nutrition knowledge was assessed using the General Nutrition Knowledge Questionnaire for Adults[8], which was adapted to become more suitable for Croatian students. The questionnaire was divided into four sections presented in the following order: expert recommendations regarding increasing and decreasing intake of different food groups; nutrient knowledge; food choice and the relationship between diet and disease. The raw data from each participant's responses were coded numerically and converted to a corrected score[8]. For the purpose of our study, the questionnaire was validated. Some changes in content validity due to translation misunderstandings were removed and changes were made to the phrasing of a number of questions after consultation with an expert panel of nutritionists and students. Reliability analysis was carried out to examine the

consistency of results using Cronbach's alpha=0.76. The minimum requirement of alpha coefficient of 0.7 or higher was considered acceptable[26]. Test-retest reliability was assessed with Pearson's correlation after administration of the questionnaire to the group of 90 students twice within a period of two weeks. Overall reliability was 0.91. The timeframe of two weeks was chosen because it has been recommended in psychometric literature as being the optimal time-period long enough for precise answers to be forgotten and short enough to minimise any real change in the measured attribute[26].

Estimations of food intake were assessed using the Quantified Food Frequency Questionnaire (FFQ), consisting of 97 different foods arranged by food groups. The participants were asked to report their usual frequency of consumption of particular foods over the past twelve months. The data obtained with FFQ were converted into number of servings for each of the food groups according to MyPyramid Food Guidance System using the Croatian tables of chemical composition of food and drinks[25,27,28]. The following groups were taken into account: grains, fruits, vegetables, milk and dairy products, meat and beans, and oils. In addition to total daily energy intake, extras were also expressed (energy that come from solid fats, added sugars and alcohol that are in some food and beverages)[25]. The MyPyramid Food Guidance System was chosen since it is a nutrition education tool which is a revision of the Food Guide Pyramid that was undertaken to meet new nutrition standards, account for changes in food consumption patterns, and improve consumer understanding of nutrition guidance. For each participant, daily recommendations on the basis of MyPyramid Food Guidance System were counted according to the self-reported data for gender, age, weight, height and level of physical activity. The adherence to the recommendations was expressed as a share of daily food intake obtained with FFQ in relation to counted individual recommendations. In order to assess the adherence to recommendations, we created binary outcome variables categorized as: 0-does not meet the guidelines, 1-meets the guidelines.

The study was performed as part of a national project (as stated in Acknowledgements), which is, in all its parts, in compliance with all international and local laws, regulations and directions concerning the protection of examinees.

Statistical analysis

Covariates considered as potentially confounding variables in our models included: gender, university status (freshmen, juniors, seniors), and eating arrangements (living at home, away from home with eating at student restaurants, away from home with self-cooking). One-way analysis of variance (ANOVA) followed by post-hoc Scheffé test was used in order to make comparison within each subgroup. We carried out stratified regression models to test the relationship between dietary intake and various predictors. The model was re-run with the aim to establish the effect of nutrition knowledge on this relationship. Logistic regression was carried out with the aim to indicate the increase in the odds ratio of eating according to recommendations for each increment of nutrition knowledge. In all tests, a p-value of <0.05 was considered as statistically significant. All statistical analysis were carried out using STATISTICA® version 7.1 software.

Results

Questionnaires were completed by 1005 students, of which 264 were male and 741 were female. The average age of study participants was 21.7±2.3 years. The characteristics of study sample and their daily food intake are shown in Table 1. Since we based our study on the assumption that gender, university status and eating arrangements affect food intake, all results are presented with regard to these parameters. Nine percent of participants were freshmen, 16.4% belonged to the group of juniors, and the majority (74.6%) were seniors. According to eating arrangements, almost half of the study participants regularly eat at student restaurants, while about one quarter live alone and regularly prepare their own food. In this »independent« group, almost three quarters were seniors. The assessment of the overall dietary intake of the selected population is one of the baselines, which needs to be established before focus is placed on the relationship between knowledge and dietary intake. From the results obtained, it could be seen that the overall dietary intake of 263 of the study participants (26.2% of total participants) adheres to the recommendations based on the My Pyramid Food Guidance System (Table 1). Men were more likely than women to adhere to all guidelines (28.8% *vs.* 25.2%, respectively). University status and eating arrangements were positively associated with adherence to guidelines, since the majority of participants, which adhere to recommendations, live and regularly eat at home with parents (34.2%). Those who had the best adherence to recommended daily intakes are men, senior students, and those who live and eat at parents' homes (Table 1). Regarding the intake of food groups (expressed in number of servings) proposed by My Pyramid Food Guidance System, it could be seen that daily intake of grains, meat and beans, fruit and vegetables, and total energy were significantly associated with gender and eating arrangements, while the consumption of fruits and vegetables were also dependent on university status. Total daily energy intake such as number of servings of all five food groups were the lowest in the group of students who live alone and prepare their own food. On the contrary, the students who regularly eat at student restaurants had the highest overall energy intake (Table 1).

In an attempt to gain greater appreciation of and insight into the impact of university status, eating arrangements and the role of nutrition knowledge on dietary intake, we have stratified participants based on their meeting the recommendations based on the My Pyramid Food Guidance System on those who either meet the recom-

TABLE 1
STUDY PARTICIPANTS' CHARACTERISTICS AND THEIR DAILY INTAKE OF FOOD GROUPS, EXTRAS AND TOTAL ENERGY

Characteristics	Total participants N (%)	Participants that adhere to recommendations N (%)	Servings of food groups						Extras (MJ)	Total energy intake (MJ)
			Grains	Milk and dairy	Meat and beans	Vegetables	Fruits	Oils		
			($\overline{X}$±SD)							
Gender										
Male	264 (26.3)	76 (28.8)	7.06±3.25	1.43±0.95	1.33±1.10	1.67±0.83	2.01±1.23	2.68±1.98	0.91±1.35	9.82±2.66
Female	741 (73.7)	187 (25.2)	6.2±2.67	1.54±0.99	1.04±0.85	1.81±1.00	2.21±1.28	2.74±2.14	0.59±0.79	11.02±3.82
p			<0.001*	0.099	<0.001*	0.043*	0.031*	0.716	<0.001*	<0.001*
University status										
Freshmen	90 (9.0)	24 (26.7)	6.40±2.33	1.54±0.98	1.06±0.75	1.63±0.71	1.96±1.00	2.59±1.47	0.64±0.80	10.32±2.70
Juniors	165 (16.4)	33 (20)	6.45±2.86	1.54±0.96	1.11±0.87	1.83±0.97	2.28±1.32	2.76±2.06	0.68±0.89	10.21±2.80
Seniors	750 (74.6)	206 (27.5)	6.32±3.08	1.37±1.04	1.21±1.24	1.65±0.99	1.80±1.10	2.61±2.51	0.67±1.37	9.69±4.10
p			0.857	0.118	0.373	0.033[c]	<0.001[c]	0.576	0.920	0.118
Eating arrangement										
Home	319 (31.7)	109 (34.2)	6.37±2.78	1.51±0.95	1.15±1.00	1.98±0.93	2.41±1.22	2.75±2.36	0.72±1.12	10.20±2.85
Student restaurants	434 (43.2)	90 (20.7)	6.83±2.90	1.55±0.95	1.21±1.01	1.80±0.97	2.16±1.38	2.84±1.96	0.69±0.91	10.51±3.44
Self-cooking	252 (25.1)	64 (25.4)	6.02±2.93	1.47±1.08	0.94±0.66	1.72±0.99	2.14±1.21	2.52±1.75	0.59±0.90	9.54±2.76
p			0.003[e]	0.619	0.002 [e,f]	0.008[e]	0.004[e]	0.193	0.284	<0.001[e,f]
Total study participants	1005 (100)	263 (26.2)	6.43±2.85	1.51±0.98	1.12±0.94	1.78±0.96	2.17±1.27	2.72±2.10	0.68±0.98	10.13±3.05

*p<0.05 based on ANOVA test for differences according to gender; differences according to university status: [a] – freshmen *vs.* juniors; [b] – freshmen *vs.* seniors; [c] – juniors *vs.* seniors; differences according to eating arrangements: [d] – home *vs.* students restaurants; [e] – home *vs.* self-cooking; [f] – students restaurants *vs.* self-cooking.

mendations or do not meet the recommendations, and the mean nutrition knowledge scores are summarized in Table 2. The results show that the average nutrition knowledge score was 64.66 (out of a possible 96). Nutrition knowledge score was in the range of 37–94. Generally, the study participants scored quite well in the section about diet-disease relationship. Well over 60% of respondents were aware of the link between fruit and vegetable intake and health problems. Notably, the nutrition knowledge scores followed a similar pattern to that of dietary intake. Significantly more knowledgeable were females (p<0.008) and senior students (p<0.001), while, according to eating arrangements, students who live alone and prepare their own food scored the best (p=0.038). Those participants, whose overall daily intake adheres to the recommendations, expressed significantly higher levels of nutrition knowledge compared to those whose intake was outside of recommendations (total score of 66.62 *vs. 6*2.67; p<0.001). Using the correlation coefficient as a simple test of association, we noted that nutrition knowledge was significantly positively correlated with intake of grains, vegetables, fruits, meat and dairy (coefficient of correlation was in a range of 0.19–0.21; p<0.010) while the correlation of nutrition knowledge with extras, oil and total energy was negative (coefficient of correlation was in a range of –0.20 to –0.31; p<0.010) (data not shown).

In order to obtain an answer to the question, whether students who were more knowledgeable had a daily intake that was more in accordance with the recommendations, study participants were divided into quartiles of nutrition knowledge, and the results obtained show that adherence to the recommendations regarding the daily number of servings of food groups increases as the level of nutrition knowledge increases (Table 3). Statistically were significant the differences in daily intakes of grains (p=0.003), meat and beans group (p=0.034), vegetables (p=0.040), fruits (p=0.009), and oils (p<0.001). The standard deviations for some food groups (i.e. meat and beans, and extras) are greater than the mean value, and this is attributed to the large variation of daily intake among this categories. Interestingly, negative trends through nutrition knowledge quartiles were observed in intake of extras, oils and total energy, since students with better knowledge continuously restricted the intake of this food as their level of nutrition knowledge increased (p<0.001).

Since gender, university status and eating arrangements were consistently related to all outcome variables (i.e. dietary intake and nutrition knowledge), these vari-

TABLE 2
STUDY PARTICIPANTS' NUTRITION KNOWLEDGE RELATED TO THEIR ADHERENCE TO RECOMMENDATIONS

Characteristics	Nutrition knowledge score ($\overline{X}$±SD)			p
	Participants that adhere to recommendations (N=263)	Participants that do not adhere to recommendations (N=742)	Total study participants (N=1005)	
Gender				
Male	61.54±7.41	62.31±8.00	62.09±7.83	0.471
Female	73.05±6.30	62.80±6.33	69.86±6.32	<0.001*
p	0.009*	0.394	0.008*	
University status				
Freshmen	61.29±4.12	59.27±6.28	59.81±5.83	0.147
Juniors	62.36±6.92	62.43±6.71	62.41±6.77	0.897
Seniors	65.18±6.01	65.36±6.43	65.33±6.33	0.889
p	0.046[c]	< 0.001[a,b,c]	< 0.001[a,b,c]	
Eating arrangement				
Home	61.12±6.77	62.09±6.54	61.09±6.59	0.239
Student restaurants	62.78±6.97	62.85±6.57	62.83±6.69	0.964
Self-cooking	63.21±6.10	63.31±7.06	63.28±6.28	0.817
p	0.043[f]	0.116	0.038[f]	
Total study participants	66.62±6.66	62.67±6.79	64.66±6.75	<0.001*

*p<0.05 based on ANOVA test for continuous variables; differences according to university status: [a] – freshmen *vs.* juniors; [b] – freshmen *vs.* seniors; [c] – juniors *vs.* seniors; differences according to eating arrangements: [d] – home *vs.* students restaurants; [e] – home *vs.* self – cooking; [f] – students restaurants *vs.* self-cooking.

TABLE 3
ADHERRENCE (PERCENT± SD) OF THE STUDY PARTICIPANTS' (N=1005) GROUPED ACCORDING TO NUTRITION KNOWLEDGE QUARTILES, TO RECOMMENDATIONS FOR DAILY INTAKE OF FOOD GROUPS, EXTRAS AND TOTAL ENERGY

Parameters	Nutrition knowledge quartiles				Total study participants (N=1005)	p
	I (N=259)	II (N=443)	III (N=281)	IV (N=22)		
	percent of recommended intake ($\overline{X}$±SD)					
Food groups						
Grains	63.10±23.96	69.86±29.22	75.57±33.52	79.70±35.78	75.65±33.58	0.003[a]
Milk and dairy	58.15±36.69	61.93±40.32	62.06±41.51	72.73±43.88	60.54±39.22	0.210
Meat and beans	38.76±30.06	47.40±42.66	46.55±35.17	36.36±17.06	44.70±37.41	0.034[a]
Vegetables	45.37±25.34	42.33±22.94	46.98±23.62	57.73±28.77	48.53±23.96	0.040[d]
Fruits	72.72±44.14	72.01±43.29	72.60±39.70	81.21±36.07	74.34±42.34	0.009[d]
Oils	48.80±40.72	43.44±35.31	40.21±32.10	34.93±17.55	42.44±33.54	<0.001[a,b]
Extras	52.49±63.65	51.87±70.30	44.79±70.83	19.86±12.85	49.52±68.03	0.090
Total energy intake	109.53±31.85	110.79±35.15	106.99±31.22	103.18±28.46	109.23±33.11	0.039[d]

p<0.05 based on ANOVA test for differences according to nutrition knowledge quartiles: a-I *vs.* II; b-I *vs.* III; c-I *vs.* IV; d-II *vs.* III; e-II *vs.* IV; f-III *vs.* IV.

ables were entered into a regression analysis with two models whose results are presented in Table 4. Model 1 presents a regression model that includes selected predictors, while in Model 2, the nutrition knowledge score, as an additional dependent variable, is included. In the Model 1, gender, university status and eating arrangements contribute significantly to the intake of grains (p<0.001), meat and beans (p<0.001), fruits (p=0.001), vegetables (p=0.014), extras (p<0.001) and total energy intake (p<0.001). This data clearly confirm our previous observation that selected predictors influence daily intake of these food groups (Table 1). When the nutrition

TABLE 4
REGRESSION ANALYSES OF DAILY FOOD INTAKE ON PARTICIPANTS' CHARACTERISTICS (MODEL 1) AND ON PARTICIPANTS' CHARACTERISTICS WITH INCLUDED NUTRITION KNOWLEDGE (MODEL 2)

	Daily food group intake												Extras (MJ)		Total energy intake (MJ)	
	Grains		Milk and dairy		Meat and beans		Vegetables		Fruits		Oils					
Model 1	β	p	β	p	β	p	β	p	β	p	β	p	β	p	β	p
Gender	–0.14	<0.001	0.04	0.208	–0.14	<0.001	0.11	<0.001	0.09	0.012	0.07	0.588	–0.14	<0.001	–0.16	<0.001
University status	–0.01	0.723	–0.06	0.049	0.06	0.068	0.001	0.969	–0.07	0.036	–0.001	0.675	0.003	0.922	–0.05	0.076
Eating arrangement	–0.10	0.001	–0.02	0.592	–0.10	0.002	0.06	0.048	0.08	0.006	–0.06	0.082	–0.04	0.268	–0.10	0.002
	Multiple R=0.17		Multiple R=0.78		Multiple R=0.18		Multiple R=0.11		Multiple R=0.12		Multiple R=0.05		Multiple R=0.15		Multiple R=0.21	
	R^2 adj=0.03		R^2 adj=0.003		R^2 adj=0.03		R^2 adj=0.01		R^2 adj=0.01		R^2 adj=0.0003		R^2 adj=0.02		R^2 adj=0.04	
	F(3.999) =10.48		F(3.999) =2.01		F(3.999) =11.47		F(3.999) =4.15		F(3.999) =5.25		F(3.999) =1.10		F(3.999) =7.29		F(3.999) =14.92	
	p<0.001		p=0.112		p<0.001		p=0.014		p=0.001		p=0.353		p<0.001		p<0.001	
Model 2	β	p	β	p	β	p	β	p	β	p	β	p	β	p	β	p
Nutrition knowledge	0.05	0.122	0.001	0.977	0.06	0.041	0.12	<0.001	0.06	0.036	0.14	<0.001	–0.01	0.861	–0.03	0.282
Gender	–0.13	<0.001	0.04	0.214	–0.14	<0.001	0.11	0.001	0.09	0.013	0.01	0.762	–0.14	<0.001	–0.16	<0.001
University status	–0.02	0.514	–0.06	0.049	0.04	0.176	0.01	0.887	–0.06	0.079	–0.03	0.356	0.004	0.886	–0.05	0.131
Eating arrangement	–0.10	0.001	–0.02	0.582	–0.10	0.002	0.06	0.582	0.06	0.063	–0.06	0.079	–0.04	0.262	–0.10	0.002
	Multiple R=0.18		Multiple R=0.08		Multiple R=0.19		Multiple R=0.13		Multiple R=0.13		Multiple R=0.15		Multiple R=0.15		Multiple R=0.21	
	R^2 adj=0.03		R^2 adj=0.002		R^2 adj=0.03		R^2 adj=0.01		R^2 adj=0.01		R^2 adj=0.02		R^2 adj=0.02		R^2 adj=0.04	
	F(4.998) =8.46		F(4.998) =1.51		F(4.998) =9.65		F(4.998) =4.37		F(4.998) =5.12		F(4.998) =5.43		F(4.998) =5.47		F(4.998) =11.49	
	p<0.001		p=0.204		p<0.001		p<0.001		p=0.002		p<0.001		p<0.001		p<0.001	

knowledge was included (Model 2), it was shown that nutrition knowledge has a significant influence on the daily intake of grains ($p<0.001$), meat and beans ($p<0.001$), fruits ($p=0.002$), vegetables ($p<0.001$) and oils ($p<0.001$). However, in this newly formed model, the effects of eating arrangements on daily food intake become insignificant, which led us to the conclusion that nutrition knowledge could partially mediate the influence eating arrangements have on dietary intake.

We conducted a logistic regression analysis aimed at identifying the variables which could be used as predictors of overall dietary intake in adherence to the guidelines that could be characterised as »healthy eating diet«. The logistic regression models of the association between gender, university status, eating arrangements and quartiles of nutrition knowledge were run, and the results are presented in Table 5. All results showed graded effects of all predictors and demonstrate that women, senior students and those students who eat at home had better adherence to the guidelines, which represent adequate intake. The importance of nutrition knowledge in this context is evident, since the group of students participating in our study those who are in the highest quartile of nutrition knowledge scores, are twelve times more likely to be eating in accordance to recommendations (Table 5).

Discussion

This study contributes to filling the gap in the current literature in understanding the effect of nutrition knowledge on dietary intake, and it provides us with an answer to the question of whether or not university students can translate their increased nutrition knowledge into a diet that is in accordance with current dietary guidelines. In aiming to assess whether nutrition knowledge could overcome the influence of other factors (i.e. gender, university status and eating arrangements) that affect daily food choices and dietary intake, we obtained very interesting results. They are of importance because, to date, only a paucity of literature exists that have examined the

TABLE 5
LOGISTIC REGRESSION ANALYSES RESULTS PREDICTING PARTICIPANTS´ HEALTHY EATING DIET (ACCORDING TO RECOMMENDATIONS)

Characteristic	Significance (p)	Odds ratio	95% confidence interval
Gender	<0.001		
Male		1.00	
Female		5.86	4.52–7.59
University status	0.001		
Freshmen		1.00	
Juniors		6.89	4.40–10.77
Seniors		15.65	10.34–23.66
Eating arrangement	<0.001		
Self-cooking		1.00	
Student restaurants		1.53	1.25–1.88
Home		2.80	2.72–2.89
Nutrition knowledge quartiles			
I	<0.001	1.00	
II	<0.001	1.60	1.48–1.74
III	<0.001	5.10	4.85–5.36
IV	<0.001	12.03	6.64–21.79

relationship between nutrition knowledge and the dietary intake of university students with no data we are aware of that have investigated the role of university status and eating arrangements on this relationship. Our main findings suggested that an association exists between nutrition knowledge and dietary intake, and this relationship is significantly dependent on the mentioned predictors. The assessment of nutrition knowledge has parallels in dietary behaviour, and it makes an important contribution to a diet in accordance to recommendations. Nutrition knowledge could act as an effective tool in modifying the influence of eating arrangements on dietary intake, which is of particular importance in university settings.

The university period is often related to changes in many aspects of the lives of young people and has been recognized as a »critical« period that dictates whether individuals will live healthy lifestyles including healthy eating in their subsequent adult years[29]. Generally, the recognized inadequate dietary intake among our sample with just 26% of participants whose daily diets adhere to current guidelines is disturbing. The overall daily energy intake, such as intake of oils, was higher in our sample compared to previously reported Croatian data from the study where food consumption was expressed on a weekly basis[30]. Similar inadequate dietary patterns have been observed among university students by other researchers in different countries[23,31–33]. The commonly found, inadequate daily intake of the recommended five servings of fruits and vegetables[32], which is quite similar to the behaviour among our study group, highlights the need of providing nutrition education to this group, in particular because it was in the example of fruit and vegetable intake in general population that a strong relationship between higher levels of nutrition knowledge and increased intake was detected[34]. Although it was previously demonstrated that people seem to be poor at spontaneously generating guidelines for healthy eating[35], when our students were asked about specific recommendations, they generally appeared to know whether they should be eating more or less of particular types of food (i.e. grains, fruits and vegetables). Among our students, it appears that in every case more food choice that are in accordance with recommendations are made by students with higher overall nutrition knowledge. The observed ranges of correlations between nutrition knowledge and diet were mostly as others have found[34,36]. Many people want to believe that nutrition knowledge is power, so if we educate people, they will eat better. Unfortunately, the matter is not so simple. Different types of knowledge about a food lead to different levels of consumption likelihood, and knowledge is best translated into consumption when it links food attribute-related knowledge with consequence-related knowledge[37]. Good results in responses to questions about the positive influences of consumption of certain types of food (i.e. fruits, vegetables and fibre-rich food) on lowering the risk of cancer or heart diseases, together with the ability students have shown in identifying certain foods, could be one of the pieces of evidence of their greater self-referencing due to the linkage of knowledge of food attributes and personal consequences, which could really lead students with greater knowledge to increase their consumption of this food.

The results of regression analysis in our study confirm that the intake of food which is mostly related to healthy eating (i.e. grains, fruits and vegetables), such as total daily energy intake, are significantly dependent on gender, university status and eating arrangements. For the specific food groups, statistically significant adherence to recommendations in more knowledgeable students is observed for grains, meat and beans, fruits and vegetables, and oils. This finding suggests that increased nutrition knowledge is associated with the greater consumption of these particularly important food groups. In this case, students can use their knowledge independently of other predictors of food choice to make their daily food intake healthier. The importance of nutrition knowledge in daily food intake is underlined by the results of logistic regression analysis, which confirm that students in the highest quartile of nutrition knowledge are twelve times more likely to have dietary intake in adherence to recommendations than students in the lowest quartile of nutrition knowledge.

It is important to understand the role that the university environment may play in the shaping dietary habits and to consider strategies that may encourage students to pursue healthy eating habits and ensure future health benefits. Relocating due to the studying and moving away from parents forces young people to take responsi-

bility for buying and preparing food, and consequently to be responsible for their own diets[38]. They are often incapable of meeting these demands, with the result being inadequate dietary intake. In Greece, it was shown that those students who moved away from home had changed their diet in less healthy direction compared to those who still live with parents[22]. This was one of the reasons for us to include eating and living arrangements as a predictor of overall dietary intake among our sample. This predictor has a broader range of importance for us, since it is also important in partially distinguishing participants according to their socio-economic status. Although this was not a major issue in our study, it is worth mentioning that a body of evidence has recently demonstrated a complex association between socio-economic factors and diet quality in dependence of nutrition knowledge among adults in different western countries[35,39-41]. It could be expected, although not necessarily a rule, that students who live alone and prepare their own food are more financially limited and are under a particular type of pressure to be more careful in spending money, which can result in spending less money for food. This could be just one of the explanations to our findings that this group of students consumed significantly less amounts of grains, fruits and vegetables, which are often related to the habit of spending more money on food[11]. This group also had lower total daily energy intake and significantly the lowest portion of participants whose diet adheres to current guidelines. Additionally, one could explain their dietary intake also with the lack of experience in planning meals, lack of time or lack of interest in food[42,43]. Surprisingly, this group is very knowledgeable compared to the groups that live at home or regularly eat at student restaurants, and this can lead us to the assumption that not the lack of interest but lack of money has shifted their priorities in spending money in a direction opposite from buying »healthy« food. On the other hand, students who regularly eat at student restaurants had the highest total daily energy intake compared to their counterparts. This group of students could buy food at very acceptable prices, since they have to pay just a small part of the real price of food, while the Ministry of Science, Education and Sport co-finances the remainder of the price. This affordable price contributes to the easier assess to food among these students versus the other two groups, encouraging them to buy and probably eat more foods than they really need. It has been shown that food making up many university restaurants meal plans contains more energy and fat than food prepared at home and also that the frequency of consuming restaurant food is positively associated with increased caloric intake among students[44,45]. Though speculative, our students who regularly eat at restaurants are under a certain risk of unhealthy eating, since several studies have suggested that eating in the kind »all-you-can-eat« situations that exist in many student restaurants is related to greater food intake[46]. Several factors probably conduce to produce such an effect, including enhanced availability and greater variability of food, increased portion size, financial incentive and positive social circumstances of eating, all of which have been shown in laboratory studies to affect and increase food intake, at least in the short term[47–49]. In this group the question remains as to the extent to which the spontaneous recognition of healthy food would be most influential in every day food choices. In this light, it is of particular importance to investigate if increased nutrition knowledge could make these students less susceptible to eating arrangements. The multiple regression analysis confirmed that dietary intake of grains, meat and beans, fruits and vegetables such as total energy intake, are significantly influenced by eating arrangements. But noteworthy is the fact that the influence of nutrition knowledge is quite important for this group of student, since our results obtained after including nutrition knowledge in model of regression analysis, have shown that knowledge could change the influence of eating arrangements towards insignificance influence. In other words, our results suggested that students with higher nutrition knowledge could apply their knowledge in food choice and thus become capable of making healthier food choices even in restrained eating arrangement like student restaurants.

The importance of the family environment in defining the relationship between nutrition knowledge and dietary intake is evident among our sample since it has been shown that the overall, most adequate intake of all food groups and the best adherence to the recommendations are expressed among student who live and regularly eat with parents. Our results obtained by logistic regression analysis, clearly confirm that those student who live with parents are almost three times more likely to have dietary intake in accordance to guidelines compared to their colleagues who live alone and prepare their own foods. However, it is the students still living with parents who have exhibited the lowest level of nutrition knowledge, and it could be concluded that they are altogether less interested in nutrition. In these families, other family members mostly perform food shopping and cooking, probably the mother, and this underlines the preserved influence of parents on their dietary intake.

The trend of increased adherence to the guidelines together with a linear relationship between nutrition knowledge and dietary intake was observed with prolonged studying. In our study sample, freshmen had, independently of other factors, a significantly lower intake of fruits and vegetables and higher total energy intake compared to their older colleagues. Vulnerability of freshmen to inadequate dietary intake and related consequences (i.e. weight gain) as a function of living accommodations is documented, since the freshman year represents a time when students acclimate themselves to the university's maze of eating choices, and it has been shown that the unfamiliarity of food that is consumed makes difficulties for them in regulating their food intake[50]. Consequently, during their junior and senior years, students have had time to become familiar with food choices and, therefore, regulate their energy intake. In addition to better adherence to the recommendations, older students also exhibited significantly better nutri-

tion knowledge. The reason for this could probably be that some students, during their years at the university, have succeeded in incorporating information that has been useful to them in answering the questionnaire. It could also be expected that as students grow older they are more willing to use different sources of information (i.e. newspapers, articles, leaflets etc.) to gain information and to implement it in their lifestyle. Surprisingly, although logistic regression has shown significant increase in prediction of overall diet in accordance with guidelines among senior students, the regression analysis models shows no significant influence of nutrition knowledge in the relationship between knowledge and intake of particular food groups relative to university status as a variable. It could be assumed that during their time at a university students do not just increase their knowledge but they also establish certain attitudes and beliefs which ultimately contribute in establishing healthy eating habits in a greater extent than nutrition knowledge in itself.

Our study sample was biased toward women, what is of importance because women are still considered to be the »gatekeepers« of the household food supply, and therefore are important in every food-related study. Women in our study consume more fruits and vegetables than men and tend to avoid fats and reduce energy intake in a greater amount. Similar gender specific differences in food choices were shown previously among students[9]. Women demonstrated superior knowledge in all areas of nutrition, as has been found in most studies looking at nutritional knowledge[35,51]. In our study, women in comparison with men, had five times greater probability of having a diet in accordance to recommendations, which was confirmed by their usage of higher nutrition knowledge in everyday food choices.

The strengths of this study are noteworthy. First, the questionnaire used differs from previous assessments of knowledge because it incorporates a broad range of nutrition concepts. Care was taken to check the psychometric criteria of validity and reliability of instrument in our settings. Second, the daily food intakes were investigated in the light of the newest dietary guidelines, and third, this study has the advantage of having a large enough sample, so that multivariate analysis could be used to establish whether selected predictors exerted independent effects. This study was not without limitations that included data collection in a single university. Data from multiply universities, representing greater student diversity, would be easier for generalisation. We are aware that we had selected participants with better nutrition knowledge than the general population, so it will be worth undertaking research with the general population using this questionnaire, since it is probable that our results over-estimate the level of nutrition knowledge of the Croatian population. One of the potential limitations of our study is that other factors such as price, taste and convenience, which could also influence dietary intake, were not considered. However, as suggested[35], these influences may to some degree be underpinned by knowledge, since knowledge is important even where other barriers and constraints are present. More research is needed to gain a clearer understanding of the interaction of nutrition knowledge and other factors influencing food intake in a university setting.

Conclusion

University students represent a readily accessible population in whom assessment and intervention are feasible and important for effecting positive changes in dietary behaviours. Our results show that a strong relationship exists between dietary intake and gender, year of study and eating arrangements. However, nutrition knowledge could partially mediate the influence of eating arrangements on particular food groups' intake. In a group of more knowledgeable students (women, seniors and those who prepare food for themselves) better adherence to dietary guidelines were observed. The importance of nutrition knowledge was pointed out with the fact that students in the highest quartile of nutrition knowledge were twelve times more likely to meet current recommendations compared to students in the lowest quartile of nutrition knowledge scores. Our results should be of interest to policy makers, nutrition professionals and educator's since it has been shown that educating the student population about nutrition could improve their dietary intakes.

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UTJECAJ ZNANJA O PREHRANI NA PREHRAMBENI UNOS HRVATSKIH STUDENATA

S A Ž E T A K

Cilj rada bio je istražiti vezu između znanja o prehrani i prehrambenog unosa među studentskom populacijom. Studenti (264 muškarca i 741 žena) su bili zamoljeni da ispune validirani Opći upitnik znanja o prehrani i da daju podatke o učestalosti konzumacije hrane i pića. Spol, godina studiranja (brucoši, niže, više godine) i mjesto gdje se obično hrane (kod roditelja, u studentskom restoranu, sami pripremaju hranu) su korišteni kao prediktori veze između znanja i prehrambenog unosa. Rezultati su pokazali da bolje znanje imaju žene ($p=0,008$), studenti viših godina ($p<0,001$) i oni koji sami pripremaju hranu ($p=0,038$). Znanje o prehrani je pokazivalo iste pravilnosti kao i prehrambeni unos, a utvrđena je također i značajna veza između znanja i usklađenosti prehrane sa preporukama ($p<0,001$). Regresijska analiza je pokazala razliku u dnevnom unosu žitarica ($p<0,001$), mesa i grahorica ($p<0,001$), povrća ($p<0,001$), voća ($p=0,002$) i ulja ($p<0,001$) u odnosu na ispitivane prediktore. Međutim, pokazano je da znanje može ublažiti utjecaj mjesta prehrane na prehrambeni unos. Logička regresija je pokazala da studenti sa najvećim znanjem imaju dvanaest puta veću vjerojatnost da će njihov svakodnevni unos hrane biti u skladu sa preporukama ([OR]=12,03, 95% [CI]= 6,64–21,79, $p<0,001$), u usporedbi sa studentima koji imaju najmanje znanje. Dobiveni rezultati potvrđuju važnost uključivanja znanja o prehrani u edukacijske programe namijenjene studentima, a sa ciljem poboljšanja njihovog prehrambenog unosa.