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Kilian Philippe, Thierry Paillard, Olivier Maurelli, Jeremy Moody, Jacques Prioux. Effects of an Offshore Sailing Competition on Anthropometry, Muscular Performance, Subjective Wellness, and Salivary Cortisol in Professional Sailors. *International Journal of Sports Physiology and Performance*, 2022, 17 (8), pp.1205-1212. 10.1123/ijsp.2021-0575 . hal-03717202

HAL Id: hal-03717202

<https://hal.science/hal-03717202>

Submitted on 6 Oct 2022

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Effects of an Offshore Sailing Competition on Anthropometry, Muscular Performance, Subjective Wellness and Salivary Cortisol in Professional Sailors.

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Abstract

Introduction: Evidence regarding the impact of offshore sailing on fatigue and readiness variables is conspicuous by its absence. This study investigated the acute effects of an offshore sailing regatta on anthropometry, muscular performance, subjective recovery and salivary biomarker cortisol. **Methods:** Ten professional offshore sailors from a mixed-sex crew partook in the study ($n = 10$; mean \pm SD; age = 32.2 ± 3.96 years; stature = 179.1 ± 7.30 cm; body mass = 84.2 ± 12.1 kg). The race involved three offshore legs over a 3-week period. Baseline measures of anthropometry, lower- and upper body muscular function, perceptions of subjective wellness and salivary cortisol were assessed 3-hours prior to competition (i.e., before the first leg). These measures were repeated within 30-min after the cessation of each event leg. During each leg, boat movements were recorded via global positioning system units. **Results:** There were significant reductions in lower- (ES = 0.49) and upper muscular (ES = 0.21) functions as well as in subjective wellness (ES = 1.65). Salivary cortisol levels increased (ES = 0.84) **Conclusion:** These results demonstrate that, during an intensified period of sailing competition, fatigue will progressively increase. This may impede sailing performance by reducing physical and cognitive efficiency. Furthermore, counter movement jump, handgrip strength, perception of subjective wellness and cortisol concentration appear to be sensitive measures for monitoring fatigue and readiness in professional sailors.

Introduction

Offshore sailing is a strategy-based sport that is intermittent in nature, with periods of high intensity activity (e.g., stacking, trimming and grinding) and low intensity recovery (e.g., standing and sleeping)¹. Depending on the nature of the race, vessels are sailed by lone sailors or crews and can last from days to months. Over the course of a crewed boat race, such as The Ocean Race (TOR), sailors are required to compete for many days during legs that rally the host cities. Few days are given to recover in between legs. Therefore, sailors need to recover quickly to start the following leg in an optimal state of readiness. Although studies from other team sports have outlined the acute effects of workload (WL) on anthropometrical, physiological and psychological variables²⁻³, the research conducted in a professional offshore crew-sailing environment is scarce⁴⁻⁵. Moreover, given the physical demands imposed during sailing, sailors typically experience high physiological stress and prolonged symptoms of fatigue⁶. This is in part due to the various weather conditions and the extensive physical demands of manoeuvring. Indeed, to optimize the vessel's speed, a sailor must be able to withstand high levels of physiological stress associated with weather conditions (temperature, wind, and sea state)⁷. To counterbalance the movement of the boat, and thus promote faster speed, stacking and trimming sails on deck requires high levels of physical readiness⁷. Sailors must also adapt to sleep deprivation and little comfort (nutrition, noise and hygiene) in order to limit impairments on cognitive performance, necessary for establishing routing strategies and evaluating weather forecasts. Past studies have investigated the impacts of sailing bouts on neuromuscular functions, energy demands and stress hormones. These studies have reported increases in neuromuscular fatigue⁴, muscular damage⁸, cognitive impairment⁹, motion sickness¹⁰ and elevated cortisol levels after sailing bouts¹¹. Although the current literature suggests that significant fatigue is induced by offshore sailing, little evidence is available in a crewed context. For this reason, monitoring the physiological and psychological adaptations from competition are thought to be important. Indeed, this can provide a better understanding of the demands of the sport and, thus, help bridge the gap between theory and practice for offshore sailing performance pathways.

Therefore, the aim of this study was to provide an overview of offshore sailing demands by a) documenting the characteristics of the race b) investigating the physiological responses to competition and c) examining the neurophysiological and psychological fatigue patterns in a professional mixed-sex crew. It was hypothesized that offshore sailing would 1) provoke body

composition turnover, 2) decrease muscular performance and 3) generate stress and perception of fatigue.

Methods

Subjects

Ten (8 males and 2 females) professional sailors (mean \pm SD; age: 32.2 ± 3.96 years; stature : 179.1 ± 7.30 cm; body mass : 84.2 ± 12.1 kg) volunteered to participate in the study. There were no reported injuries or diseases that would impair physical performance from any subject. Before starting the protocol, sailors attended a presentation and received information outlining the experimental procedures. The study protocol was approved by the ethics committee of Rennes University, France. Written informed consent was obtained from all subjects prior to the commencement of the study and all subjects were free to withdraw from the study at any time without penalty.

Design

All data was collected during a renowned international offshore sailing venue over a 3 weeks period. The TOR 2021 competition took place in June. All sailors competed in the same crew and had been training for 7 months preceding the race. Anthropometric measurements, muscular function testing, subjective recovery markers and salivary cortisol (SC) were obtained during baseline measurements (BSL) and after each of the 3 legs (Post₁₋₃). The testing protocol was adjusted to fit the complexity of the sport. BSL measurements occurred 3 hours before the start of Leg 1 and Post₁₋₃ occurred within 30 min of docking in. Over the 3 weeks study period, data from 10 days of sailing was collected and analysed (Figure 1). Testing was conducted at the team's base, located in the different host cities, to ensure minimal disruption to the recovery process. Throughout the competition period, athletes were monitored by a qualified team doctor, physiotherapist, strength and conditioning coach and nutritionist. During recovery days, sailors underwent light cardiovascular activation (e.g., 20 min of jogging at 60% of maximal heart rate), sports massage and mobility sessions (e.g., static and dynamic stretching).

94 **Methodology**

95 **Baseline Measures**

96 On the morning of the first day of competition, 3-hours prior to starting Leg 1 of TOR, sailors
97 underwent the testing battery. The crew was at the end of a tapering week and therefore had
98 not participated in high intensity training the week prior to testing. The testing battery consisted
99 of anthropometric measurements, fitness testing, wellness questionnaire control and SC
100 collection. To account for diurnal variation, SC was collected within 1-hour of waking up,
101 between 7:00-8:00 AM. The results from the first testing battery established the BSL.

102

103 ***Testing Battery***

104 *Anthropometric measurement.*

105 Anthropometric characteristics were measured in the following order: body mass and skinfolds.
106 A weighing scale (Seca®, Hamburg, Germany) was used to measure body mass. Measurements
107 for body mass were made with an accuracy of 0.1 kilograms (kg). Three skinfolds (Σ 3
108 Skinfold) were taken on the right side of each sailor (male: pectoral, abdominal and thigh;
109 female: triceps, abdominal and thigh) according to recommendations by Jackson and Pollock¹².
110 The skinfolds were measured with a Harpenden skinfold caliper (Harpenden®, Burgess Hill,
111 UK) with 10 g.mm⁻² of constant pressure. Body density was assessed while body fat (BF) was
112 calculated using Brozek's equation¹³. Lean body mass (LBM) was calculated by subtracting
113 BF from total weight.

114 *Muscular performances*

115 **Countermovement Jump**

116 Lower body power was tested on the countermovement jump (CMJ) using a chronojump
117 contact mat (Chronojump-Boscosystem™, Software, Spain). Each sailor completed three
118 attempts with 1 min of rest between trials. For the execution of each attempt, a countdown of
119 “3, 2, 1, jump” was indicated orally. All attempts were completed with sailors placing arms
120 akimbo to avoid movement disruption. Sailors were instructed to perform a rapid eccentric
121 phase, immediately followed by an explosive concentric contraction with the intention to jump
122 as high as possible. The height of the best CMJ performance was reported for analysis.

Handgrip strength

Maximal isometric hand-grip strength (HGS) was assessed with a Jamar® handgrip dynamometer (Sammons Preston Corp., Bolingbrook, Ill., USA). The test positions were standardized¹³. Three trials were performed on each hand. The first three trials started with the right hand. Sailors were instructed to squeeze the device as hard as possible for 3 s. The time between each trial was 15 s and 3 min of rest was given when changing hands. The maximal measure of the three trials was retained in Kg. Sum (HGS_{sum}) of both, dominant hand (HGS_d) and non-dominant hand (HGS_{nd}), measures were assessed and included in the results.

Subjective Recovery Status

The Hooper-Index (HI) was measured using a customized questionnaire based on the recommendations of Hooper and Mackinnon¹⁵. Levels of sleep quality (HI_{sleep}), delayed onset muscle soreness (HI_{doms}), stress (HI_{stress}) and fatigue (HI_{fatigue}) were scored on a 7-point scale on which “1” and “7” represent “very, very good” and “very, very poor” respectively. The Hooper-Index was computed by summing its four subgroups. It was applied 30 min after the leg arrival (Post₁₋₃). All questions and answers were completed individually.

Salivary Stress Marker

Sailors' saliva samples were collected upon waking (between 7:00 and 8:00 am). To ensure more rigorous testing and to limit cortisol measurement errors, sailors were required to refrain from eating, brushing their teeth and chewing gum prior to testing. Sailors placed the swab (Soma Bioscience, Wallingford, United Kingdom) on their tongue and closed their mouth. When the indicator on the swab's stem turned blue, the test was considered complete (swab collected 0.5 mL of oral fluid). The swab was then placed in the buffer bottle of assay (sodium phosphate, salts, detergents and preservatives) before gently mixing the sample for 2 min. Two drops of the sample were then placed in the window of the lateral flow device. The device was left still during the incubation period (10 min). The strip was then placed in the real-time reader and the results were ready within 20 s. SC was then collected as nanograms per millilitre (ng/mL). Soma Bioscience oral fluid collector has been validated against enzyme linked immunosorbent assay (ELISA) and have been proven as a reliable method to collect and analyse SC¹⁶.

Race analysis

Internal Sailing Load

Subjective internal load was estimated using the session-rating of perceived exertion (s-RPE), with ratings (Borg 0-10 scale) obtained from each individual sailor within 30 min of completing each leg. Each sailor was familiarized with the scale before starting the study. The obtained value was multiplied by the time sailed (in minutes) during the leg to register a sailing load in arbitrary units (AU)¹⁷.

External Sailing Load

Race data - including sailing distance, average speed, course coverage and manoeuvre count (tack and gybe) were collected during the 3 legs of competition. Data was made available through Global Positioning System (GPS) units and shared by the navigation specialist of the team. Route and manoeuvre count were measured by the official TOR tracker.

Energy intake

Energy intake (EI) was measured to prepare individual meal plans prior to TOR. Basal metabolic rate (BMR) was calculated using the Schofield equation¹⁸ and was multiplied by a physical activity coefficient which was determined by categorizing each position on-board by its physical demands¹⁹. Individual EI was prepared before each leg and controlled upon arrival by the human performance practitioner.

Statistical Analysis

Data was calculated through standard statistical methods and is presented as mean \pm standard deviation. All variables were considered normally distributed through analysis with the Shapiro-Wilk test, histograms and skewness values prior to analysis. One way ANOVA with repeated measures was used to determine the differences between the different parameters during the 3 legs. When results were significantly different, an effect size (ES) calculation was used. ES was evaluated using Cohen's *d* along with 95% confidence intervals (CI). ES of ≤ 0.2 , 0.21-0.60, 0.61-1.20, 1.21-2.0, ≥ 2.0 were considered as trivial, small, moderate, large and very large, respectively²⁰. Statistical analyses were performed using the SPSS package (15.0 version; SPSS, Inc., Chicago, IL, USA). The level of significance was set at $p < 0.05$.

Results

Table 1 shows the external and internal load parameters across the 3-legs of TOR. A total of 5167 km was sailed in 10 days 4h 31 min at an average speed of $5.87 \text{ m}\cdot\text{s}^{-1}$. 88 manoeuvres (i.e., 53 tacks and 35 gybes) were performed with each one occurring every 58.7 km. Leg 1, the longest leg of the three, was characterised by its downwind nature, fast speed (i.e., $7.5 \text{ m}\cdot\text{s}^{-1}$) and accounted for 51 % of the total distance of TOR. Leg 2 reported to have the most tacking manoeuvres (i.e., 28) and also outlined a higher RPE (7.8 ± 2), although time at sea was the shortest of the three. It was characterized by its upwind nature and high manoeuvre frequency (1 every 2h 02 min). Leg 3 held the most manoeuvres (i.e., 35) and was characterised by its slow speed (i.e., $4.02 \text{ m}\cdot\text{s}^{-1}$).

The multilevel ANOVA (Table 2) found no significant difference in anthropometric parameters during the 3 legs of racing when compared to BSL. Differences were nevertheless observed at Post₃ for BF ($p=0.004$; ES = 0.25) when compared to Post₂.

Compared with BSL ($37.0 \pm 8.0 \text{ cm}$), CMJ height (Figure 2) significantly decreased at Post₂ ($33.1 \pm 6.6 \text{ cm}$; $p=0.05$; ES = 0.53) and Post₃ ($33.2 \pm 7.7 \text{ cm}$; $p=0.05$; ES = 0.49). A significant decline was observed between Post₁ and Post₂ ($p=0.007$; ES = 0.58). Upper body strength (Figure 3) decreased for HGS_{sum} when compared with BSL ($113 \pm 22.3 \text{ kg}$) at Post₁ ($107.0 \pm 19.6 \text{ kg}$; $p=0.01$; ES = 0.29), Post₂ ($102.4 \pm 19.0 \text{ kg}$; $p=0.001$; ES = 0.51) and Post₃ ($108.6 \pm 18.8 \text{ kg}$; $p=0.05$; ES = 0.21). Post₂ ($p=0.03$; ES = 0.24) and Post₃ ($p=0.03$; ES = 0.3) were significantly different from preceding legs. HGS_d also decreased at Post₁ ($55.4 \pm 10.7 \text{ kg}$; $p=0.002$; ES = 0.44), Post₂ ($52.9 \pm 10.0 \text{ kg}$; $p<0.001$; ES = 0.62) and Post₃ ($56.2 \pm 10.4 \text{ kg}$; $p=0.02$; ES = 0.31) when compared to BSL ($59.7 \pm 11.9 \text{ kg}$). HGS_d was significantly different from preceding legs at Post₂ ($p=0.04$; ES = 0.25) and Post₃ ($p=0.02$; ES = 0.33). HGS_{nd} was only significantly different from BSL ($53.3 \pm 10.7 \text{ kg}$) at Post₂ (49.5 ± 9.5 ; $p=0.02$; ES = 0.37).

The Hooper Index (Figure 4) increased significantly at Post₁ ($17.4 \pm 2.9 \text{ AU}$; $p=0.001$; ES = 1.43) and Post₂ ($19.2 \pm 2.7 \text{ AU}$; $p=0.001$; ES = 2.23) when compared to BSL ($13.7 \pm 2.2 \text{ AU}$). HI was significantly different between Post₂ and Post₃ ($p=0.005$; ES = 1.65). Sleep quality decreased significantly at Post₁ ($4.6 \pm 0.9 \text{ AU}$; $p=0.04$; ES = 1.05) and Post₂ ($5.4 \pm 1.1 \text{ AU}$; $p=0.006$; ES = 1.76) when comparing with BSL ($3.7 \pm 0.8 \text{ AU}$) and at Post₃ ($p=0.04$; ES = 1.34) when comparing with preceding leg. Perception of fatigue was significantly different

from BSL (3.4 ± 0.5 AU) at Post₃ (4.2 ± 0.9 AU; $p=0.04$; ES = 1.09). Stress at Post₁ (4.9 ± 0.5 AU; $p<0.001$; ES = 2.33) and Post₂ (5.7 ± 0.6 AU; $p<0.001$; ES = 3.26) was significantly different to BSL (3.2 ± 0.9 AU). Muscle soreness did not differentiate with BSL (3.4 ± 0.7 AU) during the race.

SC levels (Figure 5) varied throughout the competition. Post₁ (18.6 ± 5.6 ng/mL; $p=0.005$; ES = 1.44), Post₂ (14.2 ± 2.9 ng/mL; $p=0.03$; ES = 0.76) and Post₃ (16.2 ± 6.7 ng/mL; $p=0.02$; ES = 0.84) were all significantly different from BSL (11.5 ± 4.1 ng/mL). Variation with preceding legs was significant at Post₂ ($p=0.03$; ES = 0.97).

Discussion

The hypotheses initially stated were globally validated since body composition was partially modified, muscular performance decreased and objective and subjective fatigue were observed during and after the competition.

Although previous research in sailing have observed weight loss, fat percentage and lean body mass decreases after competition^{1,5,9,29}, the results of the current study found only significant changes in BF (%) at Post₃. Indeed, during the 3-weeks of competition, when comparing BSL levels with post₁₋₃, no significant differences were observed. A potential reason for differentiation with other research may be due to sailors being tested extensively to determine their individual energetic needs on-board. Previous research has highlighted that loss in body mass and, more particularly, lean body mass decrease, could eventually hinder physical and cognitive performance²¹. It was therefore essential to provide the sailors with the adequate EI as they were confronted to irregular biological rhythm, sleep deprivation, incessant compensatory muscle activity and continuous stress⁵. Elevated EI values (i.e., 15-17 MJ.day⁻¹) have been reported in other research with considerable weight loss still being observed⁵. Nevertheless, it should be noted that the legs studied here were shorter and occurred in warmer climate. Also, daily protein consumption was more important in the present study (23% vs. 14% in the previous study mentioned⁵) and could explain, in part, the maintenance of LBM²² throughout TOR.

The results from the current study confirm that sailors experienced a significant decline in CMJ height (Figure 2) during and after TOR. Similar responses during competition have been observed across various “long distance sports”²³. A decrease in lower body strength and power abilities immediately after sailing is common in professional sailors²⁴. However, this study provides new insights that, to the author’s knowledge, have never been investigated in

professional crews. Indeed, contrarily to past research, the sailors in this study did not suffer from body mass loss and/or muscle wastage during the competition. These results are in line with findings highlighting muscular function impairment due to the yawing, rolling and pitching motions (sway) of the hull²⁵. Moreover, the downwind specificity of Leg 1 (i.e., 22 gybes) elicited no impairment to lower body muscular function contrarily to Leg 2 and Leg 3, which were mainly upwind. Upwind legs seemed to affect lower limbs muscular function more than the downwind leg despite Leg 1 being two times longer than Leg 2 and Leg 3 (Table 1). This alteration may be linked with the constant swaying of the hull caused by swell in upwind sailing conditions. Indeed, maintaining constant proprioceptive tension, due to hull movement, seems to increase the mechanical loading of hip extensors and hip flexors.

HGS (Figure 3) has received a considerable amount of interest in previous research. Indeed, it has been associated with greater upper body strength, ballistic performance, lean body mass²⁶, athlete level differentiation²⁷ and success²⁸. The offshore sailors in our study reported superior HGS_d at BSL compared to other offshore sailing research (i.e., in the present study 59.7 ± 11.9 kg vs. 53.6 ± 8.3 kg and 40 kg in previous studies^{4,29}) and similar to crewed dinghy racing (61.1 ± 9.5 kg in another study²⁸). Indeed, the physical WL associated with grinding, hoisting, stacking and trimming the sails is intense and requires a fair amount of grip strength. Nevertheless, previous research reported that HGS performance was preserved after offshore sailing competition^{4,29}. However, in this current research, the sailors observed a progressive decay of maximal strength in HGS during each leg. The decrease in performance detected in our study could be explained by the specific physical demands of the vessel used in TOR. Indeed, the racing conditions are known to be more extreme and the boat harder to handle due to its low displacement and facilitation to plane⁵. Hence, we can assume that the sailors underwent extensive upper body solicitation during TOR and suffered from high levels of neuromuscular fatigue.

The Hooper Index and its subsets (i.e., sleep quality, fatigue, stress and muscle soreness) has recently been shown to be a promising tool for monitoring indices of fatigue and preparedness in many sports³⁰. However, research examining the effects of sailing on subjective recovery variables is scarce²⁹. Indeed, research has mainly focused on sleep quality and highlights the effects of sleep deprivation on cognitive performance⁸. These studies have put forward the need to identify an optimal balance between wakefulness and planned sleeping to optimize sailing performance. The results in our study (Figure 4) found that HI_{sleep} and HI_{stress} were more pronounced during the legs where the RPE was higher (i.e., Post₁ and Post₂). In spite of the

multiple physical stressors involved in sailing, HI_{doms} was preserved during TOR, whereas HI_{fatigue} increased linearly throughout the race and was significantly different from BSL at Post₃. Nevertheless, it should be noted that sailors were provided protein supplementation on-board and in-between legs to optimize muscular recovery³¹ and to avoid muscle atrophy linked to the accumulation of high levels of cortisol during sailing⁹. In fact, sailors had been training regularly 7-months prior to competition which could have generated morphological adaptations in the muscle fibres necessary to withstand the induced mechanical stress without causing structural alterations.

Intensified WL periods have been found to increase cortisol concentration³². This hormonal increase has been associated to stress tolerance disturbances and decreases in performance. Studies in other long distance/duration sports have shown that athletes experienced greater concentration of SC in post competition phases³³. In sailing, few studies have considered analysing catabolic hormone alterations despite significant increases in cortisol concentration being observed at sea³⁴. Indeed, sailors in the current study showed an elevation of SC levels at Post₁₋₃ (Figure 5) which corresponded to the s-RPE fluctuations observed during the legs (Table 1). Moreover, HI did not differentiate from BSL at Post₃ despite its' correlation to SC³⁵. This finding may be due to the crew's winning performance during the final leg. Indeed, subjective wellness seems to be associated with competition outcome³⁶. Nevertheless, it was found that SC levels increased significantly after intense bouts of offshore sailing. This seems to be in line with other studies analysing the effects of prolonged change of circadian rhythms in confined environments³⁷.

Practical Application

This study has revealed a number of practical applications that are relevant to human performance practitioners and sailors alike. Over an intensified period of offshore sailing competition, when there is insufficient time to recover between legs, physiological and psychological fatigue accumulates. Impaired readiness when sailing may compromise the boat's performance by reducing physical and cognitive capabilities. As such, cautious WL monitoring should be implemented by practitioners during a competitive phase to determine a sailor's readiness and recovery status. Upper body and lower body muscular capabilities, as well as SC, were impacted by an offshore sailing competition and markers obtained from CMJ and HGS appear to be sensitive ways of detecting muscular fatigue. Questionnaires that assess

subjective wellness parameters are useful tools for monitoring fatigue and recovery during offshore sailing competition. Such questionnaires are non-invasive and non-expensive tools that can be used frequently to provide useful information on an athlete's readiness to sail. This research was conducted over a reduced 3-week competition as an adaptation to the current covid-19 crisis. Future research, during longer events, is required to investigate the dose-response relationships between sailing WL and monitoring markers. Larger sample sizes would also allow further exploration of activity profiles, according to crew position, on-board. In addition, as laboratory measures are expensive markers, further investigations are needed to examine the relationship between external WL parameters and subjective markers of recovery found in questionnaires. Furthermore, through the use of micro-captors and video analysis, researchers could observe position specific activity and determine the physical and physiological demands for each maneuver and/or sailing situation³⁸.

Conclusion

To the best of our knowledge, this is the first longitudinal study to provide information on the effects of offshore sailing on physiological parameters and fatigue patterns in a professional mixed-sex crew sailing team. This investigation confirmed (i) very little effect on anthropometric parameters (ii) significant decreases in lower- and upper body muscular abilities, (iii) significant variations of wellness parameters during the different legs and (iiii) increases of SC stress hormone during and after competition. Therefore, the current study presents the impacts that offshore sailing has on athletes. The results will provide helpful information for sports scientists, sailing coaches and performance practitioners to appropriately manage the training and recovery processes in their quest to optimize human performance.

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Tables and Figures

Table 1. External and internal load of TOR.

Variables	Leg 1	Leg 2	Leg 3	Total
<i>External load</i>				
Course distance (km)	2411.3	1074.2	1070.5	4556.0
Distance sailed (km)	2655.8	1299.9	1211.8	5167.5
Course coverage (%)	110	121	113	113.5
Time at sea	4 days 1h 8 min	2 days 15h 31 min	3 days 11h 52 min	10 days 4h 31 min
Total manoeuvres	22	31	35	88
<i>Tacks</i>	0	28	25	53
<i>Gybes</i>	22	3	10	35
Manoeuvre / time	4h 24 min	2h 02 min	2h 29 min	2h 47 min
Average speed (m.s ⁻¹)	7.5	5.68	4.02	5.87
<i>Internal load</i>				
RPE	7.45 ± 2.2	7.8 ± 2.0	5.85 ± 1.4	
s-RPE (AU)	43418.6 ± 12548.8	29725.8 ± 7579.5	30490.2 ± 7477.6	

Tack: Upwind Manoeuvre; Gybe: Downwind Manoeuvre; s-RPE: Session Rate of Perceived Exertion.; AU: Arbitrary Units.

Table 2. Description of body composition and energy intake throughout TOR.

Variables	BSL	Post ₁	Post ₂	Post ₃
<i>Body Composition</i>				
Body Mass (kg)	84.24 ± 12.7	83.79 ± 12.8	83.57 ± 12.8	84.38 ± 12.5
LBM (kg)	70.72 ± 11.4	70.66 ± 10.3	70.74 ± 10.6	70.42 ± 10.0
BF (%)	16.04 ± 5.6	15.66 ± 4.9	15.34 ± 4.9	16.54 ± 4.7 ^{††}
<i>Energy Intake</i>				
BMR (cal.day ⁻¹)	1802.67 ± 173.3			
Coefficient	2.23 ± 0.3			
EI (MJ.day ⁻¹)		15.57 ± 2.6	16.43 ± 2.5	16.8 ± 2.6
<i>Carbohydrates (%)</i>		57.34 ± 11.7	54.42 ± 12.2	56.75 ± 8.6
<i>Protein (%)</i>		21.55 ± 4.1	23.3 ± 6.4	24.2 ± 5.7
<i>Fat (%)</i>		21.11 ± 8.5	23.28 ± 7.3	19.05 ± 4.3

BSL: Baseline; Post₁₋₃: Measurements obtained after Leg1-3; LBM: Lean Body Mass; BF: Body Fat; BMR: Basal Metabolic Rate; EI: Energy Intake. ^{††} Significant difference with values of preceding Test; p≤0.01.

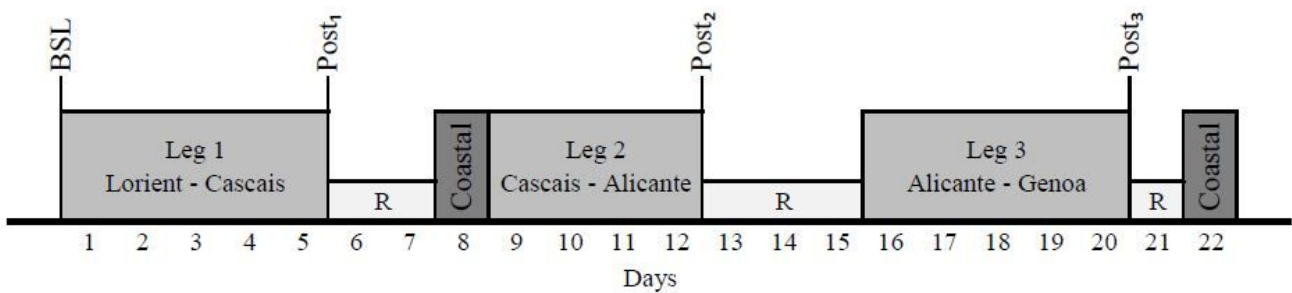


Figure 1. Timeline of TOR 2021 and assessments during 3 weeks of study. BSL: Baseline; Post_{1,3}: Measurements obtained after Leg1-3; R: Recovery.

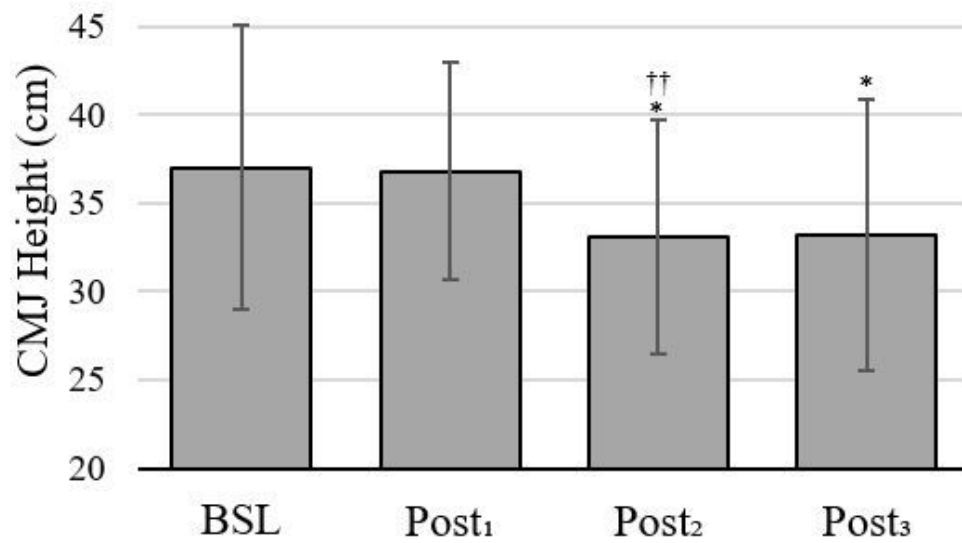


Figure 2. Changes in countermovement jump height throughout TOR. BSL: Baseline Level; CMJ: Countermovement Jump; Post₁₋₃: Measurements obtained after Leg1-3. * Difference is significant to BSL at $p \leq 0.05$; †† Significant difference with values of preceding Test; $p \leq 0.01$.

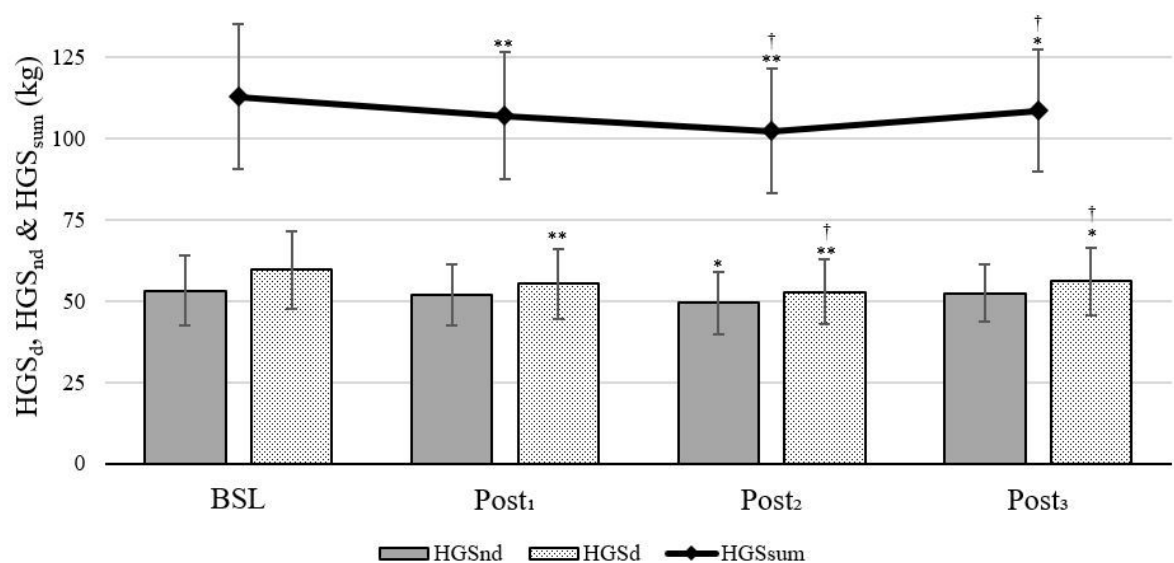


Figure 3. Changes in handgrip strength throughout TOR. HGS_d: Dominant Handgrip Strength; HGS_{nd}: Non-Dominant Handgrip Strength; HGS_{sum}: Sum of HGS_d and HGS_{nd}; BSL: Baseline Level. * Difference is significant to BSL at $p \leq 0.05$. ** Difference is significant to BSL at $p \leq 0.01$. † Significant difference with values of preceding Test; $p \leq 0.05$.

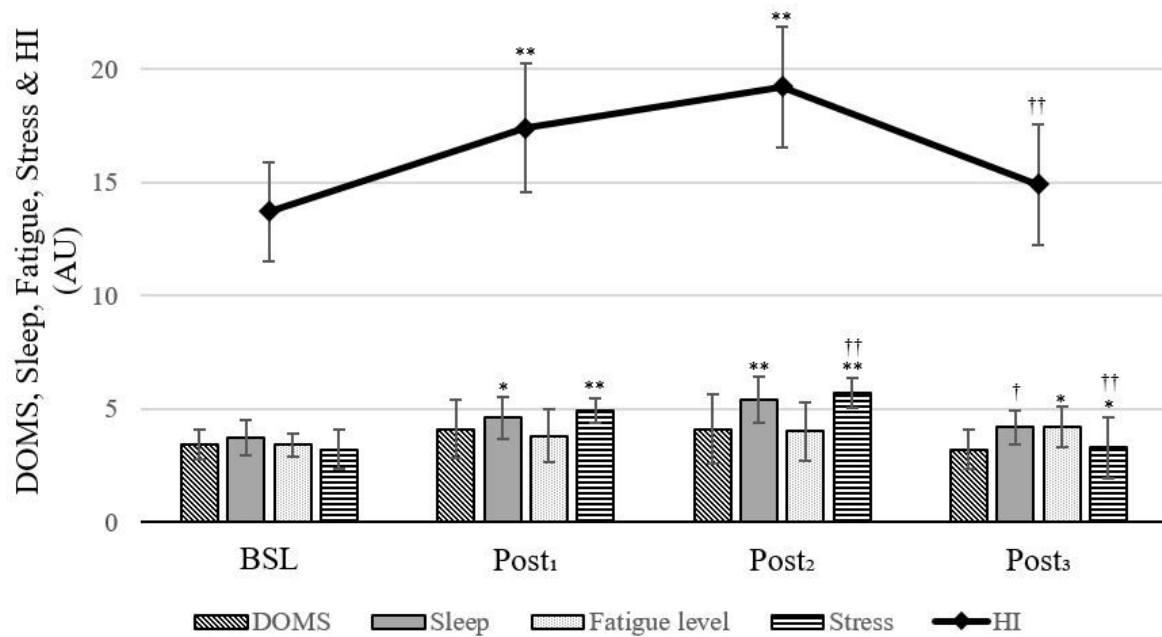


Figure 4. Changes in subjective wellbeing parameters and Hooper Index during TOR. DOMS: Delayed Onset Muscle Soreness; HI: Hooper Index; BSL: Baseline Level. * Difference is significant to BSL at $p \leq 0.05$. ** Difference is significant to BSL at $p \leq 0.01$. † Significant difference with values of preceding Test; $p \leq 0.05$. †† Significant difference with values of preceding Test; $p \leq 0.01$.

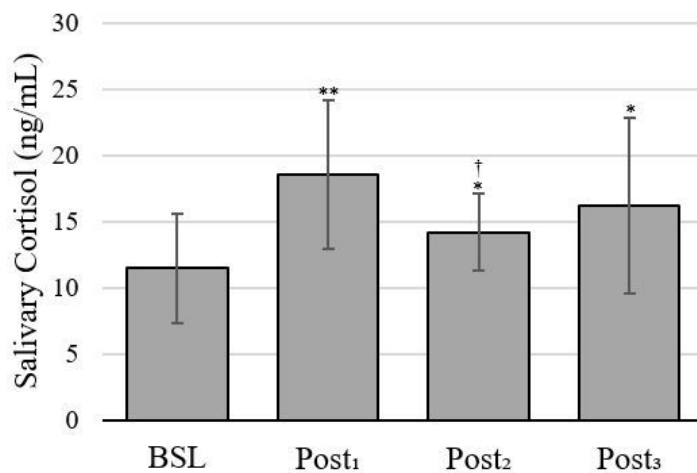


Figure 5. Changes in salivary cortisol during TOR. BSL: Baseline Level. * Difference is significant to BSL at $p \leq 0.05$. ** Difference is significant to BSL at $p \leq 0.01$. † Significant difference with values of preceding Test; $p \leq 0.05$.