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ORIGINAL

ANALYSIS OF BODY COMPOSITION AND DIETETIC PATTERNS IN MALE FIELD HOCKEY PLAYERS

ANÁLISIS DE LA COMPOSICIÓN CORPORAL Y PATRONES DIETÉTICOS EN JUGADORES DE HOCKEY

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ABSTRACT

Objective: This study analyses and compares the body composition of male field hockey players from different national teams. Method: Fifty one hockey players from Spain (n= 18), Netherlands (n=15) and Germany (n=18) were recruited as volunteers to test the differences in body composition between national teams and field positions. The obtained anthropometric values were correlated to food consumption. Results: players had a mean balanced mesomorphic somatotype (2.8-4.0-2.4). Players of the German team had the higher adiposity that correlated with higher oil consumption (p= 0.046). German players had as well more bone mass (p=0.020) that correlated with the daily consumption of non-skimmed yogurts. Conclusion: results suggest that the studied teams did not follow suitable dietetic and nutritional guidelines corresponding to this sport discipline.

KEY WORDS: food habits, sports nutrition, anthropometry, field hockey.

RESUMEN

Objetivo: El estudio trata de analizar y comparar la composición corporal y su relación con patrones dietéticos de los jugadores de hockey hierba masculinos de diferentes selecciones nacionales. Método: Se contó con cincuenta y un jugadores adultos de hockey hierba de España (n = 18), Holanda (n = 15) y Alemania (n = 18) con el fin de comprobar diferencias en la composición corporal, así como para correlacionar valores antropométricos con el consumo de alimentos entre los equipos nacionales y sus demarcaciones. Resultados: Los jugadores poseen un somatotipo medio mesomórfico balanceado (2.8-4.0-2.4). El equipo alemán tuvo una adiposidad más alta que se correlacionó con un mayor consumo de aceites (p = 0.046) así como con mayor masa ósea (p = 0.020), correlacionada con el consumo diario de yogures no desnatados. Conclusión: Finalmente, los resultados sugieren que los equipos estudiados no suelen seguir las estrategias nutricionales adecuadas a su disciplina deportiva.

PALABRAS CLAVE: hábitos alimentarios, nutrición deportiva, cineantropometría, hockey hierba.

INTRODUCTION

Field hockey is an outdoor team-based sport, in which two teams of 11 players each compete to score more goals during a match. The players of each team are distributed in different field positions. Subsequently, each player has different energy demands and anthropometric characteristics (Tumilty, 1993). The playing field is 91.4 m long and 55 m wide (Karkare, 2011), which supposes a great aerobic effort by the players (≤75%VO2max) due to the large distances covered. This is combined with periods performed in anaerobic conditions (>75%VO2max), mainly due to repeated bursts of high-intensity running and a variety of additional actions such as stick ball shoots (Ghosh et al., 1991; Reilly & Borrie, 1992; Boyle, de Mahoney & Wallace, 1994; Aziz, Chia

& Teh, 2000; Casajús, 2001). Therefore, practitioners have a high maximal oxygen uptake value (58.0 ml·kg^{-1}·min^{-1}) (Aziz, Chia & Teh, 2000).

The body composition of elite athletes correlates with sports performance (Kin-Isler, Ariburun & Ozkan, 2008) and energy demands (Norton, 1996), thereby conditioning the techniques and tactics used (Callister et al., 1991). In the particular case of field hockey, players are at a high risk of back injuries due to the bent stand-up position during the match, forcing a continuous spine flexion (Reilly & Seaton, 1990). Despite not being an ergonomic position, it is the most commonly used since it allows faster ball conduction (Fox, 1981). Body weight management could decrease the risk of injuries (Tyler et al., 2006), along with specific flexibility-based exercises (Garbutt et al., 1990) and strength training sessions (Wilby et al., 1987).

The average daily consumption of energy of a field hockey adult player has been estimated in 43 kcal·kg^{-1}·day^{-1} (van Erp-Baart et al., 1989). However, there are no studies that analyse the characteristics of field hockey player´s regular diet and its relation to body composition. Therefore, the main objective of this pilot study is: to analyse body composition of field hockey adult players from different national teams (Spain, Netherlands and Germany) in order to verify possible differences according to the sport discipline and field positions. The secondary objectives are: to analyse the dietetic habits of players using an intake frequency questionnaire and to identify possible causes that may explain the differences in dietetic and nutritional patterns between nationalities. Likewise, hydration strategies are analysed during matches and the supplementation intake by players. Finally, a comparison will be made between anthropometric results obtained and published data from other team sports.

METHODS

Participants

A total of 51 adult male Caucasian field hockey players from different national teams were assessed: Spain (18.9 ± 0.7 years), Netherlands (18.7 ± 0.5 years) and Germany (19.1 ± 0.9 years). Players were recruited as volunteers during a concentration with their respective national teams. Inclusion criteria were: more than 4 years of field hockey experience, being selected by national team, taking part of the study and signing the informed consent. Exclusion criteria were: more than 6 months of recovering injury or inactive and under a pharmacotherapy treatment for injury or illness. Participants were informed about the objective of the study and gave their written consent to participate. The study was in accordance with local legal requirements and the Helsinki Declaration for research on human beings, and approved by the Ethics Committee of University Miguel Hernandez (reference IB.ER.06.13). Anonymity was preserved for all participants. Due to coach teams of different national selections kept in secret their training sessions, these data could not be obtained. Some players reported they usually train an average of 14 hours per week and 70% of time is for tactic sessions.

Study design

This work is a cross-sectional observational study.

Procedure

Anthropometric measurements were performed in a resting day during the concentration period. The restricted profile of ISAK I (International Society for the Advancement of Kinanthropometry) methodology was used by two ISAK certified anthropometrists with an individual technical error of measurement (TEM) of 0.76-0.39% for skinfolds and 0.12% for the remaining parameters. The errors were considered acceptable for ISAK standards (<7.5% for skinfolds and <1.5% for the rest of measurements). Anthropometric parameters included weight in kg, height in m, eight skinfolds in mm, four girths in cm and three breadths in cm (Marfell-Jones et al., 2006). Skinfolds, girths and breadths were measured with a calliper, flexible metallic tape and pachymeter, respectively (Holtain, Crymych, UK). A calibrated digital scale (Tanita, Tokyo, Japan) was used to measure the volunteer´s weight.

Body composition analyses

Bone and muscle mass were obtained through Rocha's equation (Rocha, 1975) and Lee´s formula (Valensise et al., 2000), respectively. Fat mass was estimated using Siri's formula (Siri, 1959), calculating corporal density value through Withers' equation (Withers, 1987). Residual mass was calculated from the difference between the total body weight minus the sum of the bone, muscle and fat masses.

Somatotype components were measured from the analysis of different body compartments, including muscle mass for mesomorphy, fat mass for endomorphy, and thinness and relative bone linearity for ectomorphy. A somatochart was obtained from these components (Carter & Heath, 1990). The heterogeneity of each national team was calculated using the somatotype attitudinal mean (SAM) and the differences between the average somatotype in the national teams was calculated through somatotype attitudinal distance (SAD) (Carter, 2002).

Weekly food consumption record

A questionnaire of food consumption frequency was provided to each player before the anthropometric analyses in Spanish or English [see Additional file 1]. The questionnaire comprised of 19 food-related items with multiple questions regarding types of food, consumption frequency (days per week) and quantity of each food group. Also, the questionnaire addressed other issues such as hydration during the match and the use of nutritional and ergogenic aids.

Statistical analysis

For this pilot study, SPSS Statistics V. 20.0 package (Illinois, USA) was used to process the anthropometric, nutritional and dietetic data obtained from the volunteers. Standard descriptive statistics were presented as mean ± standard deviation (SD) and range. One-sample K-S test (Kolmogorov-Smirnov test) and homoscedasticity Levene test were performed in order to assess if each variable fitted a normal distribution. Non-parametric tests for independent samples (Tukey test and Games-Howell test) were used to compare data between the teams and field positions. A two-way analysis of variance (ANOVA) was used to assess the differences between national teams. Chi-square test was used to correlate anthropometric values with food consumption between national teams and field positions. Values with a $p<0.05$ were considered significant.

RESULTS

Anthropometric characteristics of field hockey players

The teams analysed in this study were: Spain (n = 18; 1.77 ± 0.1 m; 74.2 ± 6.8 kg), Netherlands (n = 15; 1.79 ± 0.1 m, 71.6 ± 5.9 kg) and Germany (n = 18; 1.80 ± 0.1 m; 78.5 ± 8.2 kg).The analysis of anthropometric data indicated that Germany was the national team with higher adiposity, with the sum of 7 skinfolds and percentage of fat mass (%FM) being 93.1 ± 26.9 mm and 16.3 ± 4.8 %, respectively, without significant differences among the other; while FM (12.3 ± 3.6 kg) showed significant differences compared to the Netherlands players (8.7 ± 2.8 kg) (Table 1). Similarly, the German team presented a higher endomorphic component (3.1 ± 0.8) and higher bone mass compared to the Netherlands team (12.6 ± 1.1 kg *vs* 11.3 ± 1.4 kg respectively), especially concerning humeral and wrist breadth.

Table 1: Descriptive anthropometric characteristics of field hockey players (without goalkeepers) for each national team and their combined score.

	Spain (n=16)		Netherlands (n=13)		Germany (n=16)		All (n=45)	
	mean ± SD[a]	[range]	mean ± SD	[range]	mean ± SD	[range]	mean ± SD	[range]
Age (years)	18.9 ± 0.7	[18.0-20.0]	18.8 ± 0.6	[18.0-20.0]	19.1 ± 0.9	[17.0-20.0]	18.9 ± 0.7	[17.0-20]
Body mass (Kg)	73.6 ± 7.3	[63.2-87.2]	71.0 ± 5.6	[62.0-79.8]	76.8 ± 6.6	[62.2-89.9]	73.8 ± 6.6	[62.0-89.8]
Height (m)	1.78 ± 0.1	[1.7-1.9]	1.77 ± 0.0	[1.7-1.8]	1.78 ± 0.1	[1.7-1.9]	1.78 ± 0.1	[1.7-1.9]
BMI[b] ($kg \cdot m^{-2}$)	23.6 ± 1.9	[20.6-27.3]	22.6 ± 1.9	[19.8-26.2]	24.1 ± 1.6	[21.5-28.7]	23.5 ± 1.8	[19.8-28.7]
Sum of 7 skinfold (mm)	77.9 ± 21.9	[43.8-117.5]	69.5 ± 19.5	[44.3-122.2]	88.6 ± 22.3	[61.6-128.4]	80.2 ± 22.0	[43.8-128.4]
Subscapular skinfold (mm)	9.8 ± 1.7	[7.4-12.8]	8.7 ± 1.1	[6.3-10.2]	10.7 ± 2.3	[7.5-15.4]	9.7 ± 1.8	[6.3-15.4]
Triceps skinfold (mm)	9.7 ± 3.1	[5-14.6]	8.2 ± 2.8*	[4.6-16.4]	11.3 ± 2.7*	[7.2-16.9]	9.7 ± 2.9	[4.616.9]
Biceps skinfold (mm)	5.0 ± 1.3	[3.0-7.4]	4.7 ± 1.7	[2.6-9.0]	6.1 ± 2.3	[4.2-13.4]	5.3 ± 1.8	[2.6-13.4]
Suprailiac skinfold (mm)	17.8 ± 6.6	[8.3-30.2]	16.7 ± 5.0	[9.4-26.2]	20.1 ± 6.5	[12.0-35.2]	18.2 ± 6.1	[8.3-35.2]
Supraspinal skinfold (mm)	9.3 ± 3.3	[4.7-17.5]	8.3 ± 2.9	[5.6-16.0]	10.2 ± 3.1	[6.4-15.3]	9.2 ± 3.1	[4.7-17.5]
Abdominal skinfold (mm)	13.5 ± 5.0	[6.7-22.3]	12.1 ± 6.1	[7.2-27.0]	16.3 ± 6.7	[8.7-27.8]	14.1 ± 6.0	[6.7-27.8]
Thigh skinfold (mm)	12.7 ± 4.5	[6.8-21.2]	10.8 ± 3.1	[6.8-18.2]	13.2 ± 3.4	[8.6-20.0]	12.2 ± 3.8	[6.8-21.2]
Calf skinfold (mm)	7.9 ± 3.0	[4.1-15.6]	6.4 ± 2.3	[3.8-12.6]	8.1 ± 1.5	[4.8-10.6]	7.4 ± 2.3	[3.8-15.6]
Upper arm girth relaxed (cm)	29.9 ± 2.2	[26.4-34.0]	28.5 ± 1.9**	[26.0-31.3]	30.9 ± 1.4**	[28.3-33.3]	29.8 ± 1.8	[26.0-34.0]
Upper arm girth flexed and tensed (cm)	31.6 ± 1.9	[28.0-35.5]	30.9 ± 2.3	[28.0-34.5]	32.6 ± 1.4	[30.6-35.8]	31.7 ± 1.9	[28-35.8]
Thigh girth (cm)	53.1 ± 2.8	[49.2-59.0]	50.6 ± 2.7	[46.0-55.8]	52.8 ± 2.1	[48.8-57.3]	52.2 ± 2.5	[46.0-59.0]
Calf girth (cm)	37.0 ± 1.5	[34.0-39.0]	36.5 ± 2.5	[33.0-40.5]	38.0 ± 1.7	[34.0-41.3]	37.2 ± 1.9	[33.0-41.3]
Humeral breadth (cm)	7.0 ± 0.4	[6.2-7.4]	6.8 ± 0.2**	[6.5-7.3]	7.2 ± 0.2**	[6.8-7.7]	7.0 ± 0.3	[6.2-7.7]
Wrist breadth (cm)	5.7 ± 0.4	[5.0-6.2]	5.5 ± 0.2**	[5.2-6.0]	5.9 ± 0.3**	[5.2-6.4]	5.7 ± 0.3	[5.0-6.4]
Femoral breadth (cm)	9.8 ± 0.4	[9.0-10.4]	9.2 ± 1.4	[4.6-10.2]	9.9 ± 0.4	[9.4-10.6]	9.6 ± 0.8	[4.6-10.6]
Endomorphy	2.8 ± 0.8	[1.6-4.0]	2.4 ± 0.7*	[1.5-4.2]	3.1 ± 0.8*	[2.2-4.5]	2.8 ± 0.7	[1.5-4.5]
Mesomorphy	4.2 ± 0.9	[2.8-6.2]	3.6 ± 1.2	[1.9-5.3]	4.4 ± 0.8	[3.1-6.0]	4.0 ± 1.0	[1.9-6.2]
Ectomorphy	2.3 ± 1.0	[0.5-3.7]	2.7 ± 1.0	[0.9-4.2]	2.2 ± 0.8	[0.1-3.4]	2.4 ± 0.9	[0.1-4.2]

MM[c] (kg)	33.2 ± 2.9	[27.3-38.6]	32.8 ± 3.0	[29.0-38.8]	34.2 ± 2.6	[29.0-39.5]	33.4 ± 2.8	[27.3-39.5]
MM (%)	45.2 ± 2.8	[40.1-49.6]	46.2 ± 2.5	[42.2-49.6]	44.7 ± 2.6	[41.1-52.2]	45.4 ± 2.6	[40.1-52.2]
FM[d] (kg)	10.1 ± 3.2	[5.2-16.9]	8.7 ± 2.8*	[4.9-16.4]	12.3 ± 3.6*	[7.1-18.4]	10.5 ± 3.5	[4.9-18.4]
FM (%)	13.7 ± 3.8	[7.8-20.6]	12.2 ± 3.4	[7.9-21.5]	15.5 ± 3.9	[10.8-22.6]	14.1 ± 3.8	[7.8-22.6]
BM[e] (kg)	12.1 ± 1.3	[9.7-13.9]	11.3 ± 1.4*	[7.3-13.3]	12.6 ± 1.1*	[10.0-15.0]	12.0 ± 1.3	[7.3-15.0]
BM (%)	16.5 ± 1.4	[14.3-19.2]	16.0 ± 2.3	[9.1-17.7]	16.5 ± 1.1	[14.0-18.7]	16.3 ± 1.6	[9.1-19.2]
RM[f] (kg)	18.2 ± 2.8	[12.3-22.7]	18.2 ± 2.9	[13-24.0]	17.3 ± 3.6	[9.7-23.3]	17.9 ± 3.1	[9.7-24.0]
RM (%)	24.6 ± 2.3	[19.5-28.7]	25.6 ± 3.1*	[20.7-30.3]	22.5 ± 4.1*	[12.4-29.6]	24.2 ± 3.3	[12.4-30.3]
Waist perimeter (cm)	82.3 ± 7.4	[73.8-98.0]	77.6 ± 4.4	[69.0-84.5]	79.9 ± 2.8	[74.0-84.2]	79.9 ± 5.2	[69.0-98.0]
Hip perimeter (cm)	93.5 ± 9.0	[73.0-104.0]	93.5 ± 3.2	[87.0-98.3]	97.7 ± 2.6	[94.3-102.0]	94.9 ± 5.8	[73.0-104.0]
SAM[g]	2.0	[2.0-2.0]	1.6	[1.6-1.6]	1.2	[1.2-1.2]	-	[1.2-2.0]

[a]SD=standard deviation; [b]BMI=body mass index; [c]MM=muscle mass; [d]FM: fat mass; [e]BM=bone mass; [f]RM=residual mass; [g]SAM=somatotype attitudinal mean. *p <0.05 comparing Netherlands vs Germany. **p <0.01 comparing Netherlands vs Germany.

The players presented a balanced mesomorphic somatotype (2.8-4.0-2.4) (Figure 1). SAM index indicated no significant differences between teams, although the Spanish players possessed the highest heterogeneity (2.0), while the Germans tended to present the lowest (1.2) (Table 1). Nevertheless, somatotype´s means between both selections were not significant, since SAD was smaller than 1 (0.4). However, significant differences were observed when comparing German and Netherlands teams (SAD = 1.4), as the last tended to be more ectomorphic, while the German team presented a more endomorphic-mesomorphic somatotype.

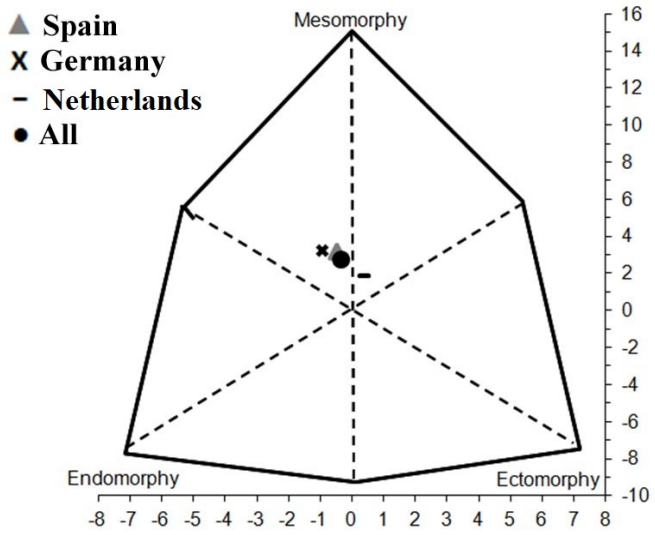

Figure 1. Mean somatotype representation of each hockey field national selections and the whole mean in somatochart.

Anthropometric analysis of the different field positions

The analysis of the anthropometric data indicated that the goalkeepers were the tallest (1.87 ± 0.1 m) and possessed the longest humeral breadth (7.5 ± 0.3 cm). In addition, they presented a significantly higher bone mass compared to midfielders (13.7 ± 1.7 and 11.4 ± 1.7 kg respectively) (Table 2). Similarly, body mass in the goalkeepers was higher than in midfielders (82.5 ± 7.7 and 71.6 ± 8.3 kg respectively).

No significant differences were detected with respect to the endomorphic, mesomorphic and ectomorphic values between the different field positions. Therefore, the goalkeeper´s somatoplots were in the balanced mesomorphic somatotype area of the somatochart, which was within the mean values of the other field players (Figure 2).

Table 2: Descriptive anthropometric characteristics of field hockey players organized by position during the game.

	Position							
	Goalkeeper (n=6)		**Defense (n=15)**		**Midfielder (n=13)**		**Forward (n=17)**	
	mean ± SD[a]	[range]	mean ± SD	[range]	mean ± SD	[range]	mean ± SD	[range]
Age (years)	19.2 ± 0.8	[18-20]	18.9 ± 0.6	[18.0-20.0]	19.1 ± 1.0	[17.0-20.0]	18.8 ± 0.7	[18.0-20.0]
Body mass (Kg)	82.5 ± 7.7*	[74.1-92.0]	75.3 ± 5.9	[67.9-89.8]	71.6 ± 8.3*	[62.0-85.0]	74.6 ± 6.4	[62.8-87.5]
Height (m)	1.87 ± 0.1*	[1.8-2.0]	1.79 ± 0.1*	[1.7-1.90]	1.77 ± 0.1*	[1.7-1.9]	1.77 ± 0.1*	[1.7-1.9]
BMI[b] ($kg \cdot m^{-2}$)	23.5 ± 1.1	[21.9-25.2]	23.5 ± 1.5	[20.5-26.2]	23.2 ± 2.4	[19.8-28.7]	23.7 ± 1.7	[20.3-27.3]
Sum of 7 skinfold (mm)	90.4 ± 16.0	[66.4-111.4]	80.7 ± 23.7	[53.3-128.4]	75.2 ± 25.4	[43.8-117.8]	80.1 ± 20.0	[58.2-120.4]
Subscapular skinfold (mm)	10.8 ± 2.3	[7.2-13.0]	9.6 ± 1.7	[7.4-13.0]	9.6 ± 2.2	[6.3-13.8]	10.1 ± 2.0	[7.2-15.4]
Triceps skinfold (mm)	12.1 ± 3.2	[9.4-18.4]	10.1 ± 3.3	[5.3-16.4]	9.7 ± 4.0	[4.6-16.9]	9.8 ± 2.1	[7.0-14.1]
Biceps skinfold (mm)	6.0 ± 3.2	[4.0-12.4]	6.1 ± 2.4	[4.0-13.4]	4.7 ± 1.4	[2.6-7.4]	5.1 ± 1.4	[3.4-8.3]
Suprailiac skinfold (mm)	22.3 ± 4.7	[14.0-28.0]	18.7 ± 6.7	[11.0-35.2]	16.7 ± 6.4	[8.3-28.8]	19.2 ± 5.6	[12.0-30.2]
Supraspinal skinfold (mm)	11.0 ± 3.3	[7.0-14.8]	9.4 ± 3.0	[5.6-16.0]	9.2 ± 3.4	[4.7-15.3]	9.3 ± 3.3	[5.5-17.5]
Abdominal skinfold (mm)	14.7 ± 3.9	[10.4-18.8]	14.4 ± 6.9	[6.7-27.8]	13.9 ± 6.6	[7.0-26.8]	13.7 ± 5.7	[7.2-27.4]
Thigh skinfold (mm)	13.5 ± 2.7	[9.2-17.5]	12.4 ± 3.6	[7.4-20.0]	11.4 ± 4.3	[6.8-20.2]	13.0 ± 3.7	[8.8-21.2]
Calf skinfold (mm)	9.0 ± 2.7	[5.4-12.6]	6.9 ± 1.7	[4.2-9.1]	7.1 ± 2.5	[3.8-10.6]	8.4 ± 2.7	[5.6-15.6]
Upper arm girth relaxed (cm)	30.8 ± 1.4	[29.0-32.5]	29.8 ± 2.2	[26.0-32.6]	29.7 ± 2.2	[26.4-33.3]	30.1 ± 1.8	[27.0-34.0]
Upper arm girth flexed and tensed (cm)	33.2 ± 1.7	[31.5-35.6]	31.5 ± 1.7	[28.2-34.5]	31.7 ± 2.5	[28.0-35.8]	32.1 ± 1.7	[28.0-35.5]
Thigh girth (cm)	52.6 ± 2.0	[51.0-55.3]	52.5 ± 1.9	[48.5-55.3]	52.4 ± 3.6	[46.0-59.0]	52.0 ± 2.6	[47.7-56.1]
Calf girth (cm)	37.7 ± 1.4	[36.5-40.2]	37.9 ± 1.9	[33.8-41.3]	36.7 ± 2.3	[33.0-39.3]	37.0 ± 1.7	[33.0-39.3]
Humeral breadth (cm)	7.5 ± 0.3*	[7.1-8.0]	7.0 ± 0.3*	[6.3-7.5]	6.9 ± 0.3**	[6.2-7.3]	7.1 ± 0.3*	[6.5-7.7]
Wrist breadth (cm)	5.8 ± 0.6	[4.9-6.4]	5.7 ± 0.3	[5.0-6.2]	5.7 ± 0.3	[5.0-6.1]	5.8 ± 0.4	[5.2-6.4]
Femoral breadth (cm)	10.2 ± 0.5	[9.7-11.1]	9.8 ± 0.4	[9.0-10.5]	9.3 ± 1.5	[4.6-10.4]	9.9 ± 0.4	[9.2-10.6]
Endomorphy	3.1 ± 0.6	[2.2-4.1]	2.8 ± 0.8	[1.9-4.2]	2.8 ± 1.0	[1.5-4.5]	2.8 ± 0.7	[1.9-4.2]
Mesomorphy	3.7 ± 1.0	[2.2-5.0]	4.0 ± 0.9	[2.2-5.4]	4.0 ± 1.2	[1.9-6.0]	4.2 ± 1.0	[2.4-6.2]
Ectomorphy	2.9 ± 0.6	[2.4-4.0]	2.5 ± 0.9	[0.9-4.1]	2.4 ± 1.2	[0.1-4.2]	2.2 ± 0.8	[0.5-3.8]

MM[c] (kg)	35.3 ± 2.4	[32.4-38.6]	33.9 ± 2.5	[30.4-39.5]	33.1 ± 3.8	[27.3-39.0]	33.3 ± 2.4	[29.0-38.6]
MM (%)	42.9 ± 1.9	[40.7-46.10]	45.1 ± 2.1	[42.1-49.6]	46.4 ± 3.1	[41.1-52.2]	44.7 ± 2.7	[40.1-49.6]
FM[d] (kg)	13.1 ± 3.0	[9.1-16.8]	10.7 ± 3.6	[6.8-18.4]	10.5 ± 4.7	[5.2-17.6]	10.6 ± 3.2	[7.0-17.5]
FM (%)	15.9 ± 2.8	[11.7-19.50]	14.2 ± 4.2	[9.4-22.6]	13.2 ± 4.4	[7.8-20.7]	14.0 ± 3.5	[10.2-21.1]
BM[e] (kg)	13.7 ± 1.7**	[11.4-15.8]	12.3 ± 1.2	[9.7-15.0]	11.4 ± 1.7**	[7.3-13.9]	12.3 ± 1.0	[10.8-14.0]
BM (%)	16.6 ± 1.1	[14.6-17.7]	16.3 ± 1.1	[14.3-18.2]	16.1 ± 2.6	[9.1-19.2]	16.6 ± 1.0	[15.0-18.7]
RM[f] (kg)	20.4 ± 2.1	[18.1-23.5]	18.4 ± 2.2	[14.9-22.9]	16.5 ± 4.1	[9.7-24.0]	18.4 ± 2.8	[13.0-23.3]
RM (%)	24.7 ± 1.6	[22.2-26.9]	24.5 ± 2.7	[19.1-28.7]	23.1 ± 4.7	[12.4-30.1]	24.7 ± 3.0	[19.6-30.3]
Waist perimeter (cm)	85.5 ± 5.9	[80.8-97.0]	79.3 ± 2.9	[75.3-84.5]	79.4 ± 6.0	[69-92.0]	81.3 ± 6.7	[74.0-98.0]
Hip perimeter (cm)	96.1 ± 8.7	[79.1-101.9]	97.2 ± 2.5	[94.0-101.7]	94.1 ± 7.4	[73.0-104.0]	93.7 ± 6.8	[78.5-102.0]

[a]SD=standard deviation; [b]BMI=body mass index; [c]MM=muscle mass; [d]FM: fat mass; [e]BM=bone mass; [f]RM=residual mass. *p <0.05; **p <0.01 comparing to goalkeepers.

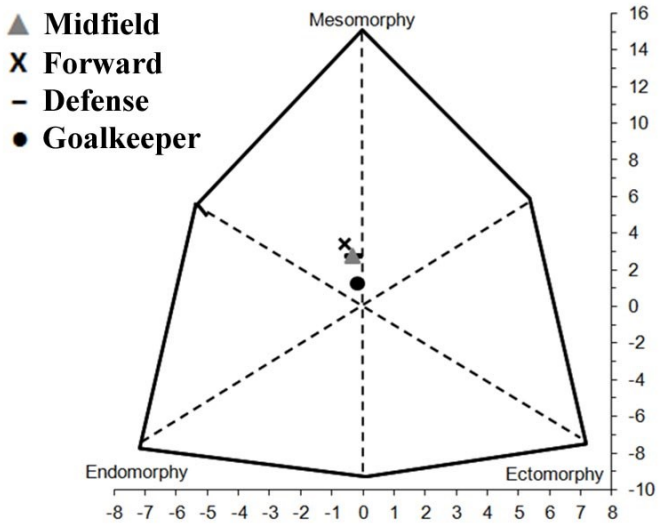

Figure 2. Mean somatotype representation of each hockey field position in somatochart.

Analysis of food type consumption in field hockey players

Regarding dairy products, 50% of players consumed at least one serving daily (Table 3), being yoghurt the least consumed, with 21.3% reporting to never include it in their diet.

A total of 59.6% of the volunteers reported moderate consumption of oils daily to cook meals or as vegetable dressing. Over half the players (51.0%) did not consume polyunsaturated fats from nuts, while 47.0 % reported a daily intake of 25-50 g.

The majority (78.7%) consumed 100-200 g daily of meat and 55.3% reported eating one egg weekly. Altogether, this observation seems to indicate that foods from animal origin are the most consumed, being the main protein source in field hockey players. The exception seems to be fish or seafood, which is less consumed.

By contrast, plant-based foods were the less consumed, specifically 17.0% of the players reported not consuming fruit. Only 12.8 % of players consumed 3-4 pieces of fruit daily and only 2.1 % ate more than 2 dishes of vegetables per day. The main part of the players (85.2%) consumed legumes weekly, but only 2.1 % consumed more than 1 dish (Table 3).

Carbohydrate rich foods based on cereals were frequently consumed and at significant quantities, with 87.3% of the players eating 1-4 slices of bread per day. Only 25.0 % of players did not consume any kind of breakfast cereals and 72.4 % consumed more than 100 g daily.

Table 3: Daily and weekly intake of food groups in field hockey players.

	Frequency				
Milk	**daily**	**No consumption**	**1 glass**	**2 glasses**	**> 2 glasses**
		10.6%	51.1%	23.4%	14.9%
Yoghurt	**daily**	**No consumption**	**1 unit**	**2 units**	**> 2 units**
		21.3%	63.8%	12.8%	2.1%
Cheese	**daily**	**No consumption**	**20-40 g**	**40-60 g**	**> 60g**
		6.4%	51.1%	40.4%	2.1%
Oils	**daily**	**No consumption**	**Few**	**Moderate**	**High**
		6.4%	31.9%	59.6%	2.1%
Meats	**daily**	**No consumption**	**100-200 g**	**200-400 g**	
		4.3%	78.7%	17.0%	
Eggs	**weekly**	**No consumption**	**1 unit**	**2 units**	
		10.6%	55.3%	34.0%	
Fish/Seafood	**weekly**	**No consumption**	**100-200 g**	**200-400 g**	
		21.3%	70.2%	8.5%	
Legumes	**weekly**	**No consumption**	**Half dish**	**1 dish**	**>1 dish**
		12.8%	42.6%	42.6%	2.1%
Vegetables	**daily**	**No consumption**	**Half dish**	**1 dish**	**>1 dish**
		12.8%	42.6%	42.6%	2.1%
Fruit	**daily**	**No consumption**	**1-2 pieces**	**3-4 pieces**	**> 4 pieces**

		17.0%	68.1%	12.8%	2.1%
Nuts	**daily**	**No consumption**	**< 25 g**	**25-50 g**	
		51.0%	2.0%	47.0%	
Bread	**daily**	**No consumption**	**1-2 slices**	**3-4 slices**	**> 4 slices**
		2.1%	42.6%	44.7%	10.6%
Cereals	**daily**	**No consumption**	**50-100 g**	**100-200 g**	**> 200 g**
		25.0%	2.0%	36.2%	36.2%
Baked Goods	**weekly**	**No consumption**	**1 muffin or cake/ 6 cookies**	**2 muffin or cakes/ 12 cookies**	**> 2 muffin or cakes/ 12 cookies**
		21.3%	72.3%	4.3%	2.1%
Precooked food	**weekly**	**No consumption**	**rarely**	**sometimes**	**often**
		17.0%	34.0%	44.7%	4.3%
Soft drinks	**daily**	**No consumption**	**1 tin**	**2 tins**	**> 2 tins**
		14.9%	68.1%	12.8%	4.3%
Sugar	**daily**	**No consumption**	**20-40 g**		
		42.6%	57.4%		
Salt	**daily**	**No consumption**	**Usually added salt**		
		14.9%	85.1%		
Alcohol	**weekly**	**No consumption**	**1 glass**	**2 glasses**	**> 2 glasses**
		17.0%	23.4%	31.9%	27.7%

Regarding other food types, the majority of the field hockey players (72.3 %) consumed at least 1 serving of confectionery products weekly, accompanied with the daily intake of at least 1 soft drink (68.1 %). While the Netherlands team consumed more isotonic drinks (21.4 %, p=0.03), the Germans presented the highest daily consumption of energy drinks (25.0 %, p=0.03). The use of sugar is frequent in the majority of the players (57.0%) with a consumption of 20-40 g daily. On the other hand, 4.3% of the players did not consume precooked meals and 44.7% reported a low consumption. Hence, the daily salt consumed was that added to the different meals (85.1 %) but not from precooked meals, which usually contain high quantities of sodium.

Finally, these players tend to drink alcohol regularly during the week, mainly in the weekends. Netherlands players reported drinking more than 2 cups per day (50.0 %, p=0.02), presenting a significantly higher consumption compared to Germans, but not to Spanish. Beer is the alcoholic beverage mostly consumed by Netherlands players (42.9 %, p=0.005). Only 17.0 % of players never consumed alcohol during the season.

Relation between anthropometric characteristics and food type consumption

A correlation analysis between the differences in anthropometric parameters and food frequency consumption of the 3 national teams was performed. The differences of bone mass percentage between the Netherlands and German teams correlated (p=0.02) with the daily consumption of non-skimmed yoghurts (64.7 %) by the German team. On the other hand, the Spanish players consumed more yoghurts (93.8 %) but did not present bone mass differences compared to the other teams, indicating that other factors may be contributing to the bone mass content.

When FM were analysed, 58.8% of the German players consumed moderate amounts of oil and possessed more FM than other players of national teams, and both variables (oil intake and FM) correlated in a significant way (p = 0.046). 57.1% of the Netherlands players rarely consumed oil and presented less FM. On the other hand, 87.5% of the Spanish players consumed the same quantity of oil than the Germans, but FM differences were not significant. Again, other factors aside from oil consumption may contribute to FM content.

Hydration strategies during the match day

Regarding hydration, only 9.8 % of the players followed a hydration strategy at the beginning of the match. Approximately 21.6% consumed liquids 30-60 min before the match and an additional 39.2% consumed 1-2 h before (Table 4). Water (49.0 %) accompanied with isotonic drinks (39.2 %) were commonly used. During the match, and normally in the time breaks, water (49.0 %) accompanied with isotonic drinks (33.3 %) were again the most commonly-used beverages. After the match, field hockey players consumed water (54.8 %) to re-hydrate, while over a third consumed water along with isotonic drinks (35.3 %). The most common moment to re-hydrate was at the end of the match (60.8 %) (Table 4).

Supplementation in field hockey players

The most commonly-used nutritional supplements by the hockey field players of the 3 teams were protein shakes (7.8 %), vitamins (7.8 %) or both (5.9 %), as well as carbohydrate shakes (2.0 %). The majority of players (76.5 %) of the 3 teams did not consume any kind of supplemental aid. Regarding frequency, vitamins were consumed daily, while in the case of protein shakes, these were taken 2-4 times at week in all teams.

DISCUSSION

To our knowledge, this is the first pilot study performed in hockey players that tries to correlate body composition parameters to food type consumption. In addition, body composition with respect to the player´s field position was analysed. Finally, certain particular aspects related to performance, such as hydration the day of the match and supplement consumption was investigated. It should be noted that the characteristics of training sessions (intensity, volume, frequency and type) can also influence body composition, but these data were not provided by coach teams. Therefore, this is a weakness of the present pilot study.

Regarding anthropometric parameters and in comparison with other outdoor field sports, such as soccer (Casajús & Aragonés, 1991), field hockey players were lighter (77.3 $\pm$ 6.1 kg in soccer *vs* 73.8 $\pm$ 6.6 kg in hockey) for similar heights (1.78 $\pm$ 6.5 m in soccer *vs* 1.78 $\pm$ 0.1 in hockey). Elite soccer players have a %FM between 7.9-11.2 % (Casajús & Aragonés, 1991) below that of field hockey players (14.1 %). It must be mentioned that the regression equations used to calculate the anthropometric parameters in soccer players were different than in the present study, in spite of using a similar anthropometric methodology for the measurements. Despite this, the comparison between soccer and field hockey players indicates significant differences between somatotypes in the endomorphic component (2.2-5.1-1.9 in soccer and 2.8-4.0-2.4 in hockey). The heterogeneity in elite soccer players is low (SAM = 0.95) compared with field hockey selections (SAM = 1.2-2.0), suggesting that there is a higher degree of specialization in certain field positions in field hockey. Other national field hockey teams, such as Argentina, presented less endomorphy (2.0 $\pm$ 0.5), but similar mesomorphy (4.5 $\pm$ 0.9) and ectomorphy (2.7 $\pm$ 0.9) than the nationals teams of the present study (Holway & Seara, 2011).

When national teams were compared, only the Netherlands and German teams presented significant differences in body fat component. The German team possessed a significantly higher FM (being triceps the most significant skinfold) with respect to the Netherlands team, as well as endomorphy.

It was observed that the studied teams did not have a sport dietitian, nor suitable dietetic or nutritional guidelines specific for this sport discipline.

Table 4: Hydration strategies before, during and after the match by hockey field players.

Before match						
Time before the match	**0 min**	**15-30 min**	**30-60 min**	**1-2 h**	**2-3 h**	**3-4 h**
%	9.8	9.8	21.6	39.2	11.8	7.8
Type of beverage	**Water**	**Isotonic drink**	**Water + Isotonic drink**	**Water + Isotonic + hypotonic drink**	**Protein shake**	**Carbohydrate shake**
%	49.0	2.0	39.2	2.0	3.9	3.9

During match							
Type of beverage	**Water**	**Isotonic drink**	**Water + Isotonic drink**	**Water + Isotonic + hypotonic drink**	**Protein shake**	**Protein shake + Isotonic drink**	**Carbohydrate shake**
%	49.0	5.9	33.3	2.0	2.0	3.9	3.9

After match							
Time after match	**0 min**	**15-30 min**	**30-60 min**	**1-2 h**	**2-3 h**	**3-4 h**	
%	60.8	17.6	9.8	5.9	2.0	3.9	
Type of beverage	**Water**	**Isotonic drink**	**Water + Isotonic drink**	**Protein shake**	**Protein shake + Isotonic drink**	**Protein shake + stimulant drink**	**Carbohydrate shake + Isotonic drink**
%	54.9	2.0	35.3	2.0	2.0	2.0	2.0

Therefore, the players followed standard diet habits of their respective countries. In this context, the German players tended to consume more oils per day than the Netherlands players, which correlated with their higher fat mass. In addition, these results confirm the tendency of oil consumption in general for the German population (34 g/day) compared to the Netherlands (17-25 g/day) (Van Rossum et al., 2011; Heuer et al., 2015) for the same age ranges as those of the present pilot study. On the other hand, yoghurt consumption, in general, positively correlated with bone mass. The differences between German and Netherlands players were evident regarding humeral and wrist breadth. These results are in relation with the national consumption of yoghurts in Netherlands (28.0-31.0 g/day) and Germany (75.0 g/day) (Van Rossum et al., 2011; Heuer et al., 2015). An extra source of calcium and D vitamin from yoghurts could explain this observation during the child development phase of the German players, since there are evidences that the Netherlands´ daily dairy calcium intake is below the recommended values (van den Berg, 2014). It is possible that more factors than diet are behind these anthropometric differences (sun exposure and strength training would be the most likely). In this context, Spanish players consume similar amounts of oils as Germans, but body fat parameters presented no significant differences compared to Netherlands players. Interestingly, Spain is the highest oil consumer of all countries studied (48.6-50.4 g/day) (Varela-Moreiras et al., 2010), but Spanish players show a lower consumption than the general population. In addition, Spanish players have humeral, wrist breadth and bone mass values between these national teams but with no correlation to yoghurt consumption. Therefore, genetic differences might be the cause, which must be taken in account for future studies.

Regarding field position, the only significant differences observed were in the goalkeepers. Therefore, a higher wingspan could confer an advantage since it allows the player to cover more goal area (Srhoj, Marinović & Rogulj 2002). In the present study, the goalkeepers presented significant differences in height (1.87 m) and humeral breadth (7.5 cm) compared to the rest of the players. Although arm length was not measured, humeral breadth could indicate a higher arm size compared to other players. Therefore, height and humeral breadth could be considered as an advantage to cover the goal with certain efficiency, but other components are to also be considered, as indicated in previously published data (Heuer et al., 2015).

Finally, the pilot study analysed certain nutritional aspects related to performance, such as hydration the day of the match and supplement consumption. Regarding hydration, an excess in weight loss of more than 2% could hinder performance (Rodriguez, Di Marco & Langley, 2009; Rodriguez, Di Marco & Langley, 2009;), and is more frequent in hot conditions where high sweat losses can favour a hypo-hydration state. In this context, there are three important moments to control hydration: before the match, during the match (including the rest period and breaks) and at the end. Most of the field hockey players try to drink at least 2h before the match, using water, isotonic drinks or both. Salts contained in isotonic drinks could avoid cramps in prone players, but this is still a debated issue (Holway & Spriet, 2011). During the game breaks, in the rest period and at the end of the game, water and isotonic drinks are once

again used to rehydrate, being water the most common. A drink with 20 to 30 mmol/L of sodium and 2-5 mmol/L of potassium would be an adequate beverage and more suitable than only water, helping to the replacement of electrolyte losses during the game (Sawka et al., 2007). Nevertheless, additional information must be collected in order to define specific hydration strategies before the match (i.e. 6 ml of fluids/kg of body mass) and for replenishment once the match ended (i.e. ~100-150% of body mass losses) (Racinais et al., 2015). Moreover, field hockey is an intermittent exercise where the fluid and electrolyte losses may exceed daily dietary intake (Baker & Jeukendrup, 2014) and for this reason hydration strategies in training sessions and matches are instrumental. Only a small percentage of players consumed proteins in these three moments of the match, although advantages have not been demonstrated. However, protein intake could be useful after the match since it improves the restoration of fluids compared with a standard carbohydrate-electrolyte sport drink (Racinais et al., 2015).

Finally, it is interesting to mention that 76.5 % of the players did not consume any ergogenic or nutritional aid, being this figure above the average prevalence of male elite athletes (50-62 %) (Knapik et al., 2016). Protein and vitamin supplementation have a prevalence of 36 % and 37 %, respectively in elite sports practitioners, but in field hockey are used in less than 10 % of the players, maybe due to the idea that proteins are more associated to disciplines where resistance trainings are frequent. The use of vitamins should be used only when the daily diet is unbalanced or when there is a particular deficiency and diet cannot cover the daily requirements.

CONCLUSIONS

Field hockey players have a high degree in mesomorphy. Compared to soccer players, they are lighter and less lean but have a higher degree of specialization in certain field positions. German players present the highest values in body fat and bone mass, which correlated with a higher consumption of olive oil and yoghurt, respectively. With regard to differences in field position, only the goalkeepers presented a higher than average height and humeral breadth, which may confer a performance advantage. Strategies of hydration and recovery must be improved on the day-match.

Author contributions

Each author contributed as follows: NVS and AMR conceived and designed the experiments; NVS, AMR and BLV performed sample collection and measures; ER performed analytical measures and related data analysis.; NVS wrote the paper. All authors revised and critically evaluated the manuscript for important intellectual content. All authors approved the final version of the manuscript before submission and are accountable for data accuracy and integrity.

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Additional file 1. Weekly food consumption record.