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The Effects of Different Athletic Performances on Dietary Intake

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ABSTRACT

In recent years, wasting has become a growing concern in the world of athletes. The International Olympic Committee has proposed the concept of relative energy deficit and warned of the importance of energy intake matching energy expenditure during exercise. However, it has been suggested that it is difficult to assess this energy intake and expenditure in sport. Therefore, the present study investigated screening for relative energy deficit in male soccer players. Methods; Subjects were 83 male university student athletes belonging to a football club, and 73 subjects for whom data were available were studied. Blood samples were taken before early morning training and height, weight, body fat percentage, lean body mass and muscle mass were measured. Dietary questionnaires and activity levels were assessed. Results; screening assessment criteria have not been presented in Japan. None of the athletes had a BMI of 17.5 kg/m^2 or less. Discussion; none of the athletes were considered to have a possible lack of available energy. However, energy intake was approximately 500 kcal less than energy expenditure, indicating a possible deficit in energy intake.

Keywords: Soccer, Dietary Survey, Relative Energy.

Introduction

Thinness is a growing concern in the world of sport. The International Olympic Committee (IOC) stated in 2010 that "a diet that provides adequate energy from a wide range of commonly available foods can meet the carbohydrate, protein, fat and micronutrient requirements of training and competition"[1]. The International Olympic Committee[2] has proposed the concept of Relative Energy Deficiency in Sport (RED-S), which states that relative energy deficiency adversely affects the growth and development of all athletes, including males, as well as their metabolism, mental health, cardiovascular system and bones, resulting in poor performance. It emphasises the importance of energy intake being commensurate with the energy expenditure of exercise. University athletes who engage in high-intensity training burn through nutrients at a rapid rate and often fail to consume enough through diet alone. Consequently, they are susceptible to nutritional deficiencies. Therefore, appropriate dietary guidance and nutritional support are necessary to maintain their physical condition and improve their performance[3,4]. However, the specific nutrients and quantities required by athletes are not clearly defined. Due to significant individual differences, it is difficult to establish uniform standards[5].

Measuring each individual's basal metabolic rate would be ideal. This is defined as the minimum amount of energy required to maintain vital functions while awake. However, it is challenging to measure basal metabolic rate using indirect calorimetry due to various constraints. Even in well-equipped facilities or among athletes, it is difficult to control the conditions in which measurements are taken. Therefore, evaluating energy intake and expenditure in sport is difficult. Consequently, nutritional guidance relies not only on actual measurements but also on estimation formulas based on past knowledge. In Japan, the formula developed by the National Institute of Sports Science is used. This method is primarily used to estimate the basal metabolic rate of athletes. A study by Koshimizu et al[6] demonstrated the relationship between basal metabolic rate and fat-free mass in male athletes classified by sport, with the intercept of the regression equation ranging from -419 to 388 kcal. This relationship may have a significant impact when divided into the following two categories. However, the basal metabolic rates per fat-free mass of elite athletes are 29.3 kcal/FFM kg/day[7] and 29.4 kcal/FFM kg/day[8], respectively, which are similar to those predicted by the JISS method. Therefore, the JISS method is frequently used for male athletes.

In this study, we examined the risk of relative energy deficiency and differences in nutrient intake due to differences in athletic ability through a dietary survey of footballers.

Research Methods

1. SUBJECTS:

The subjects were 83 male university students (aged 19–22) who belonged to a soccer team. There are three groups: Group A consists of players with the potential to become professionals, Group B consists of regular or substitute players, and Group C consists of recreational players. The subjects of this study were given a thorough verbal explanation of the purpose and content of the study, and their consent to participate voluntarily was obtained. The study was reviewed and approved by the Kyoto Prefectural University Ethics Committee (Approval No. 309). Seventy-three subjects with complete data were included in the analysis.

2. MORPHOMETRIC MEASUREMENTS

These included height, weight, lean body mass, fat mass, body fat percentage and muscle mass. Height was measured using a stadiometer, while weight, muscle mass and body fat percentage were measured using a body composition analyser (Body Composition MC-780, TANITA).

3. DIETARY SURVEY

Participants were instructed to record their meals on two days other than game days during the study period (July 2024), using the approximate portion method, and to take pictures of their meals with a smartphone. Participants were asked to present their student ID card when taking the pictures, to use it as a reference for determining portion size. The collected records and photographs were analysed for nutrients and other intakes using dedicated nutrition calculation software (Eiyou Plus ver. 1.0; Kenpakusha, Tokyo). Daily intakes and energy density-adjusted values were calculated for ten items: energy, protein, fat, carbohydrate, calcium, iron, vitamins A, B_1, B_2 and C, and dietary fiber. Additionally, data on the frequency and intake of protein supplements were collected and incorporated into the nutrient and other intake analyses. However, the nutrient content of non-protein supplements, such as multivitamins, was not included in the analysis.

4. PHYSICAL ACTIVITY AND EXERCISE SURVEY

Physical activity questionnaires were collected at approximately five-minute intervals from waking to sleeping on the same two days as the dietary survey. Physical activity intensity was determined based on the Physical Activity Recording Standards for Health Promotion (2013)[6] and the revised METs table for physical activity (2013)[7]. The intensity and duration of exercise at their clubs was determined by analysing videos of training sessions, and daily energy expenditure (kcal/day) was calculated using the formula: daily energy expenditure = body weight × 1.05 × (exercise intensity × time).

5. STATISTICAL ANALYSIS

Results are presented as mean (standard deviation). A one-way analysis of variance was performed using the non-parametric Wilcoxon test to compare the groups. Tukey-Kramer was used for items for which significant differences were found after one-way ANOVA. Statistical analysis was performed using JMP Pro 17, setting the significance level to 5%.

Results

The physical characteristics of the subjects are shown in Table 1.

Table 1. Physical characteristics and activity level

		A (n=30)		B1 (n=22)		C (n=22)	
Age	year	20.6	(1.2)	20.3	(1.0)	20.5	(1.3)
Height	cm	177.3	(5.5)	174.9	(6.8)	175.4	(6.0)
Weight	kg	70.2	(5.7)*	68.8	(5.8)	65.4	(6.2)
Body mass index	kg/m^2	22.3	(1.1)*	22.5	(1.3)†	21.3	(1.2)
Muscle mass	kg	60.1	(5.3)*	57.9	(5.0)	54.7	(6.3)
Body fat mass	kg	6.6	(2.0)	7.5	(2.1)	7.6	(1.3)
Body fat percentage	%	9.3	(2.9)	10.8	(2.8)	11.5	(2.6)
Activity level	kcal	3902	(477)	3777	(391)	3479	(698)

mean (SD).

*; p <0.05 vs C. †; p <0.05 vs C

Screening assessment criteria have not yet been established in Japan. Therefore, we used the adult BMI value of 17.5 kg/m^2 or less, which the American College of Sports Medicine uses as the first stage of screening for available energy deficiency. No athlete had a BMI of 17.5 kg/m^2 or less, nor did any athlete have an available energy deficiency.

The weight was significantly higher in group A than in group C, and the BMI was significantly higher in groups A and B1 than in group C. Muscle mass was significantly higher in group A than in group C. There were no significant differences between the groups in terms of age, height, body fat mass, body fat percentage, and activity.

The results of the dietary survey are presented in Table 2.

Table 2. Daily nutrient intake

		A (n=30)		B1 (n=22)		C (n=22)		Target amount
Energy	kcal	3243	(639)	3358	(715)	2940	(984)	3500
Protein	g	118	(25)*	125	(28)†	99	(28)	130
Fat	g	107	(33)	109	(40)	98	(29)	105
Carbohydrates	g	403	(94)	433	(147)	383	(162)	500
Calcium	mg	461	(152)	584	(266) †	403	(184)	1000~1200
Iron	mg	12	(3)	13	(4)†	10	(4)	10~15
Vitamin A	µg	594	(248)	635	(326)	503	(256)	900
Vitamin B1	mg	2.1	(0.8)	2.2	(0.9)	1.7	(0.6)	2.1~2.8
Vitamin B2	mg	2.0	(0.8)*	2.2	(0.7)†	1.5	(0.6)	2.1~2.8
Vitamin C	mg	159	(110)*	154	(96)†	84	(44)	100~200
Dietary fiber	g	32	(8)	31	(10)	27	(11)	28~35

mean (SD).

*; p <0.05 vs C. †; p <0.05 vs C

In the between-group comparison, protein intake was significantly lower in group C than in groups A and B. Calcium was significantly higher in B than in C. Iron levels were significantly higher in B1 than in B2. Vitamin B2 was significantly higher in groups A and B1 than in group C. Vitamin C levels were significantly higher in groups A and B than in group C. There were no significant differences between groups for energy, lipids, carbohydrates, vitamin A, vitamin B1 and dietary fiber.

Compared to the target amounts of nutrients per unit of energy for footballers, the amounts of energy, protein, carbohydrate and vitamin A were slightly lower, while the amount of calcium was around 50% of the target amount. Lipids, iron, vitamins B and C, vitamin C and fiber almost met the target amounts.

Discussion

In Japan, data on the physical characteristics, blood composition and dietary intake of professional footballers is rarely published. Therefore, we surveyed university soccer players who are likely to become professional players in the future. The groups were divided according to performance ability, with Team A consisting of future professional athletes.

There are no screening criteria for energy availability in Japan. Therefore, we used the primary screening criterion of the American College of Sports Medicine: a BMI of less than 17.5 kg/m^2. The results showed that Team A had the highest BMI, followed by Teams B and C, with BMIs ranging from 20.1 to 24.8 (with an overall average of 22.0 (1.3). All athletes had a BMI of 17.5 kg/m^2 or higher, indicating that they were not deficient in available energy.

The dietary intake of each group was then compared to the target amount. Regarding desirable nutrient intake during the training period of footballers, Rico-Sanz et al.[9] suggested an average daily energy requirement of 3,550 kcal, although body size influences this. Ebinc et al.[10] showed in their report on energy balance in footballers that energy intake was lower than energy consumption, and Kim et al.[11] reported similar results. Although the energy intake of the athletes in this study was lower than the target amount of 3,500 kcal, it is considered to be within the margin of error. However, when energy intake was compared to energy expenditure, all three groups were approximately 500 kcal below their target. These results support previous studies that have shown inadequate nutrient intake in footballers.

Calcium intake was only half of the recommended amount. Not only athletes, but Japanese people in general, are known to consume low amounts of calcium. Suzuki et al.[12] reported on the nutritional intake of professional footballers. They found that calcium intake was over 1000 mg/day in August, compared to 600–750 mg/day in November. This difference is thought to be due to the effect of temperature, with higher intakes in August due to intense thirst. This study was also conducted in July, when the temperature was sufficiently high. Nevertheless, the players consumed only around 500 mg/day. Based on previous studies, it can be inferred that intake may be even lower in winter.

Athletes are recommended to consume more vitamin C than non-athletes due to its antioxidant properties, its role in iron absorption and its use in collagen synthesis. Joint et al.[13] reported that the recommended intake of vitamins and minerals is sufficient for athletes based on the Dietary Reference Intakes. Van et al.[14] suggested that the requirement for B vitamins increases with increased energy expenditure. However, it should ideally be determined on an individual basis whether they are appropriate for athletes, based on the athlete's condition and performance. In future, it will be necessary to regularly implement a simple index that allows comparison of energy consumption and intake, as well as condition and performance.

Vitamin B2 intake was significantly higher in Team A than in the other groups. As there was no difference in activity levels between the groups, it is thought that the results were a reflection of the participants' diets. Previous studies have reported that taking vitamin B and C supplements improves exercise endurance performance, suppresses the production of fatigue metabolites after exercise and aids athlete recovery[15]. There was no significant difference in activity levels. However, activity levels were higher in Team A. It is possible that the high intake of vitamins B and C contributed to the improvement in performance. Vitamin C has high antioxidant activity.

Conclusion

This study investigated whether there were differences in the diets of athletes of different performance levels. The results showed that Team A consumed more antioxidant nutrients than the other teams.

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