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A NUTRITIONAL EVALUATION OF DIETARY BEHAVIOUR IN VARIOUS PROFESSIONAL SPORTS

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ABSTRACT

Background. The types of physical exertion undertaken by weightlifters and race walkers markedly differ. This difference should also be reflected in their respective diets.
Objectives. The aim of the study was to investigate and assess the diets of professional weightlifters and race walkers, along with a comparison to the diets of those students studying physical education (PE).
Materials and Methods. Subjects were respectively 12 weightlifters, 12 race walkers and 12 physical education students whose body composition and nutrition were determined by weighing the foods that were both eaten and drunk.
Results. The study groups showed body differences, which may have arisen through dietary differences. Higher calorie diets were observed for race walkers according to body mass whilst weightlifters showed no difference with the other groups. Dietary intakes of protein, fat, and carbohydrates were however inappropriate for all groups. Vitamin and mineral intakes in weightlifters and students were within tolerable limits, but the rather aggressive taking of supplements by race walkers resulted in standard/recommended consumption levels being greatly exceeded in some cases.
Conclusions. The diets of the study groups of weightlifters and race walkers need to be corrected.

Key words: *nutrition in sport, weightlifting, race walking, food supplementation*

STRESZCZENIE

Wprowadzenie. Wysiłki podejmowane przez ciężarowców oraz przez chodziarzy są diametralnie różne i dlatego sposób żywienia powinien być różny w tych grupach.
Cel. Celem pracy było zbadanie i ocena sposobu żywienia zawodników uprawiających chód sportowych oraz podnoszenie ciężarów i porównanie go ze sposobem żywienia studentów kierunku wychowania fizycznego.
Materiał i metody. W badaniach wzięło udział 12 ciężarowców, 12 chodziarzy i 12 studentów wychowania fizycznego, u których badano skład ciała i sposób odżywiania, poprzez ważenie zjadanych i wypijanych pokarmów.
Wyniki. Badane grupy różniły się somatycznie, co mogło być wynikiem różnic w racjach pokarmowych. Chodziarze spożywali posiłki o wyższej wartości energetycznej w odniesieniu do masy ciała niż studenci a ciężarowcy nie różnili się w tym zakresie od pozostałych grup, przy czym proporcje spożywanych białek, tłuszczów i węglowodanów we wszystkich grupach były niewłaściwe. Spożycie witamin i składników mineralnych u ciężarowców i studentów mieściło się w granicach tolerancji, natomiast zbyt agresywna suplementacja stosowana przez chodziarzy doprowadziła w niektórych przypadkach do przekraczania obowiązujących norm.
Wnioski. Konieczne jest wprowadzenie korekty do sposobu żywienia badanych sportowców uprawiających zarówno chód sportowy jak i podnoszenie ciężarów.

Słowa kluczowa*: żywienie w sporcie, podnoszenie ciężarów, chód sportowy, suplementacja żywieniowa*

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INTRODUCTION

In sportspersons, the body's metabolic effort expended from race walking is markedly different to that of weight lifting. This should thereby be reflected in differing dietary requirements. Race walking is an activity of moderate intensity and long duration, which stimulates aerobic metabolism and renders the body susceptible to hyperthermia and dehydration [23]. On the other hand, weight lifting activates phosphorylated sources of energy in those skeletal muscles generating both extremely high tensile development and momentary strength whenever the lifted weight bar (barbell) straddles the chest; reaching a power even up to 4786 W in competitors lifting the highest weight categories [13]. Physical exertion over long periods (eg. race walking), however results in the oxidation of free fatty acids powered by glycogen metabolism in the muscles, whose pool, being less than that for fats, becomes more rapidly depleted. Thus it is recommended that such a sports' diet should be composed of 60-70% carbohydrates [5].

Supporting evidence for these premises is provided by studies showing that top long distance runners from Ethiopia consume 64.3 ± 2.6% carbohydrates when training intensively [7]. A smaller dietary role is assigned to protein and fat intake for endurance sports. It is generally recommended that race walkers consume protein, fats and carbohydrates in the ratio 1.0:0.95:5 and that the respective calorific contribution is 13% : 27% : 60%. For weight lifters the recommendations specify a dietary ratio of 1:0.99:3.9 of protein, fats and carbohydrates of calorific contents 14% : 31% : 55% respectively [4].

Even though the duration of physical effort expended during weightlifting is very short, such comparisons suggest that weight lifters consume less carbohydrate but more protein and fats than race walkers. To those engaged in power/strength sports it is often advised to consume 1.2 – 1.7 g/kg protein /24 hrs [26]. Higher protein intakes do not appear beneficial for sportspersons as *Bill* et al. [2] demonstrated that an overconsumption leads to acidosis and excessive lowering of the internal pH, that may lead to longer recoveries after training; being of significance in twice daily weightlifting workouts.

The study aims were to investigate and assess the diets of sportspersons engaged in race walking and weightlifting together with comparing them to students studying physical education.

MATERIALS AND METHODS

There were 12 subjects in each study group of race walkers, weightlifters and PE students in whose body characteristics are summarised in Table 1 and consisted of; age, height and the body's mass, fat content, water content and lean body mass along with the BMI (Body Mass Index) as measured by the Tanita Body FAT Analyzer TBF 300A, Germany in the last 5 cases. Nutritional status was assessed in all 3 groups, over 3 days, to a 2 g level of precision when determining food, supplements or water intake. Any food uneaten was subtracted from the 24 hr intake totals. Subjects were also asked about their intakes of supplements and their compositions were recorded from package information. Supplements were those recommended most often in active sports, comprising of high-energy, vitamin and mineral supplements [12, 29]. With the exception of 5 subjects, these were used by all throughout the 3-day study period.

A computer programme '*Dieta 2.0*' was used to determine dietary nutritional values per 24 hrs as developed by the National Food and Nutrition Institute [28] that incorporated a nutritional value database for selected foodstuffs and dishes [19]. These included dietary calorific values along with the proportional mass amounts and calories delivered by protein, fats and carbohydrates. Also assessed, were dietary vitamins (A, D, E, B_1, B_2, B_3, B_6, B_9, B_{12} and C), and minerals (sodium, potassium, calcium, phosphorus, magnesium, iron, zinc, copper and manganese). The one-way ANOVA test was used to evaluate statistical differences in the body data characteristics, whereas the nutritional data were analysed by the two-way repeated measures ANOVA. In both cases, the *post-hoc Tukey* test was used with a $P<0.05$ level taken as showing significance. Based on the literature, it was assumed that the analysed variables were normally distributed. ANOVAs are recognised to be resistant to a lack of normality, provided that the means are a good representation of the central tendency as verified by the skewness and kurtosis of the data's distribution [20].

RESULTS

Subjects all had similar ages but with different body characteristics as shown by significant variations in BMI so indicating different body structure/frame types. The highest BMI was found in weightlifters, whilst the lowest was in race walkers. Such body structure differences arose from different heights, body mass, body fat and water content (Table 1).

When taking dietary supplementation into account, many of the studied variables became more statistically significant as follows; protein intake expressed in g, g/kg and kcal in weightlifters, and in race walkers carbohydrate intake expressed in g, g/kg and kcal as well as dietary calorific values in kcal and kcal/kg (Table 2).

Table 1. Body characteristics of examined subject groups (mean ± SD)

Group	Age (years)	Body height (cm)	Body weight (kg)	BMI (kg/m^2)	Fat content %	Water content %	Lean bodyn mass %
Weightlifters	22.87 ± 2.67	172.03^{a} ± 6.11	84.27 ± 14.86	28.45^{a} ± 2.01	13.80^{a} ± 2.11	61.89^{a} ± 2.00	86.20^{a} ± 2.13
Students	22.32 ± 1.12	179.53 ±6.58	76.61 ± 10.54	23.68^{b} ± 1.57	16.47^{b} ± 2.79	59.38^{b} ± 2.25	83.53^{b} ± 2.75
Race walkers	23.42 ± 3.07	180.47^{c} ±5.12	69.56^{c} ± 4.48	21.75^{c} ± 1.83	9.81^{c} ± 1.35	65.97^{c} ± 1.23	90.19^{c} ± 1.36

a-weightlifters vs students $p<0.05$; b-students vs race walkers $p<0.05$; c- race walkers vs weightlifters $p<0.05$.

Table 2. Profile of dietary macronutrient contents and calorific values, with and without accounting for taking supplements (mean ± SD).

Components	Diet			Diet + supplementation			Nutritional reference values
	Weightlifters	Students	Race walkers	Weightlifters	Students	Race walkers	
Proteins [g]	133.64^{a} ±27.02	106.20^{b} ±25.41	131.25 ±22.84	171.93^{aA} ±27.30	107.40^{b} ±25.91	144.94^{c} ±25.64	
Fats [g]	124.06^{a} ±32.07	95.18 ±29.43	107.65 ±22.17	124.48 ±32.86	101.32 ±29.60	121.61 ±26.55	74-84^{W} 74-84^{S} 86-93^{R} [17]
Carbohydrates [g]	402.98 ±73.76	342.99 ±69.23	352.66 ±54.43	467.47a ±76.56	355.42^{b} ±0.53	448.78^{C} ±60.19	130$^{W S R}$[17]
Calorific values [kcal]	3327.88^{a} 697.33	2698.68 ±616.19	2961.51 ±461.14	3746.71^{a} ±699.76	2813.48^{b} ±617.19	3528.47^{C} ±507.64	3350-3800^{W} 3350-3800^{S} 3850-4200^{R} [17]
Proteins [g/kg]	1.58 ±0.32	1.39b ±0.33	1.89 ±0,37	2.04^{aA} ±0.32	1.40^{b} ±0.34	2.08 ±0.41	0.9* 1.2-1.4** <3.0*** [17]
Fats [g/kg]	1.47 ±0.38	1.24 ±0.38	1.55 ±0.37	1.48 ±0.39	1.32^{b} ±0.38	1.75 ±0.42	
Carbohydrates [g/kg]	4.77 ±0.88	4.48 ±0.90	5.08 ±0.88	5.55 ±0.91	4.64^{b} ±0.92	6.47^{cC} ±0.97	9.6-10.6^{W} 8,77 11.0-13.0^{R}[4]
Calorific values [kcal/kg]	39.49 ±8.29	35.23 ±8.36	42.57 ±7.47	44.48 ±10.41	36.75b ±8.92	50.72^{C} ±8.17	39.8-45.09^{W} ± 7.02-7.95 43.73-49.60^{S} ± 6.05-6.86 53.35-60.38^{R} ± 3.50-3.96 [17]
Proteins [kcal]	548.60^{a} ±111.32	435.23^{b} ±104.25	538.08 ±93.68	702.43^{aA} ±112.35	440.71^{b} ±104.48	594.32^{c} ±102.21	
Fats [kcal]	1129.21^{a} ±297.33	865.95 ±269.57	982.54 ±201,57	1137,30 ±299,91	922,81 271,22	1101,21 ±241,34	
Carbohydrates [kcal]	1655.40 ±302,70	1407.20 ±284.73	1446.87 ±221.88	1916.45^{a} ±312.50	1457.29^{b} ±289.58	1839.74^{C} ±246.72	

a-weightlifters vs students $p<0.05$; b-students vs race walkers $p<0.05$; c- race walkers vs weightlifters $p<0.05$; A-weightlifters vs weightlifters $p<0.05$; B- students vs. students $p<0.05$; C- race walkers vs. race walkers $p<0.05$.
Nutritional reference values: W- weightlifters (PAL – 1.75-2.0), S- students (PAL – 1.75-2.0) , R- race walkers (PAL – 2.2-2.4). *persons not training, **sportspersons, ***sportspersons endurance sports

Table 3. Dietary calories derived from protein, fat and carbohydrates before and after supplementation, and taking into account the weight (g) ratio of protein: lipid: carbohydrate

Components	Diet			Diet + supplementation		
	Weightlifters	Students	Race walkers	Weightlifters	Students	Race walkers
Proteins [%]	20.23	19.51	22.08	22.50	19.04	20.26
Fats [%]	18.78	17.48	18.46	16.34	17.97	17.00
Carbohydrates [%]	60.99	63.01	59.47	61.16	62.99	62.74
Macronutrient ratio [protein: fats: carbohydrates]	1: 0.93 : 3.01	1: 0.90: 3.23	1: 0.84 : 2.69	1: 0.73 : 2.72	1: 0.95 : 3.31	1: 0.84 : 3.10
Proteins [kcal]	16.46	16.07	18.13	18.70	15.62	16.81
Fats [kcal]	33.88	31.97	33.11	30.28	32.71	31.15
Carbohydrates [kcal]	49.66	51.96	48.76	51.02	51.67	52.04

Table 4. Mineral contents of the diet and dietary supplements (mean ± SD)

Components	Diet			Diet + supplementation			Nutritional reference values
	Weightlifters	Students	Race walkers	Weightlifters	Students	Race walkers	
Sodium [mg]	2431.38[a] 783.55	3482.22 ±1024.38	3200.86 ±1507.09	2463.94 ±801.01	3497.93 ±1126.66	3540.68 ±1603.89	AI=1500 mg/d [17]
Potassium [mg]	3714.05 ±1245.35	3279.92[b] ±804.46	4683.69 ±1398.58	4118.63 ±1288.38	3335.85[b] ±841.56	4818.41 ±1480.56	AI=4700 mg/d [17]
Calcium [mg]	885.59 ±543.32	776.47[b] ±335.55	1146.83 ±430.17	1003.48 ±543.76	932.25[b] ±344.87	1514.32 ±557.68	RDA=1000 mg/d [17]
Phosphorus [mg]	1854.57 ±704.94	1698.95 ±412.47	2026.54 ±602.38	2067.95 ±802.84	1735.94 ±432.56	2100.12 ±634.90	RDA=700 mg/d [17]
Magnesium [mg]	398.93 ±215.76	378.54 ±162.92	437.26 ±133.66	515.72 ±233.53	397.38[b] ±155.49	682.21[C] ±186.84	RDA=400 mg/d [17]
Iron [mg]	15.75[a] ±2.67	12.25[b] ±2.77	19.16 ±5.73	22.45[aA] ±3.21	18.01[bB] ±2.02	101.21[cC] ±20.46	RDA=10 mg/d [17]
Zinc [mg]	13.02 ±4.64	12.94[b] ±2.73	18.05 ±5.25	22.94[A] ±5.21	17.92[bB] ±3.71	26.92[CC] ±7.72	RDA=11 mg/d [17]
Copper [mg]	1.44 ±0.41	1.22[b] ±0.29	1.77 ±0.51	1.76 ±0.52	1.52[b] ±0.36	2.29 ±0.78	RDA=0,9 mg/d [17]
Manganese [mg]	5.45 ±2.21	5.75 ±2.27	5.83 ±1.91	6.31 ±2.37	6.09 ±2.45	7.03 ±2.20	RDA=3,5 mg/d [17]

a-weightlifters vs students $p<0.05$; b-students vs race walkers $p<0.05$; c- race walkers vs weightlifters $p<0.05$; A-weightlifters vs weightlifters $p<0.05$; B- students vs. students $p<0.05$; C- race walkers vs. race walkers $p<0.05$.

Table 5. Vitamin contents of the diet and dietary supplements (mean ± SD)

Components	Diet			Diet + supplementation			Nutritional reference values
	Weightlifters	Students	Race walkers	Weightlifters	Students	Race walkers	
Vitamin A[µg]	900.17 ±223.45	989.93[b] ±496.78	2441.71[c] ±1008.84	1401.45[A] ±302.15	1335.24[b] ±554.37	3990.80[cC] ±1114.57	RDA=900 ug/d [17]
Vitamin D [µg]	2.69[a] ±0.77	5.59 ±3.46	3.61 ±1.13	4.46[A] ±1.23	6.12[b] ±4.57	30.21[cC] ±10.00	RDA=15 ug/d [17]
Vitamin E [mg]	11.12 ±4.37	10.02 ±4.45	13.61 ±3.81	14.89 ±4.88	14.42[bB] ±4.39	50.02[cC] ±11.18	AI=10 mg/d [17]
Vitamin B_1 [mg]	2.67 ±1.20	1.81 ±0.90	1,79 ±0,74	2.99 ±1.21	2.02[b] ±0.91	14.19[cC] ±3.24	RDA=1.3 mg/d [17]
Vitamin B_2 [mg]	2.17 ±0.68	1.86 ±0.68	2.49 ±0.67	2.49 ±0.73	2.23[b] ±0.86	5.24[cC] ±2.50	RDA=1.3 mg/d [17]
Vitamin B_3 [mg]	27.39 ±8.39	24.55 ±8.37	29.21 ±9.93	32.33 ±8.45	28.00[b] ±7.54	57.11[cC] ±18.70	RDA=16 ug/d [17]
Vitamin B_6 [mg]	2.69 ±0.88	2.28 ±0.77	2.95 ±0.92	3.12 ±1.08	2.99[b] ±0.71	20.11[cC] ±5.05	RDA=1.3 mg/d [17]
Vitamin B_{12} [µg]	4.22 ±1.36	5.12 ±3.31	5.77 ±1.93	5.88 ±1.66	6.21 ±2.98	8.05 ±3.73	RDA=2.4 mg/d [17]
Vitamin B_9 [µg]	333.86 ±87.56	314.37[b] ±94.34	438.95 ±143.66	356.66 ±99.45	319.94[b] ±82.53	678.95[cC] ±298.22	RDA=400 mg/d [17]
Vitamin C [mg]	123.67 ±74.56	88.79[b] ±53.45	222.03[c] ±100.26	187.36[a] ±72.47	98.58[b] ±61.46	746.39[cC] ±150.46	RDA=90 mg/d [17]

a-weightlifters vs students $p<0.05$; b-students vs race walkers $p<0.05$; c- race walkers vs weightlifters $p<0.05$; A-weightlifters vs weightlifters $p<0.05$; B- students vs. students $p<0.05$; C- race walkers vs. race walkers $p<0.05$.

For mineral consumption, the taking of supplements significantly increased iron and zinc intakes in all study groups as well as magnesium intakes in race walkers (Table 4). In the case of vitamins, it was however found that taking supplements increased Vitamin A and D intakes in weightlifters and race walkers, increased vitamin E in PE students and race walkers whilst increased vitamins B_1, B_2, B_3, B_6, B_9 and C in race walkers alone (Table 5).

Protein intake, expressed in g, g/kg and calorific values in kcal, and without taking any supplementation into account, was significantly lowest in students compared to weightlifters and race walkers on the first and third occasions as well for race walkers on the second occasion. In contrast, when supplementation was included then differences in protein intake between all groups on the first and third occasions became significant, whilst they were significantly lower in students on the second occasion compared to weightlifters and race walkers.

Fat consumption (g and kcal) was seen to be significantly lower in students compared to weightlifters when supplements were excluded, however in their presence, students' intake of fats (g/kg) were lower than for race walkers ($P<0.05$). Significant lower carbohydrate intakes (g and kcal) were only observed in students compared to weightlifters and race walkers when taking supplementation into account, but when expressed in g/kg, they were significantly the highest in race walkers compared to students and weightlifters. Overall, unsupplemented students consumed fewer calorific ingredients than weightlifters ($p<0.05$). When accounting for supplements, the lowest overall calorific values were seen in students compared to weightlifters and race walkers and also weightlifters consumed more calorific foodstuffs than race walkers.

Consuming calorific foodstuff ingredients by students was lower than that for race walkers, being in turn lower than for weightlifters (Table 2). In terms of consumed mass amounts of foodstuffs and supplements, then carbohydrates were the highest followed by protein and last by fats. However, the proportion (%) of calories from the diet and supplementation was highest for consumed carbohydrates, less from fats and least from protein (Table 3).

Sodium intakes, without supplements, was significantly lower in weightlifters than students, as were intakes of potassium and calcium lower in students than race walkers, irrespective of supplementation. Students taking supplements consumed significantly less magnesium than race walkers. Iron intakes were least in students and very much lower compared to weightlifters and race walkers without supplementation, however when this is taken into account, significant differences arose between all groups. Students also had lower intakes of zinc and copper than race walkers, irrespective of supplementation (Table 4).

Race walkers demonstrated the highest vitamin A intakes regardless of supplementation compared to both students and weightlifters. The latter, when not using supplements, consumed less vitamin D than students whilst those weightlifters taking this vitamin as a supplement had lower intakes than the other groups. In subjects taking supplements, a significantly higher consumption of vitamins E, B_1, B_2, B_3, B_6, and B_9 was seen in race walkers compared to students and weightlifters. In contrast, for those not taking supplements only vitamin B_9 and C intakes were higher in race walkers compared to students and weightlifters. In fact when supplements were taken, significant differences in vitamin intakes arose between all groups (Table 5). Nutrient consumption results are presented in Tables 2, 4 and 5 set against their respective reference values.

DISCUSSION

Measured differences in body characteristics between weightlifters, students and race walkers reflect the particular forms of training undertaken for these sports. Endurance training uses up body fat reserves along with an increase in body water content leading to extreme rises in lean body mass [3], without any muscular hypertrophy (ie. low BMI, body fat but high body water content in the race walkers). Changes observed in weightlifters are typical of power/strength sports consisting of excessive skeletal muscle growth, (high BMI) together with a moderate reduction of fat body mass resulting in moderate body water content and an average increase in lean body mass.

Even though weightlifters, pre or post supplementation, consume higher calorie diets than students but similar ones to race walkers, calorific intake was similar in all groups apart from significantly lower values in students compared to race walkers ($p<0.05$). This data suggests that calorific supplementation in race walkers was significant and that the long lasting, continuous and less intensity training for endurance requires a similar calorific intake as for the short but high intensity training adopted for power/strength sports. Such trends have been confirmed by *Celejowa* [4] which showed that calorific/nutritional requirements of weightlifters and race walkers to be alike, ranging 70-77 kcal/kg. *Fudge* et al. [11] demonstrated that the elite long distance runners from Ethiopia consumed in 24 hrs 3194.56 ± 329.13 kcal (56.34 ± 5.80 kcal/kg), whereas the intake for elite race walkers from another study was 4357.38 ± 286.83 kcal (61.74 ± 4.83 kcal/kg) [25].

The current study however showed lower values at 50.72 ± 8.17 kcal/kg that likely indicates a smaller level of fitness in the race walkers. They were in fact similar to those for the weightlifters (44.48 ± 10.41kcal/kg), who after 2 hrs training, with 10-12 minutes active participation, expended around 1600 kcal.

Protein intakes, (expressed as mass and calorific values), differed between groups with supplementation being sufficiently intense to cause differences, where students showed lower levels to race walkers and weightlifters with also the latter being higher than the former ($p<0.05$). Furthermore, such intakes were in all groups raised. The Recommended Daily Allowance (RDA) for persons not training should be 0.9 g protein/kg body mass [17] but 1.2 – 1.7 g/kg for those undertaking endurance sports training [1]; this can be raised to even 3.0 g/kg [17]. RDAs for strength sports, range 1.2-1.7 g/kg body mass [26].

In professional sport, carbohydrate intake levels are important, which for endurance sports can reach up to 10 g/kg body mass per 24 hrs. *Achten* et al. [1] has suggested that increasing carbohydrate intakes from 5.4 to 8.5 g/kg body mass per 24 hrs in runner athletes improves the effects of training. Such increased capacity from increasing dietary carbohydrate intake in athletes performing strength sports has not however been documented. The presented study shows carbohydrate intakes to be lower (ie. around 4.48-5.08 g/kg and 4.64-6.47 g/kg respectively before and after taking supplements) than those recommended for all groups. The highest intakes were in race walkers and lowest for students; outcome is consistent with the literature [21].

All of the study groups had raised levels of fat intakes compared to reference values. Together with protein and carbohydrate intake, fat intake should be adequately controlled within diets to ensure that the proper proportions of these components are maintained. For physical education students, *Celejowa* [4] has proposed a ratio of 1:0.96:4.5, (protein, fats, and carbohydrates respectively), where their corresponding calories delivered should be 13%:28%:59%. The presented data from all groups however indicate that carbohydrate intakes are too low, especially for the race walkers. This nutritional error arises from consuming too much protein, particularly by weightlifters, and a small excess of fats by race walkers and students. Similarly, *Czaja* et al. [9] have observed low level of carbohydrate intake in Polish medium and long distance runners.

It should be noted that from the 1990s, professional training for competitive sports underwent diametric changes. Training with using very heavy weights (up to 70 tons) had been adopted, whereas now this has been reduced to 30 tons but of a higher intensity of activity [4]. Likewise, this has been observed in training for endurance sport. Furthermore, weightlifters now have a tall and lean body frame and thus there is an urgent need for further studies on nutrition, the human body frame and the training routine in modern sport.

The study weightlifters, students and athletes had sodium intake higher than the predicted reference value of UL=2300 mg/24h [24], which may adversely affect the body. Students had particularly high levels that may be detrimental; however this excess may be lost through sweat for those doing training [30]. Potassium intakes were highest in race walkers but lowest in students, where in the former case they exceeded the reference range (AI=4700 mg/24h) [17].

Weightlifters and students had somewhat lowered calcium intake (the reference value being RDA=1000 mg/24h) [17]. When coupled to raise sodium intake, this may adversely affect health [22]. Calcium deficiency is in fact a frequently seen defect in the diets of sportspersons [30]. In contrast, race walkers consumed one third more calcium (1514.32 ± 557.68 mg) than weightlifters, especially for those taking supplements, which fell within the reference levels recommended for sportspersons ie. 1500 – 2400 mg/24h [4].

Phosphorus intake was higher than recommended in all groups, particularly the sportspersons (Table 3), thereby making any supplementation superfluous. High phosphorus consumption is considered to decrease the absorption of iron, zinc, copper and magnesium. Doses higher than 1500 mg/24h increase blood concentrations of calcium and parathyroid hormone (PTH) [17]. In parallel with phosphorus intake, magnesium intake should be followed to ensure there isn't any excess as seen mainly in race walkers. Such intake can cause diarrhoea leading to alkalosis, hypokalaemia, dehydration, breathing difficulties and electrocardiogram changes [17].

It was found that dietary intake of iron, zinc, copper and manganese exceeded recommended reference levels in all groups, especially when accounting for supplementation. Iron is essential for synthesising protein for oxygen transport (haemoglobin and myoglobin) as well as metabolic enzymes involved in energy production [32]. Efficient oxygen transport is vital for undertaking physical effort needed for endurance activities like race walking. For such a reason it is estimated that iron intake should be increased by 70% relative to those not doing any training [33]. Despite this, it seems that such high intake, particularly iron, is not justifiable. Studies by *Hinton* and *Sinclair* [14] have demonstrated that a 6 week iron supplementation in a 3 mg dose /24hrs is enough to prevent iron deficiency and to increase endurance in sportspersons. Although recommended intake levels of these minerals are significantly exceeded, there are no health concerns of reaching the many-fold and much higher levels for them to become toxic; therapeutic doses are also very high but are likewise nowhere near being toxic [16].

The levels of vitamin A in the study were within the normal RDA range for all groups and increased whenever supplemented. Sportspersons are however recommended to consume a twofold higher than normal intake. Higher intakes of vitamin E were also observed in race walkers. When undergoing training, vitamins A and E appear to be important, because as antioxidants, they eliminate free radicals that may change how efficiently the body functions [31]. Updated RDAs in 2012 for vitamin D have increased 3-fold and currently stands at 15 µg/person/day. This value was not attained in any of the study groups except for race walkers taking supplements. Nonetheless, one has to be careful about the toxicity of this vitamin, which arises at higher doses than those described here. Vitamin D also regulates the development and homeostasis of the nervous system, skeletal muscles and maintains proper bone structure; all significant to persons undertaking competitive sports [15].

Adequate intake of the B group vitamins are important for ensuring optimal energy production along with building and regenerating muscle tissue [34]. Our findings show higher than recommended intake levels, especially upon supplementation. An excess of B_1, B_2 and B_{12} vitamins are not harmful to the body as they are easily excreted in the urine [16] and an adequate vitamin B_2 level (1.3 mg/24 hrs) improves nervous system function. A long-lasting deficiency of vitamins B_9 or B_{12}, singly or together, may cause anaemia and to lower physical efficiency [10]. The excessive vitamin B_3 intake observed in race walkers is of no concern due to the previously given reasons.

An appropriate amount of vitamin C in the body maintains the appropriate oxidative potential of the cell, delays fatigue and it is recognised that long-term aerobic training creates oxidative stress in muscles and other tissue cells [27]. The presented study shows a dramatically high level of vitamin C intake, chiefly through taking supplements, noticeably in race walkers that took 4 times more of this vitamin than weightlifters. Nevertheless, it is suggested that persons undertaking sporting endurance disciplines may consume 100-1000 mg daily [18]. Any excess is eliminated by the urine, although this may lead to kidney stones and gastro-intestinal disorders [16].

It seems that excessive vitamins supplementation, mainly B group vitamins, are not justifiable. The increased tendency to take supplements may lead to metabolic disorders and not always improves sporting physical ability; indeed in some cases it may have quite the opposite effect. To counteract this tendency, educating trainers as well as sportspersons is needed to enhance their knowledge about nutrition and in the taking of supplements [6, 9].

CONCLUSIONS

1. The studied groups had differing body structure and composition arising from their various sporting disciplines, adopted training routines and possibly types of diet.
2. Depending on the training, daily dietary calorific intake was highest for race walkers, but similar in weightlifters and students.
3. The proportions of dietary components were abnormal and did not reflect the requirement differences from the physical efforts undertaken by weightlifters, students and race walkers; both protein and fat intakes were too high whilst carbohydrate intakes were too low.
4. Raised intakes of sodium, phosphorus, iron and zinc are not a cause for concern as excess sodium is lost through sweating, the increased phosphorus (derived from highly processed food) may be easily decreased, and excessive iron arising from supplements can be limited by reducing their use whilst the high zinc intake is beneficial in conferring antioxidant properties.
5. Except for vitamin B_{12}, excessive intake of all vitamins, (due to supplementation) is superfluous and costly; even when they don't necessarily cause adverse reactions. Subject groups had deficient vitamin D intakes.
6. It is necessary to correct the diets of the studied subjects undertaking both race walking and weightlifting sports.

Conflict of interest

The authors declare no conflict of interest.

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