Evidence of a Non-Linear Dose-Response Relationship between Training Load and Stress Markers in Elite Female Futsal Players

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Abstract
The aim of this study was: to describe typical training load (TL) carried out by a professional female futsal team for a period of 5 weeks; and to verify the relationship between TL, stress symptoms, salivary secretory immunoglobulin A (SIgA) levels, and symptoms of upper respiratory infections (URI). Over 45 sessions, the TL of the athletes was monitored daily by means of the “session-RPE method during the in-season period prior to the main national competition. Stress symptoms were measured weekly by means of the “Daily Analysis of Life Demands in Athletes Questionnaire” (DALDA), SIgA levels, and by symptoms of URI by the “Wisconsin Upper Respiratory Symptom Survey – 21” (WURSS). There was a significant increase in TL, monotony, and training strain in week 3, with a concomitant and significant reduction in percentage variation (Δ%) of SIgA concentration and secretion rate (p < 0.05). Additionally, a second order regression model showed a high goodness of fit (R² = 0.64 – 0.89) between TL and strain with SIgA concentration, secretory rate, and “worse than normal” responses of stress symptoms from the questionnaire. In conclusion, a link between TL and SIgA levels, and stress symptoms in female futsal players was evident in a non linear fashion. There appears to be an optimal range of values of daily TL between ~343 and ~419 AU and strain between ~2639 and 3060 AU, because at levels below and above these values there was an increase in stress symptoms and above ~435 and ~3160 AU to TL and strain there were a decrease in SIgA levels. In contrast, symptoms of URI failed to demonstrate relationship with the variables studied.

Key words: Team sports, mucosal immunity, psychometric measures, overtraining.

Introduction
Monitoring training loads (TL) in combination with psychophysiological responses has been suggested as necessary to prevent overreaching and overtraining. The session-rating of perceived exertion (i.e. session-RPE) has been demonstrated to be a simple and practical method for quantifying internal TL in team sports (Alexiou and Coutts, 2008; Foster et al., 2001; Impellizzeri et al., 2004). A way to evaluate the impact of physiological stress on immunity is to analyze the salivary secretory immunoglobulin A (SIgA) level, which is considered to be a marker inversely related to the risk of developing upper respiratory infection (URI) symptoms in athletes (Fahlman and Engels, 2005; Walsh et al., 2011). Some studies have shown that low SIgA levels may reduce resistance to infections and also increase the risk of impaired performance in competitions, which is often regarded as a higher than normal psychophysiological stress level (Gleeson et al., 1999; Tsai et al., 2011).

Additionally, “Daily Analysis of Life Demands in Athletes Questionnaire” (DALDA) (Coutts et al., 2007b; Neville et al., 2008) and the “Wisconsin Upper Respiratory Symptom Survey – 21” (WURSS-21) questionnaire (Moreira et al., 2011a; Rushall, 1990) have previously been used as simple tools to monitor the immune response and prevent excessive psychophysiological stress that may negatively alter athletes’ health and performance. In this regard, Coutts et al. (2007b) and Moreira et al. (2011a) have shown that the DALDA questionnaire is a sensitive tool for monitoring individual athletes’ responses to internal TL. Furthermore, significant relationships between increased TL (Foster, 1998) and volume of exercise (Gleeson et al., 2013) with symptoms of URI have been also documented. However, some authors presented inconsistent results between the relationship of TL, stress symptoms, SIgA levels, and URI (Cox et al., 2007; Fahlman and Engels, 2005; Gleeson et al., 2000; Leicht et al., 2012; Neville et al., 2008).

To date, the relationship between session-RPE and corresponding psychophysiological responses has not been sufficiently addressed, especially in female athletes. The clarification of this relationship is important because it is not known if typical TL carried out by professional female team sports players can induce alterations in stress symptoms, SIgA levels, and URI incidence in the same way as their male counterparts. For instance, female athletes may experience more stress in similar TL than male athletes (di Fronso et al., 2013; Killmann et al., 2001), and consequently they may require special attention from coaches and physical trainers in order to manage TL appropriately on a daily basis.

Thus, the objectives of this study were twofold: 1) to describe typical TL experienced by a professional female futsal team during the 5 weeks before the main national competition by means of the session-RPE method and; 2) to verify the relationship between TL, stress symptoms, SIgA levels and symptoms of URI. We hypothesized that periods of intensified TL would increase stress symptoms, decrease SIgA levels with a corresponding increase in the susceptibility to URI.

Methods
Participants

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Thirteen top-level professional female futsal players (mean and SD; age: 22.1 ± 4.2 years; body mass: 60.7 ± 5.9 kg; height: 1.65 ± 0.5 m and BMI 22.3 ± 1.4 kg.m⁻²) who were second place in the Brazilian National League in 2009 were enrolled in the study. The players had a training experienced of 4-5 years. They signed a written informed consent form. The study was approved by the Institutional Ethics Committee.

Design
Firstly, the players performed an incremental running test to determine the ventilatory threshold (VT), respiratory compensation point (RCP), and maximal oxygen consumption (VO₂max). The players were also submitted to an oral examination for detection of clinical signs of periodontal disease, active caries or mucosal lesions. The follow-up study initiated after the State championship played in the first half of the year and was comprised of 5 weeks during the preparation period for a national main championship in Brazil, in the second half of the year. The TL of the players was monitored on a daily basis by means of the session-RPE method for 45 training sessions. Stress symptoms as assessed by DALDA, symptoms of URI as assessed by WURSS-21 and salivary SIgA levels were measured in the afternoon, prior to the last training session of each week. Subsequently, the relationships between TL and training strain (independent variable) with stress symptoms, SIgA, and symptoms of URI responses (dependent variables) were determined to ascertain possible associations.

Procedures
Incremental test
The incremental test on the treadmill (Super ATL - Inbrasport®), Brazil) started at 6 km.h⁻¹. The inclination was kept constant at 1%, and the speed was increased by 1 km.h⁻¹ every minute until voluntary exhaustion. Heart rate (HR) was recorded with a short-range telemetry system (RS800, Polar Electro Oy, Finland). Pulmonary gas ex-

Quantification of internal training load
The internal TL was computed by using the session-RPE method. Approximately 30 minutes following the completion of every training session, the players were asked to rate the intensity of the whole session by means of a modified 10-point RPE scale (Foster et al., 2001). This value of RPE was multiplied by the total duration of the training session. All the players were previously familiarized with the use of the RPE scale. The session-RPE loads were recorded as total weekly and daily average units. Concurrently with the session-RPE, the “strain” and “monotony” were calculated weekly in accordance with Foster (1998). The monotony was calculated weekly by dividing the weekly mean TL by the standard deviation, while training strain was calculated as the overall weekly TL multiplied by monotony.

Stress symptoms
The DALDA (Rushall, 1990) was administered to measure weekly stress sources/symptoms. The DALDA questionnaire is divided into two parts, namely Part A and Part B, which represent the sources of life stress and symptoms of stress, respectively. Each subject was required to complete the DALDA prior the last training session of each week at the same time of the day. The players marked every question as being either “worse than the normal”, “normal” or “better than the normal”. This questionnaire was filled out at the end of every week of training and number of responses labeled as “worse than normal” was retained for analysis (Moreira et al., 2011b). We considered for analysis only part B of the questionnaire, in accordance with Coutts et al. (2007c).

Salivary secretory immunoglobulin A (SIgA)
Enzyme-linked immunosorbent assay (ELISA) was used for analyses of SIgA levels. The samples were collected at rest. The baseline values were determined from saliva samples collected at rest one week before the start of the training period. Saliva samples were collected prior the last training session of each week at the same time of the day. Unstimulated whole saliva samples were collected after individuals had rinsed their mouth twice with water. Participants were asked to spit saliva into sterile tubes for a period of 5 min. Saliva samples were centrifuged at 12,000 rpm for 10 min, and the supernatants were stored at -20 ºC until use. Saliva flow rate was determined by the volume of secreted saliva per minute (ml.min⁻¹).

Total levels of salivary SIgA were determined using microtiter plates (Costar 3590, Corning, NY, USA) and a commercial kit (Human IgA ELISA Quantification set, E80-102, Bethyl laboratories, Montgomery, USA) according to the manufacturer’s instructions. After being coated with primary antibody and blocking plates, saliva samples were diluted at 1:1000 and incubated for 1 h at room temperature. After washing, plates were incubated with anti IgA peroxidase conjugated antibody. For the determination of SIgA concentration (µg.ml⁻¹), absorb-
ance values at 450 nm were plotted against the standard curve obtained for the serial dilutions of a known concentration of purified human IgA. The SIgA secretion rate was expressed by the amount of IgA secreted per minute (µg·ml⁻¹).

**Upper respiratory infection (URI)**
The WURSS-21 (Barrett et al., 2005) was used to compute symptoms of URI prior to the last training session of each week at the same time of the day. It was assumed that the responses to WURSS-21 would be a reasonable marker of URI and functional impairment, in agreement with previous study of Spence et al. (2007). This questionnaire includes 10 items assessing symptoms, with nine items assessing functional impairments and one item assessing global severity and global change (‘How sick do you feel today?’ and ‘compared to yesterday, I feel that my cold is . . .’). All the items are responded to using a Likert scale of severity, ranging from 0–7. The total number of occurrences regardless of severity level was retained for analysis.

**Statistical analyses**
The distribution of data was analyzed by the Shapiro-Wilk test. The sphericity of data was analyzed by Mauchly's test with Greenhouse-Geisser correction. All variables are presented as mean ± standard deviation (SD). In addition, saliva flow rate and SIgA levels were also presented as percentage variation (Δ%) taking into account the relative change of each week investigated compared to the baseline period [i.e (week 1 value – baseline value)/baseline value*100]. All the variables over the five weeks were compared by means of repeated measures analysis of variance (ANOVA). Post-hoc analyses were carried out using Fisher’s least squares difference (LSD) test. The relationship between the TL and strain with SIgA levels, symptoms of URI and stress symptoms were estimated from a second-order regression as used by Manzi et al. (2009) based on mean values of 8 subjects to each week. Differences were considered significant if p < 0.05. SPSS (version 17.0 for Windows; Chicago, IL) was used for all statistical calculations.

**Results**
The physiological characteristics of the 13 players are shown in Table 1. Five did not complete the study. One contracted an oral infection, 2 suffered injuries during the observation period and 2 players were called to the Brazilian national team. Hence, the results for TL, stress symptoms, SIgA levels and symptoms of URI were obtained from 8 players.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂max (ml·kg⁻¹·min⁻¹)</td>
<td>53.1 (7.0)</td>
</tr>
<tr>
<td>VO₂ at VT (ml·kg⁻¹·min⁻¹)</td>
<td>40.9 (8.1)</td>
</tr>
<tr>
<td>VO₂ at RCP (ml·kg⁻¹·min⁻¹)</td>
<td>47.6 (6.3)</td>
</tr>
<tr>
<td>HR at VT (beats·min⁻¹)</td>
<td>162 (19)</td>
</tr>
<tr>
<td>HR at RCP (beats·min⁻¹)</td>
<td>181 (9)</td>
</tr>
<tr>
<td>HRmax (beats·min⁻¹)</td>
<td>190 (6)</td>
</tr>
</tbody>
</table>

Maximum oxygen uptake (VO₂max), ventilatory threshold (VT), respiratory compensation point (RCP), heart rate at ventilatory threshold (HR at VT), heart rate at respiratory compensation point (HR at RCP), maximum heart rate (HRmax).

The main effects on average TL, overall TL and training strain across the 5 weeks of observation were significant (F = 29.064, df = 4, p < 0.001; F = 29.963, df = 4, p < 0.001; F = 23.298, df = 4, p < 0.001 ). The average (Figure 1A) and overall (Figure 1B) TL were significantly higher in week 3 than in weeks 1, 4 and 5. During the two weeks (4 and 5) preceding the competition, the TL was significantly reduced compared with weeks 1, 2 and 3. The training strain (Figure 1D) was also higher in week 3 compared with weeks 1, 2, 4 and 5 (p < 0.05).
During the weeks 4 and 5 the values were significantly reduced compared with weeks 1, 2 and 3. The monotony of training (Figure 1C) was not significantly altered across the weeks.

The SIgA levels were highly variable between subjects across the weeks. The greatest variation was in the baseline, with values of 66% and 111% regarding the concentration and secretion rate of SIgA, respectively. The SIgA concentration showed tendency of change across the weeks (F = 2.05, p = 0.070). However, neither SIgA concentration, SIgA secretion nor saliva flow rates were significantly altered during the training period (Table 2). However, when values were normalized for the individual’s mean baseline values, the Δ% of SIgA concentration significantly changed across the weeks (F = 5.81, p = 0.002). The Δ% of SIgA concentration was lower in week 3 in relation to weeks 2 and 4 (Table 2).

Two players reported 17 URI symptom items in week 3 while other 2 reported 3 symptom items in week 4. There were no significant differences in weekly stress symptoms, assessed by DALDA scores across the training period (p > 0.05) (Table 2).

A second order regression model showed a high goodness of fit ($R^2 = 0.64 – 0.89$) between TL and strain with SIgA concentration and secretion rate, and with the “worse than normal” responses for stress symptoms in the DALDA questionnaire (Figures 2 A, B and C).

**Table 2.** Mean and standard deviation of saliva flow rate and SIgA levels and percentage variation (Δ%), upper respiratory illness symptoms and stress symptoms (n = 8). Data are means (±SD).

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva flow rate (ml/min$^{{}\text{3}}$)</td>
<td>.84 (.26)</td>
<td>.91 (.18)</td>
<td>.81 (.17)</td>
<td>.81 (.27)</td>
<td>.78 (.32)</td>
<td>.83 (.46)</td>
</tr>
<tr>
<td>Δ% saliva flow rate</td>
<td>-</td>
<td>12.8 (32.3)</td>
<td>79 (28.50)</td>
<td>3.49 (41.90)</td>
<td>-2.60 (44.7)</td>
<td>-7.5 (51.3)</td>
</tr>
<tr>
<td>SIgA concentration (μg/ml$^{{}\text{3}}$)</td>
<td>52.2 (32.1)</td>
<td>55.5 (32.3)</td>
<td>78.2 (30.3)</td>
<td>38.8 (16.6)</td>
<td>69.3 (34.9)</td>
<td>59.8 (31.4)</td>
</tr>
<tr>
<td>Δ% SIgA concentration</td>
<td>-</td>
<td>14.3 (34.1)</td>
<td>67.0 (37.2)</td>
<td>-15.0 (27.8)</td>
<td>97.1 (90.7)</td>
<td>35.8 (73.5)</td>
</tr>
<tr>
<td>SIgA secretion rate (μg/ml$^{{}\text{3}}$)</td>
<td>52.2 (59.4)</td>
<td>49.0 (27.1)</td>
<td>61.0 (21.9)</td>
<td>30.3 (13.7)</td>
<td>56.3 (35.3)</td>
<td>49.0 (27.3)</td>
</tr>
<tr>
<td>Δ% SIgA secretion rate</td>
<td>-</td>
<td>31.7 (68.4)</td>
<td>69.1 (74.7)</td>
<td>-10.7 (54.3)</td>
<td>60.0 (127.6)</td>
<td>54.6 (135.7)</td>
</tr>
<tr>
<td>URI – total reports</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>URI No. of affected individuals</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>URI episodes (max and min)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0-10</td>
<td>0-2</td>
<td>-</td>
</tr>
<tr>
<td>Stress symptoms</td>
<td>2.6 (2.2)</td>
<td>2.6 (3.4)</td>
<td>3.1 (4.5)</td>
<td>2.3 (3.9)</td>
<td>2.6 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Stress symptoms (max and min)</td>
<td>(0 – 6)</td>
<td>(0 – 7)</td>
<td>(0 – 11)</td>
<td>(0 – 7)</td>
<td>(0 – 10)</td>
<td></td>
</tr>
</tbody>
</table>

†† p < 0.05, in relation to weeks 2 and 4.

Figure 2. Weekly dose-response relationships based on mean values from 8 players (weeks 1-5) of training load (TL) and strain, with SIgA concentration (A and D), SIgA secretion rate (B and E), and “worse than normal” responses of stress symptoms (C and F) (n = 8).
In the week 4, RT frequency was decreased to 2 times per week, while no RT was performed in the week 5. Techni-
cal tactical training volume and intensity were maintained
constant during this period. Internal TL varied in accor-
dance to the planned external training loads (Figure 1).
The strategy of reducing TL prior to the competition is a
common practice among strength and conditioning
coaches as a recovery period because low TL may result
in a transient improvement in performance due to super-
compensation (Coultts et al., 2007b; 2007c).

In the present study there was a reduction of about
45% of TL during the taper period. Coultts et al. (2007a)
observed that large reduction (~45%) of internal TL dur-
ing taper period in male rugby players induced an in-
crease in the testosterone/cortisol (T/C) ratio and gluta-
mine/glutamate (Gln/Glu) ratio and decreased plasma
glutamate and creatine kinase (CK) activity concomitant
with positive endurance and power performance changes.
The tapering period also allows athletes to recover from
psychophysiological distress or illness. In agreement with
the findings of Papacosta et al. (2013) that reported
changes in SlgA levels during the tapering period in judo
athletes, the present study also presented a significant
positive change in Δ% of SlgA concentration in the same
period of training, suggesting that this tapering strategy is
a suitable approach to allow some degree of immune
function recovery.

The effectiveness of the training programs depends
on the successful manipulation of the total training vol-
ume and intensity. High scores of monotony and training
strain are a result of low TL variability, which in turn has
been suggested to be related to the onset of overtraining,
when combined with high TL (Foster, 1998). In the pre-
sent study, the third week presented the highest overall
weekly TL (3057 AU), monotony (1.6 AU) and training
strain (4186 AU), as noted in Figure 1A, B, C and D,
respectively. Foster et al. (1998) found that for top-level
speed skaters the incidence of banal infections, which is
thought to be a marker of the early stages of overtraining,
was higher in the weeks at which accumulated TL, mo-
notony and strain exceeded approximately 4400, 2.2, and
6000 AU, respectively. However, to determine the rela-
tionships between TL and infection risk or to determine a
secure TL threshold for individual training is still a matter
of debate, instigating further investigations in sports sci-
ences.

The perceived TL can be influenced by innate
characteristics, quantity and the nature of external TL and
fitness level (Impellizzeri et al., 2004; Milanez et al.,
2011). In male futsal, for example, players with a higher
aerobic fitness reported lower TL values compared with
their less fit counterparts, despite undergoing similar
external TL (Milanez et al., 2011). Furthermore, gender
differences would be also influencing psychophysiological
response to TL in individual and team sports (Kellmann
et al., 2001; di Fronso et al., 2013). For instance, Kellmann
et al. (2001), suggested that female rowers would experi-
ence higher levels of stress and lower levels of recovery
than males when exposed to similar TL. Further, Di Fronso et al. (2013) found lower scores of physical recov-
ery, sleep quality, and self efficacy in female basketball
players when compared to males. Consequently, female
athletes may require more attention from coaches and
physical trainers during the training monitoring process.
However, further evidence is necessary in this area for a
better understanding of the role of aerobic fitness, com-
petitive experience and immunological responses in stress
tolerance to training and competitive loads in female
athletes.

Previous studies evaluated the salivary SlgA levels
in order to monitor psychophysiological stress in response
to TL in similar training periods (Fahlman and Engels,
2005; Leicht et al., 2012) but few of them quantified the
TL by the session-RPE method (Moreira et al., 2009;
2011a). In the present study, the significant reduction in
Δ% SlgA concentration was found in week 3 in response
to increased TL, monotony and strain. Our results are in
agreement with previous studies in the literature (Leicht
et al., 2012; Moreira et al., 2011b). For instance, Moreira
et al. (2011b) found a significant decrease in the SlgA secre-
tion rate after a period of 4 weeks of training in basketball
players. Subsequently, Leicht et al. (2012) described a
negative relationship between TL and SlgA levels in
tetraplegic wheelchair rugby players. In this respect, the
goodness of fit (R² ranged from 0.68 to 0.89) found in the
present study would suggest a non-linear dose-response
relationship between SlgA with TL and strain. That is, for
this group of players, values of TL and strain ~435 and
~3160 AU respectively would be desirable because higher
values would decrease SlgA levels (Figure 2A, B, D,
E). These results provide important information for
coaches and sport scientists regarding the utilization of
SlgA as useful markers of physiological stress and the
“optimal” TL to potentially minimize the risk of URI.

Impairment of salivary SlgA secretion in response
to TL and psychophysiological stress before or during
the URI symptom items has been suggested by other authors
as a symptom of overreaching/overtraining (Gleeson et
al., 2011; Neville et al., 2008; Tsai et al., 2011). It is
assumed that increases in the symptom items of intense
and rigorous training periods may lead to the formation of
the “open-window” of immunosuppression and increase the
risk of URI (Koch et al., 2007; Nieman, 1997). Fahlman
and Engels (2005) observed, over a 12 month training
period, that college football players had a greater risk of
contracting infections when SlgA secretion was below 40
µg·min⁻¹. Gleeson et al. (1999) observed, over a 7 month
training period, that SlgA concentration values ≤ 40 µg·min⁻¹
were associated with an increased number of URI symptom items over a training season in elite swim-
ners. In the present study, mean SlgA concentration and
SlgA secretion rate of the team reached risk levels (in
week 3) as suggested by Gleeson et al. (1999) and
Fahlman and Engels (2005) respectively, but the large
increase of URI symptom items in the week 3 was not
significant.

Our results are in agreement with previous studies
that reported no significant relationships between SlgA
and symptoms of URI in different sports like tennis, fe-
male soccer, elite tetraplegic rugby and basketball (Leicht
et al., 2012; Novas et al., 2002; Novas et al., 2003). Al-
though Novas et al. (2002) found a relationship between
the increase in energy expenditure and URI symptoms, these authors did not find a relationship between URI symptoms and SlgA levels in female tennis players (Novas et al., 2003). Thus, the relationship between SlgA levels and URI is still not clear as there are contradictory results in the literature (Fahlman and Engels, 2005; Gleeson et al., 1999; Leicht et al., 2012; Novas et al., 2002; Novas et al., 2003; Vardiman et al., 2011). Hence, such a relationship must be considered with caution because factors other than salivary antibody levels may contribute to infection development (Diamond et al., 2008). Some of those studies found increased symptoms of URI concomitant with a decrease in SlgA levels, although a non-linear relationship among these variables is expected (Fahlman and Engels, 2005; Gleeson et al., 1999).

DALDA questionnaire also has been suggested to be useful for monitoring psychophysiological stress in response to TL (Coutts and Reaburn, 2008; Moreira et al., 2011b). This tool has been shown to be sensitive to TL (Coutts and Reaburn, 2008; Moreira et al., 2011b) as well as to bodily reactions to training stress (Coutts and Reaburn, 2008). For instance, Nicholls et al. (2009) found that DALDA was able to discriminate between different periods such as rest, training and pre- and post-match days. In this previous study, professional rugby players reported greater stress on training days, when compared to rest period and match days. In the present study we found a goodness of fit ($R^2$ ranged from 0.64 to 0.81) between an increased number of “worse than normal” scores with TL and strain. To the best of our knowledge, this is the first study reporting such as relationships. Therefore, it could be suggested that the DALDA questionnaire is sensitive for monitoring psychophysiological stress in response to the variations of TL. For this group of players an optimal range of values between 343 and 419 UA to TL and 2639 and 3060 AU to strain training would be suggested, since below and above these values increased responses of stress symptoms were observed (see Figure 2 C and F). Higher levels of stress symptoms at low TL values coincided with the period immediately preceding the competition. Hence, they may have been mainly caused by anxiety and psychological stress rather than by TL.

The main limitation of the present investigation is the small sample size, but some players were injured while others were called to the National Brazilian team and could not complete the study. Additionally, the goalkeepers were excluded from the study because their training routine and the TL experienced are quite different from the outfield players. Furthermore, the training program period investigated was relatively shorter than those used in previous studies that found some relationship between SlgA and URI (Fahlman and Engels, 2005; Gleeson et al., 1999). Additionally, URI symptoms could have been more reliable if diagnosed by a medical doctor rather than using the questionnaire.

In summary, the present study demonstrated an interesting link between TL, monotony and training strain with SlgA levels and stress symptoms. However, although two players reported altogether 17 URI symptoms in week 3 concurrent with an increase in TL, monotony, strain training, stress symptoms and a decrease in SlgA concentration, this increase was not statistically significant. However, a non-linear dose-response relationship between TL and strain with SlgA and stress symptoms was detected in the present study.

Conclusion

The present study confirms the need for coaches and physical trainers to monitor TL, monotony and strain in combination with psychophysiological responses during periods of training before an important competition. The study demonstrated that increased TL, monotony and training strain may be associated with SlgA levels and stress symptoms. In the present study a significant increase in SlgA levels was observed during the tapering period, suggesting that this is a suitable approach to allow immune function recovery. Furthermore, for this group of players, there appears to be an optimal range of values of daily TL between ~343 and ~419 AU and strain between ~2639 and 3060, because at levels below and above these values there was an increase in stress symptoms and above of ~435 and ~3160 AU to TL and strain there were a decrease in SlgA levels. These results provide important information regarding the utilization of SlgA and stress symptoms derived from the DALDA questionnaire as useful markers of training stress. On the other hand, URI symptom items were not directly related to the variation in SlgA and responses to the DALDA questionnaire.

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The authors would like to thank Dr. Alexandre Moreira by important contribution to this paper.

References


Key points
- There is a dose-response relationship between SlgA levels and stress symptoms with TL.
- For the athletes of the present study, values of ~336 AU to TL and ~2610 and ~3016 AU to strain would be suggested for this group of athletes, since below and above these values increased responses of SIgA levels.
- An optimal range of values of TL between ~336 and 2550 AU would be desirable because higher values would decrease responses of SlgA levels.

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