DIETARY HABITS AND NUTRITIONAL INTERVENTION IN ELITE SPANISH ATHLETES

Sillero Quintana M[1], Garcia Aparicio A[1], Torres García A[1], Garrido Pastor G[1].
manuel.sillero@upm.es; amaia.garcia@upm.es;torresenfa@gmail.com;
lupe.garrido.pastor@upm.es

[1]Faculty of Physical Activity and Sport Sciences-INEF (Technical University of Madrid, UPM, Spain).

ABSTRACT

Diet evaluation of Spanish track and field athletes (n=67) using 3 day food record by a retrospective method, same days in an activity questionnaire physical training was recall to estimate energy expenditure rate (EER). Sample was 35 female and 32 male elite athletes from middle distance (MD = 800m and 1500m events), long distance (LD ≥ 3000m events) and fast and combined events (FC ≤ 400m events, jumpers, throwers and combined events). A group of 39 of them were evaluated twice times. Energy intake (EI) (Kcal/day) value was higher in male (p≤0.01) than in female athletes. Moreover, we found a higher (p=0.0001) EER in male than in female athletes. No differences in energy intake were found between different disciplines. FC athletes had a higher EER (p=0.047) than LD, however LD athletes' energy expenditure was similar to that of MD athletes. We observed a trend towards adequate energy balance in elite Spanish athletes. Energy distribution or percentage of energy derived from carbohydrates (%CH), proteins (%P), and lipids (%L) were all within the recommended acceptable macronutrient distribution range (AMDR) established by the Food and Nutrition Board (2006) but were not optimal for an athletic population. Similar energy distribution was found in both sexes. We found that Fast and Combined Events athletes consumed a lower percentage of energy in CH (p < 0.05) and a higher percentage in lipids (p < 0.05) than LD athletes. After nutritional intervention, second evaluation (V2) we observed a reduction (p < 0.01) in EI, due to a reduction in protein and lipid intakes. Different fat (saturated, monounsaturated and polyunsaturated) intake was reduced in V2 in both sexes. The aim of this study was to conduct a nutritional intervention in a group of athletes in order to make adequate food choices to attain optimal changes in energy distribution.

Key words: Track and Field- Athletes, Diet Assessment and Nutrition Advice,

1-INTRODUCTION

It is well recognised that athletic performance is enhanced by optimal nutrition (Rodriguez et al, 2009). Nutritional support for athletic performance is a popular and widely covered topic. However, most sport nutrition research has focused on endurance performance, and relatively little has been written about nutrition for athletes such as throwers, jumpers and those who perform combined events (Houtkooper, Abbot, & Nimmo, 2007). The Spanish Athletics Federation (RFEA) was concerned about this topic and signed a collaborative agreement with the Faculty of Physical Activity and Sport Sciences (INEF) of the Technical University of Madrid (UPM), supported by the Spanish Sport Council (CSD), in order to provide top Spanish athletes with nutritional counselling and monitoring.

Articles on nutrition topics for elite athletes disclose the characteristics of specialised nutrition for top athletes (Burke, Millet, & Tarnopolsky, 2007; Houtkooper, Abbot, & Nimmo, 2007; Stellingwerff, Boit, & Res, 2007; Tipton, Jeukendrup, & Hespel, 2007) propose periodised nutrition recommendations across the primary mesocycles of yearly periodised training. The general preparation period in all disciplines (endurance, sprint, thrower, jumpers, middle-distance and combined events) is dominated by elevated energy expenditure to support the large training load. However, in the competition phase energy expenditure is reduced due to lower training load. The first aim of this study was to describe high level athlete (n=67) diet composition and identify possible mistakes to ensure optimal diet. The second aim was to conduct a nutritional intervention in a group of them (n=39) in order to make adequate food choices to attain optimal changes in energy distribution.

2-SUBJECTS AND METHODS

The study consisted of a controlled diet composition assessment of Spanish Athletic Team members who were training at the high performance training centre of Madrid. The sample (n=67) included 35 female and 32 male elite athletes from middle distance (MD = 800m and 1500m events; 12 females and 12 males), long distance (LD > 3000m events; 10 females and 11 males) and fast and combined events (FC ≤ 400m events, jumpers, throwers and combined events; 13 females and 9 males).
A group of 39 of them (12 male and 27 females) were evaluated twice (see below for details). Nutritional counselling was performed during the same training season, and the second diet assessment was conducted close to the competition phase. A more detailed description of the total cases evaluated and the sample that received the nutritional intervention are shown in the results section (Table 1 and Table 2).

We contacted the athletes and their coaches in order to explain the purpose of the evaluation and the protocols that were going to be applied. It was emphasized that they were going to be asked to report a complete description of dietary intake on three different days of the week prior to the appointment through a retrospective diet assessment method.

Diet assessment was carried out through a personal interview with each athlete, using standardized questionnaires for recording food intake throughout the day (breakfast, lunch, dinner and snacks). Three different days were measured corresponding to a hard-training day (normally double-session day), a normal-training day and a rest day, one (n=67) or two (n=39) times after nutritional intervention.

Dietary data were transformed into energy and nutrients by DIAL software (Alce Ingeniería S.A., Madrid). This computer program is open and it can be updated introducing new recipes and/or commercial products. This software allowed us to analyse diet composition in macronutrients (proteins, carbohydrates and lipids) and in micronutrients (vitamins and minerals) and their distribution among the three main meals.

Physical activity and energy expenditure were estimated by the detailed report (15 minutes fractions) of every daily activity carried out during the three recorded days (hard-training, normal-training and rest days). Data were subsequently checked by the coach.

Physical activity level (PAL) was calculated dividing sum of daily MET by 24 hours ($PAL = \Sigma MET/24$ hr.).

Activity factor (PA) and athletes' gender and age were considered for calculating the estimated energy requirements (EER) (Food and Nutrition Board & (IOM), 2002). Both in females and males, PA was established according to the previously calculated PAL following the recommendations of the Food and Nutrition Board (2002) by activity group.

Equations for the estimation of the EER by gender and age of the athlete were (Food and Nutrition Board & (IOM), 2002):

Females (Over 18 years): EER (kcal/day) = 354 – (6.91 * age [years]) + PA * [(9.36 * weight [Kg.] + (726 * height [m])]

Males (Over 18 years): EER (kcal/day) = 662 – (9.53 * age [years]) + PA * [(15.91 * weight [Kg.] + (539.6 * height [m])]

Descriptive analysis of every recorded variable was calculated using SPSS 12.0. ANOVA analysis by discipline and Tukey post hoc analysis were carried out in order to identify differences between gender and athletes from different disciplines. In the case of gender, significant diferences were determined by non-related samples Student t-test. Nutritional Intervention results were assessed by related samples Student t-test among pre- and post-intervention results. Significant values were established in $p<0.05$ in each case.

3-RESULTS

Average age and basic anthropometric data by gender and discipline are shown in Table 1 for all the cases studied (n=106). We found that weight, height and body mass index (BMI) were significantly higher in males ($p\leq0.01$). Between different disciplines we found that athletes involved in fast (sprinter, jumper or throwers) and combined events were heavier and had a higher BMI than middle distance ($p\leq0.01$) or long-distance athletes ($p\leq0.01$) (Table 1).

Energy balance of athletes was determined based on the estimated energy input (EI) by diet and energy expenditure rate (EER). Mean EER (2641±448 kcal/day) was similar to energy intake described for all athletes (Figure 1). Energy intake expressed as absolute (Kcal/day) value was higher in male ($p\leq0.01$) than in female athletes. Moreover, we found a higher ($p=0.0001$) EER (3025±333 kcal/day) in male than in female athletes (2369±293 kcal/day).

No differences in EI absolute values were found between different disciplines (Figure 1). Conversely, FC athletes had an EER (2759±518 kcal/day) higher ($p=0.047$) than LD (2495±431 kcal/day), however LD athletes' energy expenditure was similar to that of MD athletes (2657±375 kcal/day). All these data reflect a trend towards adequate energy balance in elite Spanish athletes
.
Energy distribution or percentage of energy derived from carbohydrates (%CH), proteins (%P), and lipids (%L) were analysed (Figure 2), and mean values were all within the recommended acceptable macronutrient distribution range (AMDR) established by the Food and Nutrition Board (2006). Similar energy distribution was found in both sexes. We found that Fast and Combined Event athletes consumed a lower percentage of energy in CH ($p < 0.05$) and a higher percentage in lipids ($p < 0.05$) than long distance or endurance athletes.

We found that the most balanced meal was breakfast (Figure 3). The higher energy intakes occurred during lunch and dinner; however, dinner turned out to be the most unbalanced of all the groups, in which there was low consumption of carbohydrates and high consumption of lipids.

Intake of energy, protein, carbohydrates and lipids were determined in absolute terms and relative to body weight (Table 2). Although males were the largest consumers of protein ($p < 0.01$), carbohydrates ($p < 0.01$) and lipids ($p < 0.01$) in absolute values, we noted that those differences disappear when the intake values were related to weight.

Lipid consumption is shown in its different forms (saturated, monosaturated and polyunsatured fats), as well as the cholesterol intake (Table 3). A greater intake in saturated, monounsaturated and polyunsaturated fats and cholesterol was found in males. The cholesterol intake in the male and female groups approached the limit recommended (300 mg/day) by the American Heart Association (Krauss et al., 2000). However, the male group showed consumption well above the established upper level for cholesterol intake.

Basic anthropometric data describing nutritional intervention sample are shown in Table 4, representing the athletes that have been evaluated two times: V1 (previous nutritional Intervention) and V2 (after the nutritional intervention).

In the second evaluation (V2) we observed (Figure 4) a reduction ($p < 0.01$) in EI expressed as absolute relative to weight (Kcal/Kg). Similar changes were observed in EER that were lower ($p=0.002$) in V2 (2497±440kcal/day) than in V1 (2680±455 kcal/day). This tendency was found for both sexes: in V2, female EER (2273±284 kcal/day) was lower ($p=0.017$) than female EER in V1 (2454±285 kcal/day); for male athletes EER V2 (2454±285 kcal/day) was lower ($p=0.017$) than EER V1 (3188±337 kcal/day).

Changes in energy distribution (Figure 5) have been observed in V2, tending toward a more adequate diet. After nutritional intervention (V2): more energy comes from CH and low energy was derived from lipids in both sexes (Figure 5). In female athletes, Figure 6 shows a reduction in energy derived from lipids (%L) in all meals (breakfast, lunch, dinner and snack). On the other hand, lower lipid percentage was observed in male athletes only in snack composition. However, when we analysed the effect of nutritional intervention (V2) in all athletes, we found that lipid percentage was lower in the four meals ($p < 0.01$) in V2.

The effect of intervention was evaluated on macronutrient intake (Table 5) expressed in absolute terms (g/day) and related to body weight in V1 and V2, and we observed a reduction in protein and lipid intake after the intervention (V2). Different fat (saturated, monounsaturated and polyunsaturated) intake was reduced in V2 in both sexes (Table 6). Nevertheless, a significant reduction in cholesterol intake was found in females but not in males (Table 6).

4-DISCUSSION

Dietary inadequacies continue to persist among athletes and this general pattern of relative underconsumption of CH and overconsumption of fat has been found in other athletic populations (Aerenhouts D et al, 2008; Hinton, Sanford, Davidson, Yakushko, & Beck, 2004). Higher dietary carbohydrate content during hard running training had results in a better maintenance of physical performance and may affect mood state (Achten J. et al, 2004)

The percentage of energy coming from proteins fulfilled the recommendations, however the provision of calories from CH fell within the AMDR, but was at the lower end of the range (50% of total calories), which is not desirable for such an athletic population (Rodriguez et al, 2009; Burke, Millet, & Tarnopolsky, 2007; Stellingwerff, Boit, & Res, 2007). Mean percentage of energy coming from lipids was located in the upper limit (around 35%) both in male and female athletes. However a positive effect associated to nutritional intervention lead to a lower lipid intake and a reduced percentage of energy derived from lipids have been found in our study. By other hand a decrease in physical activity or training load close to competition phase may affect appetite and energy and nutrient balance, it is well know tha during competition phase fat intake could be reduce to about 20-25% of total energy intake. Protein intake when competitive period is close should be at a level to maintain lean muscle mass. That is why during the complete season is required a periodized nutrition that include a high CH intake but a lower fat and protein intake (Stellingwerff, T.,and al., 2007).

5-CONCLUSIONS

An adequate energy balance was found in elite Spanish athletes. Carbohydrate intake fell well short of the minimum recommended level for athletes, this fact persist after nutritional intervention however the energy derived from CH or %CH was increased. Lipids consumption was in the upper limit in male and female Spanish elite athletes, but was reduced after a nutritional advice.

Most balanced meal of Spanish elite athletes is breakfast. Lunch and dinner provided higher energy intakes, but specialty dinner was high in fats and low in carbohydrates content. Most of the meal composition changes energy distribution after nutritional intervention.

Spanish athletes surpass the recommended intake levels of cholesterol but this intake was reduced after nutritional counselling.

The lack of studies on nutrition, the poor nutritional culture among elite athletes, and the relevance of this issue on sport performance should encourage carrying out research projects focused on this matter with larger samples and specific protocols of athletes.

We have experienced that nutritional counselling was crucial on elite athletes and providing them with the guidelines for a more complete and correct diet that rewards the athletes for their hard training sessions.

6- REFERENCES

Achten J., Halson, S. L. Moseley, L. Moseley, L. and Jeukendrup, A. E (2004). Higher dietary carbohydrate content during intensified running training results in better maintenance of performance and mood state. *Journal of Applied Physiology, 96, 1131-1340.*

Aerenhouts D, H. M., Poortmans JR and Clarys P. (2008). Nutritional Habits of Flemish adolescent sprint athletes. *International Journal of Sport Nutrition and Exercise Metabolism, 18*, 509-523.

Burke, L., Millet, G., & Tarnopolsky, M. (2007). Nutrition for distance events. *Journal of Sports Sciences, 25*(Supplement 1), 29-38.

Food and Nutrition Board, & (IOM). (2002). *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids*. Washington (DC): National Academy Press.

Food and Nutrition Board, & IOM. (2006). *Dietary Reference Intakes. The essencial guide to nutrient requeriments.* Washington (DC): National Academies Press.

Hawley, J. A., Dennis, S. C., Lindsay, F. H., & Noakes, T. D. (1995). Nutritional practices of athletes: are they sub-optimal? *J Sports Sci, 13 Spec No*, S75-81.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., & Beck, N. C. (2004). Nutrient intakes and dietary behaviors of male and female collegiate athletes. *Int J Sport Nutr Exerc Metab, 14*(4), 389-405.

Houtkooper, L., Abbot, J., & Nimmo, M. (2007). Nutrition for throwers, jumpers and combined events athletes *Journal of Sports Sciences, 25*(Supplement 1), 39-48.

Krauss, R. M., Eckel, R. H., Howard, B., Appel, L. J., Daniels, S. R., Deckelbaum, R. J., et al. (2000). AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Stroke, 31*(11), 2751-2766.

Rodriguez, N. R.Di Marco, N. M, Langley, S (2009). American College of Sports Medicine position stand. Nutrition and athletic performance. *Medicine and Sciences in Sports and Exercise, 41(3), 709-731.*

Stellingwerff, T., Boit, M., & Res, P. (2007). Nutritional strategies to optimize training and racing in middle-distance athletes. . *Journal of Sports Sciences, 25*(Supplement 1), 17-28.

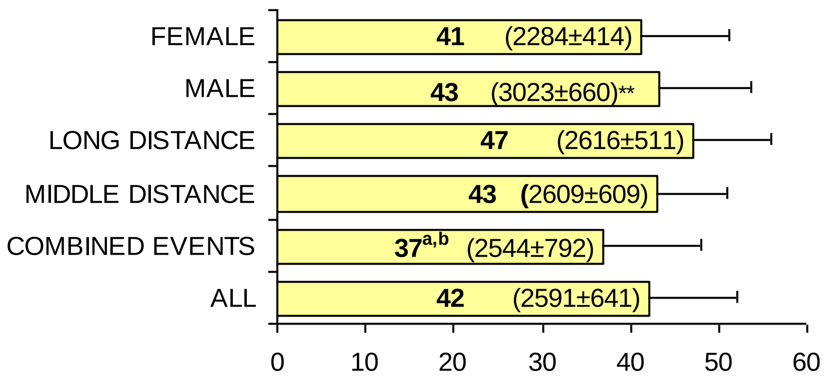
Tipton, K., Jeukendrup, A., & Hespel, P. (2007). Nutrition for the sprinter. *Journal of Sports Sciences, 25*(Supplement 1), 5-16.

Table 1.- Basic anthropometric data by gender and discipline (mean±sd).

	N	Age (yrs)	W (Kg)	H (m)	BMI (Kg/m^2)
ALL ATHLETES	106	24.1±4.5	62.8±11.7	1.74±0.09	20.7±2.5
FAST AND COMBINED EVENTS	33	22.5±4.0	70.0±13.9^{a**,b**}	1.76±0.10	22.5±3.3$^{a**, b**}$
MIDDLE DISTANCE	42	24.6±4.3	61.6±9.2	1.74±0.10	20.2±1.5
LONG DISTANCE	31	25.0±4.9	56.7±7.5	1.70±0.08	19.4±1.3
MALES	44	25.3±4.8*	71.2±10.5**	1.82±0.06**	21.5±2.3**
FEMALES	62	23.2±4.0	56.8±8.3	1.68±0.07	20.1±2.5

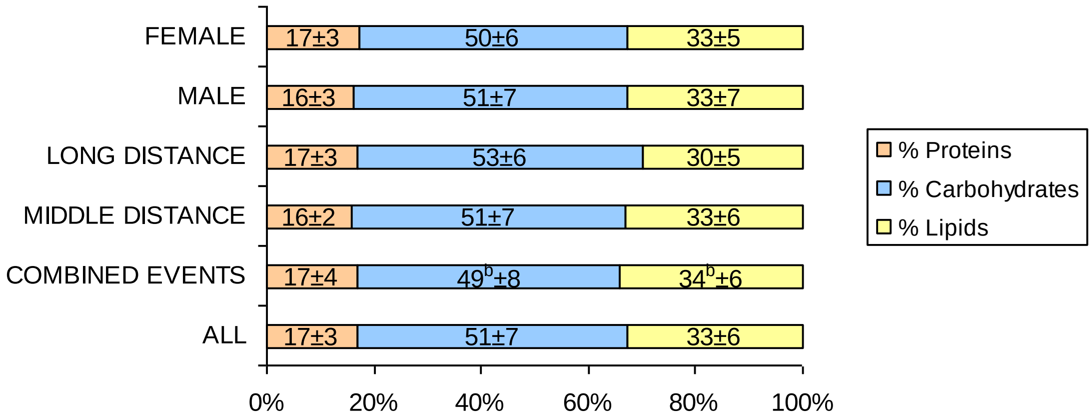
(*p≤0.05; **p≤0.01; *a* vs MD; b vs LD)

Figure 1- Energy intake related to body weight (Kcal/kg/day) and absolute value Kcal/day (mean±sd) by gender and discipline



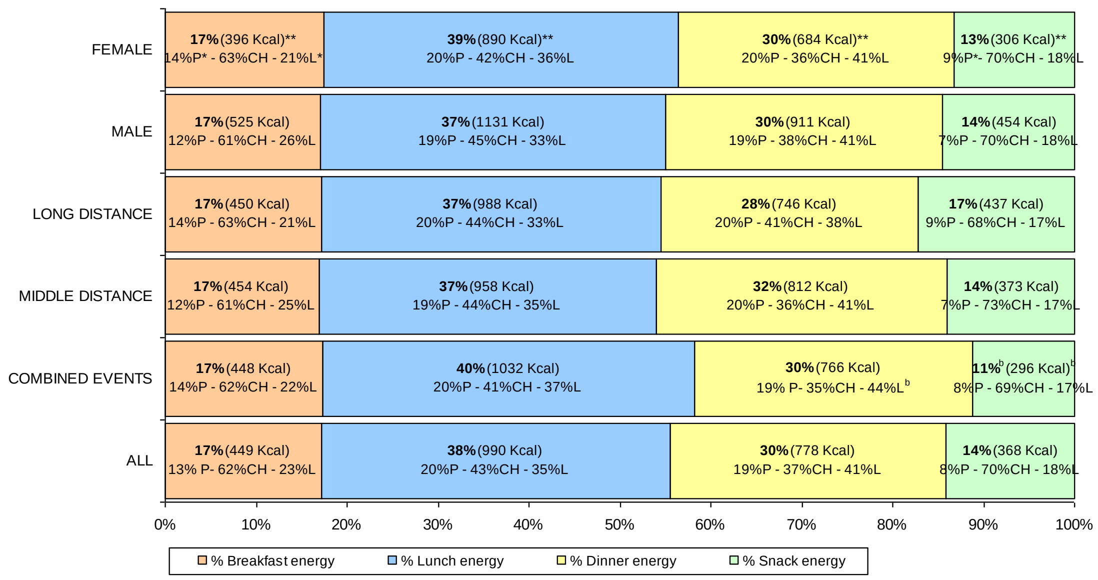
(*p≤0.05; **p≤0.01; *a*=*vs MD and b= ** vs LD)

Figure 2- Energy distribution from different macronutrients by gender and discipline



(**p*≤0.05; b= * vs LD)

Figure 3- Energy intake and percentage of macronutrients (% proteins, % carbohydrates and % lipids) in different meals by gender and discipline.



(**p*≤0.05; b= * vs LD)

Table 2- Macronutrient intakes expressed in absolute terms and relative to body weight by gender and discipline (mean±sd). (P = Proteins, CH = Carbohydrates, L = Lipids).

	P (g)	P (g/Kg)	CH (g)	CH (g/Kg)	L (g)	L (g/Kg)
ALL ATHLETES	108±24	1.8±0.4	313±96	5.1±1.5	95±30	1.5±0.5
FAST AND COMBINED EVENTS	107±29	1.6±0.4^{b**}	297±110	4.3±1.4$^{a*, b**}$	98±38	1.4±0.5
MIDDLE DISTANCE	106±23	1.7±0.3^{c*}	316±92	5.2±1.4	96±28	1.6±0.4
LONG DISTANCE	111±21	2.0±0.4	325±86	5.8±1.5	89±21	1.6±0.4
MALES	121±25**	1.7±0.4	372±102**	5.3±1.6	110±34**	1.6±0.5
FEMALES	99±20	1.8±0.4	271±64	4.9±1.4	84±20	1.5±0.4

(*p≤0.05;****p**≤0.01; **a** related FC vs MD; **b** related FC vs LD; **c** related MD vs LD)

Table 3- Different fat (saturated, monounsaturated and polyunsaturated) and cholesterol intake (mean±sd).

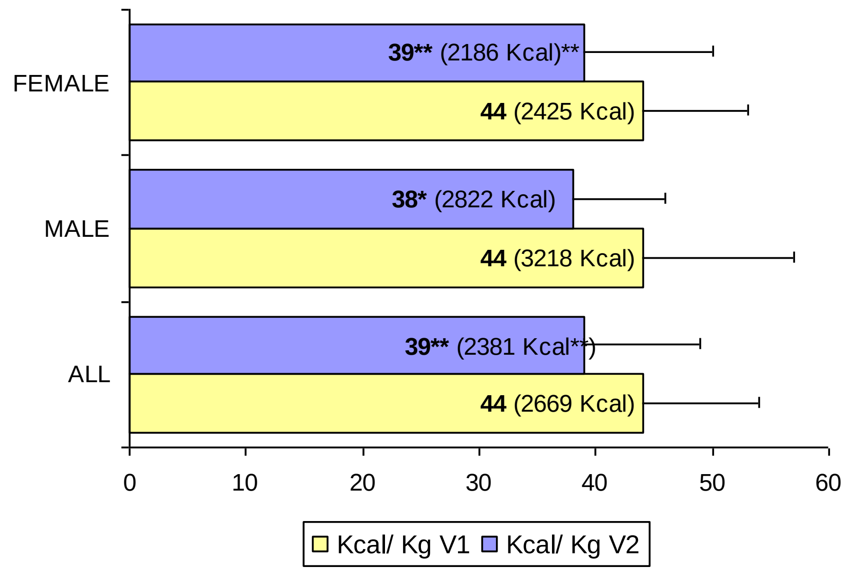
	Saturated Lipids (g)	Monosaturated Lipids (g)	Polyunsaturated Lipids (g)	Cholesterol (mg)
ALL ATHLETES	30±12	44±14	13±4	333±133
FAST AND COMBINED EVENTS	31±14	45±17	13±5	360±139
MIDDLE DISTANCE	30±12	44±13	12±3	311±105
LONG DISTANCE	27±10	40±10	13±4	335±159
MALES	35±14**	50±16**	15±5**	370±153*
FEMALES	26±9	39±9	11±3	307±112

(*p≤0.05;**p≤0.01)

Table 4- Basic anthropometric data (mean±sd).describing nutritional intervention sample by gender: V1 (before) and V2 (after) nutritional intervention.

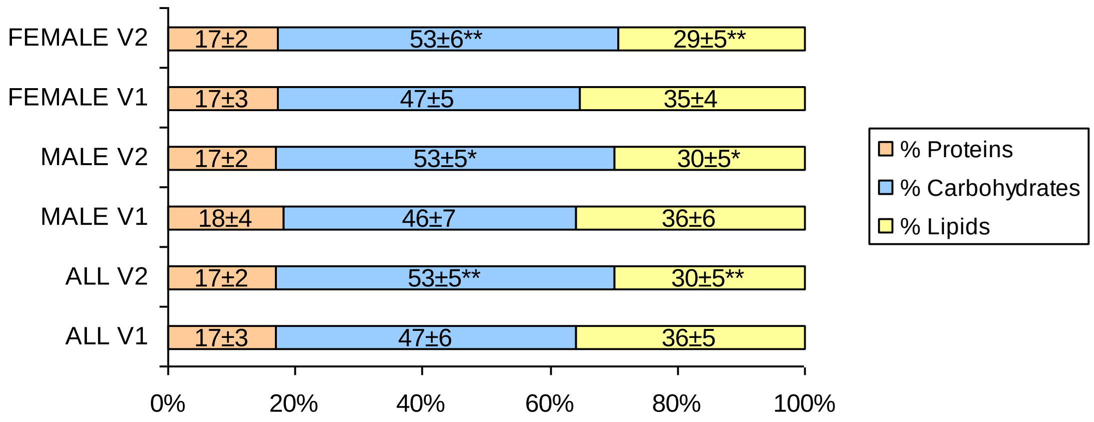
	N	Age (yrs)	W (Kg)	H (m)	BMI (Kg/m^2)
ALL ATHLETES V1	39	23.8±4.0	62.1±12.7	1.73±0.09	20.6±2.8
ALL ATHLETES V2	39	24.3±4.1	62.5±12.8	1.73±0.10	20.9±2.8
MALES V1	12	26.3±3.6	74.3±12.3	1.83±0.05	22.0±2.9
MALES V2	12	26.8±4.0	75.2±11.2	1.83±0.05	22.3±2.5
FEMALES V1	27	22.7±3.7	56.7±8.5	1.68±0.07	20.2±2.5
FEMALES V2	27	23.2±3.7	56.9±9.0	1.68±0.08	20.3±2.8

Figure 4- Energy intake related to body weight (Kcal/kg) and absolute value (Kcal/day) before (V1) and after nutritional **intervention (V2)**



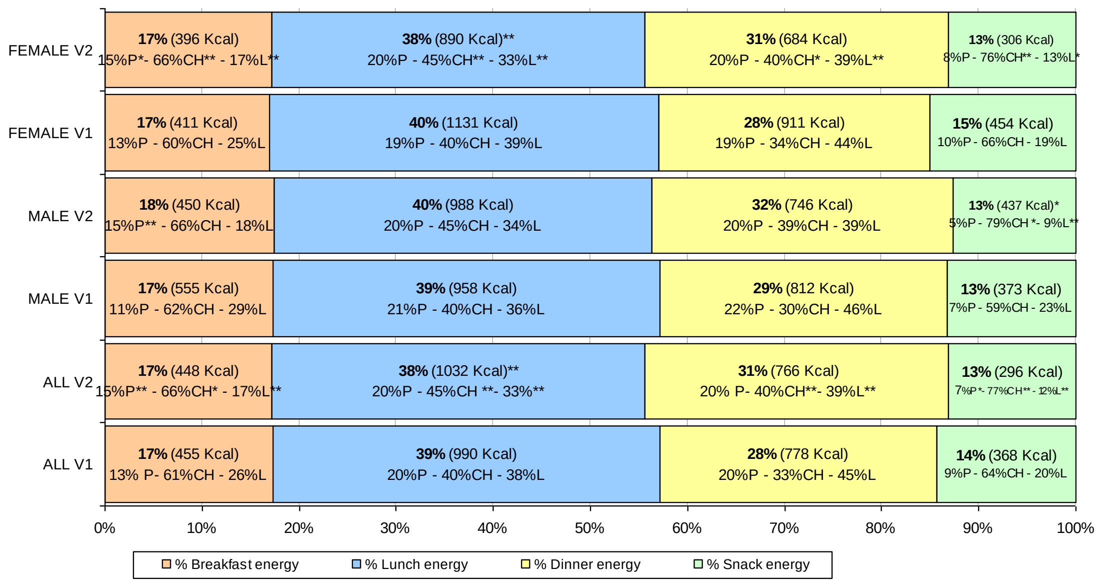
(*p≤0.05;**p≤0.01)

Figure 5- Energy distribution from different macronutrients before and after intervention by gender (mean±sd).



(*p≤0.05;**p≤0.01)

Figure 6- Energy intake and percentage of macronutrients (% proteins, % carbohydrates and % lipids) in different meals by gender before (V1) and after (V2) nutritional intervention



(*p≤0.05;**p≤0.01)

Table 5- Macronutrient intakes expressed in absolute terms and relative to body weight by gender (mean±sd). (P = Proteins, CH = Carbohydrates, L = Lipids) **before (V1) and after (V2) nutritional intervention**.

	P (g)	P (g/Kg)	CH (g)	CH (g/Kg)	L (g)	L (g/Kg)
ALL ATHLETES V1	114±27**	1.9±0.4**	299±99	4.9±1.5	150±29**	1.7±0.4**
ALL ATHLETES V2	102±21	1.7±0.4	303±80	5.0±1.4	80±25	1.3±0.4
MALES V1	139±26*	1.9±0.3*	361±136	5.0±1.9	128±40**	1.7±0.6**
MALES V2	118±18	1.6±0.3	360±77	4.9±1.2	96±28	1.3±0.4
FEMALES V1	103±20*	1.9±0.5*	272±63	4.9±1.4	95±14**	1.7±0.4**
FEMALES V2	94±18	1.7±0.4	278±69	5.0±1.6	73±19	1.3±0.4

(*p≤0.05; ****p**≤0.01)

Tabla 6 - Different fat (saturated, monounsaturated and polyunsaturated) and cholesterol intake (mean±sd) **by gender before (V1) and after (V2) nutritional intervention**.

.

	Saturated Lipids (g)	Monosaturated Lipids (g)	Polyunsaturated Lipids (g)	Cholesterol (mg)
ALL ATHLETES V1	34±12**	49±13**	13±4**	348±133*
ALL ATHLETES V2	23±10	37±12	11±3	291±113
MALES V1	41±19*	59±17*	16±4*	362±136
MALES V2	29±12	45±14	13±4	318±162
FEMALES V1	31±6**	44±7**	12±3	342±134*
FEMALES V2	21±8	34±9	11±3	279±83

(*p≤0.05;****p**≤0.01)