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A multi-factorial assessment of elite paratriathletes' response to two weeks of intensified training

PLEASE CITE THE PUBLISHED VERSION

<https://doi.org/10.1123/ijssp.2018-0838>

PUBLISHER

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VERSION

AM (Accepted Manuscript)

PUBLISHER STATEMENT

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REPOSITORY RECORD

Stephenson, Ben T., Christof A. Leicht, Keith Tolfrey, and Victoria L. Goosey-Tolfrey. 2019. "A Multi-factorial Assessment of Elite Paratriathletes' Response to Two Weeks of Intensified Training". figshare.
<https://hdl.handle.net/2134/36387>.

1 **A multi-factorial assessment of elite paratriathletes' response to**
2 **two weeks of intensified training**

3 **Original Investigation**

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20 **Running head:** Intensified training in elite paratriathletes

21

22 Abstract word count: 220

23 Text-only word count: 3315

24 Figures: 3

25 Tables: 3

26

27 **A multi-factorial assessment of elite paratriathletes' response to**
28 **two weeks of intensified training**

29

30

31 **Abstract**

32 *Purpose:* In able-bodied athletes, several hormonal, immunological and psychological
33 parameters are commonly assessed in response to intensified training due to their potential
34 relationship to acute fatigue and training/non-training stress. This has yet to be studied in
35 Paralympic athletes.

36 *Methods:* Ten elite paratriathletes were studied for five weeks around a 14-day overseas
37 training camp whereby training load was 137% of pre-camp levels. Athletes provided: six
38 saliva samples (one pre-camp, four during camp, one post-camp) for cortisol, testosterone and
39 secretory immunoglobulin A; weekly psychological questionnaires (POMS and RESTQ-S);
40 daily resting heart rate and subjective wellness measures including sleep quality and quantity.

41 *Results:* There was no significant change in salivary cortisol, testosterone, cortisol:testosterone
42 ratio or secretory immunoglobulin A during intensified training ($p \geq 0.090$). Likewise, there was
43 no meaningful change in resting heart rate or subjective wellness measures ($p \geq 0.079$).
44 Subjective sleep quality and quantity increased during intensified training ($p \leq 0.003$). There
45 was no significant effect on any POMS subscale other than lower anger ($p = 0.049$) whilst there
46 was greater general recovery and lower sport and general stress from RESTQ-S ($p \leq 0.015$).

47 *Conclusions:* There was little to no change in parameters commonly associated with the
48 fatigued state which may relate to the training camp setting minimising external life stresses
49 and the careful management of training loads from coaches. This is the first evidence of such
50 responses in Paralympic athletes.

51

52 **Key words:** overreaching, monitoring, disability, triathlon, mood disturbance

53 Introduction

54 Athletes often undergo short periods of intensified training (IT), commonly in the form of
55 training camps, purposely designed to provide an overload stimulus whereby significant acute
56 increases in training load (TL) are observed. Whilst periods of IT may result in improved
57 performance, there is the possibility athletes may be at risk of acute fatigue.¹ Meeusen *et al.*
58 define acute fatigue as the first state experienced as a result of IT and its associated stressors.¹
59 If the accumulation of physical and/or non-physical stress were to continue, the development
60 of overreaching (OR) may ensue whereby decrements in sporting performance are evident.¹
61 Testing for performance in fatigued athletes raises inherent issues such as providing a further
62 taxing stimulus or disruption to the normal training regime.³ To circumvent this, less physically
63 demanding and disruptive methods of detecting fatigue and excessive stress after periods of IT
64 have been sought. This may be particularly pertinent in heterogeneous cohorts and/or complex,
65 multi-modal sports, such as paratriathlon.

66 Due to the effect of IT on the hypothalamic axes,⁴ and their ease of measurement in
67 saliva,⁵ resting levels of cortisol and testosterone are commonly measured parameters. It is
68 reported that IT results in increases in biologically active, free cortisol with a concomitant
69 decrease in free testosterone, thus an increase in cortisol:testosterone ratio,⁶ representing a
70 greater catabolic state in the body. Studies have supported this, displaying increases in salivary
71 cortisol (sC)^{5,7} or decreases in salivary testosterone (sT)^{1,8} as a result of IT. Additionally, Coutts
72 *et al.* proposed that salivary secretory immunoglobulin A (sIgA) may also be a sensitive marker
73 in response to IT.⁹ This is due to longitudinal prospective studies evidencing athletes
74 experiencing depressions in sIgA during periods of high TL.^{10,11} Although the responses to IT
75 of other stress markers, such as resting heart rate (RHR) or sleep quality/duration, have yet to
76 show uniformity,^{4,12,13} subjective psychological states do seem to produce consistent results.¹⁴
77 This has been commonly assessed via the Profile of Mood State (POMS) or the Recovery-
78 Stress Questionnaire for Sport (RESTQ-S). POMS is a 65-item questionnaire capable of
79 profiling total mood disturbances or specific subscales; RESTQ-S is a 76-item tool detailing
80 general or sport-specific recovery or stressing activities.¹ Subjective psychological measures
81 have regularly been suggested as being sensitive enough to detect the stress imposed by IT.^{1,5,9}

82 Though the effects of IT have been studied in many types of athletes, triathletes have
83 received particular attention;^{3,8,9,12,14} this is partly due to their habitually high TLs.³ Despite the
84 extensive research focusing on able-bodied (AB) triathletes, little is known about how
85 paratriathletes respond to IT. As in studies of Mujika *et al.* and Stephenson *et al.*, paratriathletes
86 are likely to be undertaking high TLs, placing them at risk of acute fatigue.^{15,16} Furthermore,
87 there is no published literature regarding any hormonal, immunological, physiological or
88 psychological effects of IT in Paralympic endurance athletes. Thus, it is not evident how this
89 population may differ to AB athletes regarding markers of physical and/or psychological stress.
90 This topic is of particular relevance as Paralympic athletes may be at greater risk of excessive
91 stress due to physical impairments causing movement inefficiencies,¹⁷ thus heightening the
92 internal load of movement, with impairments increasing the demands of daily life.¹⁸
93 Consequently, the aims of the present study were to elucidate how paratriathletes respond to
94 IT in the form of a 14-day overseas training camp to permit a comparison with literature from
95 AB athletes.

96 Methods

97 Participants

98 Ten (seven males, three females) elite paratriathletes (age 30 ± 8 y, body mass 66.1 ± 7.6 kg,
99 cycling $\dot{V}O_{2\text{peak}}$ 57.6 ± 6.4 ml·kg⁻¹·min⁻¹) of mixed impairments (amputation $n=6$, spinal cord
100 injury $n=1$, cerebral palsy $n=1$, lower leg impairment $n=1$, visual impairment $n=1$), volunteered

101 to participate in this study. All provided written informed consent and the procedures were
102 approved by the Loughborough University Ethical Advisory Committee. All participants
103 regularly competed at an international level for 2-7 y with nine athletes racing in the 2016
104 Paralympic Games.

105 *Study design*

106 Athletes were studied over the course of five weeks which consisted of one week pre-IT, two
107 weeks IT plus two weeks post-IT (Figure 1). IT took place during the months January-February
108 in Lanzarote, Spain (mean daily temperature $18.7 \pm 0.9^\circ\text{C}$). During IT, average weekly training
109 volume was $137 \pm 33\%$ (mean \pm standard deviation) of pre-IT levels.

110 *Training load*

111 Changes in TL during the study period were as prescribed by participants' coaches. All
112 followed a similar periodised plan with deliberate overload intended during the IT phase. To
113 assess the changes in TL, training was quantified by the methods of Cejuela-Anta and Esteve-
114 Lanao whereby total training minutes for swim, bike and run were multiplied by intensity
115 factors of 0.75, 0.5 and 1, respectively, and summated.^{16,19}

116 *Saliva analysis*

117 Participants provided saliva samples on days 2, 9, 12, 16, 19 and 30. These sampling days were
118 chosen, based on athletes' schedules, to provide the most consistency with regards to the
119 preceding day's training. Each sample was collected in the morning (06:00-07:00) before
120 training, ten minutes after last fluid intake and whilst in a fasted state. These measures were
121 taken to limit any confounding effects of circadian rhythm, hydration status and salivary
122 stimulating effects of food.¹¹ A passive unstimulated saliva sample was collected over a period
123 of three minutes into a pre-weighed sterile plastic container with minimal orofacial movement.
124 sC and sT concentrations were determined in duplicate using commercially available enzyme
125 linked immunosorbent assay kits (Salimetrics Europe Ltd, Newmarket, UK). sIgA was
126 analysed using techniques described by Leicht *et al.*¹⁰ Mean intra-assay coefficients of
127 variation were 1.5%, 2.0% and 3.2% for sC, sT and sIgA, respectively. On days where
128 participants provided saliva samples, a questionnaire of illness symptoms was also completed,
129 as used by Gleeson *et al.*,²⁰ for determination of upper respiratory tract illness (URI) incidence.
130 When URI was present, requirement for training modification was noted.

131 *Psychological questionnaires*

132 Participants completed the POMS and RESTQ-S on five occasions (days 5, 12, 19, 26 and 33),
133 completed before athletes' planned recovery day of the respective week. They were asked to
134 answer POMS questions with respect to how they have felt in the last seven days/nights.
135 Responses from the POMS were used to calculate a total mood disturbance by summation of
136 negative scales (fatigue, depression, tension, anger, confusion) and subtraction of the positive
137 vigour scale. Additionally, scales were analysed individually to see any effect of IT on specific
138 mood states. When completing the RESTQ-S, participants rated how often they experienced
139 general and sport-specific stress or recovery orientated activities in the last three days or nights.
140 RESTQ-S responses were used in the calculation of total stress score via summation of stress-
141 related scales. Likewise a total recovery score was calculated in the same manner using
142 recover-related scales. Additionally, general stress, sport-specific stress, general recovery and
143 sport-specific recovery scores were produced using the appropriate scales.

144 *Daily wellness measures*

145 Upon waking every morning, participants provided several wellness measures. Similar to the
146 questionnaire used by Buchheit *et al.*,²¹ on a six-point, Likert scale participants rated their

147 energy levels, motivation, muscle soreness, sleep quality whilst providing sleep duration in
148 hours. Additionally, participants recorded their RHR using their personal heart rate monitor
149 whilst supine for at least five minutes. Participants' daily RHR and subjective wellness
150 measures were averaged over five discreet periods: day 1-7, 8-14, 15-21, 22-28 and 29-35.

151 *Statistical analyses*

152 All statistical analyses were conducted using IBM SPSS Statistics 23.0 software (IBM, New
153 York, USA). Statistical significance was set at $p < 0.05$. Data were checked for normal
154 distribution using the Shapiro-Wilk test and homogeneity of variance using Levene's test.
155 Where sphericity could not be assumed, the Greenhouse-Geisser correction was used. Changes
156 in TL, sC, sT, salivary cortisol:testosterone ratio (sC:T), sIgA, POMS and RESTQ-S scales
157 plus daily wellness measures over time were assessed via one-way within-measures analysis
158 of variance (parametric) or Friedman's test (nonparametric). The Bonferroni post-hoc test was
159 used to evaluate pairwise comparisons of time points.

160 **Results**

161 *Training load*

162 There was a significant difference in TL over time ($p < 0.001$) as TL was higher during days 8-
163 14 than all other time points ($p \leq 0.034$) and higher during days 15-21 than days 1-7 ($p = 0.014$)
164 (Figure 2).

165 *Salivary testosterone, cortisol and secretory immunoglobulin A*

166 Salivary cortisol displayed significant changes over the study period with a difference between
167 day 2 and day 30 ($p = 0.046$; Figure 3). There was no significant difference in sT, sC:T or sIgA
168 over time ($p \geq 0.090$) (Figure 3).

169 *Illness incidence*

170 Analysis of illness symptom questionnaires revealed that four participants reported at least one
171 URI during the study period. The URI incidence ranged from one to two participants reporting
172 URI per time point (Figure 3). In 43% of cases, ability to train was impaired such that training
173 was modified or cancelled.

174 *Daily wellness measures*

175 There was no significant difference over time in subjective ratings of motivation, muscle
176 soreness and energy status, nor so RHR ($p \geq 0.131$). However, there were significant differences
177 in subjective sleep duration and sleep quality. Specifically, reported sleep duration was higher
178 on days 8-14 and 22-28 than days 1-7 and 29-35 ($p \leq 0.024$) and was also higher in days 8-14
179 than days 15-21 ($p = 0.023$) (Table 1). Sleep quality was greater in days 22-28 than days 1-7, 8-
180 14 and 15-21 ($p \leq 0.043$) whilst sleep quality was lower in days 15-21 than 8-14 ($p = 0.023$)
181 (Table 1).

182 *Psychological questionnaires*

183 There was a significant change in the POMS anger scale with scores higher on day 5 than days
184 12 and 19 ($p \leq 0.044$), whilst anger was also higher on day 33 than day 19 ($p = 0.049$). There was
185 no significant difference in any other scale or total mood disturbance during the study period
186 ($p \geq 0.079$) (Table 2). There were significant differences in RESTQ-S scales for total stress,
187 general stress, sport stress and general recovery. Specifically, total stress and general stress
188 were higher on day 5 than days 12, 19 and 26 ($p \leq 0.019$) whilst sport stress was higher on day
189 5 than days 12, 19 and 33 ($p \leq 0.023$). General recovery was higher on days 12 and 19 than all
190 other time points ($p \leq 0.025$) (Table 3).

191

192 Discussion

193 The present study is the first to assess the hormonal, immunological and psychological
194 responses to a period of natural IT in a group of elite paratriathletes. IT resulted in no significant
195 change to sC, sT or sIgA whilst lowering measures of stress and anger and increasing self-
196 reported sleep parameters and perceived recovery.

197 Although TL during IT was, on average, 137% of normal training, it appears that
198 athletes in the current study were not showing acute fatigue or excessive stress. This increase
199 was as programmed by athletes' coaches as an intentional overload period and is of a similar
200 magnitude to previous studies reporting OR.^{3,12} Nonetheless, others have also shown similar
201 findings. In their study of Australian Rules footballers, Buchheit *et al.* reported that a two-week
202 training camp, comparable to the present study, resulted in no evidence of impaired
203 performance or subjective wellness.²¹ In fact, the participants improved their performance
204 during an intermittent running protocol. The authors propose this beneficial adaptation was due
205 to the participants' high-level training background and careful planning of training by the
206 coaches to minimise the risk of excessive physical stress.²¹ Similarly, Slivka *et al.* reported no
207 effect of a three-week cycling race, whereby exercise volume increased 418%, on any markers
208 of acute fatigue.²² Specifically, 60 min time trial performance was not impaired nor was
209 performance in a graded exercise test. Furthermore, there was no effect on sC, sT, sIgA or RHR
210 with only minimal influence on the POMS vigour scale. This was proposed to be due to a
211 minimisation of external life stresses.²²

212 Salivary cortisol and testosterone have previously been suggested as useful markers of
213 stress/recovery after periods of IT due to their ease of analysis⁵ and their potential relationship
214 to overreached states.⁶ Although in the current study there was an increase in sC from pre- to
215 post-IT, indicative of cumulative stress, there was little change during the 14-day IT period.
216 Also, sT and sC:T were unchanged, indicating the catabolic:anabolic hormonal balance was
217 not meaningfully perturbed, despite sC:T tending to be higher during IT albeit not to the
218 threshold of predefined significance ($p=0.090$). The responses of sC and sT to periods of IT
219 have commonly been studied in AB athletes. However, there appears to be little support for the
220 hypothesised increase in the catabolic milieu. For example, whilst some have shown increases
221 in sC,⁷ most have reported no significant changes.^{1,8,22} Similarly, studies have reported negative
222 effects of IT on sT²³, but others have found no change.^{1,22} Nonetheless, this is the first study to
223 investigate these responses in Paralympic endurance athletes. It appears, based on the current
224 findings, that the effects of IT on salivary hormones are not significantly disparate to AB
225 athletes.

226 It has previously been demonstrated that TL or training duration displays an inverse
227 relationship to sIgA measures over a prolonged period in Paralympic athletes.^{10,16} However,
228 during IT there was no significant change in sIgA concentration in this study. Similarly, URI
229 incidence was unchanged by IT. Coutts *et al.* had suggested that sIgA may be a sensitive
230 measure in response to IT.⁹ This is due to the proposed relationship between high TL, sIgA and
231 URI incidence.² However, the studies of Papacosta *et al.* and Halson *et al.*, in which participants
232 were deliberately overreached via a period of IT, showed no significant changes in sIgA.^{5,24}
233 Additionally, Slivka *et al.* noted no change in sIgA in a group who showed no signs of
234 maladaptation after IT.²² Moreover, Born *et al.* recently stated that the mucosal immune system
235 actually positively adapts to IT by increasing IgA measures.²⁵ As such, there is currently little
236 evidence to substantiate the claims of Coutts *et al.* that sIgA may show suppression as a result
237 of IT.⁹ Here, we provide the first evidence in Paralympic athletes.

238 Participants in the current study perceived their sleep quality and duration to be higher
239 during IT. Subjective sleep metrics were used due to their commonality in wellness monitoring
240 of elite athletes because of the ease of use and limited associated cost compared to objective
241 actigraphy. However, the use of subjective sleep parameters has been questioned. Hausswirth
242 *et al.* note that in a group of overreached triathletes sleep quality was degraded, as measured
243 via actigraphy, yet perceived sleep quality was unchanged.¹² Furthermore, the authors state that
244 changes in sleep variables are small and thus require extensive monitoring for the detection of
245 acute fatigue or OR.¹² Alternatively, others have supported the use of subjective sleep
246 parameters and state they are sensitive to changes in TL.²⁶ Nonetheless, due to the lack of
247 objective information gathered on participants' sleep, it is not possible to make comparisons
248 between the aforementioned methods in the current athlete cohort. Future research should seek
249 to further investigate the link between sleep and stress/recovery because, as stated in a recent
250 review, sleep quality is typically impaired during training camps,²⁷ unlike in the present study.

251 Resting heart rate in the present study was unchanged by IT, similar to previous studies.
252 For example, Killer *et al.* reported no change in morning RHR after a nine-day IT period in
253 trained cyclists, even with evidence of impaired performance.¹⁹ This is despite proposals that
254 heart rate may be altered by IT due to a negative adaptation of the autonomic nervous system.⁴
255 One reason for the lack of relationship between RHR and IT may be due to the low signal:noise
256 ratio reported by ten Haaf *et al.*²⁸ Specifically, variation in self-recorded RHR, as a result of
257 insufficient measurement control, may have masked any changes in response to IT.²⁸

258 It has previously been proposed that psychological and wellness measures are a
259 sensitive marker in response to IT.^{1,5,14} Accordingly, in the current study where acute fatigue
260 was not present, psychological measures showed either little change or slight improvements.
261 There was no significant change in athletes' self-reported motivation, muscle soreness or
262 energy status. Similarly, there was very little change in athletes' POMS profile over the study
263 period. In fact, there was a decrease in the anger subscale during IT, whilst total mood
264 disturbance tended to be lower during IT although not to the level of statistical significance
265 ($p=0.079$). This again adds support to the lack of excessive stress as previous studies have
266 found a relationship between increases in POMS negative scale scores and IT.^{1,13,24} Finally,
267 responses to the RESTQ-S indicate that during IT there was a decrease in total, general and
268 sport-specific stress with a concomitant increase in general recovery. The results for the
269 RESTQ-S are particularly pertinent as it supports the notion that during IT, external life stresses
270 were minimised despite the increase in TL. Hough *et al.* also employed the RESTQ-S to assess
271 the responses of AB triathletes undergoing a 10-day training camp and noted no change in the
272 subscales.⁸ The authors proposed that the triathletes were able to cope with the increased TL
273 which is also likely the case in the present study due to coaches' careful structuring of training
274 and minimisation of life stresses.

275 This is the first study that has reported responses to IT in a group of Paralympic
276 endurance athletes. Whilst the topic has been extensively researched in AB sports,² little is
277 known from those with physical impairments. Paralympic athletes may be at particular risk of
278 physical stress due to factors that increase the likelihood of excessive overload such as
279 movement inefficiencies.¹⁷ Although the population group in the current study only included
280 one spinal cord injured athlete, there has previously been shown to be no significant difference
281 in acute sC and sT responses to exercise compared to AB athletes,²⁹ thus there is no reason
282 why this athlete may obscure the results. Also, sIgA has been shown to display similar variance
283 between Paralympic and AB athletes.^{10,16} Moreover, the use of the POMS questionnaire has
284 been validated in male and female Paralympic athletes of mixed impairments³⁰ although this is
285 not yet the case for the RESTQ-S. Nonetheless, it can be assumed that all measures used in the

286 present study were applicable to Paralympic athletes and that results were not confounded by
287 participants' impairments.

288 **Practical Applications**

289 The present study aimed to report a range of responses to IT, previously linked to acute fatigue
290 and excessive stress, in a group of elite paratriathletes. From the results, it is unlikely acute
291 fatigue was present. This is hypothesised to be mediated by coaches' careful management of
292 TL, such as the deliberate inclusion of low TL days and the scheduling of training to maximise
293 recovery time between sessions, and the camp environment minimising external life stressors.
294 Consequently, those working with Paralympic athletes should seek to achieve the two
295 aforementioned strategies to minimise the likelihood of fatigue or even OR post-IT.
296 Nonetheless, inter-individual variation existed with response to IT. For example, there was
297 evidence of lower sT with a concomitant elevation in subjective muscle soreness for one PTWC
298 paratriathlete with a bilateral transfemoral amputation. Alternatively, a PTS5 athlete with a
299 lower leg impairment displayed a large increase in sC with a simultaneous decrease in sleep
300 quality during IT. Thus, coaches and practitioners should have an awareness of individualised
301 responses, especially in a largely heterogeneous sport such as paratriathlon.

302 Nonetheless, similar to research in AB athletes, it appears psychological states may be
303 the best tool to determine the stress response to IT in paratriathletes. These may provide greater
304 sensitivity and at a lower financial cost than hormonal or immunological analyses. Of note, a
305 performance test was not included in the present study to minimise disruption to athletes' pre-
306 season training schedule. Additionally, the usefulness of performance tests was questioned due
307 to the additive effect they can have on residual fatigue. Finally, a lack of control group
308 prevented certainty that results were due to IT rather than seasonal variation; as such, this is a
309 consideration for future research.

310 **Conclusion**

311 Despite increases in TL similar to previously published studies, the paratriathletes in the current
312 study displayed no signs of acute fatigue or maladaptation. There was little to no change in
313 hormonal, immunological or physiological parameters commonly associated with excessive
314 stress; in fact, participants displayed positive psychological changes.

315

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392 male and female able-bodied and wheelchair athletes. *Paraplegia*. 1986;24:115-122.

393 **Figure captions**

394 **Figure 1** Schematic of data collection. Grey blocks represent days on which saliva was
395 collected for assessment of cortisol, testosterone and secretory immunoglobulin A. * represents
396 days on which participants completed POMS and RESTQ-S. On all days, participants provided
397 their resting heart rate plus subjective ratings of sleep quality and quantity, motivation, muscle
398 soreness and energy levels.

399

400 **Figure 2** Training load (bars are mean values, lines are individuals' values) during the study
401 period. *Significantly greater than all other time points ($p \leq 0.034$). †Significantly greater than
402 day 1-7 ($p = 0.014$).

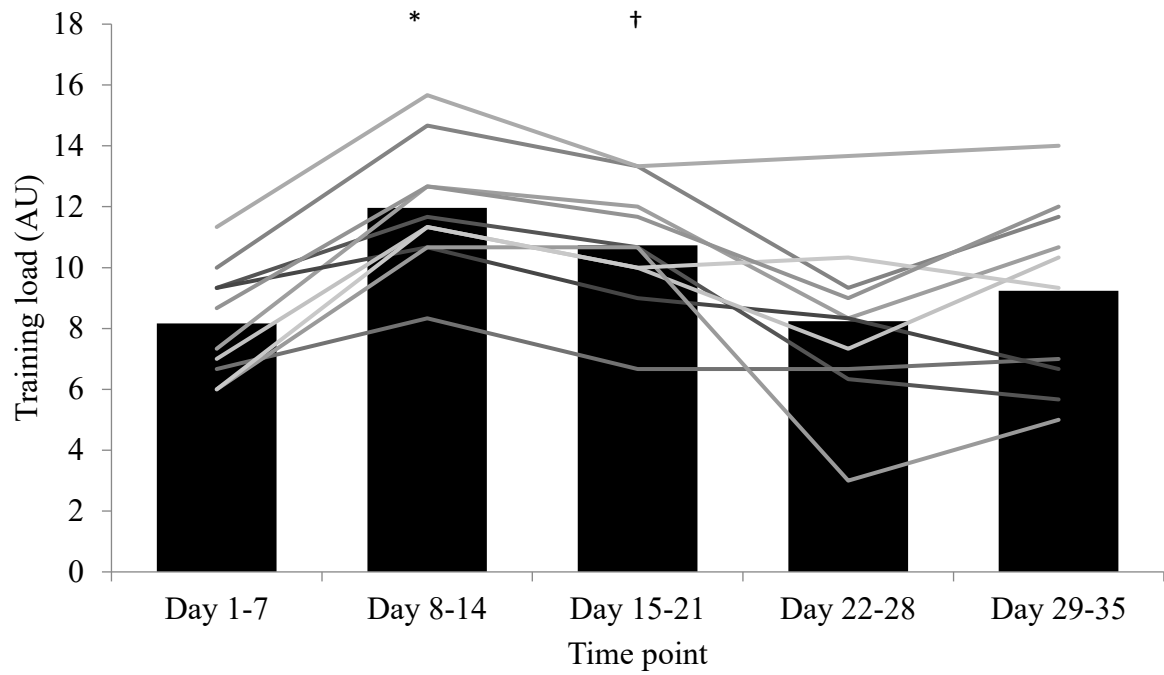
403

404 **Figure 3** Salivary cortisol concentration (A), testosterone concentration (B),
405 cortisol:testosterone ratio (C) and secretory immunoglobulin A (D) with illness incidence
406 (bars) during the study period (mean \pm SD). Shaded area signifies intensified training period.
407 *Significantly greater than day 2 ($p = 0.048$).

408

Day 1-7	Normal Training	
		*
Day 8-14	Intensified Training	
		*
Day 15-21	Intensified Training	
		*
Day 22-28	Normal Training	
Day 29-35	Normal Training	409
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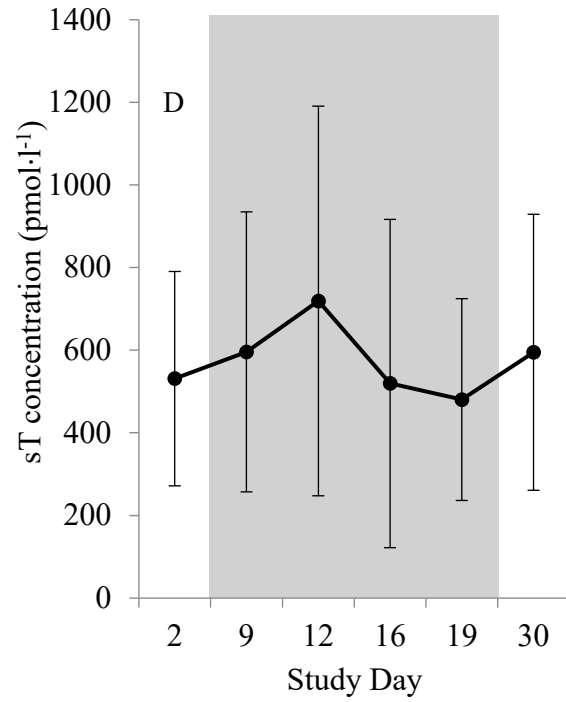
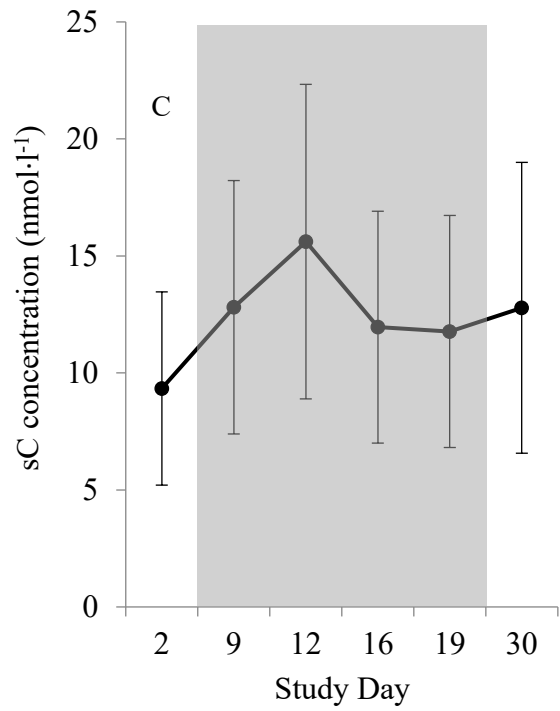
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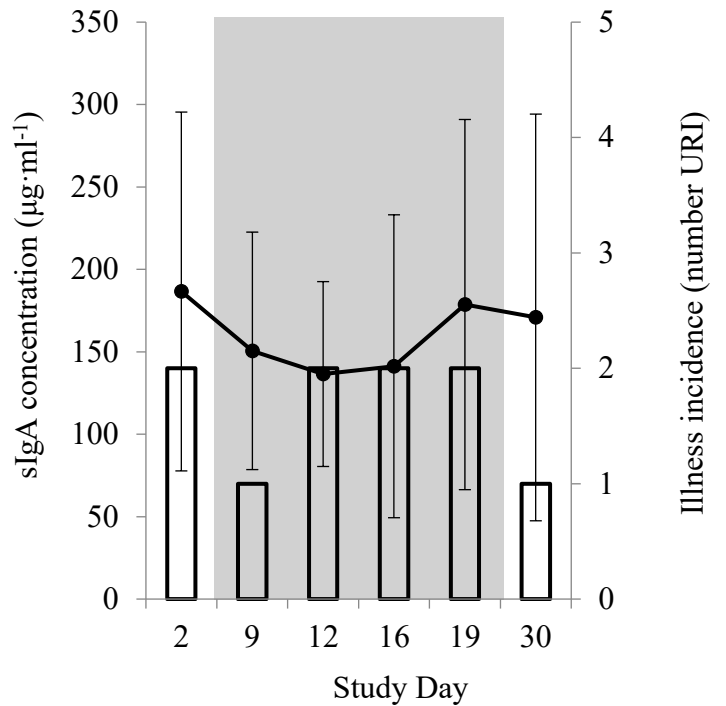
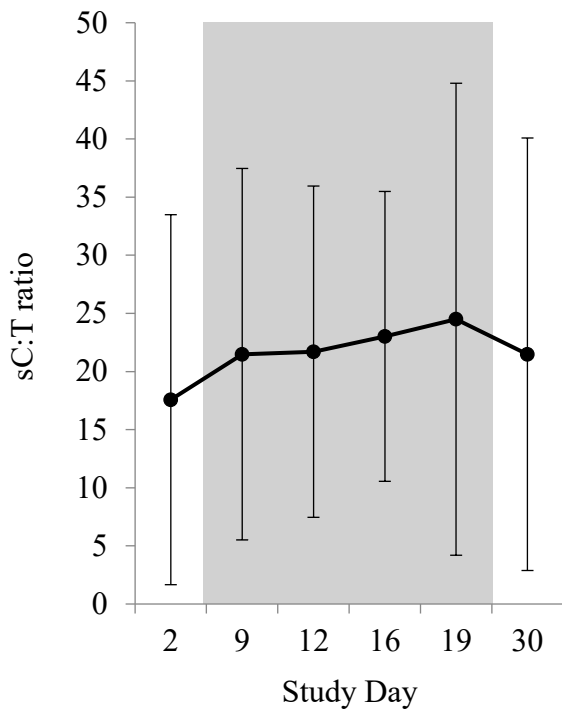
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422



423



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 427 (bars) during the study period (mean ± SD). Shaded area signifies intensified training period.

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429

430 **Table 1** Subjective ratings of energy levels, motivation, muscle soreness, sleep quality and
 431 sleep duration plus resting heart rate over the study period (mean \pm SD). *Significantly
 432 different to days 1-7 and 29-35 ($p \leq 0.024$). †Significantly different to days 15-21 ($p \leq 0.023$).
 433 §Significantly different to days 1-7, 8-14 and 15-21 ($p \leq 0.043$).

	Days 1-7	Days 8-14	Days 15-21	Days 22-28	Days 29-35
Energy levels (AU)	3.8 \pm 0.7	4.1 \pm 0.4	3.7 \pm 0.6	3.6 \pm 0.7	3.5 \pm 0.7
Motivation (AU)	3.2 \pm 0.5	3.2 \pm 0.4	2.9 \pm 0.6	3.0 \pm 0.5	3.0 \pm 0.4
Muscle soreness (AU)	2.6 \pm 0.8	3.0 \pm 1.1	3.0 \pm 1.2	2.6 \pm 1.0	2.7 \pm 1.0
Sleep quality (AU)	3.2 \pm 0.5	3.1 \pm 0.7†	2.8 \pm 0.7	3.5 \pm 0.6§	3.1 \pm 0.8
Sleep duration (min)	432 \pm 53	487 \pm 53*†	460 \pm 42	481 \pm 49*	460 \pm 57
RHR (beat·min ⁻¹)	50 \pm 6	50 \pm 5	49 \pm 6	49 \pm 5	49 \pm 6

434 RHR – Resting heart rate.

435

436 **Table 2** Results from POMS questionnaire subscales (mean \pm SD). *Significantly different to
 437 day 5 ($p \leq 0.044$). †Significantly different to day 33 ($p = 0.049$).

	Day 5	Day 12	Day 19	Day 26	Day 33
Anger	10 \pm 9	5 \pm 4*	5 \pm 3*†	10 \pm 9	11 \pm 10
Depression	13 \pm 13	8 \pm 11	9 \pm 11	16 \pm 15	18 \pm 12
Tension	10 \pm 6	8 \pm 4	8 \pm 5	12 \pm 9	13 \pm 7
Vigour	15 \pm 7	16 \pm 7	15 \pm 7	14 \pm 5	13 \pm 6
Fatigue	9 \pm 5	9 \pm 5	10 \pm 5	11 \pm 5	11 \pm 5
Confusion	7 \pm 5	5 \pm 4	6 \pm 4	9 \pm 7	11 \pm 5
TMD	34 \pm 39	19 \pm 26	23 \pm 28	45 \pm 41	51 \pm 39

438 TMD – Total mood disturbance.

439

440 **Table 3** Results from RESTQ-S subscales (mean \pm SD). *Significantly different to day 5
 441 ($p \leq 0.023$). †Significantly different to days 5, 26 and 33 ($p \leq 0.025$).

	Day 5	Day 12	Day 19	Day 26	Day 33
Total stress	2.3 \pm 0.9	1.5 \pm 0.8*	1.7 \pm 0.7*	2.0 \pm 1.0*	2.0 \pm 1.0
Total recovery	2.2 \pm 1.0	2.8 \pm 0.9	2.7 \pm 1.3	2.1 \pm 0.6	1.9 \pm 1.0
General stress	2.3 \pm 1.0	1.5 \pm 0.8*	1.7 \pm 0.7*	2.0 \pm 1.1*	2.2 \pm 1.2
General recovery	1.9 \pm 0.9	2.6 \pm 0.9†	2.6 \pm 1.2†	1.8 \pm 0.5	1.6 \pm 1.0
Sport stress	2.1 \pm 0.9	1.6 \pm 0.9*	1.8 \pm 1.1*	2.1 \pm 0.9	1.5 \pm 1.1*
Sport recovery	2.6 \pm 1.2	3.1 \pm 1.1	2.8 \pm 1.5	2.6 \pm 0.9	2.4 \pm 1.1

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