

COMPARISON OF BODY COMPOSITION AND ENERGY INTAKE OF YOUNG FEMALE BALLET DANCERS AND ORDINARY SCHOOL GIRLS

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The aim of this study is to assess body fat level, energy and nutrient intake of adolescent ballet dancers and to compare these results with those of adolescents from ordinary school. Participants included 39 ballet dancers and 70 adolescents from ordinary school. Body composition was measured using a multi-frequency 8-polar bioelectrical impedance leg-to-hand analyser (X-Scan Plus II, Korea). Dietary intakes were assessed using a three-day estimated food record. Nutritional intake was calculated using the Nutri Survey software. Ballet dancers were slightly shorter, lighter, with less fat and fat-free mass compared to girls from ordinary school. 51.3% (95% CI 35.59 to 66.97) of ballet dancers and 4% (95% CI; 0.27 to 11.15) of ordinary school girls had a body fat level of 12% or less. The recommended amount of 35–45 kcal energy to kg fat-free mass for aesthetic sports was not reached by 42.1% (95% CI 27.61 to 50.65%) of ballet dancers. No statistically significant difference was found in percent body fat between ballet dancers who consumed energy less than the recommended amount compared to those who ate normally, but fat-free mass ($p < 0.05$) was lower in those who consumed 35–45 kcal energy to kg fat-free mass or less compared to those who ate more. The investigated groups had an inadequate intake of minerals and vitamins during the winter period.

Key words: ballet dancers, body composition, dietary intake.

INTRODUCTION

Adolescents have higher nutritional needs due to rapid growth (lean body mass, fat mass, bone mineralisation) and maturational changes associated with the onset of puberty (Croll *et al.*, 2006). Training for beginning ballet dancers starts early at preschool age and quickly becomes highly intense, frequent and long lasting, always with a view to maintain minimal body weight. Because there is a need to maintain low body weight, adolescents often adhere to diets that might result in inadequate energy and nutrient intakes (Sundgot-Borgen and Garthe, 2011; Sundgot-Borgen *et al.*, 2013). Adolescents in leanness-demanding sports have an increased risk of relative energy deficiency in sport syndrome (RED-S) and of developing disordered eating behaviour and eating disorders (EDs) (Melin *et al.*, 2015). RED-S, which is called the ‘Female Athlete Triad’, refers to impaired physiological function including, but not limited to, metabolic rate, menstrual function, bone health, immu-

nity, protein synthesis, and cardiovascular health (Mountjoy *et al.*, 2014).

Body composition is an important health and performance variable. 12% body fat has recently been suggested as the minimal level for female athlete adolescents, including ballet dancers (Sundgot-Borgen *et al.*, 2013). Adipose tissue is not only a passive store of energy — it is also an active secretory tissue, producing a lot of hormones, cytokines and other metabolically active substances.

Female athletes should consume sufficient energy — 30–45 kcal/kg fat-free mass (FFM) daily (Sundgot-Borgen *et al.*, 2013). 30 kcal·kg⁻¹ FFM·d⁻¹ might be the lower threshold of energy availability for females (Anonymous, 2009). For example, the muscle protein synthesis is reduced even at energy availability (EA) of 30 kcal (kg FFM)⁻¹ (Areta *et al.*, 2013). Exposure to as few as five days of low EA has been shown to reduce blood glucose levels and carbohydrate

availability, suppress the pulsatility of gonadotropin-releasing hormone, reduce hypothalamic-pituitary-axis hormones (such as triiodothyronine and estrogen), and elevate cortisol levels (Loucks and Thuma, 2003). Typical consequences of persistent energy deficiency with or without an ED are reproductive dysfunction, and deficiency/suboptimal status of micronutrients such as iron and calcium (Nattiv *et al.*, 2007; Rauh *et al.*, 2010; Rickenlund *et al.*, 2005).

The aim of this study was to assess body fat level, energy and nutrient intake of adolescent ballet dancers and to compare these results with those of a control group — adolescents from ordinary school.

MATERIALS AND METHODS

Participants. Taking into account that the physiological demands during ballet training and performances are comparable to those in other aesthetic sports, ballet dancers were, for the purpose of this study, regarded as athletes. Thirty-nine female ballet dancers (median age 13 years, range 12–14) and seventy female respondents from ordinary school as controls (median age 14 years, range 13–15) were selected for the study. All ballet dancers were from the Rīga Choreography School and had been actively training for at least three years (mean \pm SD; 5.84 ± 2.39 years). Training volume at the time of study was 24.42 ± 3.42 h/week. Controls reported no history of participation in competitive sports and were not excluded if they participated in recreational sports (mean recreational physical activity duration 3 ± 2 h/week). None of the participants reported dieting at the time of the study.

Ethical approval. The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki (6th revision 2008). The study was approved by the Rīga Stradiņš University Ethics Committee. Participation was voluntary, based on willingness and written applications by the administrations of the respective sport organisation. After having fully informed the girls and their parents about the study and its aim, informed consent was obtained from both the participants and their parents.

Body composition. Height was measured to the nearest 1 cm with an ultrasonic height meter (UHM-101, Korea) with children standing with bare feet. Body mass and total body fat were measured using a multi frequency 8-polar bioelectrical impedance leg-to-hand analyser (BIA) (X-Scan Plus II, Korea). The subjects were required to adhere to standard BIA testing guidelines, given in the manufacturer's manual, and the subjects were measured in light clothes. All measurements were performed when the athletes were in a normal rehydrated status.

Food intake. Dietary intakes were assessed using three-day estimated food record, completed by the interviewer by asking about the food eaten in the previous day and using picture series for the estimation of the portion sizes consumed. Dietary intakes were assessed over two non-consecutive

weekdays and one weekend day. Nutritional intake was calculated using Nutri Survey software (English version of the German software (EBISpro).

Statistics. Anthropometric and body composition characteristics and daily nutrient intakes were computed as the mean and standard deviation (SD). Daily nutrient intake variables were subjected to analysis of variance (one-way ANOVA) between the control group (ordinary school adolescents) and the study group (ballet dancers), also confidence intervals (CI) were calculated. All calculations were performed using SPSS v.22.0 software for Windows. The significance level was set at $p < 0.05$.

RESULTS

Body composition. Anthropometric characteristics and body composition of the assessed groups are shown in Table 1. All anthropometric and body composition parameters differed significantly among the investigated groups as well as in the group of 13 years olds ($p \leq 0.001$), which consisted of more participants (16 ballet dancers and 17 participants from the control group). Ballet dancers were slightly shorter, lighter, with less fat and fat-free mass compared to girls from ordinary school in the same age period. Considering the 12% level for body fat (%BF) for aesthetic sports as critical (Sundgot-Borgen *et al.*, 2013), half of ballet dances were too lean for healthy growth and performance. 51.3 % (95% CI 35.59 to 66.97) of ballet dancers and 4% (95% CI 0.27 to 11.15) of ordinary school girls had inadequate body fat level. These results differed significantly between the study groups ($p \leq 0.001$). According to the National Scale, %BF for the respective age in young athletes (Kalnina *et al.*, 2015) was very low (under the 20 percentile) in 71.79% (95% CI 57.76 to 85.91) of ballet dancers and 22.86% (95% CI 13.02 to 32.70) of girls from the control group %BF. The results differed significantly between the study groups ($p \leq 0.001$).

Intake of energy and macronutrients. Reported energy and macronutrient intakes are shown in Table 2. The total intake of energy ($p < 0.001$), proteins ($p < 0.001$), carbohydrates ($p < 0.001$) and fat ($p < 0.05$) were lower in ballet dancers compared to the control group. Calculating energy intake to weight (kg), the control group consumed even less

Table 1

ANTHROPOMETRIC AND BODY COMPOSITION CHARACTERISTICS OF YOUNG FEMALE BALLET DANCERS AND FEMALES FROM AN ORDINARY SCHOOL (mean \pm SD)

Parameters	Ballet dancers n = 39	Controls n = 70
Height (cm)	156.23 \pm 8.41	166.74 \pm 6.11
Weight (kg)	40.14 \pm 7.69	59.48 \pm 10.94
Fat mass (kg)	5.18 \pm 2.52	14.38 \pm 6.39
% body fat	12.43 \pm 3.87	23.13 \pm 6.38
Fat-free mass (kg)	34.95 \pm 5.64	45.11 \pm 5.11

p (between the groups) = 0.000

Table 2

DAILY INTAKES OF ENERGY, MACRONUTRIENTS, FIBRE, AND ENERGY-SOURCE DISTRIBUTION OF YOUNG FEMALE BALLET DANCERS AND FEMALES FROM AN ORDINARY SCHOOL (mean \pm SD)

Measurements	Controls n = 70	Ballet dancers n = 39	p (between the groups)
Energy (kcal)	1700.41 \pm 369.48	1306.21 \pm 288.67	0.00
Energy (kcal/kg weight)	29.81 \pm 9.40	33.86 \pm 10.75	0.043
Energy (kcal/kg fat free-mass)	38.32 \pm 10.06	38.49 \pm 11.53	0.936
Water (g)	934.85 \pm 360.32	991.57 \pm 499.05	0.497
Proteins (g)	87.62 \pm 31.39	47.10 \pm 16.18	0.000
Proteins (g/kg weight)	1.55 \pm 0.78	1.22 \pm 0.50	0.190
Proteins (g/kg fat free mass)	1.99 \pm 0.89	1.39 \pm 0.55	0.000
Fat (g)	51.96 \pm 9.53	45.69 \pm 13.26	0.005
Fat (g/kg weight)	0.90 \pm 0.23	1.17 \pm 0.43	0.000
Fat (g/kg fat-free mass)	1.16 \pm 0.24	1.34 \pm 0.46	0.011
Carbohydrates (g)	219.61 \pm 46.68	174.56 \pm 56.34	0.000
Carbohydrates (g/kg weight)	3.84 \pm 1.35	4.53 \pm 1.83	0.027
Carbohydrates (g/kg fat-free mass)	4.94 \pm 1.18	5.15 \pm 2.01	0.539
Fibre (g)	14.57 \pm 3.54	13.03 \pm 5.2	0.071
Fibre (g/kg weight)	0.25 \pm 0.007	0.34 \pm 0.16	0.000
(g/kg fat free mass)	0.33 \pm 0.08	0.38 \pm 0.18	0.025
% kilocalories from			
protein	20.66 \pm 5.08	14.47 \pm 3.53	0.000
carbohydrates	51.10 \pm 5.81	53.08 \pm 98.87	0.162
fat	28.02 \pm 4.36	31.76 \pm 7.38	0.001

than ballet dancers ($p < 0.05$) but the energy to fat-free mass was similar. The recommended amount of 35–45 kcal energy to kg fat-free mass for aesthetic sports was not reached in 42.1% (95% CI 27.61 to 50.65) of ballet dancers. Regarding energy intake to kg FFM in adolescents from ordinary school, 39.1% (95% CI 26.4 to 57.83) consumed energy less than 35–45 kcal, which did not differ significantly in the ballet dancer group ($p > 0.05$) who underwent intensive physical activity. Ballet dancers consumed more fat ($p < 0.001$) and carbohydrates ($p < 0.05$) to weight (kg), than the control group but both consumed the same amount of proteins ($p > 0.05$). Regarding FFM (kg), which in our opinion could be more accurate, both groups consumed the same amount of carbohydrates ($p > 0.05$), and ballet dancers consumed slightly more fat ($p < 0.05$) and less proteins ($p < 0.001$) compared to the control group.

The mean intake of energy and all macronutrients of ballet dancers who consumed less than 35 kcal/kg FFM was significantly lower than those consuming 35–45 or more kcal/kg FFM ($p < 0.001$). The mean weight and body mass index (BMI) were less for those who consumed less than 35 kcal/kg FFM ($p < 0.05$). No statistically significant difference was found in %BF or FM (mean %BF 13.7 \pm 3.7 vs.

11.4 \pm 3.7; $p > 0.05$) or fat mass index (FMI), while FFM ($p < 0.05$) and fat free mass index (FFMI) ($p < 0.001$) were lower in the group consuming 35–45 or less kcal/kg fat-free mass.

Intake of minerals and vitamins. The mean of daily intake of minerals and vitamins are shown in Tables 3 and 4. The total daily intake of minerals and vitamins in ballet dancers was less than in the control group.

Analysing the mean intake of minerals, both groups consumed less than amounts recommended for their age and gender. Ballet dancers consumed less minerals compared to the girls from ordinary school, especially potassium, calcium, phosphorus and iron ($p < 0.001$).

Comparing ballet dancers who consume less than 35 kcal/kg FFM (group I) and those consuming more than 35–45 kcal/kg FFM (group II), the daily intake of all minerals except Na was less for group I, and the difference was statistically significant ($p < 0.05$) especially for P and Zn ($p < 0.001$). The daily intake of minerals did not differ statistically significantly between groups who had less or more than 12% of body fat ($p > 0.05$).

Analysing the mean intake of vitamins, ballet dancers consumed less vitamin E and vitamin B₂ and B₆ compared to the control group ($p < 0.001$). During the winter period, both investigated groups may be at risk of deficiency of specific vitamins, especially vitamins A, E, and B.

DISCUSSION

We investigated adolescents from the Riga Choreography School and one ordinary school in Riga to assess nutritional status (% BF and FFM) and food intake during the winter period.

Given the biological changes occurring in female athletes during adolescence, it is important to remember that the body of a young growing athlete often develops in a direction against the paradigm of the athlete's sport, especially in women and where the sport demands being as lean as possible (Sundgot-Borgen *et al.*, 2013). The current study showed that young ballet dancers had significantly lower anthropometric and body composition than that of the control group. Half of the ballet dancers had %BF under the recommended level (12%) and for 41% the daily intake of energy (35–45 g/kg FFM) was inadequate. It seems that pressure for leanness to our ballet dancers was quite high and against the direction of normal biological changes. The mean %BF (mean \pm SD) was slightly lower for ballet dancers than in a study conducted in Croatia (12.4% \pm 3.8 vs. 17.4% \pm 4.7%) for the same age group (Soric *et al.*, 2008).

We found that ballet dancers who ate less than recommended in order to maintain the minimum weight and dieting, did not have a reduced level of fat but had a reduced level of fat free mass or mainly muscle mass. Therefore,

Table 3

DAILY MINERAL INTAKES (mean ± SD)

Mineral	Recommended*	Ballet dancers n = 39		Controls n = 70		p (mean between the groups)
		mean ± SD	% (CI) of group below recommended	mean ± SD	% (CI) of group below recommended	
Sodium (mg)	1800 (age 11–14) 2200 (age 15–18)	1725.35 ± 766.36	35.90 (20.84–50.96)	1932.93 ± 771.42	24.29 (14.24–34.34)	0.180
Potassium (mg)	3000 (age 11–14) 3700 (age 15–18)	1729.31 ± 456.67	100	2204.35 ± 561.29	100	0.000
Calcium (mg)	1200	512.47 ± 250.92	97.44 (92.48–102.40)	584.64 ± 292.78	98.57 (95.79–101.35)	0.198
Magnesium (mg)	350	207.50 ± 86.87	94.87 (87.95–101.79)	235.15 ± 58.31	95.71 (90.74–100.39)	0.050
Phosphorus (mg)	1200	775.43 ± 217.01	100	1028.94 ± 279.02	78.57 (68.96–88.18)	0
Iron (mg)	12 (age 11–14) 15 (age 15–18)	8.14 ± 2.53	64.10 (87.95–101.70)	9.90 ± 2.19	97.14 (93.24–101.40)	0
Zinc (mg)	12 (age 11–14) 14 (age 15–18)	5.81 ± 1.99	84.62 (73.30–93.94)	9.77 ± 3.23	38.57 (27.17–49.97)	0

* Recommended energy and nutrient intake for Latvian population (approved by Ministry of Health of the Republic of Latvia in 2008)

Table 4

DAILY VITAMIN INTAKE

Vitamin	Recommended*	Ballet dancers n = 39	% (CI) of group below recommended	Controls n = 70	% (CI) of group below recommended	p (mean between the groups)
		mean ± SD	% (95% CI)	mean ± SD	% (95% CI)	
Vitamin A (µg)	1000	634.19 ± 407.09	89.74 (80.22–99.26)	744.84 ± 362.41	75.71 (65.66–85.76)	0.149
β-Carotene (µg)		2.60 ± 2.17		2.02 ± 1.64		0.123
Vitamin E (mg)	10 (age 11–14) 12 (age 15–18)	3.38 ± 2.07	100	9.24 ± 4.71	77.14 (67.3–86.98)	0.000
Vitamin B1 (mg)	1.2	1.03 ± 0.65	28.20 (14.08–42.32)	1.12 ± 0.41	45.71 (11.67–57.38)	0.399
Vitamin B2 (mg)	1.5 (age 11–14) 1.6 (age 15–18)	0.93 ± 0.34	89.74 (80.22–99.26)	1.18 ± 0.37	80.00 (70.63–89.37)	0.001
Vitamin B6 (mg)	1.7 (age 11–14) 2.0 (age 15–18)	0.92 ± 0.49	97.43 (92.46–102.4)	1.45 ± 0.42	77.14 (67.3–86.98)	0.000
Folic acid (µg)	150 (age 11–14) 200 (age 15–18)	207.10 ± 113.13	25.64 (11.94–39.34)	172.97 ± 74.21	52.85 (41.16–64.54)	0.060
Vitamin C (mg)	75 (age 11–14) 100 (age 15–18)	86.84 ± 40.95	38.46 (23.19–53.73)	79.68 ± 44.06	61.42 (50.02–72.82)	0.407

* Recommended energy and nutrient intake for Latvian population (approved by Ministry of Health of the Republic of Latvia in 2008)

these young adolescent ballet dancers were under the risk of development of RED-s (or Athlete triad). In order to maintain leanness and dieting, these 40% of ballet dancers reduced muscle mass without reducing fat mass (and without improving body shape). It means they were not only at health risk, but also at risk of decreased performance and with great possibility in future to be asked to leave this profession at all. Findings from this study corresponds to the literature (Bernadot, 2012), where this kind of dieting (fasting) is mentioned as one of the greatest health risk at adolescent age.

Findings from the ordinary school showed that 4% of girls had a fat level less than 12%. Calculating their energy in-

take to FFM, 39% of girls had energy intake less than recommended for aesthetic sports (but they did not undergo any intensive physical activity). It seems that because of massive advertisements for being lean and talking only of the risk of too much fat, normal ordinary school girls, and not only ballet dancers, practise diets to reduce weight. According to our knowledge, there is no research on food intake in the ordinary school population calculated to FFM.

More research is needed to assess the nutritional status of adolescent ballet dancers. Research (Żuławka and Pilch, 2012) has documented deficiencies in fats, fibre, minerals like K, Ca, Fe, Mg, and vitamins B₁ and PP. The mean consumed energy (kcal) in that study was higher than in the

current study (1965.48 ± 156.32 vs. 1306.21 ± 288.67). Comparing our results to those of a study from New Zealand (Beck *et al.*, 2015) our ballet dancers consumed less energy (1306.21 ± 288.67 vs. 1925.23 ± 515.23 kcal). However, the comparisons are not completely valid due to age differences (14–18 years compared to our age group 12–14 years old). Nevertheless, both studies showed inadequate intake of nutrients (minerals and vitamins).

CONCLUSION

In half of the studied adolescent ballet dancers, body fat was under the recommended 12%. Assessing energy intake, 41% of ballet dancers did not consume an adequate amount of energy (35–40 g/kg FFM). There is no significant difference the proportion of dieting ballet dancers (42%) and ordinary school girls (39%) in consumed energy to FFM less than 35–45 kcal. Both investigated groups had an inadequate intake of minerals and vitamins during the winter period. There is a need to evaluate immediately our young ballet dancers for other signs of Female Athlete Triad to avoid serious health damage.

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ĶERMEŅA UZBŪVES UN UZŅEMTĀS ENERĢIJAS SALĪDZINĀJUMS JAUNĀM BALETA DEJOTĀJĀM UN PARASTĀM SKOLNIECĒM

Pētījuma mērķis ir novērtēt jauno baleta dejotāju ķermeņa tauku % daudzumu, uzņemto enerģijas un uzturvielu daudzumu un salīdzināt iegūtos rezultātus ar pusaudzēm, kuras mācās parastā skolā. Pētījumā ietvertas 39 pusaudzes baleta dejotājas un 70 pusaudzes no parastās skolas kā kontroles grupa. Ķermeņa tauku % daudzums noteikts, izmantojot daudzfrekvenču bioelektriskās impedances analizatoru (*X-Scan Plus II*, Koreja). Uzturvielu novērtēšanai izmantota trīs dienu uztura dienasgrāmata. Uzņemtais uztura vielas aprēķinātais, izmantojot *Nutri Survey* programmu. Baleta dejotājas ir nedaudz īsākas, vieglākas, ar mazāku tauku un beztauku masu, salīdzinot ar meitenēm parastā skolā. Tauku procentuālais daudzums 12% un mazāk konstatēts 51,3% (95% CI 35,59–66,97) baleta dejotāju un 4% (95% CI, 0,27–11,15) meitenēm parastā skolā. Ieteicamo enerģijas daudzumu estētiskam sporta veidam 35–45 kcal/kg beztauku masas neuzņem 42,1% (95% CI 27,61–50,65%) baleta dejotājas un 39% (95% CI 26,4–57,6) meitenes, kas mācās parastā skolā. Nav statistiski nozīmīgu atšķirību tauku procentuālā daudzumā starp baleta dejotājām, kuras uzņem nepietiekamu enerģijas daudzumu, un tām, kuras uzņem enerģiju atbilstoši rekomendācijām, bet beztauku masa ($p < 0,05$) ir zemāka baleta dejotājām, kuras ēd nepietiekami, salīdzinot ar baleta dejotājām, kuras ēd normāli. Abu pētījuma grupu dalībniecēm ziemas periodā konstatēts nepietiekams uzņemto minerālvielu un vitamīnu daudzums.