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Original Article

Changes in body composition and psychological profile when overcoming four Everesting bike challenges

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Abstract:
Problem Statement: During ultra-endurance races, given the long duration of the competitions, athletes can experience variations in body composition and moods. These elements can greatly affect the athlete's performance. **Purpose:** To evaluate the effects of an ultra-endurance race (4 consecutive Everesting Bike Challenges) on the body composition and moods of an adult athlete. **Material and Methods:** A well-trained amateur cyclist (male; 46 years; 64 kg; 1.69 cm; BMI 22.4 kg/m^2) was monitored during the 4 Everesting Bike Challenges. This test is an ultra-endurance challenge that involves overcoming 8848 meters by climbing a single peak several times. The changes in body composition and hydration, calculated by bio-impedentiometry, and the changes in moods, obtained by administering the Profile of Mood States (POMS), in addition to Rating of Perceived Exertion (RPE) and Visual Analogic Scale, were measured at the beginning, during or at the end of each Everesting passed. **Results:** The resting heart rate was 42 beats per minute. The estimated theoretical maximal heart rate was 174 bpm. The monitored athlete overcame the 4 Everesting Bike Challenges covering a total of 904.79 km. The time taken to complete the race was 113 hours and 18 minutes. The total height difference exceeded was 35395 m. During the race the athlete pedaled with an average heart rate of 97 bpm. Body mass dropped from 64.0 to 63.1 kg between the start and end of the test. Wide variations in the athlete's Vigor (T0=16:T5=6), fatigue (T0=0:T5=6) and Sleep quality (T0=100:T5= ≈0) were found during the competition. Regarding the Rating of Perceived Exertion scale , the results obtained indicate a medium-low value (RP=3). **Conclusion:** The results of this study showed negligible reduction in body mass in the athlete who performed an ultra-endurance challenge. During and at the end of the climbing challenge, a significant reduction in Vigor and an important increase in Fatigue levels was highlighted, as well as a very evident reduction in Sleep quality. From the analysis of the RPE scale, medium-low values emerge at the end of each EBC.
Key Words*:* **Body composition, Cycling, Psychological profile, Sports performance, Ultra-endurance races.**

Introduction

The Everesting Bike Challenge (EBC) is an ultra-endurance challenge that is becoming increasingly popular. Ultra-endurance events are defined as sporting events lasting more than 6 hours (Scheer, 2019). Regarding EBC, it consists in overcoming a vertical drop of 8848 meters (height of Mount Everest) by climbing the same mountain anywhere in the world. Currently, more than 3400 official tests of this challenge have been carried out (Cesanelli et al., 2019). Clearly, competition of this type can have important consequences on the condition of athletes. Considering the duration of the competitions, the monitoring and management of the athletes is very important for the health and performance of the athletes themselves.

The data obtained in several studies (Bertuccioli et al., 2019; Löllgen & Leyk, 2018) show how during an ultra-endurance cycling event the body composition of athletes is subjected to marked changes. In this regard, it is known how participating in an ultra-endurance competition can cause a decrease in body mass of more than 5% (Knechtle et al., 2008).

The changes in body composition detected in athletes are mainly due to the reduction of body fat and lean mass. Regarding the monitoring and management of athletes during ultra-endurance competition, it is important to consider how a reduction in the level of hydration also leads to a greater perception of fatigue and pain (Moyen et al., 2015). Overall, all of these conditions can negatively affect athletes' performance.

Regarding the Everesting Bike Challenge, it has been reported that activities with predominantly concentric muscle contraction (e.g. cycling) induce a greater reduction in fat mass than eccentric exercise (e.g. running) (Knechtle et al., 2009A). Moreover, prolonged eccentric exercise can cause a significant reduction in skeletal muscle mass (Knechtle & Kohler, 2007). In order to avoid body mass loss during EBC it is important to maintain a correct energy level and fluid intake. In this type of event, the main energy intake is based on carbohydrate intake, followed by lipids and proteins (Eden & Abernethy, 1994). However, in particular weather

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conditions, such as low temperatures, it may be preferable to provide a lower quantity of carbohydrates and a higher intake of lipids (Paulin et al., 2015).

Consequently, verifying how body composition changes during an ultra-endurance race is an objective of great interest both for the performance and for the health of cyclists.

The monitoring of athletes by Bio-impedancemetry (BIA) allows to evaluate the body composition. This assessment provides information on the athlete's muscular and nutritional status. The data collected through the use of BIA can therefore be particularly useful for the diet and performance management of athletes involved in competitions lasting several days.

Even the psychological aspect can play an important role with respect to the performance obtainable during an ultra-endurance competition. In fact, it has been shown that the mood of athletes may be significantly affected during this type of event (Speedy et al., 1999) both before, during and after the competition (Knechtle et al., 2009B; Parry et al., 2011; Raglin, 2007). Very high levels of anger and confusion are emotions that can occur during competition (Ekkekakis, 2009) and that athletes themselves try to regulate to facilitate performance (Lane et al., 2011). Changes in mood can affect the performance (Beedie et al., 2000) and for this reason they have to be known and appropriately managed in order to not compromise the competition

A parameter to be carefully evaluated during challenges that lasts several days, is the lack or reduction of sleep. During an EBC the goal of sleeping the number of hours considered necessary for health and performance is a long way off (Lastella et al., 2015; Fullagar et al., 2015).

In this sense it has been reported that lower performance was achieved after partial or total sleep deprivation in addition to its quality (Chase et al., 2017; Roberts et al., 2019). Moreover, it is known that even partial sleep deprivation can increase the perception of fatigue and the reduction in strength in addition to attenuating cardiorespiratory and psycho-cognitive responses (Martin et al., 2018; Scott et al., 2006, Souissi et al., 2020).

The main objective of this study was to monitor and evaluate changes in the body composition and mood of the first cyclist in the world to overcome 4 Everesting Bike Challenges consecutively.

Material & methods

Participant**:** A well-trained amateur cyclist (male; 46 years; 64 kg; 1.69 cm; BMI 22.4 kg/m^2) who had previously passed a single and double EBC was monitored. The athlete had a resting heart rate of 42 beats per minute and an estimated maximal heart rate of 174 bpm (Gellish et al., 2007). A road bike has been used (Pinarello Prince 2020), with Shimano Dura-Ace gearbox, 50/34 crankset with 10-speed sprocket set (11-40 teeth).

Study Design: This case study was conducted by monitoring an amateur cyclist for 5 days during which he climbed the Everesting bike challenge (EBC) four consecutive times.

The competition took place on Monte Petrano (Cagli - PU, Italy) where there is a 10.3 km long climb with an average gradient of 7.7%, a total height difference of 815 m. Therefore, it was necessary to climb Monte Petrano 11 times to reach a single EBC and 45 total climbs to overcome the EBC 4 times.

Training Period: To face the EBC 4 times, the athlete underwent a training period of 7 months (November 2018-June 2019), in which he cycled for 6961 km, covered in 332 h and 31 min and overcoming a total altitude difference of 156164 meters (Table 1). In the first three months (November and December 2018 - January 2019) he performed core stability training three times a week. The month in which he ran the greatest distance was February 2019 (1101 km; 48:11; 22596 m); the one in which he performed a higher training volume was the month of April 2019 (1009 km; 52:00; 25074 m); the one in which he overcame a greater difference in height was the month of May 2019 (967 km; 47:38; 26417 m). During the training period, the cyclist crossed the 8848 m vertical drop twice: on 06/04/19 he covered 149 km with 8852 m in altitude in 15:02, while on 01/05/19 he cycled for 13:35 facing 214 km and overcoming an altitude difference of 9109 m.

Table 1. Report of monthly training sessions carried out for the Everesting Bike Challenge competition.

	Distance (km)	Difference in altitude (m)	Time (h:min)	Average speed (km/h)
November	829	16058	38:14	21.7
December	817	16233	37:53	21.6
January	739	16504	36:26	20.3
February	1101	22596	48:11	22.8
March	998	24835	50:47	19.7
April	1009	25074	52:00	19.4
May	967	26417	47:38	20.3
June	500	8447	21:21	23.4
Total	6961	156164	332:31	21.2

Protocol of the Study: The monitoring of the athlete during the performance was carried out using a cycle computer (Garmin EDGE 520) to which a heart rate monitor (Garmin HRM-Dual) was connected via an ANT+ sensor. Through these instruments it was possible to detect the distance travelled, the positive difference in height exceeded, the time of the challenge and various parameters relating to speed and heart rate.

The day before (T0), immediately before starting the challenge (T1) and at the end of each EBC (T2, T3, T4, T5), the athlete underwent various anthropometric and psychophysical tests: Bioimpedance was used to evaluate changes in body composition, the Rate of Perceived Exertion (RPE) was administered to assess the perception of physical fatigue during individual EBCs, the Profile of Mood States (POMS) and the Visual Analogue Scales (VAS) were used to describe change in moods, motivation and sleep quality.

Bio-Impedancementry (BIA): is a test that allows you to analyze the body composition and, consequently, evaluate the physical condition of the athlete from a muscular and nutritional point of view.

Specifically, bioimpedance analysis is able to measure numerous aspects of body composition: total body water, intracellular and extracellular water, lean mass and body fat. These parameters are measured indirectly, in fact, the analyzes are performed by observing:

- the body's resistance to electric current, i.e., the ability to hinder the passage of electric current;
- reactance, or capacitive resistance, which is the force that opposes the passage of electric current due to a capacitor, i.e., a capacitor (given by the cell mass due to the presence of lipids);
- phase angle, which is the ratio between reactance and resistance and it expresses the proportions of intra and extra cellular liquid (Schoeller, 2020).

Rating of Perceived Exertion: The Rating of Perceived Exertion (RPE) scale is one of the most used methods for monitoring internal load. The scale used is the "OMNI-Bike Scale of Perceived Exertion", validated as a substitute for the CR-10 for cycling sports (Barkley & Roemmich, 2008). To obtain precise results, RPE scale was presented to the athlete before the beginning of the study in order to know and be familiar with it. During the study, the subject was asked to indicate within half an hour after the end of each Everesting, the value of effort perceived during the whole session. The RPE scale was administered asking the athlete to answer a simple question: "How intense was your session?" in order to obtain a simple answer that reflects the overall impression of the subject during each EBC (Barkley & Roemmich, 2008).

Profile of Mood States (POMS): is a questionnaire that allows you to describe the profile of the athlete's mood. Training questionnaires and diaries can be an extremely simple and inexpensive method for determining the load and post-training responses. However, these give subjective information, therefore they must be associated with physiological data. The POMS, in the version we used (Terry & Lane, 2000; Terry et al., 2003), is made up of 24 items divided into six categories: Anger / Aggression; Confusion / Bewilderment; Depression / Depression; Fatigue / Tiredness; Tension / Anxiety; Strength / Activity. Each category corresponds to four different sensations, for each of which a score will be assigned Not at all (0 points); A little (1 point); Moderately (2 points); A lot (3 points); Extremely (4 points).

The various scores obtained will be added together in order to define how much that category affects the person's mood. For each category, the maximum score is 16 points (Terry et al., 2003). The POMS were administered before each workout, the subject was asked to fill them in according to his mood at the time.

Visual Analogic Scale (VAS): is the acronym for "Visual Analogic Scale". It is graphic method by which the subject can describe the magnitude of a personal experience or symptom and it was validated by numerous authors such as Bond, Lader, Cella & Perry. They highlighted the advantages of these cards in collecting data without the bias of the examiner, comparing the various graphs over time and underlining the fact that the subjects show a higher affinity with this type of evaluation, compared to other methods of measurement (Flandry et al., 1991). The VAS we used describes the person's daily profile and consist of 7 items (Piacentini & Meeusen, 2015): Quality of sleep; Mental well-being; Physical well-being; Muscular pain; Fatigue; Preparation for today's training; Attractiveness of today's training.

These items are flanked by a horizontal line of 10 cm in length, which represents a graduated index ranging from a minimum / negative to a maximum / positive score. The athletes were made to complete the VAS scale at the beginning of each training session, together with the POMS. Each subject was asked to mark a vertical sign to indicate the degree of intensity of each given item.

Everesting bike challenge rules: To complete an Everesting bike challenge it is necessary to overcome the 8848 m difference in altitude in a single activity, covering a single mountain (to be tackled both uphill and downhill) and recording the results on Strava. It is not possible to sleep before passing a single EBC, instead rest is allowed for up to two hours between each challenge when a multiple Everesting challenge is been faced.

Performing the race is also allowed using various types of bicycles: Road, MTB, CX, Track, BMX and ElliptiGO.

Results

The athlete completed the four Everesting bike challenges covering 904.79 km in 11 hours and 18 minutes with a total difference in elevation of 35395 m and climbing Mount Petrano 45 times. Throughout the performance, the average heart rate was 97 bpm and reached peaks of 153bpm. Between T0 and T5 the athlete lost 0.9 kg of body weight and a calorie consumption of 18903 kcal was estimated.

The BIA data shows a difference in resistance of -1% between T0 and T1, of 6.9% between T1 and T2, of -4.7% between T2 and T3, of -5.2% between T3 and T4 and 8.3% between Q4 and Q5. Between T0 and T5 the percentage difference is 3.5% (Table 2). Regarding the reactance, the percentage difference was 5.5% between T0 and T1, 1.1% between T1 and T2, -4.2% between T2 and T3, -9.2% between T3 and T4 and 8.5% between T4 and T5. Between T0 and T5 the percentage difference is 0.7% (Table 2). Instead, the Phase Angle data shows differences between T0 and T1 of 6.4%, -4.8% between T1 and T2, -1.3% between T2 and T3, -2.6% between T3 and T4 and 0% between T4 and T5. Between T0 and T5 the percentage difference is 0.7%. Between T0 and T5 the percentage difference is -2.6% (Table 2).

Table 2. Bio-Impedancementry, the trend of resistance, reactance, and phase angle values during ultra-endurance events.

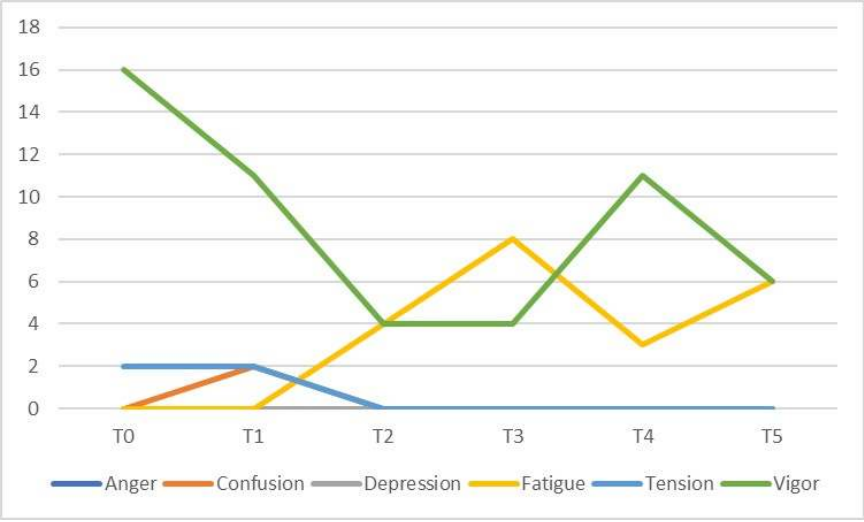
	RESISTANCE (Ω)	DIFF. (%)	REACTANCE (Ω)	DIFF. (%)	PHASE ANGLE (°)	DIFF. (%)
T0	426.9		58.5		7.8	
T1	422.5	-1.0%	61.7	5.5%	8.3	6.4%
T2	451.6	6.9%	62.4	1.1%	7.9	-4.8%
T3	430.2	-4.7%	59.8	-4.2%	7.8	-1.3%
T4	408.0	-5.2%	54.3	-9.2%	7.6	-2.6%
T5	441.7	8.3%	58.9	8.5%	7.6	0.0%

T0: the day before Everesting Bike Challenge (EBC); T1: immediately before EBC starting; (T2, T3, T4, T5): at the end of each EBC. Diff.: difference.

By applying the RPE scale, at the end of each Everesting, we found a value of 3 for T2, 5 for T3, 3.5 for T4 and 4 for T5.

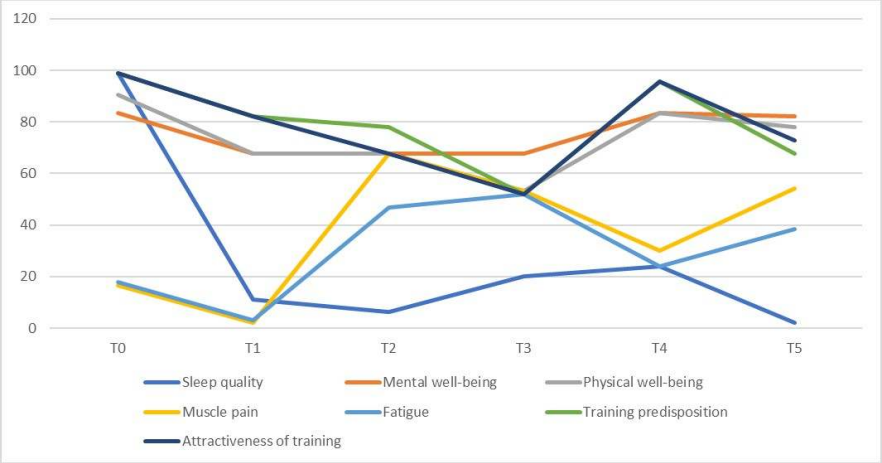
From the POMS analysis there are no differences between the various tests carried out with regard to the items of Anger (value 0) and Depression (value 0). There were slight changes in Confusion (value 0 in T0, T2, T3, T4 and T5; value 2 in T1) and in Tension (value 2 in T0 and T1, value 0 during subsequent evaluations). There are marked differences in Fatigue (value 0 in T0 and T1; 4 in T2; 8 in T3; 3 in T4; 6 in T5) and in Strength (value 16 in T0; 11 in T1; 4 in T2 and T3; 11 in T4 and 6 in T5; Figure 1).

Figure 1. Profile of mood states at different time points (T) of the Everesting challenge. T were recorded the day before (T0), immediately before starting the challenge (T1), and after the First - Second - Third – Fourth (T2,T3,T4,T5) Everesting challenge.



As for the VAS, we observe a sleep quality of 99 mm in the T0, 11 mm in the T1, of 6 mm in the T2, of 2 mm in the T3, of 24 mm in the T4 and of 2 in the T5. Mental well-being is 83 mm in T0 and T4, 68mm in T1, T2 and T3 and 82 mm in T5. Physical well-being of 91mm in T0, 68 mm in T1 and T2, 53 mm in T3, 83 mm in T4 and 78 mm in T5. As regards the item of muscle pain, there are values of 17 mm in T0, 2 mm in T1, 68 mm in T2, 53 mm in T3, 30 mm in T4 and 54 mm in T5. Fatigue shows values of 18 mm in T0, 3 mm in T1, 47 mm in T2, 52 mm in T3, 24 mm in T4 and 39 mm in T5. The assessment of training readiness shows a value of 99 mm in T0, 82 mm in T1, 78 mm in T2, 52 mm in T3, 96 mm in T4 and 68 mm in T5. Finally, as regards the attractiveness of the training, we observe values of 99, 82, 68, 52, 96 and 72 mm respectively in T0, T1, T2, T3, T4, and T5 (Figure 2).

Figure 2. Visual analogic scale at different time points (T) of the Everesting challenge. T were recorded the day before (T0), immediately before starting the challenge (T1), and after the 1st (T2), 2nd (T3), 3rd (T4), and 4th (T5) Everesting challenge.



Dicussion

The Everesting Bike Challenge is a sporting event that is attracting an increasing number of participants of all ages and both genders. What attracts participants is the ability to challenge their limits and to be able to compete with people from all over the world in a virtual way.

The athlete who participated in this study was the first in the world to succeed in the feat of overcoming 4 consecutive EBCs. The athlete completed the trial in good physical condition not showing the need to resort to medical evaluations. Moreover, despite the studies described by Knechtle et al. (2008), no marked reduction in body mass, which may be attributable to an optimal caloric and fluid intake throughout the duration of the trial was detected by the evaluation carried out this study

This resulti s important to achieve in order to promote the performance and health condition of the athlete and it should be also considered in the pre- and post-trial phases.

From the analysis of the RPE scale, medium-low values result at the end of each EBC. In fact, since the event has a very long duration, in order to overcome it, it is necessary to maintain a very low intensity of exercise throughout the performance. In this regard, the average heart rate was 97 bpm and reached peaks of 153 bpm. Therefore, the average heart rate was much lower than the maximum heart rate estimated using Gellish et al. (2007) formula (i.e.174 bpm). According to Martin et al. (2018) and Souissi et al. (2020), the POMS data shows a significant reduction in the levels of Vigor and an important increase in the levels of fatigue attributable, above all, to a very evident reduction in sleep quality highlighted by the VAS (Chase et al., 2017).

In particular, the results achieved in this study showed that in the pre-trial condition (T0-T1) the fatigue levels showed by the athlete were low while the levels of Tension and Vigor were high. During the trials (T2-T5) fatigue levels increased while Vigor levels decreased. A slight tendency to decrease was observed by considering the condition of Confusion, Tension and Anger. Comparing the pre-trial condition with that observed during the trial, the values for Mental and Physical Wellbeing did not change while the Fatigue and Muscle Pain levels showed an increase. Overall, these results may be due to the appropriate preparation of the athlete to the EBC in addition to the extreme physical effort that a test of this type requires.

As regards the condition of Training Predisposition and Attractiveness of training, a non-constant trend was observed during the EBC. In particular, a reduction in the value of Training predisposition and attractiveness of training was found in the first part of the competition (T0-T3) while it increased in phase T4. This result could be due to the effects that such an extreme competition can have on the will of the athletes and to the increase in motivation that the athletes themselves can show in the final phase of the trial competition.

Conclusions

During this study, we were able to analyze sports performance, changes in body composition and psychological state that occurred before, during and after the activity of the athlete who first managed to overcome 4 EBC. The changes of the parameters evaluated during the study indicate how the appropriate preparation and management of the climbing challenge can have a limited effect on the body mass as well as on the Mental and Physical Wellbeing. Conversely, Fatigue and Muscle Pain levels increased over the 4 EBCs while sleep quality decreased. Further studies are planned for the near future to continue analyzing and monitoring changes in the body composition and psychological profile of athletes during ultra-endurance events

Conflicts of interest

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