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Analysis of Dietary Intake and Body Composition of Collegiate Runners

Análisis de la Ingesta Dietética y Composición Corporal de Corredores Universitarios

Myriam Zaraí García-Dávila[1]; María Grethel Ramírez-Siqueiros[2]; Pascal Bauer[3]; Bojan Makivic[4]; Germán Hernández-Cruz[1]; Blanca R. Rangel-Colmenero[1]; Teresita Valencia-Falcón[2]; Rodrigo Yáñez-Sepúlveda[5] & Alejandro Martínez-Rodríguez[6]

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SUMMARY: The aim of this cross-sectional study was to compare dietary intake to published recommendations and to analyze the potential relationship between body composition and dietary intake in collegiate athletes. Eighteen healthy male middle- and long-distance runners (age 20.11 ± 2.72 y; height, 174.7 ± 6.1 cm; body mass, 64.0 ± 7.7 kg), were recruited from a Mexican university track and field team at the beginning of the general preparation phase for national competitions. Participants completed three 24-hour dietary recalls, which were used to estimate dietary intake. Body composition was measured by Dual-energy X-ray absorptiometry (DXA). Athletes displayed high body fat values. Protein intake was significantly higher than published recommendations. Iron, zinc, sodium, and vitamin C intake were significantly higher than recommended values, while potassium and calcium intake were below established recommendations. No significant correlations between body composition variables (i.e body fat, lean body mass, bone mineral content) and dietary intake (i.e energy, macronutrients and selected vitamins and minerals) could be found. These findings suggest that coaches and practitioners should pay close attention to dietary intake and body composition of endurance athletes starting general preparation for competition. Future studies on changes of dietary intake and body composition during off-season and competitive phase, which also track physical activity, are warranted.

KEY WORDS: Sports nutrition; College athletes; Fat mass; Muscle mass; Diet.

INTRODUCTION

It is well known that dietary intake has a significant effect on athletes' performance and health (Thomas *et al*., 2016). Evidence suggests that athletes have elevated energy and nutrient requirements due to the heightened energy expenditure caused by physical training (Kerksick, 2019), which led international organizations to establish specific dietary recommendations for athletes (Thomas *et al*., 2016). In recent years, these recommendations have received considerable attention both in research and practice. Many researchers have used the published recommendations to analyze dietary intake and identify potential problems (Gogojewicz *et al*., 2020; Gomez-Hixson *et al*., 2022). To date, however, few studies have investigated dietary intake and nutritional habits in endurance athletes, such as middle- and long-distance runners (Baranauskas *et al*., 2017; Barrientos *et al*., 2020).

Besides dietary intake, body composition is an integral part of assessing athletes' nutritional status (Manjarrez-Bastidas *et al*., 2022). Since many endurance athletes have a strong desire to modify their body structure, evaluation and monitoring of body composition is important and could identify relevant parameters of an athlete's performance status. In fact, body composition has been shown to significantly influence endurance performance. That change may be possible with proper attention and control of body

[1] Facultad de Organización Deportiva, Universidad Autónoma de Nuevo León, México.
[2] Licenciado en Entrenamiento Deportivo, Universidad Estatal de Sonora, México.
[3] Centre for Sports Science and University Sports, University of Vienna, Austria.
[4] University of Applied Science Wiener Neustadt, Austria.
[5] Faculty of Education and Social Sciences, Universidad Andres Bello, Santiago, Chile.
[6] Department of Analytical Chemistry, Nutrition and Food Sciences, Faculty of Sciences, University of Alicante, Alicante, Spain.

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composition (Francis *et al*., 2017). Additionally, the mentioned monitoring could identify relevant parameters of an athlete's performance status (Mooses & Hackney, 2017). Despite the importance of evaluating body composition, there is little published data on middle – and long-distance runners. It should be also noted that although there is a considerable amount of literature on dietary intake of athletes internationally (Jenner *et al*., 2019; Barrientos *et al*., 2020; Dengel *et al*., 2020), little is known about the intake of athletes from Mexico. These issues are likely further magnified at the college level, where nutrition-based support services or educational resources are often not available to athletes (Heaney *et al*., 2008; Parks *et al*., 2018).

Therefore, this cross-sectional study was designed to analyze dietary intake and body composition of healthy male college athletes from Mexico and to examine the potential relationship between body composition and dietary intake variables. It was hypothesized that athletes have an adequate diet, which is reflected in their body composition.

MATERIAL AND METHOD

Study design. This cross-sectional study was conducted according to the Declaration of Helsinki and was approved by the Universidad Autónoma de Nuevo León Bioethics Committee (COBICIS-801/2015/124-01HCG/ 3rd March 2015). Written informed consent was obtained from participants before participation. Body composition and dietary intake evaluations were carried out in the same week in the Human Performance Laboratory of the Faculty of Sports Organization of the same university at the beginning of the general preparation phase. This period was chosen because assessments could be incorporated into regular medical screenings.

Participants. Eighteen healthy male middle- and long-distance runners (mean ± standard deviation [SD]: age 20.11 ± 2.72 y; body height, 174.7 ± 6.1 cm; body mass, 64.0 ± 7.7 kg) participated in this study on a voluntary basis. Participants were members of Autonomous University of Nuevo Leon track- and field team and in the general preparation phase for the national university games 2017. The athletes followed the same training pattern during the general preparation phase for national competition (i.e five days per week, two hours per training day, moderate level of physical) for about three months and some of the athletes were competing in both, middle- and long-distance competitions. As inclusion criteria, they had to be part of the representative team of the University and attend their trainings regularly. As exclusion criteria, the participants could not present any injuries and needed to comply with the adequate conditions for measurement of body composition.

Dietary intake registration and analysis. Three 24-hour dietary recalls were conducted based on the protocol of Ortega *et al*. (1999). These were registered by the Nutrition and Development Research Center (Centro de Investigación en Alimentación y Desarrollo, CIAD, A.C). The 3-day food record included 2 weekdays and 1 weekend day to account for food intake variability during the week.

Pictures, food replicas, and kitchen utensils (cups, plates, silverware) were used as material. Data were processed using Excel spreadsheets, which contained special food codes from an extensive database (Food Processor ESHA, 1987-98; United States Department of Agriculture, USDA; Instituto Nacional de Nutrición Salvador Zubirán, INNSZ D). This database contains a variety of foods, including foods that are commonly eaten in Mexico according to the CIAD and their amounts of macro– and micronutrients.

Dietary Intake Recommendations. The recommended energy consumption was calculated by multiplying the basal metabolism results with the Harris & Benedict formula (Roza & Shizgal, 1984), with a fixed activity factor of 1.8 appropriate for the formula used. Which would represent a moderate level of physical activity, in relation to their training (American Dietetic Association *et al*., 2009). Macronutrient intake was calculated by multiplying athletes' body mass with the grams per day (i.e, recommended 5.1 to 7 g/kg/d for carbohydrates recommended values of 1.2 to 1.5 g/kg/d for protein and recommended .8 to 1.6 g/kg/d for fats), compared to nutrition recommendations of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine (Rodriguez *et al*., 2009; Thomas *et al*., 2016; Vitale & Getzin, 2019). Athletes` micronutrient intake was compared to the Dietary Reference Intakes (DRIs) established by Whiting & Barabash (2006) and supported by Vitale & Getzin (2019). because some of them do not have well-established values for athletes.

Body Composition assessment. Body composition was determined using dual X-ray absorptiometry (DXA, Lunar Prodigy Advance, General Electric). All body composition measurements were carried out in the morning after an 12 h overnight fast. The subjects were asked to wear shorts and no metal embellishments and to avoid vigorous exercise the day before the measurement. During measurements, participants were asked to rest in a supine position, arms stretched to the sides of the body, to remain still and quiet and to breathe normally. All scans were performed and analyse by the same trained operator. The results of the DXA-scan were used to estimate body fat (%), lean mass (%), and bone mineral content (%), which were computed the systems integrated software.

Statistical Analysis. Statistical analysis was performed using IBM® SPSS® Statistics Software V26 for Windows (IBM Corp., Armonk, NY, USA) and Python 3.6 (Python Software Foundation, Beaverton, OR, USA). Descriptive statistics were calculated and reported as means and standard deviations (SD). The Shapiro-Wilk's normality test was carried out for each variable separately to determine whether the data were normally distributed. Both normality tests did not demonstrate normal distribution, and therefore, the non-parametric Wilcoxon signed rank-test was used to compare the mean difference between two corresponding samples.

A series of Pearson's linear correlation tests were used to compare the relationship between every single dependent body composition variable (n=3) and series of independent dietary intake variables (n=13) separately.

Statistical significance was accepted at a p-value of < 0.05 (2-tailed). The strength and direction of the linear relationship was presented with Pearson's correlation coefficients (R) ranging from -1 to +1. All coefficients for independent variables representing the mean change in the dependent variable given a one-unit change in the independent variable were reported with 95 % confidence intervals (CI).

RESULTS

Subjects characteristics such as age, body height, and body mass are shown in Table I. Statistics of dietary intake and comparison with recommendations can be found in Table II. The relationship between dietary intake variables and body composition is shown in Tables III-V, respectively.

Overall, athletes´ calorie, carbohydrate, and fat intake were not significantly different from published recommendations (p > 0.05). Only protein intake was significantly higher compared to recommendations (p= 0.0001). Similarly, iron, zinc, sodium, and vitamin C intake were significantly higher than recommended values. In contrast, potassium and calcium intake were below established recommendations. Only vitamin A and vitamin E consumption were in line with reference intake.

Correlations between all body composition variables (i.e., body fat, lean mass, and bone mineral composition) and independent variables (i.e., dietary intake) were generally small and ranged from r=0.03 to r=0.43. None of the correlations reached statistical significance.

Table I. Subjects' characteristics (means ± SD).

Variable	Athletes (n=18)
Age (y)	20.11 ± 2.72
Body height (cm)	174.7 ± 6.1
Body mass (kg)	64.0 ± 7.7
Body fat (%)	18.1 ± 4.3
Lean mass (%)	78.2 ± 4.0
Bone mineral content (%)	4.3 ± 0.3
Basal metabolic rate (Kcal)	1685.9 ± 122.1

Standard deviation; body composition variables are expressed as % of overall body mass.

DISCUSSION

The aim of the study was to analyze the dietary intake and body composition of Mexican collegiate middle- and long-distance runners and to examine potential relationships between these variables.

Table II. Dietary intake of athletes and daily reference intake (means ± SD).

	Variable	Intake (n=18)	Recommendation	*p* value
Energy & macronutrients	Energy (kcal)	2945.2 ± 851.4	3034.62 ± 219.83	0.53
	Carbohydrates (g)	437.4 ± 130.1	448.58 ± 54.09	0.37
	Proteins (g)	119.1 ± 27.2	89.72 ± 10.82	0.0001*
	Fats (g)	94.2 ± 46.8	102.53 ± 12.36	0.14
Minerals	Calcium (mg)	1038.3 ± 421.1	1500.00	0.003*
	Iron (mg)	25.7 ± 6.1	13.60	0.000*
	Potassium (mg)	3503.1 ± 871.0	4700.00	0.001*
	Zinc (mg)	16.7 ± 5.1	11.00	0.001*
	Sodium (mg)	3213.2 ± 1018.9	2300.00	0.002*
Vitamins	Vitamin A (mg)	1186.7 ± 581.4	900.00	0.094
	Vitamin C (mg)	135.9 ± 62.1	100.00	0.010*
	Vitamin E (mg)	12.9 ± 8.3	15.00	0.133

SD = Standard deviation; ingestion of athletes calculated as a mean of 3-day nutrition protocols. *p < 0.05.

Table III. Regression correlation between body fat and dietary intake.

	Variable	R	Coefficient	95% CI
Energy & acronutrients	Energy (Kcal)	0.11	0.001	- 0.002 to 0.003
	CHO diff. (%)	0.06	0.01	- 0.08 to 0.1
	Protein diff. (%)	- 0.19	- 0.03	- 0.11 to 0.05
	Fat diff. (%)	- 0.03	- 0.003	- 0.06 to 0.05
	Intake diff. (%)	0.003	- 0.00002	- 0.003 to 0.003
Minerals	Calcium (%)	0.21	0.03	- 0.05 to 0.11
	Iron (%)	0.43	0.04	- 0.004 to 0.09
	Potassium (%)	0.25	0.06	- 0.06 to 0.18
	Zinc (%)	0.17	0.02	- 0.03 to 0.06
	Sodium (%)	0.27	0.03	- 0.02 to 0.08
Vitamins	Vitamin A (%)	0.05	0.003	- 0.03 to 0.04
	Vitamin C (%)	0.11	- 0.008	- 0.04 to 0.03
	Vitamin E (%)	0.12	0.01	- 0.03 to 0.05

Table IV. Regression correlation between bone mineral content and intake.

	Variable	R	Coefficient	95% CI
Energy & acronutrients	Energy (Kcal)	- 0.17	- 0.00008	- 0.0003 to 0.0002
	CHO diff. (%)	- 0.09	-0.001	- 0.009 to 0.006
	Protein diff. (%)	0.13	0.002	- 0.005 to 0.009
	Fat diff. (%)	- 0.05	- 0.0002	- 0.005 to 0.004
	Intake diff. (%)	0.11	0.002	- 0.006 to 0.009
Minerals	Calcium (%)	- 0.10	- 0.001	- 0.009 to 0.006
	Iron (%)	- 0.43	- 0.004	- 0.008 to 0.0004
	Potassium (%)	- 0.15	- 0.003	- 0.014 to 0.008
	Zinc (%)	- 0.12	- 0.001	- 0.005 to 0.003
	Sodium (%)	- 0.22	- 0.002	- 0.006 to 0.003
Vitamins	Vitamin A (%)	- 0.04	- 0.0002	- 0.003 to 0.003
	Vitamin C (%)	- 0.10	- 0.001	- 0.004 to 0.003
	Vitamin E (%)	- 0.13	- 0.001	- 0.005 to 0.003

Table V. Regression correlation between lean mass and dietary intake.

	Variable	R	Coefficient	95% CI
Energy & acronutrients	Energy (Kcal)	- 0.10	- 0.0005	- 0.003 to 0.002
	CHO diff. (%)	- 0.06	- 0.009	- 0.09 to 0.07
	Protein diff. (%)	0.19	0.03	- 0.04 to 0.1
	Fat diff. (%)	0.04	0.003	- 0.46 to 0.53
	Intake diff. (%)	0.03	0.004	- 0.075 to 0.083
Minerals	Calcium (%)	- 0.21	- 0.03	- 0.10 to 0.04
	Iron (%)	- 0.42	- 0.04	- 0.08 to 0.006
	Potassium (%)	- 0.25	- 0.05	- 0.16 to 0.06
	Zinc (%)	- 0.16	- 0.01	- 0.06 to 0.03
	Sodium (%)	- 0.26	- 0.02	- 0.07 to 0.02
Vitamins	Vitamin A (%)	- 0.05	- 0.003	- 0.04 to 0.03
	Vitamin C (%)	0.12	0.008	- 0.03 to 0.04
	Vitamin E (%)	- 0.11	- 0.008	- 0.05 to 0.03

Carbohydrate consumption of 6.8 g/kg/d (recommended 5.1 to 7 g/kg/d, preparation phase), consumption was adequate according to the recommended levels for their physical activity (Thomas *et al.*, 2016). The most frequent foods and main sources of carbohydrates were cooked beans, corn tortillas and cola beverages. It is worth mentioning that the subjects are university students, and their eating habits can be described as basic and with little variety. It is important to maintain a recommended consumption of carbohydrates for endurance athletes (Vitale & Getzin, 2019); however, special care is needed in defining their quality.

Protein intake of 1.9 g/kg/d was higher than recommended values of 1.2 to 1.5 g/kg/d (Thomas *et al*., 2016). The primary protein source was cooked chicken, followed by other meats and fried fish. Protein intake is essential for the metabolic adaptation process and the recovery of damaged muscular fibers; however, it is only recommended in larger quantities for short periods during intensive training or when total energy and carbohydrate intake is reduced (Mettler *et al*., 2010). Furthermore, there is evidence to suggest that protein intake during exercise may have an ergogenic effect by delaying the runners´ exhaustion (Phillips & Van Loon, 2011).

Fat intake was at the recommended level of .9 g/kg/d (recommended .8 to 1.6 g/kg/d, preparation phase), for the activity of the athletes. Athletes` fat intake should be as recommended in public health guidelines and personalized according to the stage of training or the requirements of body composition (Larson, 2013). Relative recommended fat intake is between 20 % and 35 % of total calories. This was met by the subjects (i.e 22 %), however, saturated fat was higher than recommendations (i.e 29.5 % vs. 10 %, respectively) (Thomas *et al*., 2016). The primary sources of fat in the athletes` diets were cold cuts and chips, which could explain the high percentage of saturated fats. Fats have gained popularity among ultra-endurance athletes, but in phases of moderate training, as seen in our sample, evidence does not support positive effects above recommended levels (Vitale & Getzin, 2019).

While most micronutrients were within recommendations, calcium and potassium levels are below what is recommended for this sample of athletes. These low calcium intake levels can be explained by the poor quality of their diets and the lack of supplements. In fact, micronutrient deficits are commonly observed for calcium, vitamin D, and iron (Lukaski, 2004). Unfortunately, diet adaptations are generally not done until pathology is detected or there is a medical problem (Thomas *et al*., 2016). Calcium is necessary to maintain and repair bone tissue and also regulates muscle contractions. Therefore, runners with low calcium intake may be at greater risk for injury (Frost, 2000).

In this study, male athletes had suboptimal body composition values compared to other studies. Mean fat mass was 18.2 %, 78.3 % was lean mass, and 4.37 % bone mineral content. Santos *et al*. (2014), investigated athletes in the same age range with preferable body composition values (10.4 %, 86 %, and 4.07 % for fat mass, lean mass, and bone mineral content, respectively). Similarly, Dengel *et al*. (2020), found that collegiate middle- and long-distance runners have lower body fat percent values (i.e., 10.8 % for middle distance runners and 12.5 % for long-distance runners), higher lean body mass (i.e., 85 % and 83 % for middle- and long-distance runners, respectively) as well as higher bone mineral content (i.e., 4.6 % for both middle- and long-distance runners).

It was hypothesized that the variation of athletes' body composition could be explained by dietary intake of individuals. However, as shown above, no significant correlation was found, which could be due to the small sample size and high interindividual variability of data analyzed. Another factor which could have influenced the results was the timing of the testing periods. As mentioned, athletes were in the general preparation phase for a national competition. The general preparation phase is started after a long off-season, potentially resulting in suboptimal body composition values and dietary habits. Therefore, future projects should try to analyze dietary intake and body composition at various timepoints throughout the competitive year to account for seasonal fluctuations. Another major source of uncertainty is the distance-specific specialization of individual athletes. Although all athletes were carrying out nearly the same training program in the general preparation phase and some of the athletes were competing in both, middle- and long-distance competitions, it cannot be ruled out that the present findings would have been different if the study had been conducted in middle- or long-distance runners separately. Future studies with higher sample sizes could address this and maybe even compare middle- and long-distance runners directly.

Factors such as inadequate nutrition knowledge, time spent practicing, accessibility and food availability, and inadequate financial resources are often listed as key barriers to adequate nutrition in athletes (Heaney *et al*., 2008). Therefore, future studies should investigate these factors and physiological traits (i.e., body composition, performance, etc.), and dietary intake. In conclusion this study showed that further evaluation of dietary intake revealed poor food choices, probably resulting in inadequate intake of calcium and potassium and high intake of sodium and saturated fats. It is suggested that collegiate athletes would benefit from nutritional guidance. This could potentially result in improved body composition and overall athletic performance.

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RESUMEN: El objetivo de este estudio transversal fue comparar la ingesta dietética con las recomendaciones publicadas y analizar la relación potencial entre la composición corporal y la ingesta dietética en corredores universitarios. Dieciocho atletas masculinos sanos de media y larga distancia (edad 20,11 ± 2,72 años; altura, 174,7 ± 6,1 cm; masa corporal, 64,0 ± 7,7 kg), fueron reclutados de un equipo de atletismo de una universidad mexicana al comienzo de la fase de preparación general de competiciones nacionales. Los participantes completaron tres recordatorios dietéticos de 24 horas, que se utilizaron para estimar la ingesta dietética. La composición corporal se midió mediante absorciometría de rayos X de energía dual (DXA). Los atletas mostraron altos valores de grasa corporal. La ingesta de proteínas fue significativamente mayor que las recomendaciones publicadas. La ingesta de hierro, zinc, sodio y vitamina C fue significativamente superior a los valores recomendados, mientras que la ingesta de potasio y calcio estuvo por debajo de las recomendaciones establecidas. No se encontraron correlaciones significativas entre las variables de composición corporal (es decir, grasa corporal, masa corporal magra, contenido mineral óseo) y la ingesta dietética (es decir, energía, macronutrientes y vitaminas y minerales seleccionados). Estos hallazgos sugieren que los entrenadores y los practicantes deberían prestar mucha atención a la ingesta dietética y la composición corporal de los atletas de resistencia que comienzan la preparación general para la competencia. Se justifican estudios futuros sobre los cambios en la ingesta dietética y la composición corporal durante la fase fuera de temporada y competitiva, como también un seguimiento de la actividad física.

PALABRAS CLAVE: Nutrición deportiva; Atletas universitarios; Grasa corporal; Masa muscular; Dieta.

REFERENCES

American Dietetic Association; Dietitians of Canada; American College of Sports Medicine; Rodríguez, N.; Di Marco, N. & Langley, S. American College of Sports Medicine position stand. Nutrition and athletic performance. *Med. Sci. Sports Exerc., 41(3)*:709-31, 2009.

Baranauskas, M. N.; Miller, B.; Olson, J. T.; Boltz, M.; Richardson, L.; Juravich, M. & Otterstetter, R. Differential in maximal aerobic capacity by sex in collegiate endurance athletes consuming a marginally low carbohydrate diet. *J. Am. Coll. Nutr., 36(5)*:370-7, 2017.

Barrientos, G.; Alves, J.; Toro, V.; Robles, M.; Muñoz, D. & Maynar, M. Association between trace elements and body composition parameters in endurance runners. *Int. J. Environ. Res. Public Health, 17(18)*:6563, 2020.

Dengel, D.; Keller, K.; Stanforth, P.; Oliver, J.; Carbuhn, A. & Bosch, T. Body composition and bone mineral density of division 1 collegiate track and field athletes, a Consortium of College Athlete Research (C-CAR) study. *J. Clin. Densitom., 23(2)*:303-13, 2020.

Francis, P.; McCormack, W.; Caseley, A.; Copeman, J. & Jones, G. Body composition changes in an endurance athlete using two different training strategies. *J. Sports Med. Phys. Fitness, 57(6)*:811-5, 2017.

Frost, H. M. The Utah paradigm of skeletal physiology: an overview of its insights for bone, cartilage and collagenous tissue organs. *J. Bone Miner. Metab., 18(6)*:305-16, 2000.

Gogojewicz, A.; Sliwicka, E. & Durkalec-Michalski, K. Assessment of dietary intake and nutritional status in CrossFit-trained individuals: a descriptive study. *Int. J. Environ. Res. Public Health, 17(13)*:4772, 2020.

Gomez-Hixson, K.; Biagioni, E. & Brown, M. Significant differences in dietary intake of NCAA Division III soccer players compared to recommended levels. *J. Am. Coll. Health, 70(1)*:150-7, 2022.

Heaney, S.; O'Connor, H.; Naughton, G. & Gifford, J. Towards an understanding of the barriers to good nutrition for elite athletes. *Int. J. Sports Sci. Coach., 3(3)*:391-401, 2008.

Jenner, S. L.; Buckley, G. L.; Belski, R.; Devlin, B. L. & Forsyth, A. K. Dietary intakes of professional and semi-professional team sport athletes do not meet sport nutrition recommendations-A systematic literature review. *Nutrients, 11(5)*:1160, 2019.

Kerksick, C. M. Chapter 38 - *Requirements of Proteins, Carbohydrates, and Fats for Athletes*. In: Debasis, B.; Sreejayan, N. & Chandan, F. S. (Eds.). Nutrition and Enhanced Sports Performance. Muscle Building, Endurance, and Strength. 2nd ed. Amsterdam, Academic Press/Elsevier, 2019. pp.443-59.

Larson, T. *Sports Nutrition: A Practice Manual for Professionals*. Volume 45. 5th ed. Amsterdam, Elsevier, 2013.

Lukaski, H. C. Vitamin and mineral status: effects on physical performance. *Nutrition, 20(7-8)*:632-44, 2004.

Manjarrez-Bastidas, I. A.; Hernández-Murúa, J. A.; Salazar, C. C. M.; Avendaño-Soto, M.; Salazar-Landeros, M. M.; Soto-Peña, J. L. & Barajas Pineda, L. T. Anthropometric profile, somatotype and nutritional status of Mexican taekwondoin. *Int. J. Morphol., 40(4)*:959-65, 2022.

Mettler, S.; Mitchell, N. & Tipton, K. D. Increased protein intake reduces lean body mass loss during weight loss in athletes. *Med. Sci. Sports Exerc., 42(2)*:326-37, 2010.

Mooses, M. & Hackney, A. C. Anthropometrics and body composition in East African runners: potential impact on performance. *Int. J. Sports Physiol. Perform., 12(4)*:422-30, 2017.

Ortega, M.; Quizan, P.; Morales, G. & Preciado, M. *Cálculo de Ingestión Dietaria y Coeficientes de Adecuación a partir de Registro de 24 Horas y Frecuencia e Consumo e Alimentos. Estimación del Consumo de Alimentos*. Sonora, Cuaderno de trabajo No. 1. Serie Evaluación del Consumo de Alimentos. Centro de Investigación en Alimentación y Desarrollo, 1999.

Parks, R.; Sanfilippo, J.; Domeyer, T.; Hetzel, S. & Brooks, A. Eating behaviors and nutrition challenges of collegiate athletes: the role of the athletic trainer in a performance nutrition program. *Athl. Train. Sport Health Care, 10*:117-24, 2018.

Phillips, S. M. & Van Loon, L. J. C. Dietary protein for athletes: from requirements to optimum adaptation. *J. Sports Sci., 29 Suppl. 1*:S29-38, 2011.

Rodriguez, N. R.; DiMarco, N. M.; Langley, S.; American Dietetic Association; Dietitians of Canada & American College of Sports Medicine. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *J. Am. Diet. Assoc., 109(3)*:509-27. 2009.

Roza, A. M. & Shizgal, H. M. The Harris Benedict equation reevaluated: resting energy requirements and the body cell mass. *Am. J. Clin. Nutr., 40(1)*:168-82, 1984.

Santos, D. A.; Dawson, J. A.; Matias, C. N.; Rocha, P. M.; Minderico, C. S.; Allison, D. B.; Sardinha, L. B. & Silva, A. M. Reference values for body composition and anthropometric measurements in athletes. *PLoS One, 9(5)*:e97846, 2014.

Thomas, D.; Erdman, K. & Burke L. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J. Acad. Nutr. Diet., 116(3)*:501-28, 2016.

Vitale, K. & Getzin, A. Nutrition and supplement update for the endurance athlete: review and recommendations. *Nutrients, 11(6)*:1289, 2019.

Whiting, S. J. & Barabash, W. A. Dietary Reference Intakes for the micronutrients: considerations for physical activity. *Appl. Physiol. Nutr. Metab., 31(1)*:80-5, 2006.

Corresponding author:
Blanca R. Rangel-Colmenero
Facultad de Organización Deportiva
Universidad Autónoma de Nuevo León
MÉXICO

E-mail: blanca.rangelcl@uanl.edu.mx
myriam.garciadvl@uanl.edu.mx