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Anaerobic power performance and anthropometric parameters of the 1st and 2nd year male cycling riders in the U17 category.

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Abstract

The purpose of this study is to determine the differences that might exist between 1st and 2nd year U17 cycling riders (15-16year old) from an anthropometric and anaerobic power performance. Twenty nine (29) male riders sub-divided into two chronological groups, U17 1st year (n=11) and U17 2nd year (n=18) participated in this study.Our study community is composed of adolescents riders, competing in the U17 category, and belonging to specialized clubs affiliated to cycling leagues in Algeria. These riders underwent anthropometric measurements and a force-velocity test on an axiom stationary ergometer, which involved two 10-second accelerations, interspersed with at least 5 minutes of active recovery. The purpose of the test is the measurement of peak and mean power using a Powertap G3 hub power meter. All statistical analyses were performed using SPSS version 21.0 for windows. using a t-test for Comparisons between the 1st and the 2nd year. Then, the confounding effects of biological age and muscle mass (i.e., covariates) on anaerobic power performance were examined using analysis of covariance (ANCOVA). The body mass, lean body mass, and muscle mass are significantly higher in 2nd year riders. Regarding the force-velocity test, the 2nd year riders had higher peak power and mean power than 1st year riders ($p>0,05$). In the U17 category, there is high variability in biological age. Coaches must be careful in dealing with riders in this category age, in the selection of these athletes and training planning.

1. Introduction

Cycling is a multifactorial sport in which the performance is affected by many different variables (physiological, anthropometric, biomechanical technical, and tactical), Lucia et al. (2001). Cycling is a non-weight -bearing activity in which the lower body is primarily active. Road ricing requires of the cyclist an aerobic for prolonged exertion and an anaerobic potential to be called upon breakaways, hill climbing, and all-out sprints, Reilly et al. (1990).

Sprints call upon the utilization of high energy compound adenosine triphosphate (ATP) and phosphocreatine (PC). Match sprints, which last approximately 10 seconds, rely heavily on the combined ATP-CP energy source, Reilly et al. (1990).

For instance, during ten second cycling sprints, Ratel et al. (2002) showed that 10-year old boys were able to sustain their peak power output with only thirty second recovery intervals. In contrast, 15-year-old male adolescents and 20-year-old men needed a five-minute recovery period.

The mechanical power produced by a cyclist corresponds to the amount of work he does per unit of time. The work he does depends on the level of force he applies over a given distance, Grappe (2012).

Measuring the power of anaerobic metabolism becomes important in children since it is the ideal time to detect young talents and guide them towards explosive sports. In an attempt to screen large cohorts of children and adolescents cycling federations around the world use such performance tests for talent identification. For example, the Wattbike air-braked ergometer is used by British Cycling for talent identification of young cyclists.

At the age of 15 - 16 years old, the second pubertal phase or adolescence, characterized by an increase in testosterone levels, occurs. This male hormone has a direct impact on muscle mass (Van Praagh, 2007). As a consequence, Speed and velocity of movement are improved, as they are among the conditional abilities that experience maximum "trainability" at this age, which is a sensitive phase of their development, Abdelmalek et al. (2015).

Several protocols have been used to measure the anaerobic power of the lower limb: force-velocity tests on the cycle ergometer (Khiat, 2010), vertical jump test (Koutchouk, 2011; Chenour and Nacer, 2017; Deradji and Mazari, 2020), the RAST test (Hallouz and Hannat, 2019) squat jump and countermovement jump (Sayeh et al., 2020), and staircase (Margaria et al., 1966). And others use the sprint running tests, like 30 meters (Bensalem et al., 2020; Ghidi and sedira, 2019) and 40 meters (Mokkedes, 2013). On ergometer tests, peak power is obtained by combining optimal values of force (N) and pedal velocity (rad. s^{-1}). Martin et al. (1997) have also shown that for the cycle ergometer, the crank length, and pedaling cadence were important determinants of the peak power.

In our study, we have used a force-velocity test on an axiom stationary ergometer (Bertucci et al., 2012) with a constant brake force. The cyclists ride their bicycles during the test. This practice helps to ensure that the cyclist will not alter the cycling style, whereby much of the natural cycling technique may be preserved, Reilly et al. (1990). There are many systems for measuring mechanical power. These are either fixed and used in the laboratory (Scientific SRM), or mobile (Powertap G3 hub) and usable in real locomotion conditions in training and competition.

1.1. Literature Review

Sports activities for young people are largely organized by chronological age within each gender. The chronological age when registering for a specific sport or competition is based on the date of birth and the prescribed deadline for age groups and seasons, Lloyd et al. (2014).

However, literature has demonstrated that individuals of the same chronological age or the same age category can differ markedly concerning biological maturity (Baxter-Jones et al., 2005 and Rowland, 2005). Biological maturation refers to progress toward a mature state and varies in timing and tempo and between different bodily systems.

Several studies have investigated the effect of chronological age and biological age on physical performance, Hammami et al. (2019) on youth handball, Torres Unda et al. (2013) and Guimarães et al. (2019) on adolescent's basketball players and Patel et al. (2020) on soccer players. In Others side, numerous studies have described the effects of age on peak anaerobic power, (Doré et al., 2001; Carvalho et al., 2011 and Khiat, 2014).

There are many methods for assessing biological maturation, the method of determination of bone age (Tanner, 1962), through several procedures, determination of dental age and study of morphological characteristics (statural age, weight age, cranial age, sitting height, body mass index, KEI index (Beunen et al., 1982; Szczesny 1983; Wutscherk 1988, Mc Dougal et al., 1991). In our study, we have used the Wutscherk method, using KEI index. It is a simple and less expensive method than measuring salivary testosterone concentration (Fellmann et al., 1988; Van Praagh et al., 1990) and determining bone age. This method was readjusted on Algerian subjects by Abdelmalek et al. (2006), with a correlation between the biological age determined by the KEI index and the bone age of the 2nd reader on his second reading of a coefficient (r=0,914).

The U17 category includes riders who will be fifteen and sixteen years old within a year. Riders who turn seventeen years old change age category on January 1st of the following year. This category has different names according to the rules of the federations, for example, in Belgium it is called "Débutants", while in Italy "Allievi", meaning "student", and "Jugend" in Germany, meaning “young”.

Pineau (1991) posed the problem of the arbitrary and ever-present choice of the age categories: U15 (13-14 years) and U17 (15-16 years) for boys. Indeed, it is known that growth peaks at a variable chronological age (Kemper, 1985), sometimes located in these two categories. In the U17 category, Pineau (1991) confirms that there is high variability in biological age. For this reason, it would be interesting to examine the differences that might exist between 1st and 2nd year riders in this category in anthropometric and anaerobic power performance. The purpose of this paper is to determine the differences that might exist between 1st and 2nd year U17 cycling riders from an anthropometric and anaerobic power performance. Following this, two questions arise:

What are the anthropometric and anaerobic power performance differences that exist between riders in the U17 category, grouped according to chronological age?

What is the effect of biological age and muscle mass on the anaerobic power performance?

It is hypothesized that anthropometric and anaerobic power performance will be greater in 2nd year U17 riders.

It is hypothesized that biological age and muscle mass have an effect on anaerobic power performance.

2. Method and Materials

According to Boudaoud and Atallah (2009), the descriptive method is used by many researchers in many different fields, including sport, to study many of the current cases. We opted for this method, which is adapted to the nature of the problem and the variables in our study, to achieve the results in light of the available data. The independent variable in our study is the U17 category, including the 1st and 2nd year. while the dependent variables are the anthropometric parameters and the anaerobic power performance.

2.1. Participants

Twenty-nine (29) male riders participated in the study. Our study community is composed of adolescent's riders, competing in the U17 category and, belonging to specialized clubs affiliated to cycling leagues in Algeria. The study sample was selected deliberately. Riders were sub-divided into two chronological groups, eleven (11) U17, 1st year riders, and eighteen U17, 2nd year riders. All measurements and assessments were performed. Participant's characteristics within the chronological groups are presented in Table 1.

Table 1 : Participant characteristics (mean (M)±standard deviation (SD))

Groups	Number of participants (n)	Age (years)	Weight (kg)	Height (cm)	Previous training experience (year)
Total	29	15,34±1,84	57,73±5,66	173,01±6,33	4,10±2,27
U17 (1st year)	11	15,02±0,30	54,27±4,99	170,28±6,65	4,45±2,91
U17 (2nd year)	18	16,25±0,28	59,85±5,06	174,67±5,69	3,56±0,62

2.2. Materials

In our study, the riders were measured anthropometrically, using an anthropometric suitcase and a scale. As well as a force-velocity test for power evaluation using a Powertap power meter and axiom stationary ergometer (see more details in design and procedure).

2.3. Design and Procedure

Within the context of the preparation of the Arabic championships 2019 (Charm el-Cheikh, Egypte), a training camp was organized by the Algerian Cycling Federation at the Oum el Bouaghi youth center, for the U17 category from the 1st to 10th August. Anthropometric measurements were done on 4 August in pairs; one person takes the measurements, the other records the type. On the 5th of August, the riders performed the force-velocity test, the first group in the morning, and the second group in the afternoon.

2.3.1. Anthropometry

Each rider had to fill in an investigation form, indicating the surname, first name, date, and place of birth, number of years of practice, and number of training sessions per week. Anthropometric measurements included: height, lower limb length, thigh length and leg length (an anthropometer of the MARTIN) and body mass (a medical scale (SECA) with an accuracy of ± 50 grams). The muscle mass was estimated, according to the following formula (Mateigka, 1921), cited by Wutscherk (1988):

$$\mathbf{MM = L \times R^2 \times 6{,}5}$$

L: height in cm

R : $\frac{\text{circumferences (arm+forearm+thigh+calf)}}{2\times\pi\times4} - \frac{\text{skinfolds (arm+forearm+thigh+calf)}}{2\times4\times10}$

In the area of the arm, the skin fold is equal to the:

Skinfold (arm) = $\frac{\text{biceps skinfold+triceps skinfold}}{2}$

The lean body mass (LBM) was estimated, using the following equation:

LBM= Body mass – (%Body fat ×Body mass/100) (kg)

% Body fat (Slaughter et al., 1988) =1,21(tricipital skinfold+ subscapulaire skinfold)- 0,008 (tricipital skinfold+ subscapulaire skinfold)^2-5,5

2.3.2. Force-velocity test on a axiom stationary ergometer

The subject uses his bicycle, fitted with the Powertap, which was connected to the stationary axiom ergometer (Elite, Fontaniva, Italy). The axiom is an electromagnetically braked computerized ergometer, by fixing the rear wheel in the stand of the stationary axiom ergometer by the rear wheel quick-release skewer (Bertucci et al., 2012). The data are measured with a Powertap G3 hub power meter with an accuracy of 1,5%, the Powertap is used to measure the mechanical power at the rear hub of the bicycle (Bertucci et al., 2005). The test begins with a 15-minute warm-up at a medium intensity. After 5 minutes of recovery, the cyclist performs two (2) maximum 10-second sprints out of the saddle with braking force (simulation of a 7% gradient), with the maximum chain gear ratio (52/16), interspersed with at least 5 minutes of active recovery with low intensity. The data were recorded on a Garmin Fenix 3 watch and processed using Garmin connect software, Grappe (2012).

2.3.3. Biological age

Biological age was estimated using the anthropometric method described by Wutscherk (Wutscherk, 1988). Using the following formula:

$$\textbf{Biological age} = 34{,}204 \times \text{KEI} - 13{,}098 \text{ (years)}$$

KEI Index was determined using the following formula:

$$\textbf{KEI Index} = \frac{2\text{X Corrected arm circumference} \text{X mean breadth}}{10\text{X height}} \ (\text{cm}^2/\text{cm})$$

- ✓ The Röhrer index (Weight/10xHeight^3) determines the circumference correction value.

Mean breadth = biacromial breadth + bicretal breadth /2 (cm)

2.4. Statistical Analysis

All statistical analyses were performed using SPSS version 21.0 for windows. Descriptive statistics (mean and standard deviation (SD)) were ascertained for all variables. The equality of variances for studying variables was assessed by Levene's test before comparing the fourteen variables. Comparisons between the 1st and the 2nd year were performed using a t-test for the independent sample. Then, the confounding effects of biological age and muscle mass (i.e., covariates) on anaerobic power performance were examined using analysis of covariance (ANCOVA), and partial eta squared ($p\eta^2$) was used as a measure of effect size, giving 0,01 (small), 0,06 (medium) and 0,14 (large).

3. Results

The biological age and anthropometric parameters of 1st and 2nd year U17 riders are shown in Table 2. 2nd year riders have a higher biological age than 1st year riders. The difference between the averages is significant ($p<0{,}05$; $p\eta^2 = 0{,}14$).

As shown in Table 2, analysis of the anthropometric parameters in the two groups revealed that the body mass, lean body mass and muscle mass are significantly higher in 2nd year riders (P<0,01). Further, 2nd year riders showed a higher body fat percentage than 1st year riders ($p<0,05$; $p\eta^2$= 0,19). For the rest of the parameters (lower limb lenght, thigh length, and leg length) a slight superiority in favor of the 2nd year riders, the difference between the means was not significant (p>0,05). Regarding the force-velocity test, the 2nd year riders had higher peak power and mean power in absolute values than 1st year riders (p>0,05). However, the 1st year riders had a slightly better performance of peak and mean power in relative values than 2nd year riders (p>0,05).

Table 2. Descriptive and analysis statistics (mean (M)±standard deviation (SD)) of riders grouped by chronological age.

Variables	U17 category (n=29)		t	Sig	$p\eta^2$	Effect size
	1st year (n=11) M±SD	2nd year (n=18) M±SD				
Chronological age (years)	15,02±0,30	16,25±0,28	11,33	p<0,001	0,83	Large
Biological age (years)	14,47±1,70	15,87±1,76	2,11	P<0,05	0,14	Large
Anthropometry						
Height (cm)	170,28±6,65	174,67±5,68	1,89	ns	0,12	Medium
Body mass (kg)	54,27±4,99	59,85±5,06	2,89	p<0,01	0,24	Large
Lean body mass (kg)	49,28±3,93	53,61±4,11	2,79	P<0,01	0,22	Large
Lower limb lenght (cm)	92,83±4,39	94,03±3,76	0,78	ns	0,02	Small
Thigh length (cm)	46,29±2,40	46,59±2,17	0,33	ns	0,004	-
Leg length (cm)	36,04±1,91	36,81±2,19	0,97	ns	0,03	Small
% Body fat	5,32±0,75	6,07±0,79	2,53	p<0,05	0,19	Large
Muscle mass (kg)	23,10±2,43	26,21±2,70	3,12	p<0,01	0,26	Large
Force-velocity test						
Peak power (w)	966,73±140,12	1025,44±109,43	1,26	ns	0,06	Medium
Mean power 10’’ (w)	713,55±108,69	765,56±121,13	1,16	ns	0,05	Small
Peak power (w/lbm)	19,57±1,98	19,12±1,35	0,73	ns	0,02	Small
Mean power 10’’ (w/lbm)	14,46±1,85	14,24±1,66	0,33	ns	0,004	-

$p\eta^2$= partial eta squared; sig = signification; ns= no significant p>0,05.

When controlling for covariates of biological age and muscle mass (Table 3), it was found that significant differences between the 1st and 2nd year U17 riders occurred in peak power ($p<0,0001$; $p\eta^2$= 0,60) and mean power ($p<0,0001$; $p\eta^2$= 0,54) with absolute values in favor of 1st year riders. Besides, 1st year riders outperformed 2nd year riders in peak and mean power in relative values (p>0,05).

Table 3. Adjusted means of anaerobic power performance, for biological age and muscle mass

Variables	U17 category (n=29)		F	Sig	$p\eta^2$	Effect size
	1st year (n=11) AdjM±SE	2nd year (n=18) AdjM±SE				
Peak power (w)	1030,26±28,24	982,03±19,47	19,30	P<0,0001	0,60	Large
Peak power (w/lbm)	20,03±0,54	18,88±0,37	2,09	ns	0,14	Large
Mean power 10'' (w)	766,36±28,90	728,71±19,93	15,12	P<0,0001	0,54	Large
Mean power 10'' (w/lbm)	14,91±0,57	13,98±2,25	2,25	ns	0,15	Large

AdjM±SE= adjusted means and standard-errors; $p\eta^2$= partial eta squared; sig = signification; ns= no significant p>0,05.

4. Discussion

The purpose of this study is to determine the differences that might exist between 1st and 2nd year U17 riders from anthropometric parameters and anaerobic power performance.

Our finding of this study revealed that 2nd year U17 riders are taller and heavier than 1st year riders. This is due to the growth spurts occurs in this age category, i.e. when the staturo-ponderal increases are the most pronounced (Kemper, 1985; Buckler, 1990) and the greatest variability in the puberty stage occurs at 15 and 16 years of age (Pineau, 1991).

The 2nd year riders showed a higher body fat percentage and lean body mass than 1st year riders.

According to Maciejczyk et al. (2015), body fat is passive tissue during exercise, and it adversely affects performance, especially during weight-bearing activities. Although cycling is a non-weight bearing activity, in which the lower body is primarily active. Remember that, the 2nd year riders had higher peak power and mean power in absolute values than 1st year riders. This finding is in contradiction with the findings of Maciejczyk et al. (2015), suggesting that body fat can negatively influence cycling anaerobic performance.

The 2nd year riders had higher peak power and mean power in absolute values than 1st year riders. This result shows that absolute power in cycling increase as a function of chronological age. And this confirms what has been reported by (Davies and young,1985; Falk and Bar-Or, 1993). Also, this can be the result of muscle mass, significantly higher in 2nd year riders. This corroborates what has been reported by Lafortuna et al. (2004) and Kim et al. (2011) who confirm that the generation of power primarily depends on muscle mass, which is the main component of lean body mass.

Sergeant (1992) confirms that anaerobic performance is often expressed in W. Kg^{-1} Body mass. Various authors have pointed out that in cycling where body mass is supported, the peak power between different age groups must be expressed according to active muscle mass rather than total body mass. It's our case where we've related the peak power and mean power in relation to lean body mass.

The advantage of the 1st year riders in peak and mean power in relative values than 2nd year riders. Maciejczyk et al. (2015) confirm that only increased body mass resulting from excessive body fat negatively affected peak power and mean power in relative values. Thus, this data presentation manner penalizes only athletes with high body fat. This confirmation could explain this advantage.

Group means are adjusted based on the magnitude of the effect the covariates (i.e.biological age and muscle mass).

It was found that significant differences between the 1st and 2nd year U17 riders occurred in peak power and mean power with absolute values in favor of 1st year riders. And then, the 1st year riders outperformed their peers in peak and mean power related to lean body mass. These results suggest that variation in chronological age in this category age had no influence on peak and mean power in absolute and relative values. On the other hand, biological age and muscle mass play an important role in improving performance in anaerobic power. These results are in accord with the results of (Chamari et al., 2008; Aouadi et al., 2012; Abdelmalek et al., 2017).

5. Conclusion

Coaches working with youth categories must learn to appreciate the influence of biological maturation on athlete performance.

The 2nd year riders are taller and heavier than the 1st year cycling riders. Concerning the lengths, the 2nd year riders have greater lengths (lower limb, leg, and thigh) and muscle mass than the 1st year riders.

On the other hand, the 2nd year riders are more powerful than their peers. When anaerobic power performance is related to lean body mass, the 1st year riders outperformed the 2nd year riders.

In the U17 category, there is high variability in biological age. This category corresponds to the stage of the specific basic preparation of juniors; it is a decisive phase in the choice of the cycling events (explosive or endurance events) and, for the best, in the preparation to face international competitions. Therefore, coaches must be careful in dealing with riders in this category age, in the selection and orientation of these athletes and consider biological maturation when designing exercise programs.

Opening the way to study the effect of maturation on power in aerobic and anaerobic (lactic) energy metabolism on a large sample, will be very interesting.

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