RELATIONSHIP BETWEEN NUTRITION KNOWLEDGE AND AEROBIC FITNESS IN YOUNG GYMNASTS

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Original article

Abstract
This study aimed to analyze the nutrition knowledge, nutritional status, body composition, nutrient intake and physical fitness of young gymnasts. The study used a cross-sectional design with 20 subjects comprising rhythmic and artistic gymnasts in Raden Inten, Jakarta. Nutritional status and body composition were measured using anthropometric measurements, macronutrient and micronutrient intakes were measured with 3x24-h food recall, physical fitness was measured using the bleep test (20m shuttle run), and nutrition knowledge was assessed using questionnaires consisting of 30 questions on macronutrients, micronutrients and water. The results indicated that the gymnasts (n=20, 13.7±2.1 y.o, 37.8±8.2 kg and 147.3±10 cm) generally had a fairly good nutrition knowledge score (73.2%); i.e. 10 people in the good nutrition-knowledge group and 10 people in the poor nutrition-knowledge group. The majority of the macronutrient and micronutrient intakes were below the nutritional requirements, in both the good and poor nutrition-knowledge groups. The nutrition knowledge scores were low for hydration-related knowledge (66%), while the scores for macronutrient and micronutrient knowledge were 73.8% and 84.2%, respectively. This study found that nutrition knowledge had a positive correlation with physical fitness ($p<0.05$). A sports nutrition-related education intervention is needed for those gymnasts that still have poor nutrition knowledge. Sports nutrition knowledge needs to be provided for athletes and coaches so that athletes' intakes meet their nutritional requirements in order to maximise their performance.

Keywords: *nutrition knowledge, nutrient intake, physical fitness, young gymnasts.*

INTRODUCTION

Gymnastics is a type of sport characterised by unique movement skills. It is a form of physical exercise involving the systematic arrangement of selected and planned movements to achieve certain goals. As a sport, it relates to motor components such as strength, speed, balance, flexibility and accuracy (Douda, Toubekis, Avloniti & Tokmakidis, 2008; Suchomel, Nimphius & Stone, 2016). A nutrient intake that meets the nutritional requirement is needed in order to maximise the motor components and improve performance. Sleep quality, body composition and food intake are all factors that affect fitness (Silva & Paiva, 2016).

The nutrient intakes of gymnasts often do not meet their nutritional requirements, and this will have a negative impact on their body condition. Calcium and vitamin D deficiencies will also lead to bone health problems among athletes (Lovell, 2008). Athletes' nutritional requirements are influenced by many factors, such as their nutrition knowledge. Adequate nutrition

knowledge will affect the ability to select good food for athletes. A previous study by Nikolaidis and Theodoropoulou (2014) demonstrated that good nutrition knowledge had an impact on the high levels of fitness and performance among soccer athletes in Australia.

From the results of research conducted by Silva and Paiva (2014) involving young gymnasts, most of them had macronutrient and micronutrient deficiencies that would have a negative effect on their growth and development. Thus, nutrition knowledge needs to be improved among both athletes and their coaches. The results of scientific reviews indicate that nutrition knowledge has a positive correlation with nutrient intake, although this correlation is still weak. Thus, it is necessary to conduct a follow-up study using more valid measurement tools in order to better describe these two variables (Desbrow & Mccormack, 2014; Naughton, Gifford, Michael, O'Connor & Heaney, 2016; Spronk, Kullen, Burdon & O'Connor, 2014).

Young gymnasts are a group at risk of micronutrient problems such as calcium, iron, folic acid, vitamin D and zinc deficiencies. Nutrition knowledge and nutrient intake arrangements that are appropriate to their requirements are needed to prevent these problems and help improve young gymnasts' immune systems and post-injury recovery (Dallas, Dallas, Simatos, & Simatos, 2017; Desbrow & Mccormack, 2014). Therefore, this study aimed to analyse the nutrition knowledge, nutritional status, body composition, nutrient intake and aerobic fitness of young gymnasts.

METHODS

This study used a cross-sectional design. The population in this study comprised 20 adolescent athlete gymnasts (5 male and 15 female) who trained at the Raden Inten Gymnastics Building in East Jakarta. The individuals in the research sample were rhythmic and artistic gymnasts aged 10–18 years that had participated in national and international championships. This study protocol was approved by the Ethics Committee of the Faculty of Health Sciences, Esa Unggul University (Number: 0014-19.595/DPKE-KEP/FINAL-EA/UEU/I/2019).

The anthropometric measurements performed consisted of height and weight measurements, while the percentage of body fat was determined using a body composition measurement. Height was measured using a microtoise (GEA SH-2A), while the WHO AnthroPlus standards were used to assess nutritional status. Weight and body fat percentage were measured using an Omron HBF-375.

The gymnasts' nutrient intakes were assessed using the 3x24-h food recall method taken for two days of training time and one day's rest. The macronutrient intakes included were carbohydrates, protein, fat and water, while the micronutrients were iron and calcium. Macronutrient and micronutrient intake were calculated by Indonesia Food Composition database.

The nutrition knowledge questionnaire was a modified questionnaire containing 30 questions on macronutrients, micronutrients and hydration. It comprised 13 macronutrient-related questions, 7 micronutrient-related questions and 10 hydration-related questions. The questionnaire was assessed for internal consistency and determined the level of nutrition knowledge of the young gymnasts. Nutrition knowledge was assessed as low if correct answers were given for less than 70% of the total questions, and high if correct answers were given for ≥70% of the total questions.

The aerobic fitness data were collected using the bleep test (20m shuttle run) in order to obtain the VO_2max scores (ml/kg/min). The VO_2max data (ml/kg/min) in this study were secondary data obtained from the strength and conditioning (SC) team at the Sports

Training Center for Students (STCS) and the Regional Training Center (RTC) in the Special Capital Region of Jakarta.

The data were analysed using Microsoft Excel 2010 and SPSS version 20. Univariate analysis was performed to obtain the distribution and proportion of the variables studied. This analysis was used to determine the association between the independent variables (i.e. nutrition knowledge, nutrient intake and body composition) and the dependent variable (fitness). The confidence interval used was 95%, and the association between the independent and dependent variables was significant if the p-value (Sig.) was ≤0.05. A p-value greater than 0.05 indicated there was no significant association between the independent and dependent variables.

RESULTS

A total of 20 subjects participated in this study, consisting of 8 rhythmic gymnasts and 12 artistic gymnasts. The main findings were that the young gymnasts had a good level of nutrition knowledge (74%). Overall, the artistic gymnasts had a higher level of nutrition knowledge than the rhythmic gymnasts. This study found that the gymnasts had a low level of hydration-related knowledge (66%). However, their levels of macronutrient and micronutrient knowledge were found to be relatively good (i.e. 73.8% and 84.2%, respectively). The nutrition knowledge categories can be seen in Table 1.

Based on the nutritional status data, most of the subjects had a normal nutritional status (-0.8±0.7 SD). The subjects' mean body fat percentage was 15.9±5.1%. The statistical analysis revealed no significant differences in nutritional status and body fat percentage between the two nutrition knowledge groups. Based on their nutrient intake, most of the gymnasts did not meet the adequate nutritional requirement in areas such as protein, fat, carbohydrates, iron and calcium. The nutritional status and nutrient intake data for each group are shown in Table 2.

Table 1

Nutrition knowledge categories.

No	Nutrition knowledge categories	All (n=20)	
		Mean (SD)	%
1	Macronutrient-related questions (13 points)	9.6 (0.3)	73.8
2	Micronutrient-related questions (7 points)	5.9 (0.2)	84.2
3	Hydration-related questions (10 points)	6.6 (0.2)	66.0
	Total	7.3 (0.2)	74.6

Table 3 shows the results of the correlation analysis between some of the variables and nutrition knowledge. The variables analysed were age, weight, height, body fat percentage, energy, protein, fat, carbohydrates, iron, calcium, water and VO_2max.

Table 2

Nutritional status, nutrient intakes and aerobic fitness by nutrition knowledge.

Variables	All (n=20)	Good NK (n=10)	Low NK (n=10)	p-value (between groups)
Nutritional Status				
Age (year)	13.7 ± 2.1	13.7 ± 2.1	12.8 ± 2	0.357
Weight (kg)	37.8 ± 8.2	38.4 ± 9.1	37.1 ± 7.5	0.722
Height (cm)	147.3 ± 10	149.1 ± 10.5	145.5 ± 9.8	0.445
BMI-for-age (SD)	-0.8 ± 0.7	-1.1 ± 0.7	-0.6 ± 0.8	0.132
Body fat (%)	15.9 ± 5.1	17.9 ± 3.0	13.9 ± 6.1	0.082
Nutrient Intakes				
Energy intake (kcal)	1613 ± 189.5	1695 ± 171	1531 ± 177	0.058
Protein (g)	57 ± 14.4	60 ± 7.5	53 ± 19	0.326
Fat (g)	65 ± 15.4	60 ± 16.2	69 ± 13.6	0.159
Carbohydrates (g)	195 ± 36.2	206 ± 32.8	184 ± 37.6	0.174
Fe (mg)	8.4 ±2.7	8.5 ± 2.3	8.2 ± 3.1	0.310
Calcium (mg)	1017.5 ± 175.5	1034.6 ± 201	1000 ±153.6	0.275
Water (ml)	1327 ± 252	1390 ± 148	1264 ± 321	0.278
Aerobic Fitness				
VO_2max (ml/kg/min)	42.1 ± 4.4	44.3 ± 1.9	40.0 ± 5.2	0.028*

Note: BMI-for-age = body mass index-for-age

∗ Nutrition knowledge determined by independent-samples t tests, $p < 0.05$

Table 3

Pearson's correlation of nutrition knowledge.

Variable	Pearson r
Age (year)	- 0.006
Weight (kg)	- 0.035
BMI-for-age (SD)	- 0.225
Body fat (%)	0.441
Energy intake (kcal)	- 0.488
Protein (g)	- 0.213
Fat (g)	- 0.353
Carbohydrates (g)	- 0.264
Fe (mg)	0.180
Calcium (mg)	-0.192
Water (ml)	0.287
VO2max (ml/kg/min)	0.512*

Note: BMI-for-age = body mass index-for-age

$*p<0.05$

DISCUSSION

As a whole, the gymnasts' level of nutrition knowledge was good (73.2%). Based on the nutrition knowledge levels, 25% of the rhythmic gymnasts and 35% of the artistic gymnasts had good nutrition knowledge. All of the rhythmic gymnasts were female but their nutrition knowledge was low, while female athletes are at risk if their nutritional requirements are not met. In a previous study, Spronk *et al*. (2014) found that the nutrition knowledge of female athletes was higher than that of male

athletes, and the correlation was statistically positive but weak. Based on its results, the study stressed the importance of increasing knowledge through education, especially among male athletes. Nutrition knowledge plays an important role in eating behaviour, and thereby it can be used as a method for improving performance (Holden, Forester, Smith, Keshock, & Williford, 2018; Trakman, Forsyth, Devlin, & Belski, 2016).

While body composition is one of the factors affecting an athlete's performance, body fat percentage is the main variable in young athletes. Muscle mass is one of the components of body composition and works to maximise movements during training and competition (Malina & Geithner, 2011). Body fat percentage is affected by growth, development, diet and exercise. The results of this study show that the mean body fat percentages for all athletes, the good nutrition-knowledge group and the poor nutrition-knowledge group were 15.9±5.1%,

17.9±3.0% and 13.9±6.1%, respectively. Compared to the standards, these body fat percentages fell within the normal cut-off (<20%) and were in the optimal category. The gymnasts had a normal body mass index (BMI), high muscle mass, low body fat percentage and better physical fitness. However, all the gymnasts were late for menarche (Ávila-Carvalho, Klentrou, Palomero, & Lebre, 2012).

The survey results from a previous study (Kolimechkov, Yanev, Kiuchukov, Petrov, Alexandrova, Zaykova & Stoimenov, 2019) indicated that protein intake was sufficient but carbohydrate intake needed to be increased, while fat intake from food was reduced due to excessive intake. However, based on the statistical analysis, there was no difference in energy intake among the Bulgarian gymnasts in the study. In the current study, the good nutrition-knowledge group had better energy intake (1695±171 kcal) than the poor nutrition-knowledge group (1531±177 kcal). The statistical analysis indicated that there was no significant difference ($p>0.05$) in energy intake among the gymnasts based on nutrition knowledge. Overall, the good nutrition-knowledge group had better energy intake, although both groups were below the recommended levels for gymnasts' energy requirements (Desbrow (McCormack, 2014). The results of a study on soccer athletes (Devlin, Leveritt, Kingsley, & Belski, 2017) showed that while nutrition knowledge was positively correlated with nutrient intake, the correlation was not consistent. Thus, an education intervention focusing on increasing sports nutrition knowledge in athletes is needed. In addition to this, the factors that can help increase their performance need to be studied. Another study (Hoogenboom, Morris, Morris, & Schaefer, 2009) indicated that swimmers had low levels of nutrition knowledge; therefore, they were not achieving a balanced diet, which results in macronutrient and micronutrient deficiencies. Therefore, athletes, whether adolescents or adults, should have good nutrition knowledge.

Vitamin D and calcium intakes play a very important role in bone density. The results of a study on gymnasts in Australia (Lovell G, 2008) indicated both vitamin D deficiency and low calcium intake. The current study also found a relatively low calcium intake. The mean iron intake of both groups was 8.4±2.7 mg, with neither group meeting the nutritional requirement. Previous research (M., O., & H., 2004) indicated that gymnasts were at risk of iron deficiency, one of the causal factors for which was exercise. The current study found higher levels of calcium and iron intake in the good nutrition-knowledge group, although these were still below the recommended nutritional requirements. The results of a previous study (Karabudak, Köksal, Ertaş, & Küçükerdönmez, 2016) showed that gymnasts in Turkey had not implemented a balanced diet and they therefore experienced nutrient

deficiencies. Thus, sports nutrition education is needed to maximise performance through a balanced diet.

While the gymnasts had good nutrition knowledge regarding macronutrients with a score of 84.2%, the scores for sports nutrition supplements for athletes were low. If this result is associated with the previous study (Marco Malaguti, Michele Scarpino, Cristina Angeloni, 2019), then the nutrition supplement knowledge of the soccer athletes was still low. Thus, education is also needed with regard to knowledge of the nutritional contents of sports supplements that are useful for improving performance.

Water is one of the important macronutrients required by the body. Dehydration of ≥2% has an impact in terms of decreased fitness and performance. From the results of this study, the gymnasts had a low nutrition knowledge score regarding hydration (66%). Based on the 24-h food recall, water intake was low in both groups with a mean of 1327±252 ml. Nutrition education is one of the methods that can be used to increase nutrition knowledge about hydration. The results of a previous study (Pamela, Gallagher, & Jacqueline M. McCormack, 2011) showed that most athletes with low nutrition knowledge about hydration experienced dehydration of less than 1%, resulting in decreased performance and cognitive function. Special nutrition education for athletes is thus needed in order to both enhance performance and prevent bad performance.

This study found a moderate correlation between the nutrition knowledge and aerobic fitness of the gymnast participants. Although the same result has been reported elsewhere (Nikolaidis & Theodoropoulou, 2014), it was also indicated by that study that good nutrition knowledge would contribute to the high fitness levels and performance of soccer athletes in Australia. It is possible to improve the nutrient intake and nutrition knowledge of athletes through sports nutrition education delivered by sports nutritionists (Valliant, Pittman, Wenzel, & Garner, 2012). As such, there is a need for optimal nutrition education to be provided by registered sports nutritionists.

The limitation of this study is that the nutrition knowledge questionnaire did not fully cover the nutrition knowledge of the gymnasts. Measurements of nutritional status such as muscle mass and biochemical indicators (e.g. hemoglobin and serum ferritin measurements) can also be undertaken to obtain optimal results. The results of this preliminary study may be used as a reference for sports nutrition education intervention, especially for gymnasts.

CONCLUSION

Most of the gymnasts in this study had good nutrition knowledge, although they had low scores with respect to the hydration-related questions. The study found a moderate positive correlation between the nutrition knowledge and aerobic fitness of the gymnasts. Good nutrition knowledge is required to ensure sufficient nutrient intake that meets the nutritional requirements and to achieve good nutritional status.

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