

PSYCHOMETRIC, ANTHROPOMETRIC AND BIOCHEMICAL PROFILE OF MOUNTAIN BIKE AMATEUR CYCLISTS: A LONGITUDINAL STUDY

PERFIL PSICOMÉTRICO, DE COMPOSIÇÃO CORPORAL E BIOQUÍMICO DE CICLISTAS AMADORES DE *MOUNTAIN BIKE*: UM ESTUDO LONGITUDINAL

Ozineide Sousa Dantas de Andrade¹, Adeilma Lima-dos-Santos², Rodrigo Ramalho Aniceto³ e Alesandra Araújo de Souza⁴

¹Faculdades Integradas de Patos, Patos-PB, Brasil.

²Universidade Federal da Paraíba, João Pessoa-PB, Brasil.

³Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Currais Novos-RN, Brasil.

⁴Universidade Federal do Tocantins, Tocantins-TO, Brasil.

RESUMO

Atletas praticantes de mountain bike podem desenvolver problemas relacionados ao excesso de treinamento, ocasionando perda de desempenho. O objetivo foi analisar as variáveis psicométricas, bioquímicas e composição corporal de ciclistas amadores que praticam o mountain bike. Participaram 10 ciclistas ativos a dois anos. Registrou-se as variáveis no 1º, 15º e 30º dia durante um mês. Por meio dos questionários POMS e REST-Q foram avaliados estado de humor e estresse-recuperação, por meio do percentual e quilograma de gordura, e massa magra, analisou-se a composição corporal, por meio das enzimas creatinaquinase (CK) e lactato desidrogenase (LDH) avaliou o dano muscular. Para a análise foi utilizada ANOVA/medidas repetidas. Observou-se que os voluntários estavam com índices significativos de tensão, depressão e hostilidade no 15º e 30º dia em relação ao 1º ($p < 0.05$); relataram menor conflito/pressão e exaustão emocional no 15º dia em relação ao 1º ($p < 0.05$). Não foram encontradas diferenças significantes na atividade das enzimas LDH e CK, e em nenhum dos componentes de composição corporal no 30º dia em relação ao primeiro ($p < 0.05$). Conclui-se que o treinamento realizado sem monitoramento de um profissional que prescreva e o acompanhe diariamente pode acarretar em alterações psicométricas importantes e indicativas de overtraining.

Palavras-chave: Atletas. Educação Física e treinamento. Metabolismo.

ABSTRACT

Mountain biking athletes may develop problems related to excessive training, leading to loss of performance. The objective was to analyze the psychometric, biochemical and body composition variables of amateur cyclists who practice mountain biking. Ten active cyclists participated in two years. The variables were recorded on the 1st, 15th and 30th day for a month. Through the POMS and REST-Q questionnaires, the state of humor and stress-recovery, through percentage and kilogram of fat, and lean body mass, were analyzed through creatine kinase (CK) and lactate dehydrogenase (LDH) evaluated muscle damage. ANOVA / repeated measurements were used for the analysis. It was observed that the volunteers had significant indices of tension, depression, hostility and fatigue on the 15th and 30th day compared to the 1st ($p < 0.05$); reported less conflict / pressure, emotional exhaustion and self-regulation on the 15th day compared to the 1st ($p < 0.05$). There were no significant differences in the activity of LDH and CK enzymes, nor in any of the components of body composition at the 30th day in relation to the first day ($p < 0.05$). It was concluded that the training performed without monitoring of a professional who prescribes and accompanies the training daily can lead to important psychometric changes indicative of overtraining.

Keywords: Athletes. Physical Education and training. Metabolism.

Introduction

Mountain Bike emerged in the 1970s through a group of young cyclists in California (USA) who decided to ride bicycles, hiking trails to reach the top of mountains and feel the pleasure and excitement of cycling downhill¹. Mountain Bike is a sports modality that has been expanding in Brazil in the 1980's and developing elite or recreational athletes, who prepare themselves for regional, national or international competitions². In this sport, cyclists train or compete on terrain with obstacles such as slopes, rocks and/or holes³. Therefore, these factors make mountain biking one of the sports modalities that require exercise prescription and monitoring in order to prevent injuries, excessive training or loss of performance⁴.

In this perspective, the maintenance of good sports performance involves determinant factors as: monitoring of training loads, follow-up of predictive physical performance variables such as psychometric variables, verified through mood state (POMS)⁵ and stress-recovery questionnaires (REST-Q Sport)⁶, and biochemical variables for detection of muscle damage and inflammatory status, in addition to anthropometric variables⁶. However, these monitoring variables when used in isolation may not correctly detect alterations caused by overtraining.

Studies have reported that after the rupture of skeletal muscle cell membranes caused by injuries, serum levels of proteins such as creatine kinase (CK) and lactate dehydrogenase (LHD) leak out into the bloodstream⁷, but the existence of three CK isoforms present in large release sites impairs the use of this enzyme alone as an indicator of overtraining⁸. The interaction of physical fitness on psychophysiological responses demonstrates that individuals who present better aerobic conditioning obtain lower physiological responses to stress^{9,10}, thus proving to be a determinant of athlete performance.

In order to avoid a significant loss of performance, athletes should have physical, psychometric and biochemical assessments performed by a physical education professional. However, although the benefits of cycling are evident, some athletes train daily without the monitoring of these professionals, with no adequate exercise planning and progression, being exposed to greater risk for the development of overtraining state denominated as excessive training state, resulting from inadequate recovery, increased oxidative and physiological stress and changes in mood state¹¹.

Considering the need for studies on physiological parameters related to mountain bike training that can improve the performance of cyclists, this study aimed to analyze the psychometric, biochemical and body composition variables of amateur mountain bike cyclists.

Methods

Sample

Athletes were recruited through posters / invitations performed by the Laboratory of Physiology and Human Performance of the Integrated Faculty of Patos. Twelve male volunteers, Mountain Bike cyclists, who had at least two years of uninterrupted training and trained 150 kilometers per week, participated in this study. Cyclists were considered trained when, after analysis of the cardiorespiratory test, showed VO_2max equal to or greater than 50 ml / kg / min. This value was determined according to data previously verified in literature in which mountain bike athletes trained and able to participate in competitions presented, on average, 50ml / kg / min¹². Amateur mountain bike athletes aged 18-35 years without the presence of cardiometabolic diseases such as systemic arterial hypertension and type I or II diabetes were included in the sample.

Athletes using anti-inflammatory drugs, those who modified their training to less than 150 kilometers per week, or suffered osteoarticular injury during the month of training observation were excluded from the study. In this sense, two athletes were excluded from the sample, one due to the use of food supplements and the other for moving to another state. In this context, the sample consisted of 10 volunteers who met all inclusion criteria.

The project was approved by the Committee of Ethics in Research with Human Beings of the Integrated Faculty of Patos under protocol number 1.539.600. For all athletes, information regarding the conduction of the study, variables analyzed, and aim of the study and each procedure was provided. Thus, the present investigation started after all athletes read and signed the Free and Informed Consent Form.

Procedures

Athletes were informed that they should attend the Laboratory of Human Physiology three times, always after a period of 48 hours at rest, without any type of training. Thus, during the first visit, the following procedures were performed: cardiorespiratory test, systolic and diastolic blood pressure recording, and baseline metabolic rate assessment only as characterization variables; analyses of the mood state profile, stress and recovery profile, muscle damage, lean mass and fat mass percentage and weight.

After 15 and 30 days, that is, in the second and third training observation visit, respectively, athletes returned to the laboratory to perform new analyses of the mood state profile, stress and recovery profile, muscle damage, lean mass and fat mass percentage and weight.

The training observation period started 48 hours after the first visit and lasted for the entire training month. It is noteworthy that the researchers did not perform any intervention in the prescription of the exercise for athletes, since they already followed a training protocol determined by the own group.

Familiarization

At the first visit, volunteers were instructed on the procedures of the cardiorespiratory test, being familiarized before the test with the gas analyzer and the cycle ergometer, respectively, the mask was placed and the volunteer spent 2-3 minutes with it, adjusting the seat, pedal and handle of the cycle ergometer, and the volunteer pedaled for a certain time to adapt to the equipment. There was also familiarization regarding the questionnaires applied.

Evaluation of the Maximum Oxygen Uptake (VO_{2max})

A protocol was used in Inbramed cycle ergometer model CG-04 (Porto Alegre, Brazil) adapted by Basset and Boulay¹², in which the volunteer warmed-up for three minutes at 50W with speed above 60 rpm, soon after they started the test with initial load of 100W and increment of 25W every minute. Shortly after reaching 200W, the volunteer performed 25W every 2 minutes until voluntary exhaustion. Importantly, during the test, volunteers pedaled at speed of 80 to 90 rpm¹³.

A gas analyzer was used (Medical Graphics VO2000, Saint Paul, USA), in which VO_2 and VCO_2 values were collected every ten seconds. Thus, the highest VO_2 value reached (mL / kg / min) was used. VO_{2max} was considered valid when at least two of these criteria were observed: 1) maximum heart rate reached ($HR_{max} = 220 - age$); 2) respiratory coefficient greater than or equal to 1.10; 3) VO_{2max} plateau despite the load increment^{14,15}.

Mood State Assessment - Profile of Mood States Questionnaire (POMS)

The POMS version used in this work corresponds to an adapted version of the original scale. The original scale was initially translated into Portuguese by Vianna, Almeida and Santos⁵ and used in several psychological evaluation works composed of 49 items. The smaller version of POMS began to be used in the psychological monitoring of training by authors such as Ragline and Morgan¹⁶.

The version presented in this paper is composed of 42 items, with six scales - Tension, Depression, Hostility, Vigor, Fatigue and Confusion, as well as the training distress scale (TDS), and total mood profile (PTH), adapted by Viana, Almeida and Santos⁵. According to recommendation contained in the questionnaire, responses should correspond to a period of seven days including the day of questionnaire application.

Stress and Recovery Assessment - RESTQ-Sport Questionnaire

This questionnaire was previously developed by Kallus and Kellman¹⁷ with the aim of being applied to athletes. Later, Costa and Samulski⁶ validated it for the Portuguese language. The questionnaire was filled by volunteers at the Laboratory of Physiology and Human Performance in order to avoid any external interference and keep volunteers in a quiet environment. Data analysis was performed using RESTQ-Sport® software on Windows® platform. This software calculated the mean values of each of the 19 questionnaire scales.

Creatine Kinase (CK)

Plasma creatine kinase concentrations were quantified in kinetic mode by the International Federation of Clinical Chemistry and Laboratory Medicine (UV-IFCC, 2002) using CK-NAC Liquiform commercial kit (Labtest, Minas Gerais, Brazil), according to manufacturer's instructions. Absorbance was obtained on the Labmax 240 premium automatic analyzer at wavelength 340nm.

Lactate Dehydrogenase (LDH)

Plasma lactate dehydrogenase concentrations were quantified using the Pyruvate-Lactate method in kinetic mode using the LDH Liquiform commercial kit (Labtest, Minas Gerais, Brazil), according to manufacturer's instructions. Absorbance was obtained on the Labmax 240 premium automatic analyzer at wavelength 340nm.

Anthropometric measurements

Filizola® scale was used to obtain body mass (kg) and height (cm). Body mass index (BMI) was then obtained by dividing body mass by square height (kg / m^2). Variables were collected according to procedures standardized by the International Society for the Advancement of Kinanthropometry¹⁸.

Body Composition Analysis

A bioimpedance device (Maltron BF-906) was used to determine the lean mass, fat mass, bone mass and water percentage and weight, according to manufacturer's instructions. The entire procedure was performed by technician experienced in the use of the apparatus.

Statistical analysis

The Shapiro-Wilk and Levene normality and homogeneity test was performed. Data are presented as mean and standard deviation. For comparisons of mood state, stress and recovery, creatine kinase, lactate dehydrogenase, lean and fat mass percentage and weight among the first, fifteenth and thirtieth day of the training month, ANOVA test was used for repeated measurements with *post-hoc* Bonferroni. $p < 0.05$ was adopted as statistical significance value. The effect size was determined by means of the eta-squared test obtained by performing the ANOVA test for repeated measures. Data were analyzed in the Statistical Package for the Social Sciences - SPSS - (Chicago, USA).

Results

Table 1 shows the characterization data of mountain bike athletes. It was observed that they were young adults, overweight, and fat and lean mass percentage and weight suitable for age. They also presented excellent cardiorespiratory condition, systolic and diastolic blood pressure and heart rate values within normal range. Finally, biochemical parameters indicate that lactate dehydrogenase and creatine kinase concentrations were within reference ranges.

Table 1. Sociodemographic, anthropometric, cardiovascular and biochemical characterization of volunteers at baseline or during the cardiorespiratory test

Variable	Mean \pm SD
Age (years)	26.20 \pm 9.20
Height (m)	1.80 \pm 0.10
Body Mass (kg)	81.50 \pm 18.00
BMI (kg/m ²)	26.10 \pm 4.90
Fat Mass (Kg)	11.50 \pm 2.70
Lean Mass (Kg)	70.47 \pm 16.30
Fat Mass (%)	14.20 \pm 1.50
Lean Mass (%)	85.40 \pm 2.40
Basal Metabolic Rate (kcal/day)	1975.00 \pm 276.80
VO ₂ max (ml/kg/min)	55.30 \pm 10.60
Heart Rate (spm)	64.60 \pm 9.30
Systolic Blood Pressure (mmHg)	129.60 \pm 6.70
Diastolic Blood Pressure (mmHg)	79.50 \pm 7.30
Lactate Dehydrogenase (U/L)	144.00 \pm 20.00
Creatine Kinase (U/L)	157.30 \pm 73.00

Note: Data are presented as mean and standard deviation of the mean (Mean \pm SD). BMI = body mass index; VO₂max = maximum oxygen uptake

Source: Authors

Table 2 shows the eight profile of mood state questionnaire scales (POMS). It was observed that on the 30th day of evaluation, athletes had significantly higher tension, depression, hostility, and confusion values when compared with the first or 15th day of evaluation ($p < 0.05$). Regarding the training distress scale, no change was verified during evaluation days ($p > 0.05$). Differently, the total mood profile was significantly higher on the 30th day in relation to the other moments of comparison ($p < 0.05$).

Table 2. Tension, depression, hostility, vigor, fatigue, confusion, TDS and total mood profile (PTH) of mountain bike cyclists on the first, fifteenth and thirtieth day of evaluation (n = 10)

	1 st day	15 th day	30 th day	p	Effect Size (Eta-squared)
Tension	4.50 \pm 3.70	2.70 \pm 3.40	7.20 \pm 2.90 ^{&}	0.01	0.60
Depression	3.40 \pm 2.80	2.50 \pm 2.50	5.40 \pm 2.20 ^{*,&}	0.03	0.63
Hostility	4.10 \pm 2.60	3.90 \pm 3.20	6.80 \pm 2.70 ^{*,&}	0.02	0.74
Vigor	17.10 \pm 4.10	17.80 \pm 4.40	17.80 \pm 2.50	0.76	0.60
Fatigue	6.60 \pm 4.00	5.70 \pm 2.90	7.80 \pm 3.20	0.07	0.61
Confusion	-1.20 \pm 2.50	-2.40 \pm 2.50	-0.90 \pm 1.80 ^{#,&}	0.04	0.63
TDS	2.40 \pm 2.90	1.90 \pm 2.20	2.90 \pm 3.20	0.43	0.14

Note: TDS: training distress scale; PTH: total mood profile. Data are presented as mean and standard deviation of the mean. *difference between the 1st and 30th evaluation day. # difference between the 1st and the 15th day. & difference between the 15th and 30th evaluation day. ANOVA test for repeated measurements

Source: Authors

In Table 3, 19 REST-Q scales of mountain bike cyclists are observed. It was observed that significant differences were found in the emotional stress, conflict / pressure and emotional exhaustion scales on the 15th day in relation to the first day ($p < 0.05$). The emotional exhaustion scale suffered a significant decrease on the thirtieth day in relation to the first day ($p < 0.05$).

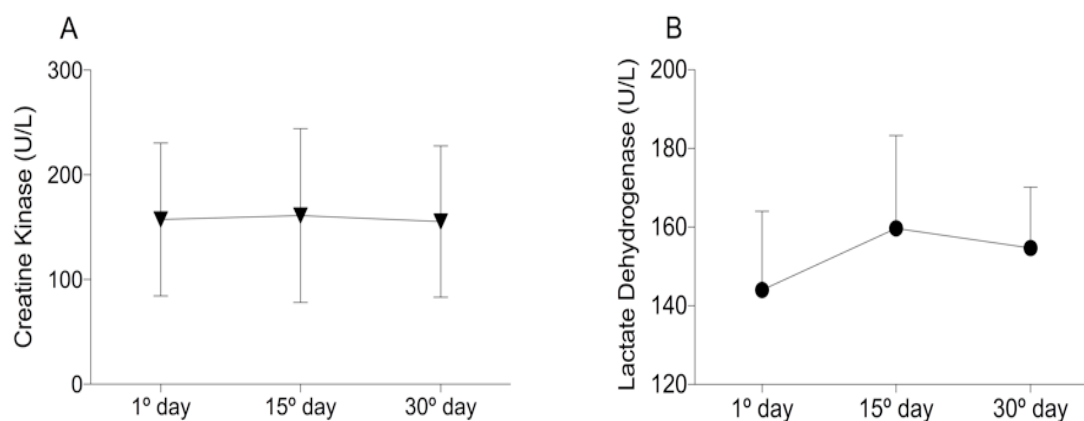
Table 3. Scores of the 19 REST-Q sport questionnaire scales (n = 10)

Scales	1 st day	15 th day	30 th day	p	Effect Size (Eta-squared)
General Stress	1.20±1.01	1.07±1.11	1.78±1.18	0.16	0.23
Emotional Stress	2.18±0.89	1.48±1.04 [#]	2.15±0.99	0.04	0.51
Social Stress	1.17±0.83	1.38±0.91	1.90±1.21	0.15	0.23
Conflicts / Pressure	2.55±1.38	1.70±1.01 [#]	2.18±1.09	0.03	0.61
Fatigue	2.45±1.12	1.95±1.27	2.33±0.93	0.38	0.33
Lack of Energy	1.90±0.96	1.68±0.90	1.80±0.73	0.58	0.14
Somatic Complaints	1.73±0.98	1.30±0.93	1.85±1.33	0.43	0.30
Success	3.28±1.35	3.63±1.35	3.23±1.16	0.51	0.27
Social Recovery	4.08±0.99	4.13±1.34	3.83±1.16	0.68	0.05
Physical Recovery	3.50±0.89	3.53±0.72	2.85±1.14	0.25	0.16
General Welfare	4.20±1.24	4.23±1.40	3.78±1.16	0.41	0.15
Quality of Sleep	3.80±1.01	3.55±0.98	3.30±0.59	0.25	0.25
Disturbances in Intervals	2.60±0.94	2.13±0.95	2.43±1.08	0.08	0.42
Emotional Exhaustion	2.23±0.79	^{#, &} 1.50±0.81	2.25±1.11	0.00	0.80
Injuries	2.63±0.68	2.35±1.29	2.38±0.96	0.51	0.09
Being in Shape	3.55±0.99	3.05±0.54	3.03±0.85	0.23	0.09
Personal Acceptance	3.23±1.35	2.95±1.55	2.90±0.98	0.71	0.09
Self-Efficacy	3.28±0.71	2.88±0.73	2.55±0.81	0.10	0.04
Self-Regulation	3.85±1.98	3.08±1.59	2.45±0.84	0.03	0.49

Note: Data are presented as mean and standard deviation. * difference between the 1st and 30th day of evaluation, # difference between the 1st and 15th day considering p < 0.05, and difference between the 15th and 30th day of evaluation considering p < 0.05

Source: Authors

Regarding biochemical parameters, the results obtained for variables creatine kinase and lactate dehydrogenase used as muscle damage markers are shown in Figure 1. Thus, cyclists, on the thirtieth day of evaluation, did not present significant changes in creatine kinase concentrations (p > 0.05, eta-squared = 0.08). However, they showed higher activity of the lactate dehydrogenase enzyme in relation to the first day of evaluation (p < 0.05, eta-squared = 0.41).

**Figure 1.** Creatine kinase and lactate dehydrogenase concentrations of mountain bike cyclists on the first, fifteenth and thirtieth day of evaluation (n = 10)

Note: Data are presented as mean and standard deviation of the mean. No significant differences were found between the days of analysis considering p < 0.05

Source: Authors

Figure 2 shows body mass (panel A) and fat and lean mass percentage (panel B and C) and weight (panel D and E) on the first, fifteenth and thirtieth day of evaluation. No variables were significantly modified between evaluation days ($p > 0.05$).

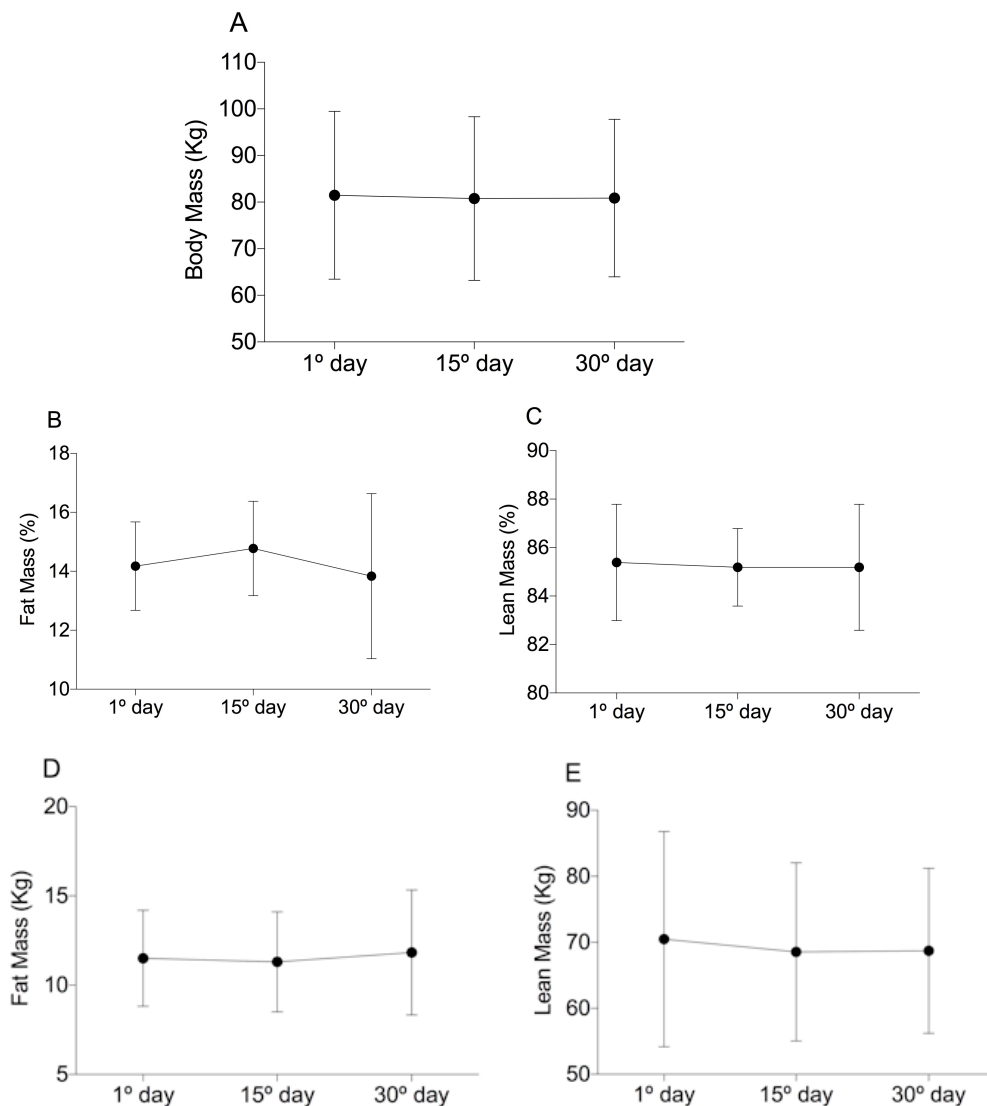


Figure 2. Body mass values (panel A) and lean and fat mass percentage (panel B and C) and weight (panel D and E) of mountain bike cyclists on the first, fifteenth and thirtieth day of evaluation ($n = 10$)

Note: No significant differences were found between days of analysis. ANOVA test for repeated measurements

Source: Authors

Discussion

The present study had the aim of analyzing the psychometric, anthropometric and biochemical profile of amateur mountain bike cyclists. Taken together, the results demonstrate that the mood state, stress and recovery profile are the first indicators of alterations in the training period, followed by alterations in the biochemical profile, indicating the need for greater attention to amateur athletes in the training phases that this phenomenon occurs.

The overreaching/overtraining syndrome is considered as any situation in which there is poor physiological adaptation to excessive training and little rest¹⁹. In addition, the parameters for the diagnosis of psychological, immunological, neurological, biochemical and anthropometric alterations caused by physical training are not yet clear and require constant studies in the most diverse populations. For this reason, evaluations should not only consider a marker, but a set of markers capable of mapping if overreaching / overtraining is already present in a given sample¹⁹.

The acute effect of physical exercise has been investigated in order to identify the biochemical responses both at rest and after training²⁰. In this sense, Detanico²¹ evaluated the isokinetic torque, pain and muscle damage by evaluating creatine kinase concentrations before, after 90 minutes, and 48 hours of a judo training session. As a result, the authors found a decrease of 2.9% in jump height, a 49.4% increase in creatine kinase concentration and 20.6% in muscle pain and no change in isokinetic torque 48 hours after training. Detanico et al.²¹ concluded that these biomarkers can be used as non-recuperative muscle damage markers and need to be performed together since, depending on the muscle torque, no alterations in the musculoskeletal system would be identified in judo athletes, leading to misinterpretations in their diagnosis and follow-up.

Corroborating results obtained by Detanico et al.²¹, Ramos-Campo et al.²² evaluated the subjective perception of exertion, lactate dehydrogenase and creatine kinase concentration, heart rate and heart rate variability of ultra-endurance mountain cycling athletes only during one competition (54 km). In this investigation, increases in lactate dehydrogenase ($p < 0.01$), creatine kinase (from 820 ± 2087.3 to 2421.1 ± 2336.2 IU / L, $p < 0.01$) concentrations were observed, decreases in parasympathetic activity and increases in sympathetic activity.

Regarding the chronic effect of physical exercise on muscle damage biomarkers and overreaching / overtraining syndrome diagnosis, Lee et al.²³ evaluated triathlete adolescents for two weeks in order to evaluate creatine kinase, ammonia, VO_{2peak} concentrations and evaluate if peak heart rate could be included as a new form of training monitoring. The authors verified that, after two weeks of high-intensity physical exercise, adolescents obtained significant improvements in cardiorespiratory capacity assessed by VO_{2peak} , increase in ammonia concentration and decrease in creatine kinase concentration. They also concluded that these improvements were only possible due to the monitoring method through the peak heart rate.

As observed through studies, investigations have been conducted to evaluate the acute effect of training for judo athletes, triathletes, or cyclists without investigating long-term results. This is an interesting way of conducting the study since the monitoring of training loads occurs daily so that the cumulative effect of loads on the physiological maladaptation is attenuated. However, further studies should be conducted with the purpose of knowing and identifying the chronic effects of training loads and, especially with the aim of evaluating the best way to apply training after the overreaching / overtraining diagnosis. However, it is noteworthy that conducting daily monitoring using biochemical, anthropometric and immunological variables may require significant expenditure of financial resources. In this sense, the use of less expensive tools, but with sensitivity to detect alterations caused by excessive training and little rest can be an alternative.

In this sense, POMS and REST-Q questionnaires have been widely used. In the present investigation, it was verified that tension, depression, hostility and total mood profile scales of the POMS questionnaire presented higher scores on the thirtieth day of observation than on the first day, demonstrating that athletes had undergone important psychological alterations, whereas no alterations in the biochemical and anthropometric profile were observed. On the other hand, through the REST-Q questionnaire, it was observed that athletes had lower scores

in the conflict/pressure and emotional exhaustion scales between the fifteenth and first day of observation.

The dichotomy between POMS and REST-Q questionnaire scales is reported in validation studies for both questionnaires. Thus, it has been observed that the conflicts/pressure and success scales do not reach satisfactory internal consistency indexes⁶, so the interpretation for the REST-Q scale is critically dependent on the sample. In this sense, it was verified that amateur athletes, despite the results observed in the stress and recovery questionnaire, behaved in accordance with the POMS questionnaire.

Although the aim of the present study was to identify whether or not mountain bike athletes were affected by this syndrome, some limitations have been found such as the absence of long-term cardiorespiratory evaluation, since in the present study, only heart rate variability and other biochemical markers such as urea, ammonia and uric acid in the last evaluation of cyclists were used as characterization variables. However, it is important to emphasize that these would be an important but complementary set of information since a series of psychometric, biochemical and anthropometric variables that did not compromise our conclusions were recorded.

Further studies should be carried out in order to prescribe training of amateur athletes, considering that they train without the guidance of a physical education professional, which as observed in our results, put them in a risk zone for developing excessive training and consequent loss of performance.

Finally, the current line of research is relatively new considering both the sample investigated and the possibilities of developing studies on monitoring, innovation in relation to the development and validation of other training monitoring methods, or even finding, together with previous studies, a well-defined psychometric, biochemical, anthropometric, neurological and immunological classification range for proper diagnosis of the overreaching/overtraining syndrome.

Conclusions

It was concluded that the data obtained in the present study indicate that the intense weekly training performed by mountain bike cyclists without the guidance of a physical education professional to prescribe and monitor the daily training can lead to psychometric and biochemical alterations indicative of excessive training state.

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Received on Oct, 25, 2017.

Reviewed on Mar, 18, 2018.

Accepted on Apr, 18, 2018.

Author address: Alesandra Araújo de Souza. Avenida Nossa Senhora de Fátima, 1104-1196, Tocantinópolis – TO, 77900-000, Universidade Federal do Tocantins, Câmpus Tocantinópolis. E-mail: alesandra.araujo@mail.uft.edu.br