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Research article

Nutritional intake of young Italian high-level soccer players: Under-reporting is the essential outcome

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Abstract
It is recognized that much of the dietary data on adolescents and athletes is prone to reporting error, mostly through under-reporting. Nevertheless, in the majority of studies assessing the nutritional intake of young soccer players under-reporting has not been taken into consideration. The purpose of this study was to assess the dietary intake of a sample of young male Italian high-level soccer players on two time points to evaluate the degree of under-reporting. Seventy-five male high level soccer players (age range: 15-17 years) completed 4-day food records on two separate occasions (T0; T1, 3 months after T0). Under-reporting was assessed by the ratio of reported estimated energy intake (EEI) to estimated energy expenditure (EEE). Forty-three subjects, whose food records were judged accurate enough both at T0 and T1, were included in the data analysis (inclusion rate 57.3%). No significant weight changes were documented between T0 and T1 and in the two weeks preceding both T0 and T1. Reported mean daily energy intake was significantly lower than mean estimated daily energy expenditure both at T0 and T1 ($p < 0.001$). The average EEI/EEE ratio was 0.75 + 0.2 both at T0 and T1. It was ≤ 80% in 27 subjects (62.8%) at T0 and in 23 (53.4%) at T1; it reached 50% in 4 subjects both at T0 and T1. The degree of under-reporting of the young soccer players was in line with the available data on this age group. This study emphasizes that under-reporting is a critical issue in the evaluation of young athletes dietary intake, which should be considered in the interpretation of data, particularly when energy inadequacies are reported. Further studies with uniformed methods are needed, in order to reduce the degree of under-reporting, obtain reliable data on the dietary intake of young soccer players and evaluate the efficacy of targeted nutrition education programs.

Key words: Adolescent athletes, dietary records, energy intake, reporting bias.

Introduction

Soccer training and competition result in increased energy and protein requirements that must be accompanied by an increased energy intake to sustain performance (Bangsbo, 1994; Clark, 1994; Lemon, 1994). An adequate dietary intake is particularly important in young athletes, since deficiency may delay development, disturb growth and muscle development, and affect performance (Rankinen et al., 1995; Weimann et al., 1999). It is recognized that much of the dietary data on adolescents and athletes is prone to reporting error, mostly through under-reporting (Magkos and Yannakoulia, 2003; Livingstone et al., 1992). The few studies assessing the nutritional intake of young soccer players adopted different methodologies and the majority of them reported sub-optimal average energy intakes (Boisseau et al., 2002; 2007; Hickson et al., 1987; Leblanc et al., 2002; Ruiz et al., 2005). Nevertheless, intakes have often been reported as if valid and under-reporting has not been taken into consideration. No studies have been conducted on the dietary habits of young high-level Italian soccer players yet. The purpose of this study was to assess the dietary intake of a sample of young male Italian high-level soccer players on two time points to evaluate the degree of under-reporting, using the EEI/EEE ratio.

Methods

Subjects

The original sample consisted of 75 young male soccer players (age range: 15-17 years) from the junior teams of an Italian First Division Soccer League (Serie A) club, living in their own environment in Northern Italy. They and their parents were fully informed about the study and its aim during a meeting organized by the authors. Written consent was obtained from all 75 families. Subjects were asked to complete a 4-day food record on two separate occasions (T0; T1, 3 months after T0). All diaries were recorded during the same week. A single skilled observer measured the young athletes at the redelivery of food records both at T0 and T1. Height was measured with a vertical altimeter (sensitivity of 1 mm) and weight with a precision balance (sensitivity of 0.1 kg).

The subjects' weight at redelivery of food diaries was compared to that recorded monthly in the soccer team medical records, whose measurement occurred 14 days before T0 and 12 days before T1.

Forty-three subjects, whose food records were judged accurate enough both at T0 and T1, were included in the data analysis (inclusion rate 57.3%).

Anthropometric characteristics of the young soccer players included in the data analysis at T0 and T1 are reported in Table 1.

Dietary assessment

Participants were required to provide detailed descriptions of food and beverages consumed on two training days, a competition day and a day of rest in the same week, including brand names of commercial and ready-to-eat-

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foods, estimated portion sizes using household measures (i.e. cups, dishes, spoons), method of preparation, place of consumption and use of condiments or added fat. Furthermore, they were asked to report each meal, training session and match time. Detailed verbal and written instructions for completing the food records, together with portion size guidelines, were provided on delivery of food records both at T0 and T1, to enable better estimation of quantities of food and beverages consumed. Food records were reviewed after completion: those clearly inaccurate (i.e. those lacking portion sizes, method of preparation, brand names of commercial and ready-to-eat-foods, meal, training session or match time) were excluded from the analysis, the other were analyzed after clarification for ambiguous information. The food records analysis was carried out by a registered dietitian, who converted food unit assessments into weights, and calculated the nutrient values ingested (macro and micronutrients, fiber and cholesterol) using the Italian food composition tables (Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione, 2000). The nutritional values of commercial, ready-to-eat-foods and dietary supplements were sought and calculated. The average values for each 4 day period were used for the analysis.

Table 1. Anthropometric characteristics of the young soccer players at T0 and T1 (n = 43). Data are means (±SD) [range].

	T0	T1
Age (years)	16 (1)	16 (1)
Weight (kg)	69.8 (7.4) [56.0-92.0]	70.9 (6.8) [58.0-91.0]
Height (m)	1.79 (.05) [1.69-1.94]	1.79 (.05) [1.70-1.94]
BMI (kg·m^{-2})	21.7 (1.7) [17.4-25]	22.0 (1.5) [18.3-25.5]

Energy expenditure

Soccer matches last approximately 90 minutes (1.5 hours) including "extra-time" (usually 4-10 minutes) for 15 to 17 year old soccer players in Italy. Each training session of the subjects involved in the study lasted nearly 120 minutes (2 hours).

Mean daily energy expenditure (DEE) was estimated for each subject combining the basal energy expenditure (BEE) according to the Schofield's equation (Schofield et al., 1985), the physical activity level (PAL) of 1.58, which corresponds to the estimated value for 14 to 17 year old Italian boys and includes the energy requirements for growth (Società Italiana di Nutrizione Umana, 1998), and the estimated energy expenditure for competitive (10 kcal·kg^{-1}·hour^{-1}) and casual, general (7 kcal·kg^{-1}·hour^{-1}) soccer according to the Compendium of Physical Activities (Ainsworth et al., 2000) as follows:

1. *Energy expenditure on rest days (kcal):*
   - BEE x PAL = BEE x 1.58 = EE^1
2. *Energy expenditure on training days (kcal):*
   - EE^1/24 = EE/hour = EE^H - (EE^H x 22) + (7 x kg body weight x 2) = EE^2
3. *Energy expenditure on match day (kcal):*
   - (EE^H x 22.5) + (10 x kg body weight x 1.5) = EE^3
4. *Mean daily energy expenditure (kcal):*
   - (EE^1 + EE^2 + EE^2 + EE^3)/4 = DEE

Under-reporting

Under-reporting was assessed by the ratio of reported estimated energy intake (EEI) to estimated energy expenditure (EEE), in accordance with the method adopted by Livingstone and colleagues (Livingstone et al., 1992).

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Science (SPSS/PC version 13.0 for Windows, Chicago, IL, USA). Means (± SD) and frequencies were calculated for all studied variables. Differences between numerical variables were assessed using the Wilcoxon two-sample paired signed rank test. Differences between proportions of cases were assessed using the Binomial Test procedure. Correlations were assessed using the Spearman's rank correlation test. A level of significance of $p < 0.05$ was required for results of statistical tests to be regarded as significant.

Results

No significant weight changes were documented in the two weeks preceding both T0 and T1, hence over the period during which intake and activity were monitored.

Reported mean daily energy intake was significantly lower than mean estimated daily energy expenditure both at T0 and T1 ($p < 0.001$) (Table 2). Average estimated energy deficiency was 890 ± 734 kcal at T0 and 851 ± 703 kcal at T1.

Only 6 subjects (13.9%) met their energy requirements both at T0 and T1.

The average ratio of reported estimated energy intake (EEI) to estimated energy expenditure (EEE) was 0.75 ± 0.2 both at T0 and T1.

The EEI/EEE ratio was ≤ 80% in 27 subjects (62.8%) at T0 and in 23 (53.4%) at T1; it reached 50% in 4 subjects both at T0 and T1.

The average number of daily meals was 4 (range: 3-6) both at T0 and T1. Mean daily energy intake was correlated with the number of daily meals both at T0 and T1 ($r = 0.50$, $p < 0.001$).

No significant variations regarding reported energy, macronutrient, fiber and cholesterol intakes between T0 and T1 were documented (Table 2).

The mean interval between meals and training sessions significantly increased at T1 ($p < 0.05$) (Table 3). At the same time, the proportion of subjects with intervals shorter than 120 minutes between meals and training sessions significantly decreased at T1 ($p < 0.001$) (Table 3).

Only 2 subjects (4.6%) reported the consumption of dietary supplements at T0; no subjects at T1. Alcohol consumption was not reported both at T0 and T1.

Discussion

We investigated the nutrient intakes and dietary practices of a sample of young Italian high level soccer players using a 4-day food record realized on two time points, and estimated energy expenditure during the same period, in order to evaluate the degree of under-reporting by the

Table 2. Energy, macronutrient, fiber and cholesterol intakes of the young soccer players at T0 and T1 (n = 43). Data are means (±SD).

		T0	T1	Recommended Values
Energy	(kcal/d)	2560 (636) *	2640 (614) *	3450 (260) §
	(MJ/d)	10.7 (2.6)	11.0 (2.5)	14.4 (1.1)
	(kcal/kg/d)	37.2 (10.4)	37.7 (9.7)	
Carbohydrates	(g/d)	339 (89)	352 (86)	
	(g/kg/d)	4.9 (1.5)	5.0 (1.3)	7 #
	(% of TEI)	52.9 (4.0)	53.4 (5.5)	55-65 †
Simple sugars	(% of TEI)	17.0 (4.8)	18.1 (5.5)	10-12 †
Proteins	(g/d)	101 (23)	104 (28)	
	(g/kg/d)	1.5 (.4)	1.5 (.4)	1.6 ‡
	(% of TEI)	16.6 (2.1)	17.0 (2.4)	
Lipids	(g/d)	87.0 (25.0)	87.1 (26.4)	
	(% of TEI)	30.5 (3.4)	29.6 (4.3)	25-30 †
Fiber	(g/d)	15.1 (5.5)	17.0 (7.3)	30 †
Cholesterol	(mg/d)	333 (126)	320 (115)	≤ 300 †

* $p < 0.001$ compared with the recommended values.
§ Mean estimated daily energy expenditure at T0.
# Recommended carbohydrate intake (g/kg/d) for soccer players (Clark, 1994).
† Recommended Dietary Allowances for Italian 14-17 year old boys (Società Italiana di Nutrizione Umana, 1998).
‡ Recommended protein intake (g/kg/d) for 15 year old soccer players (Boisseau et al., 2002).
TEI = total energy intake.

EEI/ EEE ratio. Our findings indicate a great tendency of under-reporting and suggest that the young athletes' motivation and parents' co-operation may be the key points of an appropriate participation. The weight of our subjects was similar to that of the young soccer players evaluated by Hickson et al. (1987), Ruiz et al. (2005) and Iglesias-Gutiérrez et al. (2005). Body composition was not assessed in this study, although none of the subjects were above the healthy range for BMI.

Table 3. Intervals between meals, training sessions and matches at T0 and T1 (n = 43). Data are means (±SD) [%].

	T0	T1
Minutes between meals and training sessions	94 (29)	114 ± 42 *
Minutes between meals and matches	148 (30)	151 ± 49
Number of subjects with an interval between meals and training sessions < 120 minutes	36 [83.7]	25 [58.1] **
Number of subjects with an interval between meals and matches < 120 minutes	3 [6.9]	2 [4.6]

* and ** $p < 0.05$ and 0.001, respectively, compared with T0.

The mean reported daily energy intake was slightly greater than that documented by Boisseau et al. (2002). It was similar to that of six out of nine groups of French young soccer players studied by Leblanc et al. (2002), to that reported by Boisseau et al. (2007), to the dietary intake of the Finnish adolescent athletes evaluated by Fogelholm (1998), to the daily energy intake of the adolescents investigated by Livingstone et al. (1992) and of one of the two Scottish Premier League teams studied by Maughan (1997). Furthermore, it was lower than the mean daily energy intake reported by Hickson et al. (1987), Iglesias-Gutiérrez et al. (2005) and Ruiz et al. (2005), and much lower than that documented by Rico-Sanz et al. (1998).

The mean estimated energy expenditure was intermediate between that documented by Iglesias-Gutiérrez et al. (2005) and that reported by Rico-Sanz et al. (1998), slightly greater than the total energy expenditure measured by the doubly labelled water method in male adolescents (Livingstone et al., 1992), and analogous to that of the professional soccer players with the anthropometric characteristics of our sample who were assessed with the same method (Ebine et al., 2002). These comparisons should be interpreted with caution, as all the mentioned studies adopted different methods to estimate both dietary intakes and energy expenditure.

Interestingly, the degree of under-reporting was in line with the available data on this age group (Livingstone et al., 1992) and unchanged at the two time points. Under-reporting was further confirmed by the subjects' weight maintenance over the study period and in the two weeks preceding the redelivery of food diaries both at T0 and T1.

The adopted methodology has inherent limitations, as all methods measuring dietary intake are hampered by errors of precision and validity (Black, 2001).

Energy expenditure was estimated using the recommended equation to predict resting metabolic rate in active adolescents (De Lorenzo et al., 1999), the physical activity level for our population (Società Italiana di Nutrizione Umana, 1998) and the estimated energy expenditure for competitive soccer (Ainsworth et al., 2000). Despite the intrinsic limitations, the data were in line with those obtained with the most accurate method of assessment (Ebine et al., 2002; Livingstone et al., 1992).

The low inclusion rate due to the inaccuracy in reporting dietary intakes causes serious concern and may indicate both low subjects compliance and scarce parents collaboration. Weighed diet records, physical activity diaries and longer recording period could have increased the accuracy of data, but would also have demanded

greater co-operation which could have lead to even lesser compliance.

The methodological issues remain unresolved. However, the young athletes motivation and parents co-operation may be key points that should be enhanced in the future studies. Despite under-reporting, a few comments can be made with regard to the qualitative aspects of reported dietary intakes. A worrying finding regards reported cholesterol intake, which was excessive despite under-reporting. This causes concern, as an excessive cholesterol intake could have negative long-term implications on the health of the young athletes (Cunnane, 1993; Lichtenstein et al., 1998). Fiber intake appeared clearly insufficient and could indicate a poor consumption of fruit and vegetables, which is common among Italian adolescents (Leclercq et al., 2004).

To the best of our knowledge, no previous studies assessed the interval between meals and performance in young soccer players. These data could be of interest, as timing could affect both dietary intakes and the accuracy of dietary reporting. The mean interval between meals and matches was almost acceptable both at T0 and T1, although it is usually recommended to eat 3-4 hours before competition to avoid digestive problems (Clark, 1994). Also, the proportion of subjects with inadequate intervals between meals and matches was low. We found that the interval between lunch and training sessions is critical in our young players. This area of dietary behavior had changed in a positive way at T1 compared to T0, probably because T1 occurred after the end of the school year. In fact, during school term, training begins straight after school which would affect meal time patterns.

Conclusion

Our findings emphasize that under-reporting is a critical issue in the evaluation of young athletes dietary intake, which should be considered in the interpretation of data, particularly when energy inadequacies are reported, and highlight that the young athletes motivation and parents' co-operation are key points that should be enhanced in this kind of studies. Further surveys with uniformed methods are needed, in order to reduce the degree of under-reporting, obtain reliable data on the dietary intake of young soccer players and evaluate the efficacy of targeted nutrition education programs.

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RC participated in the study design, in the data collection, analysis and interpretation, and in writing the manuscript. BC participated in the data collection, analysis and interpretation. GC participated in the study design. The study was funded by the Fondazione IRCCS Policlinico San Matteo, Pavia and A.C. Milan Football Club. The authors are grateful to the whole staff of the Youth Sector of A.C. Milan Football Club (trainers, doctors, physiotherapists, secretaries) for the enthusiastic participation in the project and the precious collaboration.

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Key points

- Under-reporting is a critical issue in the evaluation of young athletes' dietary intake, which should be always considered in the interpretation of data.
- The young athletes' motivation and parents' cooperation are key points that should be enhanced in this kind of studies.
- The nutritional intakes of young Italian high-level soccer players are likely to be qualitative inadequate, due to excessive cholesterol and very poor fiber intakes.

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