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ORIGINAL ARTICLE

EVALUATION OF DIETARY INTAKE OF VITAMINS AND MINERALS IN 13-15-YEAR-OLD BOYS FROM A SPORT SCHOOL IN WARSAW

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ABSTRACT

Background. Insufficient intake of vitamins and minerals, in teenagers engaged in physical activity increases the risk of health disorders.

Objective. The aim of this study was to evaluate selected vitamins and minerals intake in 13-15 -year-old boys from sport school.

Material and methods. The study of dietary intake was conducted among 44 boys from the School of Sport Championship (SSC). Nutritional data was collected using 24-hour recall for 3 days of week. Daily intake of minerals: sodium, potassium, calcium, phosphorus, magnesium, iron, zinc, copper, iodine and vitamins: A, E, D, $B_{1,}$ $B_{2,}$ $B_{6,}$ B_{12}, C, folate and niacin was estimated. The probability of insufficient intake of nutrients in relation to the standard levels: Estimated Average Requirement (EAR) or Adequate Intake (AI) as well as excessive intake of them in relation to the Tolerable Upper Intake Level (UL) were assessed.

Results. The highest percentage of insufficient intake concerned vitamin D (100%), potassium (69%), folate (53%), and calcium (50%), slightly lower of magnesium (27%), vitamins C (24%) and E (15%). The risk of inadequate intake of other minerals: sodium, copper, iron, zinc, phosphorus, iodine and vitamins: B_6, B_1, B_2, A, B_{12}, niacin, was relatively lower and amounted from 0.3% to 5.4%. The disturbingly high probability of exceeding the UL for sodium (99.5%) was observed.

Conclusions. A significant disproportion between the mean intake and the percentage of inadequate diets indicates a large diversity in the intake of vitamins and minerals in the group of studied boys, what was the reason of unbalanced diet. The insufficient intake concerns especially vitamin D, potassium, folate, calcium and a lesser extent magnesium, vitamins C and E. Sodium intake was disturbingly high. In order to avoid nutritional mistakes in the future education on the rational nutrition among students, their parents, and teachers is necessary.

Key words: *nutrition mode, micronutrients, male, adolescents, physical activity*

STRESZCZENIE

Wprowadzenie. Niewystarczające spożycie witamin i składników mineralnych wśród, nastoletniej młodzieży obciążonej wysiłkiem fizycznym zwiększa ryzyko wystąpienia zaburzeń w stanie zdrowia.

Cel. Ocena spożycia witamin i składników mineralnych przez trenujących chłopców w wieku gimnazjalnym.

Materiał i metody. Badaniami objęto 44 chłopców w wieku 13-15 lat ze szkoły mistrzostwa sportowego. Dane o spożyciu zebrano na podstawie wywiadów z ostatnich 24 godzin poprzedzających badanie, z 3 dni tygodnia. Obliczono spożycie składników mineralnych: sodu, potasu, wapnia, fosforu, magnezu, żelaza, cynku, miedzi, jodu oraz witamin: A, E, D, $B_{1,}$ $B_{2,}$ $B_{6,}$ $B_{12,}$ C, niacyny i folianów. Ponadto oceniono prawdopodobieństwo niedoborowego spożycia składników pokarmowych w relacji do poziomów norm średniego zapotrzebowania grupy (EAR) lub wystarczającego spożycia (AI), oraz nadmiernego ich spożycia w stosunku do najwyższego tolerowanego poziomu spożycia (UL).

Wyniki. Najwyższe ryzyko niedostatecznego spożycia dotyczyło witaminy D (100%), potasu (69%), folianów (53%) i wapnia (50%), natomiast nieco niższe, magnezu (27%), witamin: C (24%) i E (15%). Ryzyko niedostatecznego spożycia pozostałych składników mineralnych: sodu, miedzi, żelaza, cynku, fosforu, jodu i witamin: B_6, B_1, B_2, A, B_{12}, niacyny było stosunkowo niższe i mieściło się w zakresie od 0,3% do 5,4%. W badanej grupie stwierdzono niepokojąco wysokie prawdopodobieństwo przekroczenia normy UL na sód (99,5%).

Wnioski. Znaczna dysproporcja między średnim spożyciem a odsetkiem diet niedoborowych, świadczy o dużym zróżnicowaniu spożycia witamin i składników mineralnych w badanej grupie chłopców co było przyczyną niezbilansowania

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diety. Ryzyko niedostatecznego spożycia dotyczyło w szczególności witaminy D, potasu, folianów, wapnia, a w mniejszym stopniu magnezu, witaminy C i E. Niepokojąco wysokie było spożycie sodu. W celu uniknięcia błędów żywieniowych w przyszłości, istnieje potrzeba edukacji uczniów oraz ich rodziców i nauczycieli w zakresie racjonalnego żywienia.

Słowa kluczowe: *sposób żywienia, mikroskładniki odżywcze, chłopcy, młodzież, aktywność fizyczna*

INTRODUCTION

Teenagers engaged in sports are a group of increased nutritional demands. It stems not only from growth and development, but also from high physical activity [2, 35, 43]. The proper nutrition is an important factor that determines full use of genetically determined development and improves physical capacities. Dietary mistakes reduce the normal development processes and influence on the decline of motor skills, reduce concentration and increase susceptibility to fatigue; thereby they increase the risk of malnutrition, dehydration, exhaustion, injury and trauma [15, 24, 48]. On the one hand, the literature on the nutritional habits of teenagers practicing sport [6, 32, 37] and inactive teenagers [19, 27] indicates abnormal eating habits, irregular meals, and their insufficient daily number. On the other hand, research related to nutrients intake of not training teenagers of 11 to 15 years old [3, 13, 22, 40] and some studies on youth engaged in sport have shown abnormalities in intakes of vitamins and minerals [1, 14, 38, 47]. Therefore, it seemed purposeful to undertake this type of study. The purpose of this study was to evaluate the eating habits among boys practicing sports, aged 13-15 years.

MATERIAL AND METHODS

Respondents: 44 healthy secondary school students of the School of Sport Championship (SSC) in district of Bielany in Warsaw, Poland. The study group consisted of 56% the whole male peers population of the school. The characteristics of the respondents and their nutritional status were described in the earlier paper [39]. The adolescents were practicing sport 10 hours a week, on average. The study was conducted during the school year in autumn and in winter. The level of food intake was evaluated based on three individual interviews (2 school days and one day-off) related to the intake over the last 24 hours prior to the evaluation.

The volume of the consumed servings was evaluated using the "Album of photographs of food products and dishes" [41]. The calculations took into account the occasional intake of supplements, mainly in the form of sports drinks. The mean daily intake of minerals (sodium, potassium, calcium, phosphorus, magnesium, iron, zinc, copper, iodine) and vitamins (A, E, D, B_1, B_2, B_6, B_{12}, C, niacin, folate) was calculated with computer software "DIETA 5" [9], which contains current tables of composition as well as nutrition values [21] and up-to-date nutritional standards [17]. For the micronutrients analysed, the value of the mean daily intake and the prevalence of inadequate intakes were calculated. Nutrient deficiency was evaluated with the probability method in reference to the existing standard levels; Estimated Average Requirement (EAR) (vitamins: A, D, B_1, B_2, B_6, B_{12}, C, niacin, folate, minerals: calcium, phosphorus, magnesium, iron, zinc, copper and iodine) or Adequate Intake (AI) (vitamin E, sodium, potassium). In addition to sodium and zinc, for which exceeding of the Tolerable Upper Intake Level (UL) was established, the probability of excessive amounts of these nutrients in relation to the UL value was evaluated. Deficiency in iron intake was evaluated based on percentile distribution of iron intake.

RESULTS

The mean daily intake of minerals and vitamins in students' diet and the risk of inadequate intakes of the selected nutrients have been presented in Table 1.

The mean intake of minerals and vitamins by the boys exceeded the relevant standards levels EAR or AI, except for vitamin D and potassium, for which the suitable reference levels were not reached and percentage implement standards were respectively 31.6% and 93.8%. Assessment of the risk of inadequate intakes estimated by the probability method indicates that the highest percentage of deficient diets for all examined nutrients concerned vitamin D (100%), followed by potassium (69%). Deficient intake of folate and calcium was found in nearly half of the students. A large percentage of boys also showed a deficient intake of magnesium, vitamin C and vitamin E, which concerned approximately 27%, 24%, 15% of respondents, respectively. For other vitamins and minerals deficient intake concerned a small percentage of students (fluctuated in the range of 0.3% to 5.4%).

DISCUSSION

Mean daily intake of vitamin D amounted to 3.2 µg/day, which met the Polish standard at the EAR value only in

Table 1. The mean (X± SD) daily intake of minerals and vitamins and the prevalence of inadequate intakes in the diets of the boys, estimated by means of the probability method (n=44)

Vitamins and Minerals		Mean values X± SD	Range	Risk of inadequate intake (%) in relation to EAR or AI	EAR or AI
Sodium	(mg)	5528.2±1705.7	1983.8 - 9237.9	0.3	1500
Potassium[2]	(mg)	4410.7±1356.2	2016.9 – 8079.9	69.2	4700
Calcium[1]	(mg)	1334.8±754.0	178.0 – 3640.8	50.0	1100
Phosphorus[2]	(mg)	1853.9±626.7	694.7 – 3604.9	5.1	1050
Magnesium	(mg)	396.0±114.3	155.2 – 678.9	26.8	340
Iron	(mg)	15.9±5.3	7.1 – 33.6	-	8
Zinc [2]	(mg)	13.6±4.0	6.8 – 24.0	4.8	8.5
Copper	(mg)	1.56±0.46	0.59 – 2.60	0.6	0.7
Iodine[2]	(µg)	185.7±67.5	39.7 – 356.0	5.4	95
Vitamin A (retinol equivalent)[1]	(µg)	1619.4±1207.5	281.4 – 6451.1	3.9	630
Vitamin E[5]	(mg)	16.1± 7.9	3.1 – 53.1	15.1	10
Vitamin D[1]	(µg)	3.2 ± 1.5	0.9 – 8.3	100.0	10
Vitamin B_1[3]	(mg)	2.2± 0.8	1.0 – 4.5	1.0	1.0
Vitamin B_2[4]	(mg)	2.6± 1.1	0.9 – 6.2	1.6	1.1
Niacin [2]	(mg)	24.3 ± 8.9	9.3 – 52.4	2.6	12
Vitamin B_6[6]	(mg)	2.8± 1.0	1.3 – 5.6	0.5	1.1
Vitamin C[6]	mg	150.4± 107.1	17.4 – 538.2	23.9	65
Folate [2]	(µg)	349.1± 122.2	95.0 – 684.0	52.6	330
Vitamin B_{12}[4]	(µg)	5.2± 3.9	1.3 – 23.5	5.2	2.0

[1]exponential transformation α=0.2
[2]exponential transformation α =0.3333
[3]exponential transformation α =0.125
[4] exponential transformation α =0.1
[5]exponential transformation α =0.25
[6]logarithmic transformation

32%. The results of these studies reflect rather general situation; a similarly low intake (3.09 µg/day) was reported in the study of boys from Warsaw aged 11-15 years [7]. An even lower intake of vitamin D – that of 2.01 µg/day – was recorded in the studies of secondary school students from the Warsaw district of Bemowo [36]. Inadequate intake of vitamin D was also indicated by results of the studies conducted in nine European countries: Belgium, Denmark, France, Poland, Spain, the Netherlands, the United Kingdom, Germany, and Serbia [28]. These studies revealed that the mean daily intake of vitamin D with unsupplemented diets among boys aged 11-17 years (n=3240) was too low and it fell within the range from 1.9 µg/day (n=393) in France to 4.8 µg/day (n=295) in Poland. Similarly to our studies, the percentage of subjects with mean intake of vitamin D below the EAR level in the respective countries was high, and it fell within the range from 72.2% in Poland to 100% in France and Spain, whilst it must be noted that in those studies, the standard value at the EAR level (5.6 µg/d) was almost twice lower that is the currently applicable standard in Poland for the corresponding male age group. Comparing the present results to the studies of Spanish boys practicing skiing (aged 10-18 years), the average daily intake of vitamin D was higher and it amounted to 5.6 µg/day, while in the same age group of students who were not practicing any sports, the intake of this vitamin was that of 3.8 µg/day [26]. On the other hand, among teenage Spanish football players (age 13-19 years), dining at a hotel buffet or at college residence, the intake of vitamin D amounted to 3.2 µg/day and 5.9 µg/day, respectively, while the intake below the standard AI level (5 µg/day) was found in 88% and 28% of the study subjects, respectively [14]. The data mentioned above indicate that the intake of vitamin D with a diet among adolescent boys, regardless of their physical activity, was insufficient not only in Poland, but also in other countries, what was noted by a team of experts who pointed out the need to supplement vitamin D intake in all age groups, and who published guidelines for supplementation of vitamin D for the Central Europe, as relating to prevention of its deficiencies [31]. Vitamin D favours the absorption of calcium and phosphorus in the intestine, thus stimulates the differentiation of osteoclasts, resorption of calcium from the bones and activates the mineralisation of the bone matrix [29]. In the light of that, a suitable nutrition state of vitamin D is particularly important during pubescence, since the bone remodelling is at its highest level in that period of growth [25]. Optimum accumulation of inorganic bone matter within the period of puberty and early adulthood is crucial in ensuring an attainment of a sufficiently high peak bone mass and, thus, decreasing the risk of osteoporosis in later life [33]. The qualitative analysis

of menus showed that the inadequate intake of vitamin D in diet was caused by a very low consumption of fish, average 4.2 g/day.

Another nutrient with a high risk of inadequate intake in the studied group of secondary school students was potassium. It has been shown that approximately 2/3 of the boys consumed this nutrient in amounts below the AI level value (Table 1), despite the fact that its mean intake of 4411 mg/day accounted for 94% of potassium standard. This indicates a large diversity in the intake of this nutrient in the studied group of boys. However, it is worth noting that according to standards in Poland before 2008, the daily requirement of potassium intake was significantly lower and it amounted to 2500 mg in 13-15-year-old boys, because it was defined at the level of the minimum standard of daily intake, and for this reason, meeting standards for this nutrient in the studied nutritional portions in select social groups ranged from 120-145% [48]. The average intake of potassium, which was lower than that observed in our study, amounted to 2786 mg/day, was established among 13-14-year-old secondary school students from the Warsaw district of Bemowo [36]; whereas among students of both genders, aged 11-13 years from five different Warsaw schools, the intake of this nutrient in the group of subjects who were consuming their lunches at school, was 2419 mg/day and those who did not eat at school 2218 mg/day [45]. A similarly low intake of potassium, at the level of 2441 mg/day, was shown among younger overweight and obese boys aged 10-12 years from the region of the Malopolska Poland [44]. Inadequate intake of potassium was also indicated in the European studies which revealed that the intake of this nutrient fell within the range from 2529 mg/day in the United Kingdom up to 3899 mg/day in Germany; while the intake below the EAR level (2325 mg/day for 11-14-year-old boys and 2625 mg/day for 15-17-year-old boys) was referred to the range from 9.5% of the subjects in the Netherlands up to 49.6% of the boys in the United Kingdom [28]. The intake of potassium, which was lower than that observed in the present study, was also found among teenage (12-18 year-olds) Flemish sprinters, whose intake of this nutrient as part of an unsupplemented diet was that of 3616 mg/day [1]. The quoted results of the studies conducted in Poland and in other European countries revealed that the studied group of boys from SSC was characterised by higher mean intake of potassium despite the fact that the diet of approximately 2/3 of them was inadequate in reference to this nutrient. A diet low in fruit and vegetables, wholegrain cereals, milk and dairy products results in a low intake of potassium, what has been observed in the analysed menus. Some of the boys were not consume these products at all.

The third nutrient in terms of the prevalence of inadequate intake, which are related to more than half of the subjects from the SSC, are folate, despite the fact that a mean daily intake (349.1 μg/d) constituted 106% of the EAR value (Table 1). It was due to insufficient quantity of fruit and vegetables in the diet. An even higher incidence of folate deficiency (73.7%) in diets of Warsaw boys at the age of 11-15 years has been indicated by the studies conducted by *Charzewska* et al. [7]. In order to compare, in European studies, the lowest mean daily intake of folate, at the level of 166 μg/day, was established among boys at the age of 11-17 years in Spain, while the highest - at the level of 381 μg/day – was noted in Germany; whereas the percentage of the subjects with inadequate intake of this vitamin was lower than that detected in our study, as it fell within the range from 4.7% in Denmark to 38% in Spain, which resulted from use of more than twice lower standard at the EAR level (150 μg) [28]. A too low mean intake of folate has also been shown among Spanish adolescents practicing skiing (156 μg/d) and among participants not practicing any sport (143 μg/d) [26]. A higher intake of folate, similar to that observed in our studies, was found in a group of Spanish football players fed at a hotel and in the canteen of the college residence, and it amounted to 317 μg/day and 308μg/day, respectively, whereas the percentage of persons with inadequate intake of this nutrient in reference to the Recommended Dietary Intake (RDA) (400 μg/day) was higher in the present study and it amounted to 75.8% and 82.8%, respectively [14].

A high percentage of inadequate intake of folate among young secondary school students may result in concern, because these compounds are necessary for the correct development of all body cells and for the proper functioning of the nervous and the haematopoietic systems [18], and so persistent deficits of this vitamin may lead to disturbances in normal growth processes and they may negatively affect the general health condition.

Another nutrient, in which prevalence of inadequate intake related to half of the SSC students is calcium, despite the fact that mean daily intake of this element met the standard at the EAR level in 121% (Table 1). The reason for this was too low consumption of milk and dairy products by the respondents. In other studies of Warsaw students at the age of 11-15 years, the average calcium intake was significantly lower than that one observed in our study, and it amounted to 854.5 mg/day, what was 78% of the AI (1300 mg/day) [7]. For this group, it was also showed that the percentage of the boys with inadequate intake of this nutrient (82.2%) was higher than that in a present study. A lower intake of calcium (708 mg/day), which met the standards at the AI (1300 mg/day) only in 64%, was shown among 13-14-year-old boys from the Warsaw district of Bemowo [36]. A similarly low intake of calcium amounting to 713 mg has been shown in boys aged of 13-15 years in another study, while an intake of this nutrient amounting

to below 66.7% of the standard in safe level of intake, related to 54% of the study subjects [10]. Previous studies in adolescents in Poland also revealed low intake of calcium ranging between 570-760 mg/day among boys aged of 11-15 years [3]. When interpreting results regarding intake of calcium, it should be considered that the binding standards of nutrition for the Polish population, as amended in 2012, the AI (1300 mg/day) was replaced with a lower level of EAR (1100 mg/day), what should be taken into account, when comparing results. European studies reveal that calcium intake in a group of boys at the age of 11-17 years fell within the range from 742 mg/day in Poland to 1487 mg/day in Germany, what was below the EAR value (750 mg/day); furthermore, this nutrient was shown to be consumed within the range from 5% of the subjects in Denmark to 57.3% of the subjects in Poland [28]. When compared with adolescents who engage in increased physical activity, among Flemish sprinters aged 12-18 years, the mean daily intake of calcium amounted to 958 mg/day [1], while among Spanish skiers at the age of 10-18 years, it was that of 1032 mg/day [26], and among Spanish football players fed at a hotel and at the college residence canteen, it amounted to 1095 mg/day and 1335 mg/day, respectively, whereas an inadequate intake of this nutrient below the AI standard (1300 mg/day) was shown in 66.6% and 41.4% subjects, respectively [14]. Inadequate intake of calcium occurring at a such large scale within the pubescence period is seriously alarming, because it is not conducive to achieving high peak bone mass and consequently, it increases risk of occurrence of osteoporosis in the future, particularly in connection with inadequate intake of vitamin D, what was shown for all subjects.

Metabolism of calcium is also crucially affected by magnesium, the inadequate intake of which related to approximately 27% of the studied boys from the SSC, even though the mean daily intake of this nutrient was relatively high, amounting to 396 mg/day, what met the standard at the level of 116% (Table 1). A daily intake of magnesium (285.5 mg/day) which was lower than the one observed in our study, was also demonstrated in other group of Warsaw boys aged of 11-15 years, what then resulted in a higher percentage (53.5%) of persons who run the risk of incurring a deficiency of this element [7]. An even lower mean intake of magnesium by the boys in the same age group, which ranged from 191 mg/day to 290 mg/day, was shown in Poland in the years 1989-1997 [3]. Studies conducted in Europe revealed the lowest average magnesium intake among boys at the age of 11-17 years, amounted to 227 mg/day has been shown in the United Kingdom, and the highest amounted to 531 mg/day in Germany. Consequently, the percentage of teenage subjects with an intake of this nutrient maintained below the EAR (230 mg/day and 250 mg/day, respectively for the age group of 11-14 years and 15-17 years) in these countries was noted at the level of 58.1% and 1.7%, respectively [28]. To compare with the results of the studies among adolescents (aged 13-19 years) engaged in increased physical activity, the average magnesium intake among boys practicing football and fed at a hotel was that of 256 mg/day, and 338 mg/day among football players eating in the canteen at the college residence; while an intake below the RDA was demonstrated in 100% and 45% of the respondents, respectively [14]. However, among teenage Spanish skiers (aged 10-18 years), the mean magnesium intake amounted to 217 mg/day, while in their peers who were not practicing any sports, it was that of 204 mg/day [26].

Other nutrients in terms of their risk of inadequate intake, which related to approximately 24% and 15% of the adolescent students from the SSC, are vitamins C and E, respectively. For comparison, in the studies among boys from other Warsaw secondary schools, an inadequate intake of these vitamins affected a significantly higher percentage of subjects: 67% and 47%, respectively [12]. However, in the studies conducted by *Charzewska* et al., an inadequate intake of vitamin C was shown among 42% of the boys [7]. In our studies, the mean daily intake of vitamin C and E amounted to 150.4 mg/day and 16.1 mg/day, respectively, and significantly exceeded the currently applicable standards for these nutrients. For the sake of a comparison, international studies conducted in other European countries indicated that the mean daily intake of vitamin C was diverse and it ranged from 71 mg/day in the Netherlands to 203 mg/day in Germany, whereas the average daily intake of vitamin E ranged from 6.9 mg/day in Denmark to 18.6 mg/day in Germany, and an inadequate intake of vitamin C ranged from 0.4% of teenagers in Germany to 7,5 % in Poland, followed by an insufficient intake of vitamin E ranging from 1.8% of study subjects in Germany to 38% in Denmark [28]. However, it should be noted that in evaluating an inadequate intake, lower standard levels were used than in the presented studies students and in the aforementioned Warsaw teenagers [7, 12]. In European studies of vitamin C, the EAR ranged from 22 to 25 mg/day depending on age, and for vitamin E the AI amounted to 6 mg of α-TE/day (equivalent of α-tocopherol). The mean daily intake for these vitamins among Spanish teenagers engaging in skiing practice and in the subjects who were not practicing any sports in the case of vitamin C amounted to: 108 mg/day and 88 mg/day, respectively, and in the case of vitamin E to 7.3 mg/day and 6.5 mg/day, respectively [26], while in football players of the same nationality, it was recorded at 7.9 mg of α-TE/day for the subjects fed at a hotel and 13.5 mg of α-TE/day for the users of the canteen at the college residence [14].

In the case of remaining select micronutrients, their inadequate intake related to an insignificant percentage of the students (it ranged from 0.3% to 5.4%).

An average intake of other vitamins: A, B_1, B_2, B_6 B_{12} and niacin, significantly exceeded of the EAR value within the range from 215% to 261%, and their inadequate intake related to a low percentage of the subjects and it ranged from 0.5% to 5.2% (Table 1).

Also in the studies of 5th and the 6th grade students of elementary schools [46], as in the case of adolescents attending Warsaw secondary and high schools [36], the average intake of these vitamins exceeded the EAR within the range from 100% to 215%, although it should be noted that the inadequate intake of these vitamins referred to a significantly higher percentage of 12-13-year-old boys, ranging from 28% in the case of riboflavin to 51% in the case of thiamine [46]. However, among 13-year-old boys from Szczecin with BMI≥90 of a percentile, only a mean intake of vitamin A was compliant with the standard at the level of the recommended intake, but in reference to other vitamins, as B_1, B_2, B_6, PP, it was below the standard [16]. In the case of vitamin A, it has been observed in several studies that its intake was high with a diet, frequently exceeding 1000 µg [20, 26, 30, 36]. *Augustyniak* and *Brzozowska* emphasise that in the years 1980-1997 the intake of vitamin A among boys from Warsaw and Poznan was always higher or equal to standards at the safe consumption level [3]. Different results were obtained in studies conducted in teenage Spanish football players fed at a hotel and at the college residence. In those groups, the mean intake of vitamin A covered the RDA standard in 86% and 82%, respectively, and the intake of this vitamin below the RDA was established in approximately 64% and 76% of the subjects, respectively [14]. Similarly among Spanish sprinters aged 12-18 years, only approximately 43% of them achieved the recommended daily intake of vitamin A [1]. Against the background of the quoted study results and in reference to the applicable nutrition standards, the intake of vitamins: A, B_1, B_2, B_6 B_{12} and niacin in the studied group of boys from the SSC may be recognised as normal.

The average daily intake of phosphorus by the boys from the SSC met the EAR in 177%, whereas only 5% of the subjects consumed this element below this value. According to the reference literature published in 1990-2000, the intake of phosphorus by Polish adolescents was higher than the recommended standards, and the degree of their implementation for this element in food rations for the boys, remained at 150% of standard level [3]. Similarly in the studies of children and adolescents from the region of Biala Podlaska, the mean intake of phosphorus (1317 mg/day) in 13-15-year-old boys exceeded the standard at the safe level of intake, while 97% of the subjects consumed this element within the range of 90-110% of the norm and above [10]. According to *Szponar* et al., the mean intake of phosphorus in Poland amounts to 1208 mg/day, while among boys and adult males it is calculated at 1441 mg/day so in general, there are no nutritional deficits of this nutrient [17, 40]. Comparing with the results of the studies on physically active adolescents, an intake of phosphorus with unsupplemented diets in Flemish sprinters (aged of 12-18 years) amounted to 1636 mg/day, what was lower than the value observed in the present studies, while the consumption of this nutrient in approximately 97% of them was in compliance with the standards at the Recommended Daily Intake (RDI) level [1]. Consumption of highly processed food contributes to high content of phosphorus in a diet and to an inadequate proportion between calcium and phosphorus. The weight ratio of calcium to phosphorus obtained in the studies from mean values of their daily intake by the secondary school subjects amounted to1:1.4, while the ratio based on the standards was that of 1:1. Although many studies indicate that high phosphorus intake of is unfavourable for bones in persons whose proportion of Ca to P in the diet is very low, at the same time, it is pointed out that a high intake of this element does not bear a negative consequences on the calcium balance in healthy people, if the consumption of calcium is adequate [23]. However, in our study, a high intake of phosphorus in daily food rations was accompanied by a relatively high percentage of an inadequate calcium intake, which may increase the risk of lower absorption of this element, and thereby also the risk of worse bone mineralisation.

A high intake with diet has also been observed in the case of sodium. In the studied students group of SSC, the mean daily intake of this element exceeded the AI value by over 3.5 times, which calculates into 13.8 g of salt. According to the recommendations of the World Health Organization, a maximum intake of salt should not exceed 5 g/day [11]. An excessive intake of salt may lead to an increased risk of occurrence of hypertension, stroke, myocardial infarction and development of gastric cancer [11]. An increased amount of sodium in a diet also causes an increased excretion of calcium with urine, thus raising the risk of occurrence of nephrolithiasis [18]. In the light of reference literature, the results of the present study are not isolated, since other studies also revealed too high intake of sodium among adolescents [8, 36, 44, 45, 46]. However, according to the American Dietetic Association Dietitians of Canada and the American College of Sports Medicine, the requirement for sodium in many endurance athletes is higher than the UL (2300 mg/day, what corresponds to 5.75 g of salt) in the case of this element. Sodium is a critical electrolyte for athletes, especially for those who sweat profusely [2]. The study of adult athletes found that mean daily

intake of sodium exceeds up to seven times a minimum standard for consumption this nutrient [4, 5].

All of the boys subjected to our study showed an intake of sodium which exceeds UL, while the probability that this level is not exceeded is only that of 0.5%. Consequently, such a high intake of this element by the boys from the SSC should be recognised as excessive, even considering their increased requirement for sodium, which is related to their heightened physical activity. A nearly twice higher than recommended intake of iodine, which was observed in present study, probably results from the high content of salt in the consumed diets.

Exceeded UL was also shown in the case of zinc in 7% of the studied boys from the SSC in Warsaw. It is not an isolated case, since exceeding the UL of zinc has also been observed in 4% of the students aged 11-15 years attending various Warsaw schools, but it has been emphasised that the risk of exceeding this level as a result of consumed food is minimal [7]. The mean daily intake of zinc revealed in our study amounted to 13.6 mg/day, what corresponded to 160% of the EAR value, and an inadequate intake of this element related only to 4.8% of the students. The average intake of zinc amounted to 7.6 mg and 9.8 mg, what was lower than that observed in our study, and a significantly higher percentage of the studied boys with inadequate intake of this element (48.3% and 34.9%) have been revealed in the studies of 5th and 6th grade students of Warsaw elementary schools [46] and, respectively, of Warsaw students at the age of pubescence [7]. A low intake of zinc was also established in the study of boys aged 10-12 years from the region of the Malopolska, whose intake of this element in spring time was 7.5 mg/day, and in autumn it amounted to 7.3 mg/day, but in 81% and 87% of the subjects, respectively, the intake of this element was below 66.7% of the standard at the safe level of intake [44]. In European studies, the lowest intake of zinc among boys at the age of 11-17 years amounting to 8.4 mg/day was observed in the United Kingdom, and the highest of 14.7 mg/day was noted in Germany [28]. However, among athletes, Spanish teenage skiers consumed 12.1 mg of zinc per day, while the subjects who were not practicing any sports and who belonged to the same age group consumed 11.8 mg of this element per day [26]. The presented data indicate that the secondary school students participating in our studies consumed relatively high amounts of zinc, which makes the risk of its deficit very low.

An average intake of copper with diet met the standard in 223%, whereas an inadequate intake of this mineral related only to 0.6% of boys attending the SSC (Table 1). A twice lower amount of copper at the level of 0.8 mg was shown in the studies of daily food rations of 5th and 6th grade students of various Warsaw elementary schools, whereby the percentage of boys with inadequate intake of this element amounted to 20.5% [46]. Similarly, a much lower intake of copper than the one noted in the present study was observed among 10-12 year-old boys from the region of Malopolska, amounting to 0.9 mg/day in springtime and 0.8 mg/day in autumn. An intake of this element below 66.7% of the bottom threshold value of the recommended range of safe intake has been found in 65% and 77% of them, respectively [44]. A content of copper (1.07 mg), which was lower than that observed in our studies, was also established in the daily food rations of the boys attending early grades of Szczecin secondary schools [16] and from the secondary school in Warsaw [36]. In European studies, a mean daily intake of this nutrient in unsupplemented diets among boys aged 11-17 years fell within the range from 1.04 mg to 2.60 mg [28].

Table 2 presents the percentile of iron intake from the food in the studied group of the boys.

Table 2. Percentile of iron intake from food by 13-15-year old boys

Percentile	p5	p10	p30	p50	p70	p90	p95
Percentile intake (mg)	8.4	9.3	12.2	14.8	18.3	23.0	26.1

The mean daily intake of iron (15.9 mg) by the students of the SSC was higher than the EAR value, which currently amounts to 8 mg for this age group (Table 1). Only 5% of the students consumed iron in amounts lower than 8.4 mg (5 percentile) and only one boy had an inadequate intake of iron (7.08 mg/day) (Table 2). The results of previous studies indicate that the mean daily iron intake among Polish adolescents who do not practice sports as well as in adult males is relatively high and it approximately amounts to 15 mg [34, 40], whereas in other European countries it ranges from 11.0 mg to 16.7 mg daily [42], which has been confirmed by the results of the present study. However, it is worth noting that in other Polish studies related to Warsaw adolescents aged of 11-15 years, an inadequate intake of iron occurred in higher prevalence, as it referred to approximately 1/3 of the subjects [7].

CONCLUSIONS

1. A significant disproportion between the mean intake and the percentage of inadequate diets indicates a large diversity in the intake of vitamins and minerals in the studied group of boys.
2. Analysis of nutrition mode indicates abnormalities in the intake of many vitamins and minerals.
3. The highest percentage of insufficient intake concerned vitamin D (100%), potassium (69%), folate (53%), and calcium (50%). The lower percentage of

respondents indicates a deficient intake of magnesium (27%), vitamin C (24%), and E (15%). The disturbingly high percentage of respondents with excessive sodium intake (99.5%) was noticed.
4. The revealed abnormalities indicate an incorrect quantitative and qualitative composition of diet products.
5. Noticeable nutritional mistakes increase the risk of the vitamins and minerals deficiencies and an excess of sodium. The study results indicate the need for education on the rational nutrition among the students their parents, and teachers.

Conflict of interest

The authors declares no conflict of interest.

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