OPEN ACCESS
Journal of Advances in Sports and Physical Education
Abbreviated Key Title: J Adv Sport Phys Edu
ISSN 2616-8642 (Print) |ISSN 2617-3905 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Differences in Anthropometric Characteristics and Body Composition of Athletes in Cyclic Endurance-Type Activities: A Case Study

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DOI: 10.36348/jaspe.2022.v05i10.003 | **Received:** 05.09.2022 | **Accepted:** 08.10.2022 | **Published:** 12.10.2022

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Abstract

Endurance-type disciplines (running, cycling, biathlon) define the cyclic structure of an athlete's movements, which, in addition to functional parameters, also includes an adequate morphological profile and body composition. Based on the detection, analysis and evaluation of these parameters, it is possible to define the body composition of the competitors as well as possible mutual differences even though it is endurance sports. The results are all the more relevant if the profile of top athletes with notable results is being evaluated. The current case study analyzes the morphological dimensions and body composition of competitors of three different disciplines (middle and long distances, cycling, biathlon) of top-level competitors, members of national teams. The study was conducted: Uroš Gutić (UG) - runner middle and long distances, member of AK "Sarajevo" and the BIH athletic national team; Milan Milivojević (MM) – cyclist, member of Cycling club "Borac" Čačak (Serbia), and the member Serbian national team; Stefan Lopatić (SL) – biathlete, member SK "Romanija" Pale, and BIH national team.

Keywords: anthropometric characteristics, body composition, abilities, detection, evaluation.

INTRODUCTION

Anthropometry is the most commonly used method of assessing body composition and body composition in the sports population. They Anthropometric characteristics (AC) define the dimensions of the human body and skeleton allowing individual or combined predictions of body composition, energy content, regional fat, body fat and fat mass (Molla, 2017). Skin fold analysis is a common field assessment to predict the amount of subcutaneous adipose tissue, and as much as 50-70% of stored fat lies between the skin and muscle forming subcutaneous adipose tissue. A study by Wang, Thornton, Kolesnik, & Pierson (2000) proved that 40-60% of body fat is found in the subcutaneous region. Certain skin folds provide information about local fat depots and the distribution of fat in the athlete's body, which are extremely important parameters when top athletes are concerned. Anthropological studies show that body composition of athletes in different sports is different (Agello, Tkačuk & Agello, 2003; Bunc, Vávra & Levora, 2005; Podrigalo, Galaško & Lozovoj, 2007; Agello & Krušenskij, 2008; Kočergina, Čepulenas, 2012). In different sports athletes‟ height, body mass and their components have a different effect on competition activities (Čepulėnas, 2006; Podrigalo, Galaško & Lozovoj, 2007; Larson & Henriksson-Larsén, 2007; Psotta *et al.*, 2009). Specificity of a sport also affects changes in body composition indices (Wilmore & Costill, 2004). In different sports body composition indices are specifically related to sports results (Larson & Henriksson- Larsén, 2008; Psotta *et al.*, 2009). Planning athletic training of elite athletes is linked to prediction of optimal age limits aiming at achieving the best individual sports results (Wilmore & Costill, 2004), regardless of the sport regardless of the sport.

Background: Runners (Middle and Long Distance)

Anthropometric characteristics and body composition are associated with running performance in middle and long-distance athletes (Arrese & Ostariz, 2006; Knechtle, Knechtle, Schulze, & Kohler, 2008), with skin folds determining body fat distribution by defining relevant morphological parameters of top runners. The amount of subcutaneous adipose tissue of the lower extremities in men is directly related to the result of running 1500m and 10000m, enabling a much more efficient effect of the activity. According to Maldonado, Mujika, & Padilla (2002) significant running performance is correlated with body height and weight (cranial and caudal limb circumference and skin folds) (Knechtle, Knechtle, Schulze, & Kohler, 2008). Some research (Billat, Demarle, Slawinski, Paiva, & Koralsztein, 2001; Muñoz, Muros, Belmonte, & Zabala, 2020) analyzed the anthropometric characteristics, somatotype and body composition of elite male athletes in an effort to define an adequate profile for certain athletic disciplines. It has been determined that body morphology together with body composition have a significant impact on physical performance (Gabbett & Georgieff, 2007) where a high degree of endomorphic component limits physical abilities, while a high degree of mesomorphic component is more adapted to physical abilities (Pavlović, Mihajlović, Radulović, Gutić, 2021). According to Wan Nudri, Ismail, & Zawiak (1996) physical ability and physique are important for success in athletic performance where a different type of body composition (endomorph, mesomorph, ectomorph). It is known that physical characteristics and body composition are important for excellence in athletic performance, where most often for certain athletic disciplines a different type of body composition and body mass is required for maximum performance (Wan Nudri, Ismail & Zawiak, 1996). The study of body composition divides and quantifies body weight or mass into its basic components, where body weight is a gross measure of body weight. It can be analyzed from basic chemical elements and specific tissues to the whole body, while body composition is a factor that can affect sports performance and as such is of great interest to athletes and coaches (Malina, 2007). According to Khan, Ahmed & Raja (2016) such competitions are a product of the overall physique of the athlete which implies a certain body size and its shape taking a major role in the movement of runners. Variables associated with motor performance include physical characteristics, maximum oxygen consumption (Bassett, & Howley, 2000; Maldonado-Martin, Mujika, & Padilla, 2004), body composition, thigh length (Deason, Powers, Lawyer, Ayers, & Stuart, 1991; Brandon, & Boileau, 1992), lactate threshold, energy expenditure during running, running economy and stride length (Heinert, Serfass, & Stull, 1988; Maldonado, Mujika, & Padilla, 2002). Running on medium and long distances is a demanding athletic discipline which, in addition to good functional abilities, appropriate anthropometric characteristics, adequate body composition, also implies an exceptional fitness profile of runners. Body size and strength contribute to motor performance, so an increase in strength is associated with an increase in total muscle mass (Lucia, Esteve-Lanao, Olivan, Gomez-Gallego, San Juan, Santiago, *et al.*, 2006). A significant positive correlation between strength and performance suggests that stronger and more powerful individuals were athletes who also had more successful results (Ball, Massey, Misner, McKeown, & Lohman, 1992). However, the pattern of improving strength and physical ability is not uniform in all tasks, because strength may be important for the successful performance of some motor performances (throwing disciplines), but not so important for some others (long-distance racing disciplines). High-performance athletes require specific biological profiles with exceptional abilities and strong psychological characteristics. Today, all runners are as capable and technically tactically advanced as their opponents.

Several researchers have published the physical characteristics of different types of runners (Knechtle, Knechtle, Schulze, & Kohler, 2005; Legaz Arrese, González Badillo, & Serrano Ostáriz, 2005). Arrese, & Ostariz (2006) proved that the amount of subcutaneous adipose tissue of the lower limbs in men is directly related to the result of running 1500m and 10,000m, allowing a much more efficient effect of activity. Middle-aged male top-level runners have greater muscle mass in the lower extremities and torso, and less subcutaneous fat thickness in the central parts of the body than middle-aged men who usually run at the middle level or do not run at all Oguri, Zhao, Du, Kato, *et al.*, (2004). Some studies (Billat, Demarle, Slawinski, Paiva, & Koralsztein, 2001; Muñoz, Muros, Belmonte, & Zabala, 2020) have studied the anthropometric characteristics, somatotype, and body composition of elite male runners. However, to our knowledge, few studies have conducted research for individual and cumulative values of skin folds among runners as well as individual anthropometric characteristics (Arazi, Mirzaei, & Nobari, 2015, Khan, Ahmed, & Raja, 2016).

Background: Cycling

Cycling, along with Nordic running and marathon, is one of the most demanding sports in terms of aerobic abilities, and due to its prevalence around the world, it is considered a planetary sport. According to the rules of the World Cycling Federation (UCI), competitions are held on the road (Road cycling), on the track (Track), cyclo-cross competitions, mountain bike competitions (Mountain bike - MTB), bicycle moto-races (bicycle moto cross “BMX”) and cyclo-tourism competitions. Each of the disciplines uses a different type of bicycle and equipment for cyclists, which is adapted to specific conditions (Nikolić, 2018; Pavlović, Milivojević, Gerdijan, 2022). It is very important to understand the specificity of road cycling due to the fact that the distances are of different duration and terrain configuration. In the 250 km road stage, the plain and mountain terrain configurations are represented, so that most world-class cyclists participate in a combination of these different configurations and specialties. In today's conditions, world-class professional cyclists cover an average of 35,000 km to 45,000 km in one season (Coyle, Feltner, Kautz, *et al.*, 1991; Mujika, & Padilla, 2001; Lucia, Hoyos, & Chicharro, 2003), between 800 and 1,200 hours, while amateur national cyclists cover 15,000 to 18,000 km in the same period (Lucia, Hoyos, and Chicharro, 2001), between 350 and 500 hours (Friel, 2003). In professional cycling, 93min and 123min are spent in races on mostly flat terrain on mountain stages, which are at an intensity of 70% VO2max.

Numerous studies deal with the impact, studying and analyzing the anthropometric characteristics, functional abilities of cyclists in order to reach the relevant parameters that are necessary in cycling for a successful outcome. Identification of objective indicators on the basis of which it would be possible to determine the specialty of cyclists is very important, because it would help trainers in practice to optimize the training process and adapt the methodology of their preparation to the morpho-functional type of individual cyclists (Rauter, Milič, Žele, *et al.,* 2015). Somatotype and individual anthropometric characteristics differ depending on the specialization of the cyclist, i.e. the length of the track they drive. According to Knechtle, Rosemann, Wirth & Knechtle, (2009) anthropometric parameters correlate with race speed while training volume shows no significant correlation. It turns out that anthropometry has a greater impact on racing performance than training volume. Most studies have measured more anthropometric parameters that could relate to athlete performance. Only a few anthropometric parameters have been shown to be useful for identifying talent and development programs in several sports (Brunkhorst, & Kielstein, 2013). The aim of study Brunkhorst, & Kielstein (2013) was to compare several anthropometric parameters and subjective characteristics of professional elite triathletes with anthropometric profiles of professional cyclists and sportive students. Eight different anthropometric parameters were measured and a five-page questionnaire containing 35 general questions had to be completed. Interestingly, there were no significant differences between the arm span, the lengths of the lower limb and the circumference of waist and hip between male triathletes and cyclists. As expected, the athletes had significantly lower heart rates and lower weights as compared to the controls. Further results showed that male cyclists had a higher BMI, larger thighs and were taller as compared to the male triathletes. The present study could not evaluate specific anthropometric characteristics as predictive factors of performance in elite athletes. Thus, individual successful performance is linked to discipline and talent rather than to a specific anthropometric profile. Also, monitoring body composition (BC), and especially regional adiposity, can identify patterns associated with athletic performance and health (Ackland, Lohman, Sundgot-Borgen, *et al.*, 2012). Although BC can reflect many factors unrelated to physical activity and training, it is common knowledge that specific low or high adiposity itself can affect many different sports and cyclist performance (Alvero-Cruz, García Romero, Ordonez, *et al.*, 2022). Knowing the regional adiposity and profile of BC athletes can be very useful for coaches, for example, in improving development programs for their athletes and in longitudinal monitoring of changes in BC athletes, which may indicate athletic fitness (Legaz, 2005). Cycling training models are constantly evolving, and the results of top athletes are becoming more homogeneous, as shown by tables from the world cycling championships for professional cyclists in the disciplines: chronometer, cycle track (time trial) and mountain biking (MTB). In the process of many years of training, there are seasonal variations in relation to the type of training and competition preparation of cyclists. A very important control of the level of current training of athletes involves periodic testing using standardized procedures, where the method of laboratory testing provides the most reference data on the state of training of athletes - cyclists (Peiffer, Abbiss, Chapman, *et al.*, 2008). On the other hand, laboratory tests are non-specific in relation to the general conditions of the athlete, so the obtained data are optimal for assessing the level of morphological and motor development of the cyclist's body and body composition as a relevant factor in success (Dopsaj, *et al*., 2010).

Background: Ski biathlon

Cross-country skiing is an endurance sport popular in Northern Europe, Canada and the United States of America. Individual races last 12 to 90 minutes for female athletes, and 22 to 140 minutes for the men, involving downhill, uphill and level skiing (Ekblom, & Bergh, 2000). In contrast to distance running and long-distance cycling, cross-country skiing uses both upper and lower body muscles (Mahood. Kenefick, Kertzer, Quinn, 2001). Athletes spend many years building their aerobic performance capabilities, and this explains why elite cross-country skiers demonstrate increased training age compared to athletes from other endurance sports (Papadopoulou, Gouvianaki, Grammatikopoulou *et al.,* 2012). An optimum sport-specific body size and body composition is required in order to maximize athletic performance; elite cross-country skiers are as lean as distance runners (Eisenman PA, Johnson SC, Bainbridge CN, Zupan MF, 1989). However, within the sport itself variations in physiology have been noted being attributed mainly to the body mass of the athletes, with the heavy skiers being faster in all types of terrain, except for the steep uphills, and the light skiers having an advantage on steep uphill courses. Given the high exercise demands, proper nutrition is important for performance and endurance in crosscountry skiing. The sport is mainly dependent on carbohydrates as the main energy source, and a high-carbohydrate diet (7-10 g/kg body mass (BM)) has therefore been recommended (Burke, Cox, Culmmings, Desbrow, 2001). Proteins have a low contribution to the energy production (5%), and the daily intake of 1.2-1.7g/kg of BM has been proposed as adequate (American Dietetic Association, 2009). Cross-country skiing is a sport that requires endurance, as with cycling and running (Mahood, Robert, Kertzer, *et al.*, 2001; Sandbakk, Holmberg, 2014). Generally, in endurance sports, the higher the performance, the better the maximum oxygen intake. In cross- country skiing events, world-class athletes are reported to have higher maximum oxygen intake than the national-level athletes (Holmberg, Rosdahl, Svedenhag, 2007; Sandbakk, Holmberg, Leirdal, 2011). In addition, compared to national- level cross-country skiers, world-class cross-country skiers have superior anaerobic power, muscular endurance and muscle power, and high aerobic and endurance capabilities (Staib, Im, Caldwell, Rundell, 2000; McGawley, Holmberg, 2014; Akay, About, Özçiloglu, Heil, 2016; Danielsen, Sandbakk, McGhie, Ettema, 2018). Therefore, endurance training is very important for cross-country skiers because it improves capillary density, myoglobin content, and mitochondria number and size, which improve maximum oxygen intake, aerobic metabolism, and energy production. An important consideration in endurance training is the efficient distribution of exercise intensity, duration, and frequency (Sandbakk, Hegge, Losnegard, Skattebo, Tønnessen, Holmberg, 2016; Aagaard, Andersen, 2010, Kim, Han, Lee, Choi, 2021). In biathlon sports mastery is highly dependent on sliding speed, accurate and fast shooting (Cholewa *et al.*, 2005; Carlson, 2011; Kočergina, Čepulenas, 2012). High sports mastery is affected by athletic and technical fitness, functional capacity, age and years of sports experience (Cholewa *et al.*, 2005; Psotta *et al.*, 2009; Carlson, 2011). Skiing technique and sliding speed in the distance depend on body composition indices (Mahvod *et al.*, 2001). Shooting results depend on athletes‟ mental fitness, shooting technique, sports experience and age (Manfredini *et al.*, 2002; Vickers & Williams, 2007). Physical working capacity and body function indices of biathletes are related to the ration of body mass and their components (Bunc, Vávra & Levora, 2005; Psotta *et al.*, 2009). The problem of interaction of biathletes‟ age and their sports results is particularly relevant while planning biathlete training in Olympic four- year cycles (Kočergina, Čepulenas, 2012). Body composition is the most important anthropometry indicator in cross-country skiers (body fat in elite cross-country skiers is 5–10% of the body mass in males and, let us say, 16–22% in females). Male cross-country skiers have as their somatotype the ectomorphic mesomorph, while female skiers are of the endomorphic mesomorph type. Cross-country skiing is a sport discipline which focuses mostly on the pre-season "dry" preparatory training period. Training tools such as running, roller-skiing, cycling, swimming, canoeing, etc. are used for the development of endurance and strength performance. About 20% of the total volume of the training load is the training intensity which is called "the developing intensity". Training should be focused on building up one's musles. Above all, development of upper body muscles is necessary for cross-country skiing, esp. for the requirements of the skating technique (Randakova, 2005).

The main goal of the current study is to analyze and detect similarities and differences between athletes in the previously defined cyclical endurance disciplines, on the basis of which appropriate conclusions will be drawn.

METHOD AND MATERIAL

The Sample of Participants

The study was conducted:

1. Uroš Gutić - runner middle and long distances (23 year, Body height 181cm; Body weight 67kg; BMI 20.02kg/m^2; Heart pulse 41bmp; saturation O_2 98%), a member of AK "Sarajevo" and the BIH athletic national team.
2. Milan Milivojević - cyclist (22 years old; Body height 185cm; Body weight 70kg; BMI 20,4kg/m^2; Heart pulse 58bpm, saturation O_2 98%), a member of Cycling club "Borac" Čačak (Serbia), and the member Serbian national team.
3. Lopatić Stefan -biathlete (28 years old; Body height 188cm; Body weight 87,8kg; BMI 24,8kg/m^2; Heart pulse=56bpm, saturation O_2 98%), a member SK "Romanija" Pale, and BIH national team.

All three respondents have over 10 years of sports experience. The respondents voluntarily participated in the research.

The Sample of Variables

The total of 16 variables (1-16) were variables of anthropometric space which primarily referred to longitudinal, circular and body mass dimensions and skin folds dimensions and 16 variables of Body composition (17-32).

1. Body height (cm)
2. Body weight (kg)
3. Body mass index-(BMI (kg/m²)
4. Chest perimeter (cm)
5. Upper arm perimeter (cm)
6. Forearm perimeter (cm)
7. Abdomen perimeter (cm)
8. Upper leg perimeter (cm)
9. Lower leg perimeter (cm)
10. Triceps skinfold (mm)
11. Biceps skinfold (mm)
12. Subscapular skinfold (mm)
13. Chest skinfold (mm)
14. Abdomen skinfold (mm)
15. Suprailiac skinfold (mm)
16. 14. Front thigh skinfold (mm)
17. Rear thigh skinfold (mm)
18. Body fat mass (%)
19. Body water (%)
20. Body muscle (kg)
21. Bones (kg)
22. Right arm muscle (kg)

23. Left arm muscle (kg)
24. Trunk muscle (kg)
25. Right leg muscle (kg)
26. Left leg muscle (kg)
27. Right arm fat (%)
28. Left arm fat (%)
29. Trunk fat (%)
30. Right leg fat (%)
31. Left leg fat (%)
32. Basal metabolism (kCal)
33. Daily calorie intake (kCal)

Testing Protocol

Anthropometric measurements were performed according to the methodology of the International Society for the Assessment of Kinanthropometry - ISAK standard procedures. (Marfell-Jones, Olds, Stew, & Carter, 2006). The standard metric instruments were applied Stadiometer (SECA 206-Gemany) used for measuring body height; flexible anthropometric tape (**Baseline**) used for measuring the body perimeter and its segments; Body weight and Body Composition (BC) were assessed with the bioelectrical impedance method using a body composition analyser (Tanita Inner ScanV BC545N, Tokyo, JAPAN), in accordance with the measurement protocol. The Digital caliper for measuring skin folds (GIMA model Plicometro, Italy). All measurements were in accordance with the procedures of the Declaration of Helsinki.

RESULT AND DISCUSSION

Running on middle and long distances, cycling and biathlon belong to endurance disciplines with similar requirements, morphological and functional structure of competitors, as well as muscle structure. These disciplines are mostly based on aerobic potential, where morphological structure and physical status play an important role. The main goal of the current study is to analyze and detect similarities and differences between athletes in the previously defined cyclical endurance disciplines.

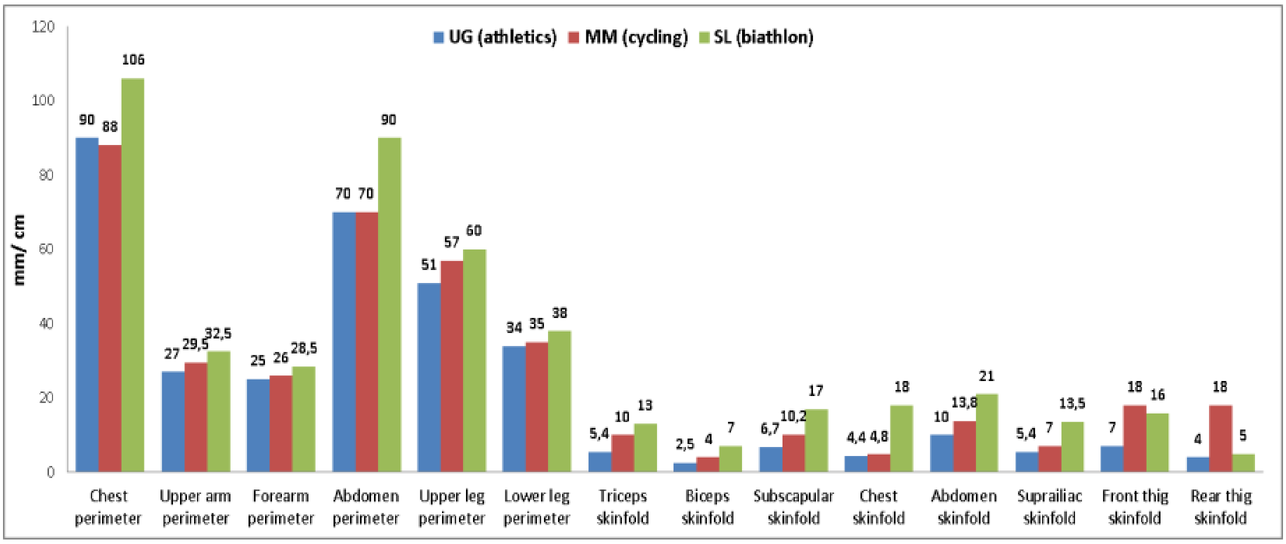
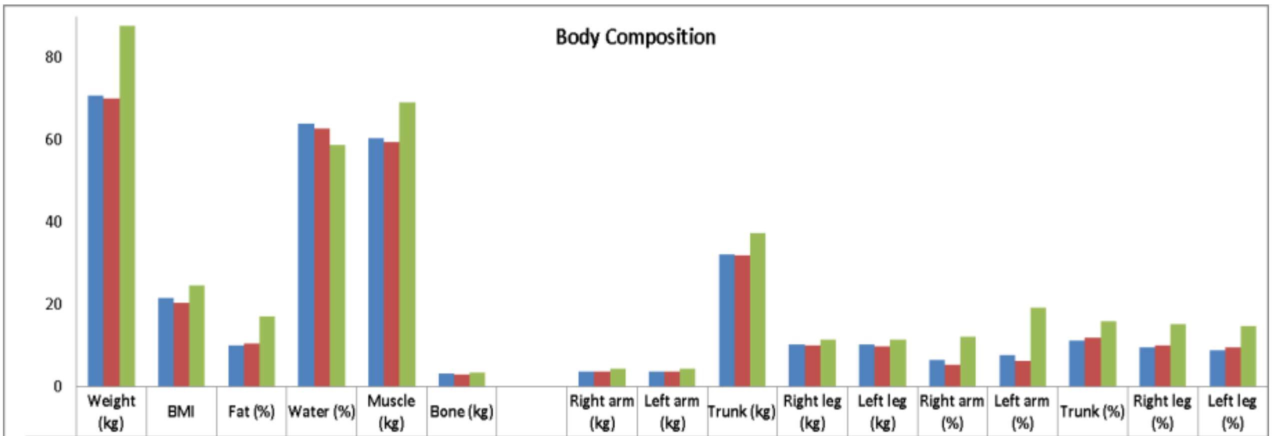


Figure 1: **Anthropometric characteristics sportsmen**



	Weight (kg)	BMI	Fat (%)	Water (%)	Muscle (kg)	Bone (kg)		Right arm (kg)	Left arm (kg)	Trunk (kg)	Right leg (kg)	Left leg (kg)	Right arm (%)	Left arm (%)	Trunk (%)	Right leg (%)	Left leg (%)
UG	70,7	21,6	10,1	64,1	60,4	3,2		3,8	3,7	32,2	10,4	10,3	6,6	7,7	11,2	9,7	8,9
MM	70	20,4	10,6	62,9	59,4	3,1		3,8	3,7	31,9	10,1	9,9	5,4	6,4	12,1	10,2	9,6
SL	87,8	24,8	17,2	58,9	69,1	3,6		4,4	4,4	37,3	11,4	11,6	12,3	19,3	16,1	15,3	14,8

Figure 2: Body composition sportsmen

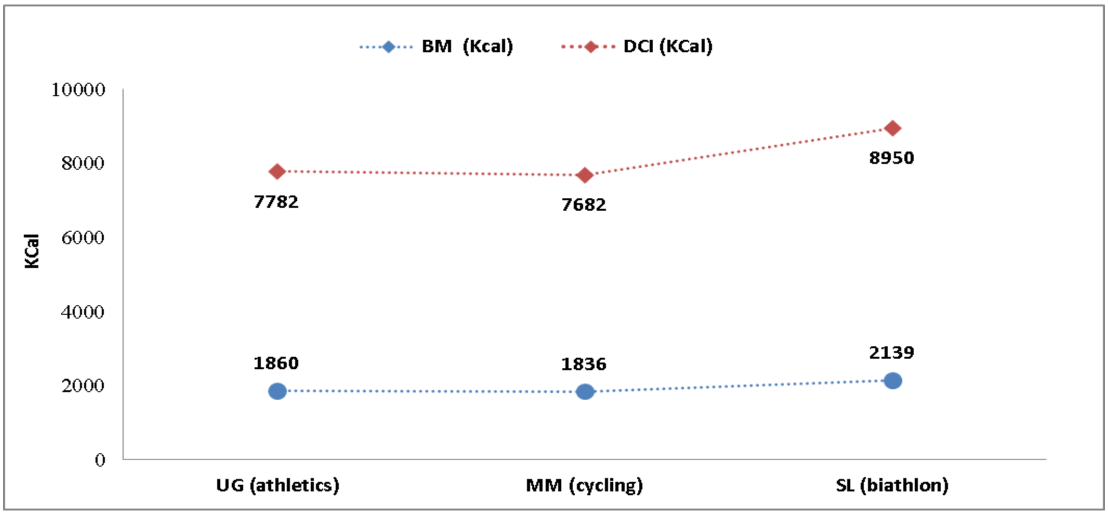


Figure 3: Basal metabolism (BM) and daily calorie intake (DCI)

By looking at the results (Figure 1) of anthropometric characteristics (circumference, skin folds), minor differences are evident between subjects of different endurance sports. In the volume region, the biathlete (S.L) records higher values (volume) compared to the runner (U.G) and the cyclist (M.M). Cumulatively, the chest circumference values range from (88-106cm), upper arm (27-32.5cm), forearm (25-28.5cm), abdomen (70-90cm), upper leg (51-60cm), lower leg (34 -38 cm). Also, an almost identical numerical ratio was maintained in the area of skin folds, where the skin folds of the biathlete were slightly increased compared to the others, except for the folds of the upper leg, where the cyclist showed a higher value. Topologically, the fold of the triceps is the smallest in runners (5.4mm) and the highest in biathletes (13mm). The same order was maintained for the other skin folds (runner U.G has the least and biathlete S.L the highest values). In general, all three competitors have low values of skin folds, which is expected because it is a well- selected, trained sample. The results showed that adipose tissue is a confounding factor in these endurance sports. The training process in these disciplines is very important, and with adequate cybernetic models, it contributes to the achievement of results, with a controlled reduction of fat tissue. The anthropometric characteristics of our sample are determinants of the performance of top athletes, which is in line with earlier results (Mahvod *et al.*, 2001; Maldonado, Mujika, & Padilla, 2002; Knechtle, Knechtle, Schulze, & Kohler, 2008; Rauter *et al.*, 2015; Kim, Han, Lee, Choi, (2021) where, together with body composition, they have an impact on physical performance. Also, the amount of subcutaneous fat tissue of the lower extremities is directly related to the results of running at 1500 and 10000m (Legaz Arrese, Gonzalez Badillo and Serrano Ostariz, 2005) which corresponds to the obtained results of our sample of athletes where skin folds are of low values. Somatotype and individual anthropometric characteristics differ depending on the specialization of the sports discipline. Tracking identifies patterns associated with sports performance and health. It is well known that specific low or high adiposity in itself can be influential in many different sports and on the performance of runners, cyclists or biathletes (Alvero-Cruz, García Romero, Ordonez, Mongin, *et al.*, 2022).

For years, exercise scientists and sports medicine professionals have examined the physiological profiles of elite athletes. Typically, athletes and physically active individuals are leaner than sedentary individuals, regardless of gender. Determination of body composition, especially concerning body fat, total body water and according to up-to-date research, even intracellular and extracellular water, and the amount of oxygen processed by muscle cells is an important part of most of the evaluation of so-called health fitness on the one hand, and the assessment of nutrition and an individual's state of health on the other hand. The determination of body composition provides useful information on predisposition for physical performance (Hannan, *et al.*, 1995; Bunc, *et al.*, 2000).

Based on the results of the research, minor differences are observed regarding the body composition of our sample. Mostly it follows the type of sport and is an adequate type of sports discipline that is practiced. The body mass of the participants (Figure 2) is almost the same for cyclist and runner (70kg vs 70.7kg) compared to biathlete (87.8kg). As a consequence of body mass and height, BMI biathlon (SL-24.8kg/m²) increased compared to runner (UG-21.6kg/m²) and cycling (MM-20.4kg/m²). The percentage of fat in the body of runners and cyclists is extremely low (10.1% vs. 10.6) compared to biathletes (17.2%), which is expected because they are top quality athletes. Fat is inversely related to the percentage of water in the muscles in all participants. The highest percentage of water is present in UG (64.1%), MM (62.9%), SL (58.9%). Muscle mass is dominant in biathletes (69.1kg), which makes up 79% of the total body mass, it is significantly lower in runners (60.4kg) or 85% of the total body mass and cyclists (59.4kg) or 85% of the total mass. It is evident that the differences are significant in favor of biathletes compared to runners and cyclists. Bone content defines the mineralization and nutritional status of athletes. In our sample, bone weight ranges from 3.1 kg (cyclist) to 3.6 kg (biathlete), which is in a linear relationship with body mass. The results of body composition by segment define the approximate values of muscle mass and fat percentage between runners and cyclists, while slightly higher values in muscle mass and fat percentage are recorded for biathletes (Figure 2). The results of the muscle mass of the upper limbs and trunk record identical values for runners and cyclists, in contrast to the regional distribution of fat percentage in the lower regions of the body. According Radenkova (2005) regular training generally results in a decrease in fatness and an increase in fat free mass and is an important factor in the regulation of body weight. Regular training for sport of young athletes has the potential to influence body composition favorably, by means of increasing the bone mineral and skeletal muscle tissue, and by decreasing fatness (Maffulli *et al.,* 2001). The magnitude of changes in body composition with RT varies with the type, intensity, and duration of the program (Malina & Bouchard, 1991). Although body composition, as well as its age-related changes, has a strong genetic predisposition, it is also influenced by enviromental factors. The primary influences are nutrition, disease, and physical activity (Bunc *et al.*, 2000). At present, the studies of body composition are focusing their attention on changes in body composition during growth, maturation and aging, changes under the influence of physical exercise and sport training. Greater body fatness can be affected by endurance performance, and the higher values of fat free mass can be an advantage in strength and power activities. Body composition is one of the most important indicators of the development level within ontogenesis, health, fitness, and physical performance, as well as nutrition (Parizkova, 1998). Generally, a relatively low measure of body fat is desirable in order to optimize physical performance in sports in cyclical sports that require endurance (running, cycling, biathlon), which is in line with our results. Our results correspond to the findings of the study (Gabbett & Georgieff, 2007; Alvero- Cruz, García Romero, Ordonez, *et al.*, 2022), which are based on the fact that body morphology together with body composition is important in the physical performance of sports endurance, which adapts to one of the three known somatotypes (endomorph, mesomorph, ectomorph). Mostly, physical characteristics and body composition are important for excellence in athletic performance, where most often certain disciplines require a different type of structure and body mass for maximum performance (Van Nudri, Ismail & Zaviak, 1996). According to Malina (2007), body composition is most often a factor that affects sports performance.

Results in endurance disciplines are the product of adequate morphological structure, body composition, which is closely related to physical performance, maximum oxygen consumption, energy consumption during activity, economy of activity (Khan, Ahmed, & Raja, 2016; Bassett, & Hovley, 2000; Maldonado- Martin, Mujika, & Padilla, 2004; Kim, Han, Lee, Choi, 2021).

By looking at the parameters of basal metabolism and DCI (Figure 3), it is evident that a runner and a cyclist have almost identical energy consumption and energy requirements compared to a biathlete. The value of the BM runner (1860Kcal) is slightly higher than the cyclist's (1860Kcal vs. 1836Kcal). However, they are significantly lower values compared to the metabolism of a biathlete (2139Kcal). DCI is almost identical in runners and cyclists for slightly higher daily consumption of runners (7782Kcal vs. 7682Kcal). Compared to a biathlete, daily caloric consumption is lower (8950 Kcal). The increased results of caloric consumption confirm the demanding activity and structure of the endurance discipline (running medium and long distances, cycling and biathlon) as well as the adequate body composition of our sample. The consequences of higher body mass and other morphological parameters lead to higher basal metabolism and daily caloric consumption to maintain body function. Our results are in line with the results of some authors (Bunc Vavra & Levora, 2005; Psotta *et al.*, 2009).

CONCLUSION

It can be concluded that the body composition of our sample (runner, cyclist, biathlete) is one of the factors of good results and overall ranking that makes them candidates for national teams. Mutual differences are evident between biathletes versus runners and cyclists in terms of morphology, body composition and energy expenditure. A cyclist and a runner have an almost identical morphological profile and body composition. This is precisely their status as a consequence of a certain similarity between these two sports, which defines less fatty tissue and greater functional capacity.

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