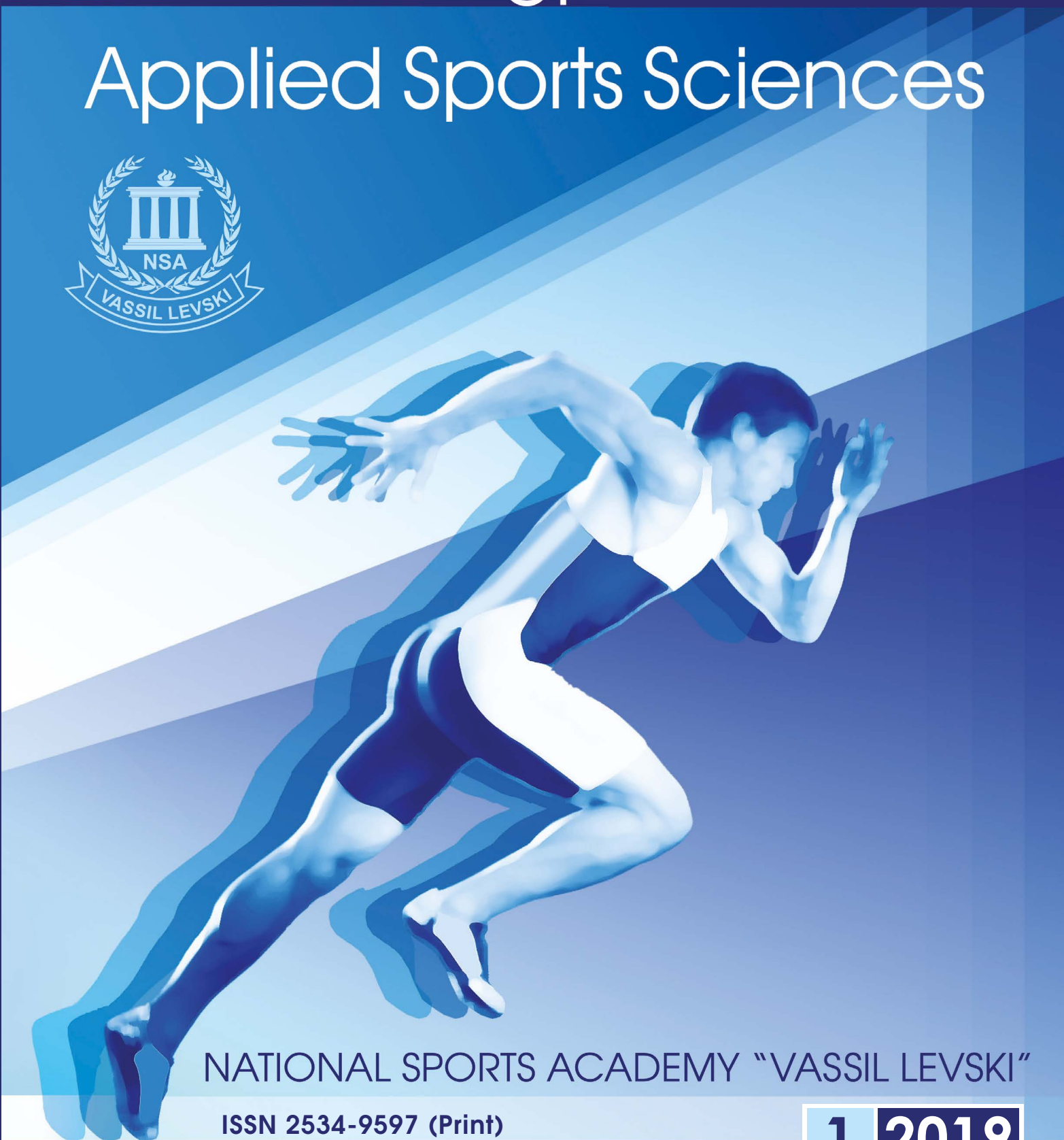
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NUTRITIONAL STATUS AND BODY COMPOSITION OF YOUNG ARTISTIC GYMNASTS FROM BULGARIA

Stefan Kolimechkov, Iliya Yanev, Iliya Kiuchukov, Lubomir Petrov, Albena Alexandrova, Dilyana Zaykova, Emil Stoimenov
National Sports Academy „Vassil Levski", Sofia, Bulgaria

ABSTRACT

Young gymnasts should not have excessive body mass because that might lead to under-performance. Therefore, children practising gymnastics should consume a balanced diet, which will promote their physical abilities and optimal body mass. The aim of this study was to compare the nutrient intake of young Bulgarian artistic gymnasts to matched groups from the National Nutrition Survey in Bulgaria (NNSB2003). The study consisted of 76 artistic gymnasts (5 to 14 years of age) from four cities in Bulgaria, and the participants were divided into three groups in accordance with the age and gender categories applied in the NNSB2003. Anthropometric measurements were taken and a food frequency questionnaire was applied in order to assess the body composition and nutrient intake of the gymnasts. The percentile scores in the height and %Fat of the gymnasts were significantly lower than the 50th percentile of the international norms. The energy intake of the gymnasts did not differ significantly from those reported in the NNSB2003, whilst the protein intake, relative protein intake, and energy contribution of proteins were significantly higher than those in the same survey. The energy contribution of fats was above the recommended norms (15-30%), as provided by the WHO. The fat intake was slightly higher, and the carbohydrate intake was slightly lower than the recommended values in the literature, and, therefore, the former should be reduced and the latter increased in their food.

Key words: *nutrition, diet, body composition, artistic gymnastics*

INTRODUCTION

It is of particular importance to all athletes, young and old, to pay special attention to nutrition in order to achieve good results in sport (Nisevich, 2008). A good and balanced diet can support consistent intensive training, while reducing the risk of injuries. Furthermore, good food choices will also promote muscle adaptations in response to the training workload. (International Olympic Committee, 2012). The recommended nutrient intake in children and adolescents who are engaged in sports is different from those of non-athletes due to the additional physical exercise.

Artistic gymnastics is a strength sport which can be practised from an early age. It is recommended that young gymnasts should not have excessive body mass because that might lead to under-performance. Moreover, overweight can decrease the technique of the gymnasts and expose them to an increased risk of injuries due to the excess load on the body structure. (British Gymnastics, 2005). Therefore, children practising gymnastics should consume a balanced amount of proteins, carbohydrates and fats, which will help sustain and promote their physical abilities, as well as their optimal body mass.

Young athletes need a higher protein content than that recommended for non-athletes, but the studies conducted on children engaged in sports are scarce (Petrie et al., 2004). More-

over, the reported data on protein intake in child athletes differ in the scientific literature. For instance, Cupisti et al. reported that the relative protein intake (RPI) of adolescents engaged in sports and a control group not similarly engaged is comparable (1.09 g/kg vs 1.13 g/kg, $p > 0.05$) (Cupisti et al., 2002). Other authors recommend RPI of 1.0 – 1.5 g/kg for children who have just begun a training programme, and 1.2 - 1.4 g/kg for children who practise sports (Nevin-Folino, 2003, Nisevich, 2008). Dallas et al. recommend ≥ 1.5 g/kg RPI for competitive female gymnasts (Dallas et al., 2017). However, other studies reported a higher amount of RPI, such as 1.6 g/kg for children practising gymnastics (O'Connor, 2000), and 2-3 g/kg for young competitive gymnasts (Benardot et al., 1989). In our pilot study on nutrition of children engaged in gymnastics, the RPI was 3.2 g/kg for those who were between the ages of 4 and 6, and 2.9 g/kg for those between the ages of 7 and 10 (Kolimechkov et al., 2016).

Studies on the nutrition of gymnasts (Benardot et al., 1989, Ersoy, 1991, Reggiani et al., 1989, Lindholm et al., 1995, Moffatt, 1984, Kirchner et al., 1995) showed that the energy contribution which comes from protein is either at the upper limit of the 10-15% recommended by the WHO, or above it (Karabudak et al., 2016, Kolimechkov et al., 2016, Benardot, 1996).

The American Dietetic Association (ADA) recommends the following relative carbohydrate intake (RCI) for young athletes: 3-5 g/kg for very light intensity training; 5-8 g/kg for moderate or heavy training; 8-9 g/kg for pre-event loading (24-48 hours prior to the competition); 1.7 g/kg for post-event refuelling, within 2-3 hours (Nevin-Folino, 2003, Nisevich, 2008). Carbohydrate food with a high glycaemic index should be consumed immediately following completion of training for best energy restoration results (British Gymnastics, 2005). Due to its importance as an energy supplier, carbohydrates should provide at least 50% of the energy intake in child athletes. For intensive training, the energy contribution from carbohydrates should increase to 65-70% (Petrie et al., 2004). However, many studies on the nutrient intake of gymnasts (Filaire and Lac, 2002, Reggiani et al., 1989, Benardot et al., 1989, Moffatt, 1984) reported that these athletes receive less than the recommended 55-75% energy intake from carbohydrates (WHO, 2003).

The following relative fat intake (RFI) of gymnasts is reported in the literature: 2.1 ± 0.8 g/kg for 7-15-year-old gymnasts with energy contribution of 36.5 ± 6.3% from the daily energy intake (Karabudak et al., 2016); 2.7 ± 0.9 g/kg for 6-10-year-old gymnasts with energy contribution of 34.4 ± 4.5% (Kolimechkov et al., 2016); and fat intake of 72.0 ± 25.0 g for 13-16-year-old gymnasts with energy contribution of 32.0 ± 4.0% (Lindholm et al., 1995). Other authors (Filaire and Lac, 2002, Reggiani et al., 1989, Benardot et al., 1989, Calabrese, 1985) also report that gymnasts consume above the recommended 15-30% (WHO, 2003) of energy deriving from fat.

The aim of this study was to compare the energy and nutrient intakes of young Bulgarian artistic gymnasts to age- and gender-matched groups from the National Nutrition Survey for school children in Bulgaria, NNSB2003 (Petrova et al., 2003).

METHODOLOGY

Participants

The study consisted of 76 artistic gymnasts (43 girls and 33 boys) between the ages of five and fourteen, from four different cities in Bulgaria (Sofia, Blagoevgrad, Veliko Tarnovo and Ruse). The participants had on average 3.8 years of sports experience in artistic

gymnastics (ranging from 1 to 10 years), and they regularly took part in, or were preparing for, competitions representing five gymnastic clubs which are registered with the Bulgarian Gymnastics Federation.

The participants were divided into three groups: Group-A (boys and girls from 5 to 9), Group-B (girls from 10 to 14), and Group-C (boys from 10 to 14), in accordance with the age and gender categories applied in the National Nutrition Survey for school children in Bulgaria, NNSB2003 (Petrova et al., 2003).

Institutional ethics approval for this research was granted by the National Sports Academy in Sofia, and informed consent was obtained from the parents of each gymnast.

Body composition

The height of the gymnasts was recorded to the nearest 0.1 cm using a height measure, body mass was recorded to within an accuracy of 0.1 kg by using the Omron BF511 electronic scale, and waist circumference was measured to the nearest 0.1 cm with the Lufkin W606PM tape measure. The anthropometric procedures for those measurements were followed thoroughly (Piwoz and Viteri, 1985, NHNES, 2007). Body mass index (BMI = body weight in kg/height in metres squared) and waist-to-height ratio (WHtR= waist circumference in cm/height in cm) were calculated, and the recommended cut-off of WHtR = 0.500 was used to assess increased health risk in children relating to an excessive accumulation of body fat on the upper body (Ashwell and Hsieh, 2005, McCarthy and Ashwell, 2006). Moreover, the WHO AnthroPlus specialised software based on the international norms in children (WHO, 2011), as well as on the most recent Bulgarian norms as provided by the "Physical Development of Children and Youths in Bulgaria" study, PDCYB (Nacheva et al., 2012), were applied in order to calculate the percentile scores for height, weight and BMI of each gymnast. The following classification for the BMI percentile scores (PRs) in children and adolescents was applied: 'overweight' (BMI > 85th PRs); 'obese' (BMI > 97th PRs); 'thinness' (BMI < 15th PRs); and 'severe thinness' (BMI < 3rd PRs), (WHO, 2007a).

In order to appropriately assess the body composition of gymnasts, body fat percentage (%Fat) was also calculated. Two skinfolds (triceps and subscapular) were measured to an accuracy of 1 mm with the Lange Skinfold Calliper, Beta Technology Inc, Cambridge, USA, and the %Fat was determined by the sum of the two skinfolds, using Slaughter's equations (Slaughter et al., 1988, Heyward and Stolarczyk, 1996). This method is highly recommended in literature to assess body composition in children and adolescents because of its accuracy and simplicity (Boye et al., 2002, ALPHA, 2009, Laurson et al., 2011). In addition, the percentile scores of %Fat were also calculated by using the international norms for Caucasian children and adolescents (McCarthy et al., 2006). The %Fat was classified by the following cut-offs: 'overweight' (%Fat > 85th PRs;); 'obese' (%Fat > 95th); and 'underfat' (%Fat < 2nd PRs), (McCarthy et al., 2006).

Nutritional assessment

The food frequency questionnaire (FFQ), which had been used for children practising gymnastics (Kolimechkov et al., 2016), was applied in this study in order to assess the nutrient intake of the artistic gymnasts.

The FFQ consists of 30 questions relating to the weekly consumption of different types of food and questions about the physical activity, height and weight of children. In addition to that, tables for measuring the frequency of fruit and vegetable consumption were also added. The frequency tables included a total of 22 common fruits and 24 common vegetables with five possible answers for each fruit and vegetable (never, rarely, sometimes, often,

and always). The FFQs were completed by the children's parents, which is a common practice when assessing nutrition in children and elderly people (Gibson, 1990).

Based on the results, the daily intake of proteins, carbohydrates and fats, relative protein intake per kg body mass (RPI), relative carbohydrate intake (RCI), relative fat intake (RFI), and the energy contribution of each nutrient (E%), in addition to the total daily energy intake (kcal/24h) and relative energy intake (REN) were calculated. Moreover, the percent of protein and fat which comes from animal sources (animal protein% and animal fat%) was also calculated.

The basal metabolic rate (BMR kcal/24h) was calculated by using the equations of Harris-Benedict (Harris and Benedict, 1919), which are commonly applied in research (Blinman and Cook, 2011).

The estimated daily energy needs (kcal/24h) were derived by employing the following formula (BMR kcal/24h x (1.2 + 0.08 x number of sessions)), (Harris and Benedict, 1919). The two lessons of physical education (2 x 45 min) at school were considered as 1 sports session.

Statistical Analysis

The statistical analyses were conducted with SPSS Statistics 19 software, using descriptive statistics and One-way ANOVA with the Bonferroni *post hoc* test. Statistically significant differences between the average values were evaluated at $p < 0.05$, and the data in the text and the tables are presented as mean ± SD, and in the figures are presented as mean ± SE. In addition, one sample t-test and Cohen's effect size (d) of the percentile scores for the anthropometric parameters vs their 50th percentile were calculated in order to present the magnitude of the effects. Pared samples t-test was used in order to compare the PRs scores of height, weight and BMI as calculated by the WHO norms vs the Bulgarian norms. Two sample t-test and Cohen's effect size of the nutrients and energy intake vs the data from the NNSB2003 were also calculated. The following classification of the effect size was applied: d (0.01) = very small, d (0.20) = small, d (0.50) = medium, d (0.80) = large, d (1.20) = very large, and d (2.00) = huge (Sawilowsky, 2009, Cohen, 1988).

RESULTS

The anthropometric parameters, their percentile scores and their effect size vs the 50th percentiles (PRs) of the three groups are presented in Table 1. As expected, Group-A (5-9 years) has the smallest average sports experience (2.5 years). The average frequency of the gymnastics training ranged from 3 to 6 sessions per week and was significantly lower in the youngest group (5-9 years). The height-for-age percentile scores in all groups were significantly lower than the 50th percentile of both international norms (WHO, 2006) and Bulgarian norms (Nacheva et al., 2012) for children and adolescents at this age (Table 1). The average weight PRs of the gymnasts did not differ from the average international standards in Group-A, but it was significantly lower than the Bulgarian norms in Group-A and Group-C. However, it should be taken into account that the World Health Organization (WHO) does not provide weight-for-age reference data for children over 10 years of age, because this indicator cannot distinguish between height and body mass at an age when many children are experiencing the pubertal growth spurt (WHO, 2007b). The percentile scores of the body mass index (BMI) for all three groups did not differ significantly from the 50th PRs of the WHO and the Bulgarian norms, except for Group-A, and the average waist-to-height ratio was below the boundary of 0.500, which distinguishes children at risk

as far as their health is concerned (Ashwell and Hsieh, 2005, McCarthy and Ashwell, 2006). The absolute value of %Fat is significantly lower in the male group (Group-C) in comparison with the female group (Group-B). Overall, the %Fat percentile scores in all

Table 1. *Anthropometric parameters, their percentile scores as provided by the international norms (WHO, 2011), and the Bulgarian norms (Nacheva et al., 2012), in addition to their effect size vs the 50th percentile (PRs) of the artistic gymnasts (mean ± SD).*

	5-9 years (n=45) Group-A	**10-14 years Female** (n=18) Group-B	**10-14 years Male** (n=13) Group-C
Age (years)	7.93 ± 1.26 BC	12.01 ± 1.56	12.22 ± 1.60
Sports experience (months)	30.22 ± 18.57 BC	63.42 ± 38.74	71.69 ± 25.95
Sessions per week	4.17 ± 1.16 ^{b}C	5.22 ± 1.06	5.54 ± 0.78
Height (cm)	122.96 ± 8.79 BC	146.96 ± 10.15	146.38 ± 9.43
Height WHO percentile score	32.49 ± 29.54	36.35 ± 26.66	29.50 ± 21.86
Effect size vs 50th PRs	0.59 D	0.51 d	0.94 ^{d}
Height BG percentile score	23.31 ± 26.58 W	33.87 ± 25.13	24.52 ± 19.42 w
Effect size vs 50th PRs	1.00 D	0.64 d	1.31 D
Weight (kg)	25.09 ± 5.21 BC	40.03 ± 9.62	38.90 ± 8.06
Weight WHO percentile score	43.56 ± 27.51	-*	-*
Effect size vs 50th PRs	NS		
Weight BG percentile score	35.35 ± 26.66 W	43.03 ± 25.67	37.26 ± 15.83
Effect size vs 50th PRs	0.55 D	NS	0.80 d
BMI (kg/cm^2)	16.43 ± 1.82	18.26 ± 2.24	17.97 ± 1.65
BMI WHO percentile score	57.50 ± 25.88	50.67 ± 23.09	51.05 ± 22.18
Effect size vs 50th PRs	NS	NS	NS
BMI BG percentile score	59.85 ± 23.26 w	59.61 ± 23.91 W	56.16 ± 19.53
Effect size vs 50th PRs	0.42 ^{d}	NS	NS
Waist-to-height ratio	0.44 ± 0.04 ^{b}	0.41 ± 0.03	0.43 ± 0.02
% Fat	15.30 ± 3.97	16.77 ± 3.93 c	12.63 ± 2.48
% Fat percentile score	16.00 ± 22.71	12.31 ± 13.67	9.92 ± 15.76
Effect size vs 50th PRs	1.50 D	2.76 D	2.54 D

* *WHO does not provide weight-for-age reference data for children older than 10 years of age (WHO, 2007b).*

^{b} *– p < 0.01 vs Group-B; B – p < 0.001 vs Group-B;*

c – p < 0.05 vs Group-C; C – p < 0.001 vs Group-C;

d – p < 0.05 vs 50th PRs; ^{d} *– p < 0.01 vs 50th PRs; D – p < 0.001 vs 50th PRs;*

w – p < 0.05 vs WHO PRs norms; W – p < 0.001 vs WHO PRs norms;

NS – not significant

Table 2. *Daily intake of macronutrients and energy contribution of each nutrient (E%) of the gymnasts' diet (mean ± SD), in addition to their effect size vs the data from the National Nutrition Survey in Bulgaria (NNSB2003).*

	5-9 years (n=45) Group-A	**10-14 years Female** (n=18) Group-B	**10-14 years Male** (n=13) Group-C
Energy needs (kcal/24h)	1865.16 ± 258.72 BC	2405.11 ± 274.59	2500.92 ± 348.44
Relative energy needs (REN) (kcal/kg/24h)	75.53 ± 9.17 B[c]	62.31 ± 10.14	65.11 ± 5.18
Energy intake (kcal/24h)	1950.80 ± 460.17	2181.45 ± 595.12	2301.00 ± 640.96
Effect size	NS	NS	NS
Relative energy intake (REI) (kcal/kg/24h)	79.72 ± 21.57 B[c]	56.23 ± 15.78	59.60 ± 12.52
Energy needs/Energy intake	1.06 ± 0.28	0.91 ± 0.25	0.92 ± 0.20
Protein (g/24h)	77.72 ± 16.19	84.86 ± 21.37	88.29 ± 28.27
Effect size	1.10 D	1.05 D	0.77 [d]
Relative protein intake (RPI) (g/kg/24h)	3.20 ± 0.87 B[c]	2.19 ± 0.58	2.28 ± 0.56
Effect size	1.45 D	1.13 D	0.97 D
Protein-E%	16.60 ± 1.80	16.11 ± 2.00	15.69 ± 2.14
Effect size	2.06 D	1.78 D	1.66 D
Fat (g/24h)	69.13 ± 16.63	77.55 ± 25.89	77.30 ± 21.90
Effect size	NS	NS	NS
Relative fat intake (RFI) (g/kg/24h)	2.83 ± 0.79	2.01 ± 0.73	2.00 ± 0.44
Fat-E%	33.11 ± 5.34	32.72 ± 6.32	31.15 ± 4.60
Effect size	0.37 d	NS	NS
Carbohydrates (g/24h)	243.58 ± 74.44	275.08 ± 91.14	300.74 ± 94.61
Effect size	NS	NS	NS
Relative carbohydrates intake (RCI), (g/kg/24h)	9.92 ± 3.26 [b]	7.07 ± 2.34	7.81 ± 2.04
Carbohydrates-E%	50.40 ± 6.01	51.06 ± 7.26	53.15 ± 6.12
Effect size	NS	NS	NS
Animal Protein (%)	53.13 ± 8.49	52.28 ± 10.68	50.69 ± 11.68
Effect size	0.78 D	0.70 [d]	0.68 d
Animal Fat (%)	64.44 ± 10.81	66.56 ± 14.55	62.38 ± 16.30

[b] – $p < 0.01$ vs Group-B; B – $p < 0.001$ vs Group-B;
[c] – $p < 0.01$ vs Group-C; C – $p < 0.001$ vs Group-C;
d – $p < 0.05$ vs NNSB2003; [d] – $p < 0.01$ vs NNSB2003; D – $p < 0.001$ vs NNSB2003;
NS – not significant

groups were substantially lower than the 50th percentile of the international norms for children and adolescents (McCarthy et al., 2006), and Cohen's effect size was very large (d = 1.50) for Group-A, and huge for Group-B and Group-C (d = 2.76 and d = 2.54, respectively), in accordance with the benchmarks provided by Cohen and Sawilowsky (Sawilowsky, 2009, Lakens, 2013).

The data from the nutritional survey for all three groups are presented in Table 2. The average REN and REI values in Group-A were significantly higher than those in the other two groups. The daily energy intake in all groups did not differ from those reported in the National Nutrition Survey, 2003, in Bulgarian school children (NNSB2003), (Table 3). However, the protein intake, RPI, and the energy contribution of proteins were significantly higher in the artistic gymnasts in comparison with those published in the NNSB2003 for children and adolescents of the same gender and at the same age. The effect size of these differences according to Sawilowsky and Cohen (Sawilowsky, 2009, Cohen, 1988) varied from 0.77 (large) to 2.06 (huge). In addition to that, Group-A had a significantly higher RPI of approximately 1 g/kg/24h, compared to Group-B and Group-C.

The fat and carbohydrate intake, as well as the energy contribution from those macronutrients, did not differ from those of the NNSB2003, except in the Fat-E%, which was higher in Group-A, where there was a small effect size (d = 0.37). The protein and fat which come from animal sources did not show any significant differences between the three groups. However, the protein which comes from animal sources was significantly higher than the NNSB2003 data, with medium effect size (d = 0.78 for Group-A, d = 0.70 for Group-B and d = 0.68 for Group-C).

Table 3. *Daily intake of macronutrients and % of energy (E%) in school children from the National Nutrition Survey in Bulgaria, NNSB2003 (Petrova et al., 2003) (mean ± SD)*

	7-9 years Female and Male (n=888)	**10-14 years Female (n=853)**	**10-14 years Male (n=861)**
Energy (kcal/24h)	1853 ± 713.0	2056 ± 792.0	2313 ± 915.0
Protein (g/24h)	53.4 ± 22.3	59.1 ± 24.6	67.1 ± 27.5
Relative protein intake (g/kg/24h)	1.9 ± 0.9	1.4 ± 0.7	1.6 ± 0.7
Protein (E %)	11.5 ± 2.5	11.5 ± 2.6	11.7 ± 2.4
Fat (g/24h)	76.7 ± 38.4	85.2 ± 42.9	93.0 ± 47.7
Fat (E %)	36.3 ± 8.7	36.4 ± 8.6	35.4 ± 8.9
Carbohydrates (g/24h)	237.2 ± 91.8	262.8 ± 100.7	301.6 ± 120.5
Carbohydrates (E %)	52.0 ± 9.1	51.8 ± 9.1	52.8 ± 9.3
Animal Protein (%)	38.5 ± 19.2	39.0 ± 19.2	38.4 ± 18.1

The average frequency consumption of fruits and vegetables did not differ significantly between the three groups of gymnasts. Therefore, the results of fruit and vegetable consumption of all three groups of gymnasts were combined together and are presented in Figure 1 and Figure 2, respectively.

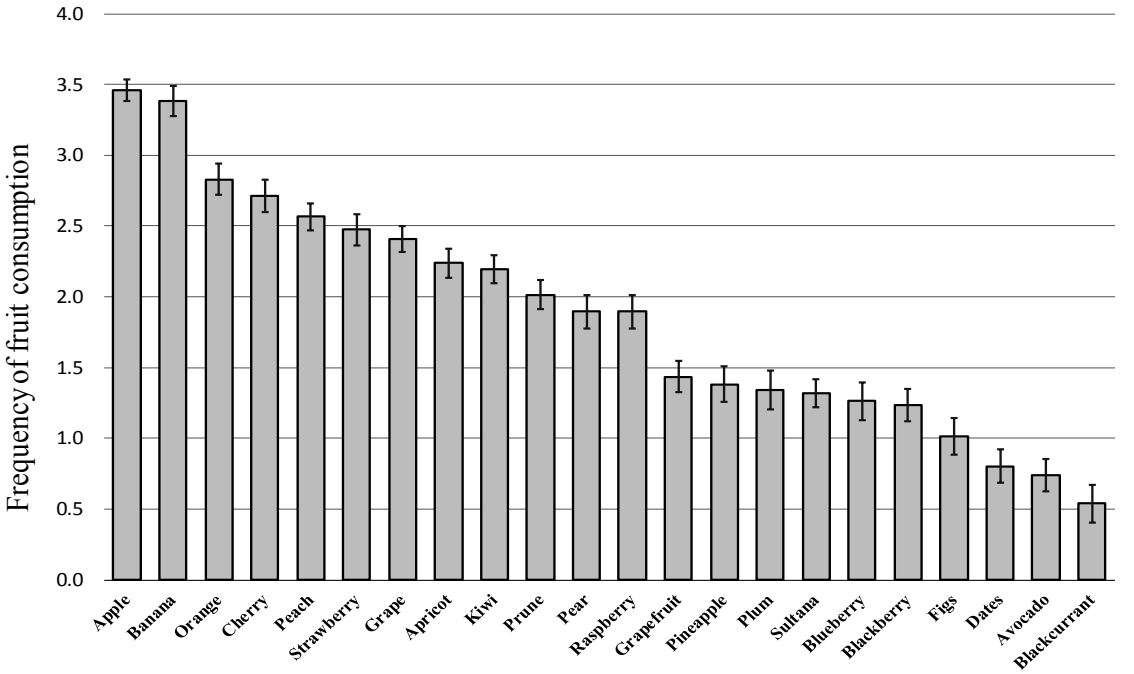


Figure 1. *Frequency of fruit consumption of all artistic gymnasts (n=76)*

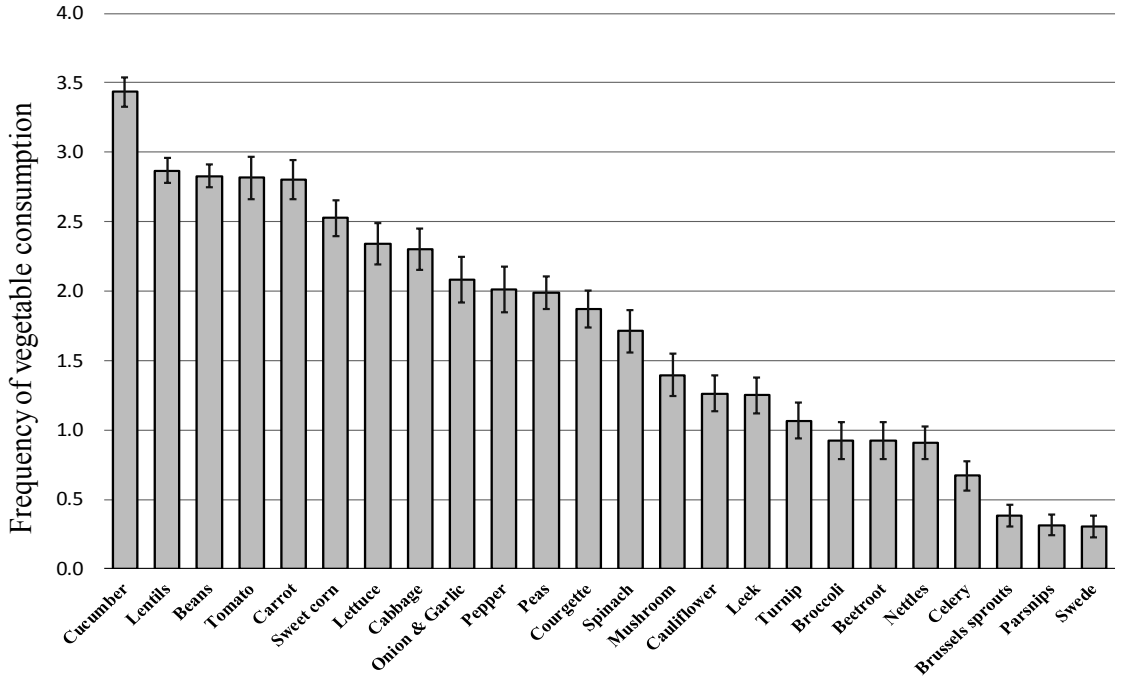


Figure 2. *Frequency of vegetable consumption of all artistic gymnasts (n=76)*

The most often consumed fruits were bananas and apples, and the most frequently consumed vegetables were cucumbers, lentils, beans, tomatoes and carrots. The results from our survey, presented in Figure 3, showed that 38 out of 76 artistic gymnasts (50%) did not meet the minimum recommendation of 400 g or 5 portions (standard portion weighs about 80 g) of fruits and vegetables a day, provided by the World Health Organization (Agudo, 2004, WHO, 2003).

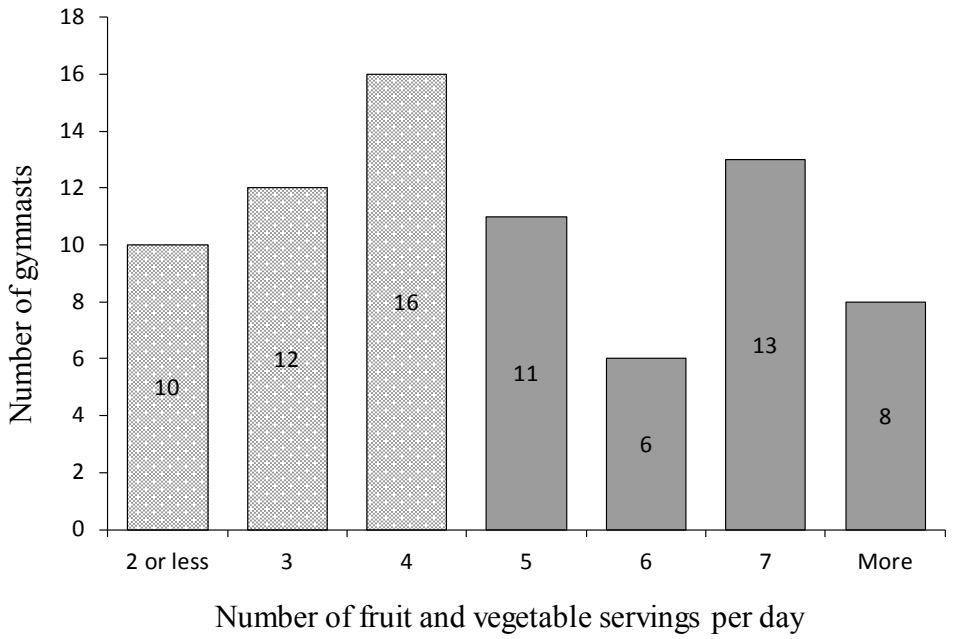


Figure 3. *Fruit and vegetable intake (1 portion = 80 g) of all artistic gymnasts (n=76)*

DISCUSSION

The percentile scores in the height of the gymnasts are significantly lower than the 50th percentile of both international and Bulgarian norms (Table 1), with medium to large effect size for Group-A (Cohen's d = 0.59 and 1.00, respectively), medium effect size for Group-B (Cohen's d = 0.51 and 0.64, respectively), and large effect size for Group-C (Cohen's d = 0.94 and 1.31, respectively). The gymnasts with shorter stature probably have an advantage while executing gymnastics exercises. The absolute average values of the height of young gymnasts in different studies (Benardot, 2014) are similar to those in our study. Another example can be seen in the height-for-age of female junior elite gymnasts, which progressively dropped from the 48th to the 20th percentile as age increased (Benardot and Czerwinski, 1991). These results do not signify a slowdown in growth as a result of artistic gymnastics training. Malina et al. (2013) in their review, which analysed the role of intensive training on the growth of artistic gymnasts, came to the conclusion that adult height or near adult height of artistic gymnasts of both genders is not compromised by intensive gymnastics training at a young age or during the pubertal growth spurt (Malina et al., 2013). Sands (1999) recognises gymnastics to be a unique area of physical activity which, unlike many sports which favour athletes of greater stature or weight, provides opportunities for even the smallest and lightest athletes in the area of competitive activities (Sands, 1999).

The BMI percentile scores in all groups did not differ from the 50th percentile of the international norm, but they did not provide an accurate assessment for some individual gymnasts involved in our study because of the limitations of the BMI. It should be stated that the BMI provides a simple way, employing a standardised methodology, to assess and monitor the health of school children (Boeva and Marinova, 2013, Boeva and Margaritova, 2014), in addition to providing a safe, inexpensive, and widely applied anthropometric method (Pekar, 2011, Keys et al., 2014). However, the BMI does not distinguish between fat and muscle mass, and, therefore, some authors maintain

that this specific parameter is not appropriate for some groups of people, such as professional athletes, body building enthusiasts, people engaged in jobs with strenuous physical activity (Bogin and Varela-Silva, 2012), and adolescent athletes (Lutoslawska et al., 2014).

The %Fat percentile scores in all groups were significantly lower than the 50th percentile (p<0.001) with very large to huge effect size, which is normal for children and adolescents who are engaged in artistic gymnastics (Jemni, 2011). Our results are also similar to those reviewed by Benardot (Benardot, 2014), where the average %Fat for young female and male gymnasts ranged between 8.6% and 21.5%.

The energy intake of the gymnasts from all groups did not differ significantly from those reported in the national survey, NNSB2003. The REI of Group-A was significantly higher than the older gymnasts (Group-B and Group-C) by about 20 kcal/kg, which is probably because of the increased energy needs for growth at this age. There is a good consistency between the REN and REI in all groups, as can be seen from their ratio, which is close to 1 (Table 2).

The protein intake and the relative protein intake (RPI) were both significantly higher (p<0.001) than those published in the NNSB2003. This higher protein intake is in line with our previous study (Kolimechkov et al., 2016) and with other authors who reported higher values of RPI for young competitive gymnasts (Benardot et al., 1989, Karabudak et al., 2016). Consequently, the energy contribution of proteins was significantly higher than the NNSB2003 and the values of 10-15%, as recommended by the WHO (WHO, 2003), but this was in line with data reported for gymnasts (Benardot, 1996, Benardot et al., 1989, Karabudak et al., 2016, Kirchner et al., 1995). Although half of the consumed protein by the gymnasts in our study comes from animal sources, a recent review concluded that a well-planned vegan diet is also capable of fulfilling the protein needs of competitive gymnasts, in addition to helping them lose excess weight, improving the quality of diet, and at the same time reducing the risk of modern chronic diseases in the long term (Jakše and Jakše, 2018).

The fat and carbohydrate intake, as well as the energy contribution did not differ from those reported in the NNSB2003, except for the energy contribution of fats in Group-A, which was slightly lower. Overall in all groups, the energy contribution of fats was above the recommended norms (15-30%), as provided by the WHO (WHO, 2003). The reported data in literature show similar findings in line with our results: the energy contribution of fats for gymnasts is above the recommended 15-30%, and that of carbohydrates is below 55-75% (Karabudak et al., 2016, Benardot et al., 1989, Reggiani et al., 1989, Kirchner et al., 1995, Moffatt, 1984, Kolimechkov et al., 2016). It has been suggested that children seem to be more suited to absorbing free fatty acids as a primary substrate for exercise compared with carbohydrates (Unnithan and Goulopoulou, 2004). However, after reviewing multiple studies on nutrition for young gymnasts, Benardot (2014) highlights that they should increase the energy contribution of carbohydrates and lower their fat intake, as a diet high in carbohydrates, with a moderate amount of protein, and with a low fat content, will provide the best combination for those athletes (Benardot, 2014).

The gymnasts from our study predominantly consumed non-seasonal fruits, such as apples, bananas and citrus fruits, as well as vegetables which are traditional in Bulgaria: cucumbers, tomatoes and carrots, and high-in-protein lentils and beans. However, 50%

of all artistic gymnasts had a low intake of fruits and vegetables, which was below the minimum figure of 400 g or 5 portions, as recommended by the WHO (Agudo, 2004, WHO, 2003).

CONCLUSIONS

The results showed that the height percentile scores of the gymnasts were significantly lower than the 50th percentile of both international and Bulgarian norms. The %Fat and its percentile scores showed substantially low levels for all three groups, which are within the norms and parameters for artistic gymnasts.

The energy intake of the artistic gymnasts did not differ significantly from those reported in the Bulgarian nutritional survey, NNSB2003. However, the protein intake, the relative protein intake (RPI), and the energy contribution of proteins were significantly higher than those for children and adolescents from the national survey, but were in line with other nutritional studies on gymnasts. The fat intake was slightly higher, and the carbohydrate intake was slightly lower than the recommended values in literature. Therefore, the carbohydrate intake should be increased, and the fat content in their food reduced. Gymnasts should increase their fruit and vegetable intake to at least five portions a day, as recommended by the WHO.

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Corresponding author:

Stefan Kolimechkov
National Sports Academy „Vassil Levski"
Studentski grad, 21, Acad. Stefan Mladenov Str.
Sofia 1700, Bulgaria
E-mail: dr.stefan.kolimechkov@gmail.com