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ANTHROPOMETRIC CHARACTERISTICS, BODY COMPOSITION AND FITNESS PROFILE OF SERBIAN CYCLIST MILAN MILIVOJEVIĆ: CASE STUDY

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Abstract:
Cycling is one of the most demanding sports in terms of aerobic ability. Individual profiling, selection of cyclists implies adequate analysis of anthropometric characteristics and body composition. In addition to the analysis of anthropometric characteristics and body composition, it is necessary to detect and assess motor (physical) abilities, which are often defined by the term fitness profile. In this study, the anthropometric space, body composition and fitness abilities of cyclist M.M, a member of the Cycling Club "Borac" from Čačak and a member of the Serbian national team were analyzed in detail. As many as 60 variants were measured to assess the defined segments (anthropometric space, body composition, fitness profile). The obtained results of anthropometry and physical status confirmed the presence of the ectomorphic-mesomorphic somatotype of the cyclist, which is represented in the so-called road disciplines and endurance disciplines. Also, the fitness profile of the competitor determines extremely good results in all motor skills. To conclude that in addition to the dominance of aerobic abilities, cyclists define exceptional parameters of anaerobic abilities and fitness (motor) abilities (strength, speed, coordination, ...) and their pronounced synergistic effect.

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

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1. Introduction

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. The development of modern cycling and the first bicycle races are related to Paris. Today, the world's most famous bicycle race (*Tour de France*) began in 1903. 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).

According to Dopsaj, Nikolić, Mazić, et al. (2010) the most represented bicycle competitions in the world are road competitions, where within one-day road competitions for world championships up to 280 km are won, for the World Cup up to 250 km, while for other road races the section is 200 km. Compared to other competitions, the distances that cyclists cover are in the range of 200m for sprint competitions on the track, then the so-called stage races lasting from 4 to 10 days, all the way to professional three-week races up to 5000 km long, the so-called tours, i.e. multi-week road competitions such as the "Tour de France", the "Giro d'Italia" and the "Vuelta a Espana" (Mujika, & Padilla, 2001). 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, J., 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% VO^2max. In addition, cyclists perform on an individual chronometer, which lasts about 20 minutes in the zone of anaerobic load (Perez, Fernandez-Garcia, & Rodriguez-Alonso, 2002). According to Štimec (2015) in 2012, the Englishman Bradley Wiggins is the overall winner of the Tour de France, but also the Olympic individual time trial (2004 and 2008) in the individual time trial on the 4km bike path, which leads to the conclusion that the individual time trial is 4km on the cycle path an appropriate test to assess the competitive performance of cyclists. Most often, coaches in larger clubs in developed countries distinguish several specialties of cyclists based on morphological structure and functional abilities of athletes, riders who are successful in flat trial riding, riders on hill terrain (*hill climbing*), riders who are prepared to ride on different terrain riding configurations (*all terrain riding)*, sprinter riders who have the ability to finish the sprint race after several hours to take the winning position and riders who are time trial racing specialists who have the ability to ride on upper limit of aerobic capacity over a long period of time (Padilla, Mujika, & Cuesta, 1999; Menaspa, Rampinini, & Bosio, 2012).

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 results of the research of anthropometric characteristics (McLean, Parker, 1989) on 35 elite male cyclists (sprinters and long-distance riders) on the track show that it is mainly an ectomorphic-mesomorphic somatotype that it is mainly an ectomorphic-mesomorphic somatotype (height 178±4.8cm and average weight 72.5±6.6kg). There was a significant correlation between strength and body weight (r=0.57) and thigh circumference (r=0.55). No significant correlation was observed between any anthropometric parameter and performance in a single event. Bicyclists in the sprint group were heavier (76.2 vs. 70.0) and stronger (258 vs. 216 Nm) and had higher chest (96.2 vs. 92.4 ± 2.9 cm), arm circumference (33.0 vs. 30.7 cm), thigh (57.5 vs. 54.3 cm) and lower leg circumference 37.8 vs. 36,2 cm) than cyclists in the endurance group. They were also more mesomorphic (5.3 vs. 4.7) and less ectomorphic (2.3 vs. 2.9) than endurance cyclists.

The aim of the 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 the 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.

Authors Dopsaj, et al. (2010) define the profile of preparedness of cyclists in the junior category and determine the differences in functional indicators in cyclists who perform in different competitive disciplines: road cyclist, mountain riders, and sprinters. The results show that the maximum oxygen consumption of national cyclists of junior category ($VO^2max=56.42\pm5.82ml\bullet min$-1kg-1) was measured, where $VO^2max=61.43\pm4.94$ was measured for hillers, 56.78±3.33 for sprinters, and 53.37±7.82 for tempo riders. The analysis of the obtained results showed that there were no significant differences between the sample of cyclists at the general level in relation to the functional indicators. These results lead to the conclusion that the tested athletes were trained by applying general training, because although they predominantly compete in different disciplines, the level of preparedness indicates that the training process used in cycling in Serbia in juniors does not imply specific training in the competitive discipline. Studies Impellizzeri & Marcora (2007) report an average heart rate during competitions close to 90% of the maximum (HRmax), corresponding to ≈85% of maximal oxygen uptake (VO^2max), and a large amount of time, ≈40% of total race time, spent in a high-intensity domain, above the power at individual anaerobic threshold (Stapelfeldt, Schwirtz, Schumacher, et al., 2004). In addition, due to the significant involvement of anaerobic metabolism authors suggest the importance of anaerobic power and capacity indices in the requirements of cycling.

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). The difference between the first and second place in the men's time trial is 2.5%, and between the first and fifth place in the 4 km on the bike path is less than 0.5% of the total race time. In mountain biking, the difference between the first and tenth at the World Championships is less than 3%, and the difference between the first and fiftieth riders on the Tour de France (race lasts 21 days, approx. 40 hours) is about 1% of the total race time. These data show that any small progress in the training process can significantly affect the sports result, i.e. competitive success (Štimec, 2015).

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). According to our information, there are no studies aimed at analyzing the anthropometric characteristics, physical status and fitness abilities of Serbian cyclists.

This is the first research (case study) with an individual, a cyclist (so-called "Road cyclist"), a member of BC "Borac" Čačak and the Serbian national team. The purpose of this case study was to analyze the anthropometric profile, body composition and fitness abilities that characterize it.

2. Methods and Materials

2.1 The sample of participants

The study was conducted with Milan Milivojević (M.M), Serbian cyclist (22 years old; Body height 185cm; Body weight 70kg; BMI 20,4kg/m^2; Body fat 10,6%; Body water 62,9%; Body muscle 59,4kg; Heart pulse=59bpm, saturation O_2=98%), a member of Cycling club "Borac" Čačak (Serbia), and the member Serbian national team. His 11 years in cycling sport. The aim of the study was to analyze Anthropometric characteristics (AC), Body composition (BC) and Fitness profile (FP).

2.2 The sample of variables

The total of 60 variables were variables of AC, BC and FP evaluations:

Table 1: The total of 60 variables

Body height (cm)	Basal metabolism (kCal)
Body weight (kg)	Daily calorie intake (kCal)
Body mass index-(BMI (kg/m²)	Metabolic years
Chest perimeter (cm)	Visceral fat
Upper arm perimeter (cm)	Press-ups test (max.)
Forearm perimeter (cm)	Sit-ups test (max.)
Abdomen perimeter (cm)	Chin up test (max.)
Upper leg perimeter (cm	Standing broad jump test (m)
Lower leg perimeter (cm)	Triple jump standing (m)
Triceps skinfold (mm)	Five jumps standing (m)
Biceps skinfold (mm)	Run 15m (sec.)
Subscapular skinfold (mm)	Run 30 (sec.)
Suprailiac skinfold (mm)	Run 100m (sec.)
Abdomen skinfold (mm)	$HGS_{Right\ hand}$ (kg)
Front thigh skinfold (mm)	$HGS_{Left\ hand}$ (kg)
Rear thigh skinfold (mm)	Throwing the ball 3kg standing (m)
Body fat mass (%)	Throwing the ball 3kg sitting (m)
Body water (%)	Ball throwing speed with 7m (m/s)
Body muscle (kg)	Leg strength test-jumps on one leg (sec.)
Bones (kg)	Sprint Bound index
Right hand muscle (kg)	Illinois agility run test (sec.)
Left hand muscle (kg)	Squat jump - SJ (cm)

Torso muscle (kg)	Countermovement jump-CMJ (cm)
Right leg muscle (kg)	Countermovement jump with arm swing-$CMJ_{arm\ swing}$ (cm)
Left leg muscle (kg)	Stiffness test (cm)
Right hand fat (%)	Energy of elasticity
Left hand fat (%)	Coordination index
Torso fat (%)	Peak anaerobic power - SJ_{PAP} (W)***
Right leg fat (%)	Peak anaerobic power - CMJ_{PAP} (W)***
Left leg fat (%)	Peak anaerobic power- $CMJ_{arm\ PAP}$ (W)***

2.3 Experimental design

Anthropometric measurements were performed according to the methodology of the International Society for the Assessment of Kinanthropometry - ISAK standard procedures. The standard metric instruments were applied: Stadiometer-used for measuring body height (SECA 206, Germany); flexible tape used for measuring the body perimeter and its segments. Body weight and Body Composition were assessed with the bioelectrical impedance method using a body composition analyser (Tanita InnerScanV BC-545N, Tokyo, JAPAN), in accordance with the measurement protocol. The Caliper for measuring skin folds (GIMA-model Plicometro, ITALY). All variables applied to the assessment of fitness profile according to (Bosco, Luhtanen, Komi, 1983; Sayers, Harackiewicz, Harman, et al. 1999; Mackenzie, 2005). Participant M.M provided oral informed consent prior to testing. All measurements were conducted during the month of May 2021., in accordance with the procedures of the Declaration of Helsinki.

3. Results and Discussion

The main goal of the study was to analyze the anthropometric profile, body composition and fitness profile of a cyclist M.M member of the cycling club "Borac" Čačak (Serbia) (Table 2, Figure 1-4). Specific physical characteristics (fitness), anthropometric profile, and body composition are required for the highest levels of performance in each cycling discipline (sprint, endurance, road, etc.).

Table 2: Measured parameters

Measured parameters (AC, BC, FP)	Value
Body height (cm)	185
Body weight (cm)	70
BMI (kg/m2)	20,40
Chest perimeter (cm)	88
Upper arm perimeter (cm)	29,5
Forearm perimeter (cm)	26
Abdomen perimeter (cm)	70
Upper leg perimeter (cm)	57
Lower leg perimeter (cm)	35
Triceps skinfold (mm)	10
Biceps skinfold (mm)	4
Subscapular skinfold (mm)	10
Chest skinfold (mm)	4,8
Abdomen skinfold (mm)	13

Suprailiac skinfold (mm)		7
Front thigh skinfold (mm)		18
Rear thigh skinfold (mm)		17
Sum of 8 skinfolds (mm)		45,4
Body Fat Mass (%)		10,6
Body Water (%)		62,9
Body Muscle (kg)		59,4
Bones (kg)		3,1
Basal metabolism (kCal)		1836
Daily calorie intake- DCI (kCal)		7682
Metabolic years		12
Visceral fat		1
Segmental values	**Muscle (kg)**	**Fat %**
Right arm	3,8	5,4
Left arm	3,7	6,4
Trunk	31,9	12,1
Right leg	10,1	10,2
Left leg	9,9	9,6
Press-ups test (max.)		40
Sit-ups test (max.)		130
Chin up test (max.) above average		10
Standing broad jump test (cm)		275
Triple jump standing (m)		735
Five jumps standing (m)		12,90
Run 15m (sec.)		3,10
Run 30m (sec.) average		4,91
Run 100m (sec.)		12,25
Hand grip strength test- HGS Right hand (kg)		47,4
Hand grip strength test -HGS Left hand (kg)		45,7
Throwing the ball 3kg standing (m)		8,7
Throwing the ball 3kg sitting (m)		6,6
Ball Throwing Speed with 7meters (m/s)		16,66
Leg strength test-(jumps on one leg (sec)		5,1
Sprint Bound index		61,92
Illinois agility run test (sec)		17,61 Average 3,70m/s
SJ (cm)		43,4
CMJ (cm)		45,8
CMJ arm swing (cm)		54,7
Stiffness test (cm)		H=34,7 AW=33,63W/kg
Energy of elasticity *		5,53
Coordination index **		16,27
SJ_{PAP} (W)***		3750,38
CMJ_{PAP} (W)***		3896,06
$CMJ_{arm\ PAP}$ (W)***		4436,29

Note: *the formula is used ((CMJ-SJ)/CMJ)x100; **the formula is used ((ABK-CMJ)/ABK)x100
***The Sayers Equation: Peak anaerobic power output-PAPw = (60.7x jump height (cm))+(45.3 x body mass(kg))–2055.

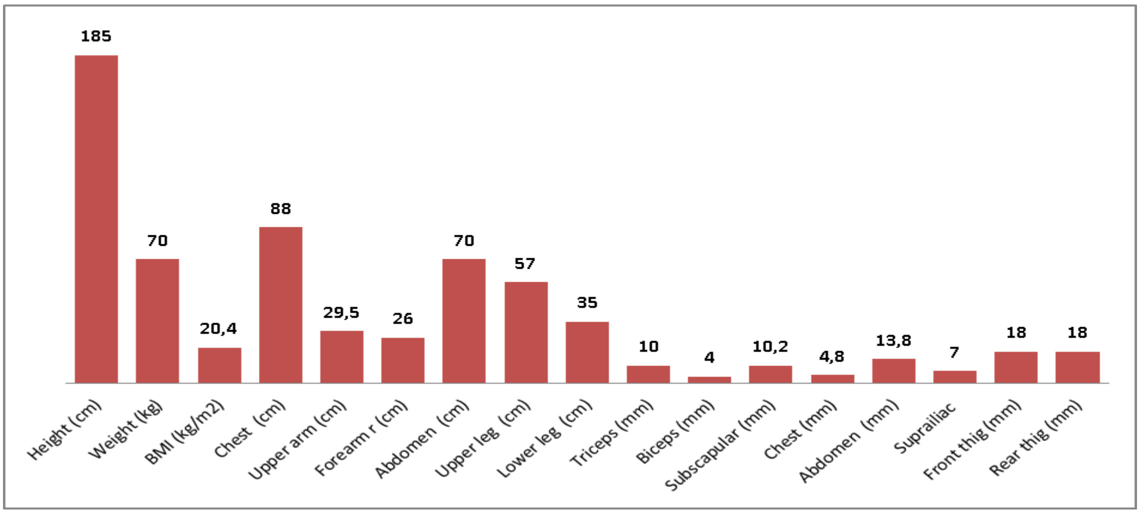

Figure 1: Anthropometric parameters

Figure 2: Body composition

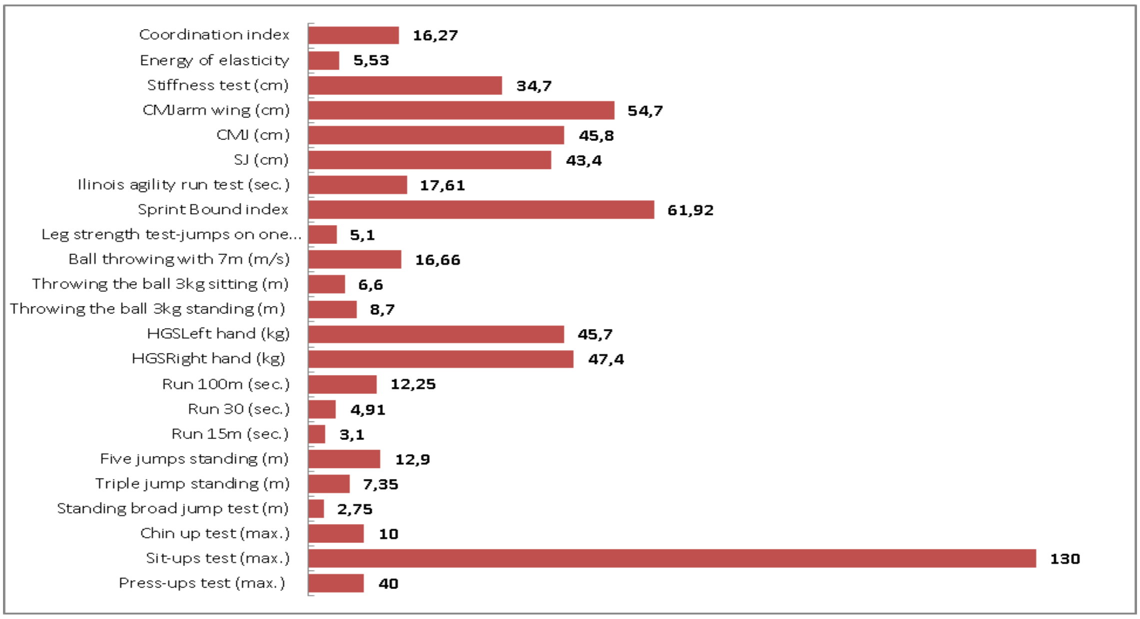

Figure 3: Fitness profile

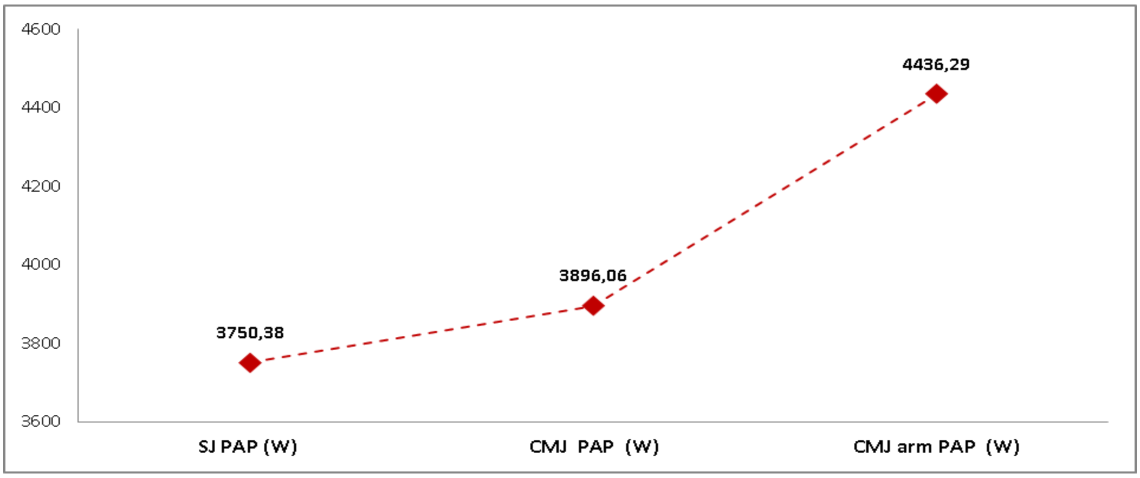

Figure 4: Peak anaerobic power output - PAP (W)

Anthropometric characteristics and athlete's physique of an individual athlete are considered to be an important determinant of success in many sports (Brunkhorst, & Kielstein, 2013). Even though there are many determinants that contribute to the performance of athletes, most sports require a specific range in body size and shape to compete at the top level (Norton, & Olds, 2001; van der Zwaard, de Ruiter, Jaspers, et al. 2019). Consequently, athletes tend to specialize toward sports disciplines that are well aligned with their anthropometry (Foley, Bird, & White, 1989). In cycling, for example, athletes specialize into the disciplines sprint, pursuit, uphill, time trial, flat-terrain, and all-terrain, each demonstrating distinct anthropometric characteristics (Foley et al., 1989; Padilla, Mujika, Cuesta, et al. 1999; Mujika, & Padilla, 2001; Menaspà et al., 2012). For instance, road climbers pursue a low body mass to enhance their uphill performance, as body mass increases the resistance from gravity. Flatterrain cyclists reduce their frontal area per body mass to improve performance during flat stages, minimizing relative energy costs to aerodynamic resistance (Mujika, & Padilla, 2001).

Table 2 and Graphs (1-4) contain the results of anthropometric characteristics, body composition and fitness abilities of the studied sample. Anthropometric characteristics quantitatively and qualitatively define the corresponding ectomorphic-mesomorphic somatotype where the average height (185 cm) with body weight (70 kg) and BMI (20.40 kg/m^2) are good indicators of pronounced longitudinality (in relation to body mass and volume) which is primary in endurance cycling. Body volume parameters are also within the limits that are dominant for this sample of cyclists and together with longitudinality significantly determine the ectomorphic somatotype. There is a significant difference between the cranial extremities with the following values (Upper arm perimeter 29.5cm; Forearm perimeter 26cm) in relation to the circumference of the caudal extremities (Upper leg perimeter 57cm; Lower leg perimeter 35cm). Skin folds also record lower values in the cranial extremity region. This is expected due to the fact that the total circumferences define the joint and the variance of body weight, which in this case is relatively small (70 kg), while the sum of 8 skin folds is 83.8 mm. The body fats of our sample are also represented in a low percentage (10.6%) and according to the tabular values they record a healthy level. The percentage of water in the muscles is about 63%, which is a relevant indicator of good hydration and muscle function. Muscle mass participates with close to 60 kg (88.78%) of the total body weight and with a bone mass of 3.1 kg. Most often, bone mass is not conditioned by BMI and weight of competitors, but by some other factors such as exposure to sunlight, calcium intake and individual habits such as diet (Atri, Malandish, Rashidlamir, et al. 2013).

The nutrition is a very important segment in cycling, because it manifests high energy consumption during the cycling race. The nutritional requirements of the training and competition programmes of elite endurance cyclists are challenging. Notwithstanding the limitations of dietary survey techniques, studies of high-level male road cyclists provide important information about nutrient intake and food practices during training and major stage races. Typically, male cyclists undertaking intensive training programmes report a high energy intake (≥250 kJ/kg/day) and carbohydrate (CHO) intakes of 8 to 11 g/kg/day. Intakes of protein and micronutrients are likely to meet Recommended Dietary Intake levels, because of high energy intakes (Burke, 2001). It is very important that sports nutritionists design personalised diets in order to maintain a correct proportion of nutrients as well as controlling possible anthropometrical changes that could affect performance. The basal metabolism of cyclist records 1836kCal, while the daily consumption is 7682kCal, defining together with all parameters of physical status (composition) the metabolic age of 12 years, which is 11 years less than his biological age and is an indicator of good shape and health. Body composition, and especially regional adiposity, identifies and influences patterns associated with cyclist sports performance (Ackland, Lohman, Sundgot-Borgen, et al., 2012; Alvero-Cruz, García Romero, Ordonez, et al. 2022) which may indicate sports fitness. In our cyclist (Figure 2) body composition is defined by a greater presence of muscle mass in the torso (31.9kg), then almost equal values of caudal extremities (left leg 9.9kg vs. right leg10.1 kg) and cranial extremities (left arm 3,7kg vs. right arm 3.8kg). Out of only 10.6% of body fat, the highest percentage is topographically occupied by the trunk region (12.1%), slightly higher for caudal extremities (left leg 9.6% vs. right leg 10.2%) and cranial extremities (left arm) 6.4% vs. right arm 5.4%).

Cycling is a complex sport in which several physiological, mechanical and environmental factors can affect strength and speed. According to Swain (1994), it is sport in which an athlete's energy cost is related to two principal forces: air resistance when traveling on flat terrain, and gravity when traveling uphill. Both wind tunnel data and physiological measurements suggest that air resistance scales as body mass to about the 1/3 power. Thus, large cyclists have only slightly greater frontal drags than small cyclists. If expressed relative to body mass, the frontal drag of small cyclists is considerably greater than that of large cyclists. The difference in frontal drag (energy cost) is not made up for by the advantage to small cyclists in relative VO2max (energy supply), since the mass exponent for drag (1/3) is closer to zero than that for VO2max (2/3). Professional cycle racing is one of the most demanding of all sports combining extremes of exercise duration, intensity, and frequency. Riders are required to perform on a variety of surfaces (track, road, cross-country, mountain), terrains (level, uphill, and downhill), and race situations (criteria, sprints, time trials, massstart road races) in events ranging in duration from 10 s to 3 wk stage races covering 200 m to 4,000 km. Furthermore, professional road cyclists typically have ~ 100 race d/yr. Because of the diversity of cycle races, there are vastly different physics (motoric) and physiological demands associated with the various events (Jeukendrup, Craig, & Hawley, 2000).

Track cycling competitions range from the 200m sprint (10 to 11 seconds) to the 50km race (about 1 hour). Unlike road cycling competitions where most races take place at submaximal power output, shorter track competitions require cyclists to maximize both the aerobic and anaerobic metabolic pathways. Elite cyclists on the track have key physical (motor) and physiological attributes that are in line with the specific requirements of their competitions, where above all they must have an appropriate genetic predisposition which is then maximized through effective training interventions (Craig, & Norton, 2001)

Specific physical characteristics together with body composition are necessary for the highest levels of performance in cycling where energy power and economy of work are the main parameters. It is for this reason that the Fitness profile of the cyclist is very important and plays an important role in determining the potential for success within cycling disciplines. According to (Pavlović, Radulović, & Savić, 2021), motor fitness defines the relationship between the central nervous system and muscles (neuromuscular coordination), which enables athletes to successfully perform activities. Specific components of fitness (agility, balance, coordination, strength, reaction time and speed) must be integrated in the best possible way, which is confirmed by the results of this study. Insight into the personal parameters of the cyclist shows that it is an enviable morphological status, body composition and functional parameters that suit cyclists.

In the current study, the values of the basic motor components of the cyclist are estimated, which are of great importance for the success of the athlete. Findings by authors (Sunde, Storen, Bjerkaas, et al. 2010; Park, Kim, Yoo, et al. 2019) suggest evidence that muscle mass, maximal muscle strength, and isokinetic muscle function are important predictors of cyclist performance in racing. The strength of the muscular chains of the cyclist's arms and shoulder girdle MM assessed by the maximum number of push-ups (=40), torso lift (=130), the number of pull-ups (=10) are indicators of the good motor status of the cyclist and integrated upper (cranial) and lower (caudal) muscle chain body part, which supports the previous study. Cycling is a sport that is considered the dominant form of exercise in the lower part of the body that emphasizes the use of the quadriceps, knee tendons, gluteus, hip flexors, and to some extent mm. gastrocnemius. In recent years, there has been significant research to determine which upper body (i.e. grip strength) contributes to high intensity during cycling efforts lasting ≤30sec.

Canivel, Randy, Wyatt, et al. (2012) proved that peripheral isometric contractions lead to improved power output during performance, i.e. that the upper body through hand grip and back strength helps stabilize the lower body during cycling, the so-called pedaling cycle (Dore, Baker, Jammes, et al. 2006, Hansen, Raastad, & Hallén, 2007). In this regard, the estimated grip strength of our sample was estimated by dynamometry (right arm, 47.4kg vs. left arm 45.7kg) and the results confirmed previous research on the synergistic effect of grip strength on lower body stabilization during the race. Bicycle racing is a sprint competition, where the power of pedaling that explodes in a short time is an important factor in determining the victory or loss of a competition (Atkinson, Peacock, St Clair Gibson, et al., 2007). Pedaling force is a force that is repeatedly applied to the pedals by the extensor and flexor muscles of the hip, knee, and ankle (McDaniel, Behjani, Elmer et al., 2014). Among the muscle fibers in the lower limbs, the strength of pedaling is influenced by the type of muscle and the volume of muscle fibers involved in pedaling, and is closely related to the coordination of the hips, knees, ankles, and external oblique abdominal muscles (Elmer Barratt, Korff, et al., 2011).

Sakamoto, Naito, & Chow (2018), confirm that maximum and average strength in cyclists are highly correlated with maximum muscle strength around the knee and hip joint, and quadriceps strength, anaerobic strength and VO2max are key factors for success. It was the numerical parameters of different variants of vertical jumps (SJ=43.4cm, CMJ=45.8 cm; CMJarm swing=54.7 cm) that defined and confirmed the good condition of the muscular kinetic chains of the caudal extremities and their synchronized action. This is also an indication that the explosiveness of the vertical type is significant. In the vertical jump test (Stiffness test 2/6) our rider recorded an average height of 34.7cm with an average leg strength of 33.63w/kg. Also, the Peak anaerobic power output-PAP (Figure 4) of our competitor is of enviable value (SJ_{PAP}=3750.38w; CMJ_{PAP}=3896.06w and $CMJarm_{PAP}$=4436.29w) which is in line with the cyclist's body weight and cycling discipline where the muscle output-dependent pedaling cycle (PAP) where the pedaling cycle produces movement of the knee joint by the strength of the tendon and gluteal muscle. Muscle activity in the gluteus and quadriceps muscle is high at a pedaling angle of 0°-180°, and posterior lobe muscle activation increases to 181°-360° (Elmer et al., 2011; McDaniel et al., 2014). The importance of developing maximum muscle strength to improve athletic performance in most sports, including cycling, is generally accepted. During training and competition, the human body takes energy for activities depending on their intensity and duration, and most often the energy for muscle activity in cycling depends on the length of the track, which engages anaerobic or aerobic sources. It has been established that road cyclists belong to athletes with a highly developed aerobic energy system (Faria, Parker, Faria, 2005; Lucia, Hoyos, Perez, Santalla, Earnest, Chicharro, 2004; Sallet, Mathieu, Fenech, et al. 2006), however, the anaerobic system for extremely successful competition obtaining energy. The ability to achieve very high muscle strength in a short period of time is very important for situations such as mass start, mountain driving, as well as at the very end of the race where the rider sprints to the finish line for better placement is one of the factors a good competitive result also depends on (Wilber, Zawadzki, Kearney, Shannon, Disalvo, 1997; Padilla, et al. 1999).

In this regard, the state of explosiveness and speed of individual movement of the cranial extremities of our cyclist was assessed by throwing the ball (=3kg) from a standing position (=8.7m) and sitting position (=6.6m) are good, given the body weight of our rider (70kg). Also, the parameters of the explosiveness of the caudal extremities were estimated by long jump from the place (=275cm), triple jump from the place (=7.35m), five-jump from the place (=12.90m), ball speed with 7 m (=16.66m/s). The obtained results of the current measurement of our sample support the results of previous studies (Hansen et al., 2007; Hodges, 2003, Sunde et al. 2010)).

Due to the fact that the bicycle race in some parts of the sprint character (at the start of the race, during overtaking on the track, during the finish, etc.) sprint speed is extremely important, which is confirmed by the results of running at 15m (=3.10sec.), 30m (=4.91sec.), 100m (=12.25sec.) which mobilizes phosphocreatine and glycolytic mechanisms (Table 1, Figure 3). This is an indication that sprinting abilities are very present in cyclists at the beginning of the race or at the very end when fast muscle fibers are activated. The achieved result of the Sprint bound index test (SBI=61.92) is a good indicator of strength and explosiveness in the caudal extremities of cyclists. Together with the values of the leg strength test (Leg strength test=5.1sec) it projects good strength which according to the tabular values corresponds to the result above the average (Mackenzie, 2005). Illinois agility test with time (Illinois=17.61sec) and average speed (3.70m/s) is an indicator that our cyclist has a well-developed so-called motor intelligence (agility), which largely depends on the degree of development of the central nervous system. The state of the central nervous system is characterized by a variable that we defined as the energy of elasticity whose value (EE=5.53) corresponds to a good neuromuscular adaptation of the cyclist. Only the coordination index proved to be higher (CI=16.27). Elasticity plays a significant role in the pedaling cycle. If a tendon or active muscle is stretched, elastic energy is stored within these structures. This deformation energy is stored and used to improve motor output in the concentric relaxation-contraction phase. To improve cycling pedaling strength, it is necessary to implement a systematic training program for effective interaction of core strength and upper and lower muscular strength that can maintain posture while riding a bicycle (Hartmann, Wirth, Keiner et al., 2015; Rønnestad, & Hansen, 2018). The torso stability exercise is a method of exercise that increases the maximum strength of the back, thigh and hip muscles, which suggests that this increased maximum strength can improve flexibility and balance, as well as shorten the ride for cyclists. According to various studies that have published a link between performance and torso strength in elite athletes, torso exercises increase the maximum strength of the hip flexor muscles and the range of motion in the hip joint. In addition to torso strength, basic physical fitness of the upper and lower body is another factor in deciding whether to win a cycling competition (Mujika, Rønnestad, Martin, et al., 2016; Rønnestad, Hansen, Hollan, et al., 2016). Based on the presented results, it follows that the cyclist's body is a complex cybernetic mechanism with good support of a closed muscle kinetic chain and different energy output mechanisms with adequate morphological status, body composition, and fitness abilities.

4. Conclusion

The results of the study will help to understand the importance of anthropometric characteristics, physique, and fitness abilities of cyclists-competitors, which will be a kind of guide for trainers to adapt and understand the importance of these dimensions in cycling. The obtained results of anthropometry and physical status confirmed the ectomorphic-mesomorphic somatotype of the cyclist, which is represented in the so-called road disciplines and endurance disciplines. Also, the fitness profile reflects extremely good results in all motor skills. This leads to the conclusion that in addition to the dominance of aerobic abilities, cyclists define exceptional parameters of anaerobic abilities and fitness (motor) abilities (different types of strength, speed, coordination, ...) and their pronounced synergistic effect within a closed muscle kinetic chain.

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