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Original Article

Enzymatic, hormonal and psychometric marker responses to weeks with low and high internal training load in futsal players

FRANCINE CAETANO DE ANDRADE NOGUEIRA[1], VICTOR HUGO DE FREITAS[2], RUAN ALVES NOGUEIRA[1], BERNARDO MILOSKI[3], MAURÍCIO GARRÁSBARA FILHO[1].
[1,3,5,]College of Physical Education and Sports, Federal University of Juiz de Fora, BRAZIL.
[2]NúcleoMotriS, Department of Physical Education, Federal University of Bahia, BRAZIL.
[4]Faculty of Physical Education, Federal Institute of Southeastern Minas Gerais,BRAZIL.

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Abstract
The present study aimed to compare the responses of enzymatic, hormonal, and psychometric markers of two different microcycles of the season. The sample consisted of 15 athletes, members of a high performance male futsal team. Four data collections were performed on the first day oftraining and the final day of the two microcycles, consisting of blood collection for analysis of serum creatine kinase and the values of the hormones testosterone and cortisol, and the application of the Total Quality Recovery scale (TQR) and Recovery and Stress Questionnaire for Athletes (RESTQ). The findings indicated that the training weeks analysed promoted similar increases in TQR, RESTQ indicators and enzymatic markers, and improvement in the anabolic/catabolic balance of futsal players, regardless of the magnitude of the training load. Differences between Σ-stress and Σ-recovery indicated greater sensitivity to analyse the responses derived from the load applied during short periods in futsal.
Keywords: Athletic Performance; Recovery; Team sports.

Introduction

The futsal season schedule presents similar characteristics to other team sports, with a short pre-season and longcompetitive season, during which players may play 1-2 regular matches per week (Miloski, de Freitas, & Bara-Filho, 2012; Miloski, de Freitas, Nakamura, de, & Bara-Filho, 2016; Moreira, 2010).The common planning strategy adopted by futsal coachesis to intensify the internal training load (ITL) during the pre-season and alternate weeks with high and low ITL during the competitive season, in accordance to the number and difficultyof the games during eachrespective week (Kelly & Coutts, 2007; Miloski et al., 2016).One of the most used metrics to quantify ITL in futsal is the session rating of perceived exertion method(Freitas, Miloski, & Bara-Filho, 2012; Miloski et al., 2012; Miloski et al., 2016; Wilke et al., 2016). Alternating between high and lowtraining loads is proposed asan adequate training distribution aiming to inducepositive adaptations (i.e., maintenance or increase in performance) and avoid excessive fatigue accumulation and other negative outcomes (i.e., overreaching and overtraining) (Aubry, Hausswirth, Louis, Coutts, & Y, 2014; Kentta & Hassmen, 1998).Miloski et al. (Miloski et al., 2016) described the typicalITL distribution of a professional futsal teamwith their magnitudes expressed relative to the maximum levels recorded over the duration of the investigated season. The authors classified the weekly ITLinto four equal bands throughout 22 weeks of observation, being ITL≤25% (of maximum):low loads; 25–50%: moderate-low loads; 50–75%:moderate-high loads and ≥75%: high loads.Although Miloski et al.(Miloski et al., 2016)have statistically ranked low weekly ITL(Foster et al., 2001)asbelow ~2200 A.U. and high weekly ITL as above ~3900 A.U., physiological and psychological marker responses to weeks with low and high ITL infutsal players have notbeen investigated yet.Thus, it is important to examine whether the high and low training loads defined by Miloski et al. result in different biological and psychological responses that are indicative of fatigue.

Enzymatic, hormonal and psychometric markers are frequently measured in sports aiming to finelymonitor and control the effects of the training load (Cadegiani & Kater, 2017; Meeusen et al., 2013; Miloski et al., 2016). The Total Quality Recovery scale (TQR) (Kentta & Hassmen, 1998)and the Recovery and Stress Questionnaire for Athletes (RESTQ) (COSTA & SAMULSKI, 2005; Kellmann & Kallus, 2001), for example, are considered simple, practical, and valid psychometric tools to monitor stress and recovery of athletes (de Freitas et al., 2015; Freitas, Nakamura, Miloski, Samulski, & Bara-Filho, 2014; Miloski, Freitas, & Bara-Filho, 2014; Nogueira et al., 2018).Higher stress and lower recovery, identified by the TQR and RESTQ, are reported after a period of ITL intensification (Freitas et al., 2014; Noce et al., 2011), leading to performance decrement if sustainedfor prolonged time (A. J. Coutts, Wallace, & Slattery, 2007; Faude, Kellmann, Ammann,

Corresponding Author: Francine Caetano De Andrade Nogueira,E-mail: francinecanogueira@gmail.com

Schnittker, & Meyer, 2011). In practical settings, creatine kinase (CK) is a widely used enzymatic marker to monitor exercise-induced muscle damage(Brancaccio, Lippi, & Maffulli, 2010). An increase in blood CK concentration has been reportedafter a period of high ITL (Freitas et al., 2014) and is frequently associatedto muscle damage and consequently with a decrease in muscle function(Brancaccio, Maffulli, & Limongelli, 2007; Johnston et al., 2013).The testosterone to cortisol ratio (T:C) is a frequently used hormonal markerto diagnose changes in the hypothalamic-pituitary-adrenal and hypothalamic-pituitary-gonadal axis in response to periods of training and competition, indicating a more or less favorableanabolic and catabolic states, respectively(A. Coutts, Reaburn, Piva, & Murphy, 2007; Hug, Mullis, Vogt, Ventura, & Hoppeler, 2003). Kraemer et al. (Kraemer et al., 2004) indicated that the hormonal statusof male collegiate soccer players at the start of the season can have significant effects on physical performance throughout the entire season. The authors indicated that the soccer players are more susceptible to decrements in performance capabilities during competition if they start the season with predominance of catabolic state(Kraemer et al., 2004).

Previous studies investigated the changes of RESTQ, CK, and T:C during a period of regular training in futsal(Miloski et al., 2016; Nogueira et al., 2018).Nogueira, et al. (Nogueira et al., 2018) reported a smallincrease in CK afterfour weeks of pre-season period in high-level futsal players. However, in response to the same period, players presented improvement in the stress and recovery balance (RESTQ) and in anabolic/catabolic (T:C) status. The authors suggested that the small CK increment did not have harmeffects on futsal players' performance and psychophysiological states(Nogueira et al., 2018).Accordingly, in another studyfutsal players presented better anabolic indices after a pre-season composed of high ITL (> 4000 U.A.) even with an increase in blood CK concentration (Miloski et al., 2016).It is interesting to note that in the same study, the players reported an increase in cortisol and T:C after a period with modest ITL but with high incidence of matches during the in-season(Miloski et al., 2016).Therefore, better understanding the response of these psychophysiological adaptation markers (TQR, RESTQ, CK andT:Cr)to typical weeks of training with different magnitudes of ITL is necessary for the practical application and interpretation of the referredmarkers in the futsal preparation routine.

Thus, the aim of the present study was to investigate the response of enzymatic, hormonal, and psychometric markers to weeks with low and highITL in futsal players.A large alteration in these markers was expected post weeks with high ITL and minor changes in weeks with low ITL, compared with their respective baseline values.

Material &Methods

Participants

Fifteen male futsal players (Age: 28.4 ± 6.6 years, Body mass: 75 ± 6.6 kg, Height: 173.8 ± 5.2 cm, fat percentage 11.6 ± 3.7) participated in this study. The players were members of a professional futsal team that competed in the Brazilian National Futsal League. After presentation of the study proposal, players attested their voluntary participation and gave permission for the use their respective data. The study procedures complied with the international standards for human experimentation of the National Health Council (No. 196/96) and were approved by the Human Research Ethics Committee of the Federal University of Juiz de Fora under protocol 251/2011.

Procedures

The session training loads of the futsal team, as well as their effects on adaptation markers were monitored during an annual competitive season to quantifythe training loads planned by the technical staff. Two different weeks (microcycles), belonging to distinct periods of the season (the first in the preseason and the second in the competitive period), were selected as they presented large differences in the external load of training. During these microcycles, players did not play matches and started the first training session of the cycle after 48 hours without training/competing. The session-rating of perceived exertion (sRPE) method was used(Foster et al., 2001)to quantify the session internal training load. The data collected at3 different moments were analysed: on the first day of first microcycle (baseline) and on the last day of training of each microcycle. The variables collected were: blood levels of CK, testosterone and cortisol,perceived recovery through the TQR scale (Kentta & Hassmen, 1998), andthe RESTQ(COSTA & SAMULSKI, 2005). The first week (Microcycle 1)was composed of 3 training days with 5 sessions in total. The training time was divided as follows: 45.4% for technical-tactical training, 18.2% for strength, 18.2% for velocity, and 18.2% divided equally between power, core training, and sensorimotor training. The second monitored week (Microcycle 2)consisted of 5 training days with 10 training sessions, divided as follows: 59.6% for technical-tactical training, 22% for strength, 11.4% for velocity, and 7.0% for power.

Internal training load

The internal training load (ITL) was quantified using the session-RPE method(Foster et al., 2001). Thirty minutes after the end of each training session, the athletes answered the question, "How was your training?", pointing out their response on the CR-10 scale. All athletes were familiar with this method. The ITL of each session was obtained from the product between the score indicated on the scale and the session training time in minutes. The total week training load (TWTL) was scored by summing all training sessions of each week.

Psychometric markers

The perceived recovery level was measured by the Total Quality Recovery scale (TQR) proposed by Kenttä and Hassmén(Kentta & Hassmen, 1998). Before the beginning of the training session, the athletes answered the question "How do you feel about your recovery?", pointing out their response on the scale. The Recovery and Stress Questionnaire for Athletes (RESTQ) was used to evaluate the balance between stress indicators and player recovery through their own perception (COSTA & SAMULSKI, 2005). This tool is composed of 19 scales, including 12 general scales (7 on stress and 5 on recovery) and 7 scales specific to the sport (3 on stress and 4 on recovery). For each scale, the athlete responded to 4 specific items. Answers were provided using a Likert scale from 0 (never) to 6 (always), indicating how often the subject had participated in certain activities in the previous three days/nights.The sum of the stress scale (∑-stress)andrecovery scale (∑-recovery), and the difference between the ∑-stressand ∑-recovery (ERD = ∑-stress -∑-recovery) were measured.

Enzyme and hormone markers

Blood collection was performed in a room next to the training court of the team included in this study by a qualified professional respecting the principles of biosafety, hygiene, and cleaning. Approximately 5 mL of blood was collected from one vein of the antecubital fossa of the arm through a vacuum system method and stored in a tube with separating gel. The samples were stored in anambient temperature compartment and taken to the laboratory for analysis on the same day. For CK analysis, the blood sample was centrifuged for 5 minutes at 3200 rotations per minute and the serum obtained was analysedin BT 3000 Plus® Biochemical equipment with the Beckman Coulteur® kit. Testosterone and cortisol were analyzed using specificchemiluminescence tests, following the Bio System Kit specifications,according to the laboratory routine. The technique wasdeveloped by an Elecsys 2010 machine from Roche Diagnostics andthe laboratory has a quality system certified by ABNT/INMETRO/ISO9001/2000.

All collections were performed at the same time (between 9:00 AM and 9:30 AM), always preceding the first training session of the day. For the collection, the players were instructed to remain fasted during the 12 hours before the test and not to drink alcohol and caffeine for at least 24 hours.

Statistics Analysis

The descriptive analysis is presented as mean ± standard deviation. The parametric assumptions were evaluated by the Shapiro-Wilk and Levene's tests. The Wilcoxon test was used for test the difference between TWTL between microcycle 1 and 2. To test the differences in thehormonal, and psychometric markers between the different moments, we used repeated measures ANOVA, followed by the Tukey post-hoc. To test the differences in CK and TQR between different moments, the Friedman ANOVA test followed by Wilcoxon text were used. The software used was Statistica (v.8.0, StatSoft®, Tulsa, Ok) considering a difference of p <0.05.

Results

The TWTL of microcycle 1 was lower than microcycle 2 (P< 0.01; Figure 1).

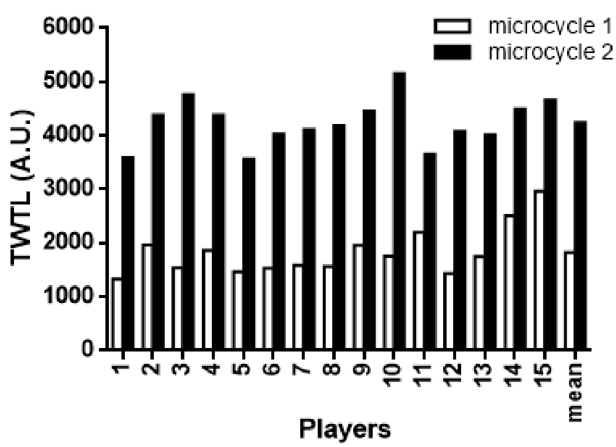

Fig 1. TWTL (A.U) of the fifteen futsal players and mean for the team in different microcycles (1 and 2).

The perceived recovery throughthe TQR was different after the first microcycle (P = 0.02) and post second microcycle (P = 0.01) when compared to baseline (table 1).

The RESTQ scales that presented differences post microcycle 1 compared to baseline were: Conflict/Pressure, Fatigue, Success, Disturbed Breaks, Emotional Exhaustion, Injuries, Being in Shape, Personal Accomplishment, Self-Efficacy, and Self-Regulation (P values in Figure 2). The RESTQ scales that presented differencespost microcycle 2 compared to the baseline state were: General Stress, Social Stress, Conflict/Pressure, Fatigue, Physical Recovery, General Well-Being, Emotional Exhaustion, Injuries, Being in Shape, Personal Accomplishment, Self-Efficacy, and Self-Regulation (P values in Figure 2). The ∑-stress and ∑-

recoveryscales were higher post microcycles 1 and 2 compared to baseline (P <0.01). However, the ERDwas not different when different moments were compared (P = 0.07) (table 1).

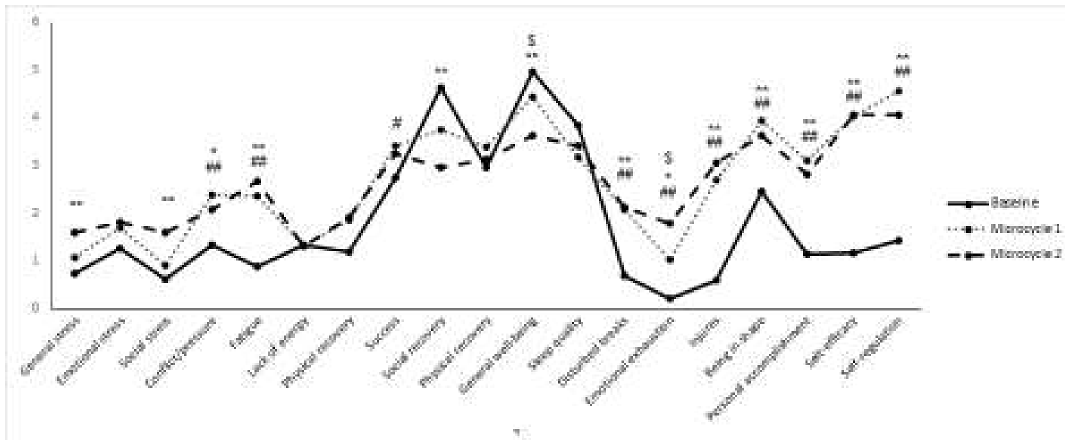

Fig 2. RESTQ scales at baseline, post microcycles 1 and 2. $^{\#}P > 0.05$ and $^{\#\#}P > 0.01$ differences between microcycle 1 and baseline. $*P > 0.05$ and $**P > 0.01$ differences between microcycle 2 and baseline. $^{\$}P>0.05$ difference between microcycles 1 and 2.

Table 1 – Perceptual markers at baseline and at post microcicle 1 and 2.

	baseline	Post 1	Post 2
TQR	16.63 ± 2.11	15.17 ± 2,08*	13.80 ± 1.91*
∑-stress	8.80 ± 4.47	17.37 ± 6.23**	19.92 ± 9.73**
∑-recovery	25.33 ± 7.22	34.04 ± 4.73**	30.70 ± 5.84**
ERD	-16.53 ± 8.43	-16.67 ± 8.89	-10.78 ± 14.20

*P<0.05; **P<0.01 different of baseline.

Serum levels of testosterone post microcycles 1 and 2 were similar to baseline (P> 0.05). However, serum cortisol levels were lower, and CK and T/Cr were higher post microcycles 1 and 2 (P <0.01) compared to baseline(table 2).

Table 2 – Psychometric markers at baseline and at post microcicle 1 and 2.

	baseline	Post 1	Post 2
CK	221.01 ± 101.35	433.21 ± 259.82**	516.45 ± 198.43**
Testosterone	14.43 ± 1.62	14.78 ± 1.43	14.80 ± 1,03
cortisol	18.11 ± 4.17	14.61 ± 3.64**	14.03 ± 3.49**
T/Cr	0.85 ± 0.25	1.08 ± 0.33**	1.11 ± 0.26**

Discussion

The main results found were that, in view of the greater TWTL in microcycle 2 compared to microcycle 1, the sum of RESTQ stress and recovery scales, serum CK, and T/Crwere higher post both microcycles, and TQR and serum cortisol levels were lower post microcycles 1 and 2 compared to baseline. In addition, serum testosterone levels were not different post microcycles 1 and 2 compared to baseline.

Lower perceived recovery values (TQR) post a period with intensified ITL, and the return of this variable to baseline values post a recovery period have previously been demonstrated in volleyball players (Freitas et al., 2014). However, in the present study, both microcicles presented of decreased values for baseline.It was expected too that players would present higher Σ-stress and lower Σ-recovery after the microcycle of greater magnitude. However, similar than TQR, the novelty of the present study was that Σ-stress and lower Σ-recovery increased post microcycles, which can be justified by the low values of the sport-specific stress scales (Being in Shape, Personal Acceptance, Self-Efficacy, and Self-Regulation) reported by athletes at baseline. Increases in stress dimensions and decreases in RESTQ recovery dimensions are usually reported in athletes undergoing periods with high TL and low recovery, often associated with overreaching symptoms (Faude et al., 2011; Nederhof, Zwerver, Brink, Meeusen, & Lemmink, 2008; Noce et al., 2011). Small increases in stress dimensions and a slight decrease in recovery dimensions occur and are expected during periods of training and competition (Faude et al., 2011). Therefore, these results suggest that, in futsal, the ITL of microcycles with magnitudes up to 4235 U.A. provides expected and positive changes in RESTQ scales, and one microcycle with this level of ITL is not sufficient to promote overreaching or accumulated fatigue symptoms.The results suggest that maybe, differences between Σ-stress and Σ-recovery may be more sensible than others psychophysiological markers analysed, and it would be confirmed in new studies.

Due to the different magnitudes of ITL applied, blood concentration of CK was expected to be higher after the microcycle of greater magnitude. In rugby athletes, for example, blood concentration of CK was higher post a microcycle with CT of 3107 U.A. (1402 U/L) compared to post a microcycle with CT of 2410 U.A. (588 U/L)(A. J. Coutts, Reaburn, Piva, & Rowsell, 2007). However, the blood concentration of CK increased similarly after the 2 microcycles investigated herein. In a recent study, the blood concentration of CK of futsal players was similar throughout the competitive season, regardless of the magnitude of training loads applied(Miloski et al., 2016). These results suggest that a transient increase in CK levels above baseline occurs in futsal players, and CK values up to ~ 500 U/L (Freitas et al., 2014), as reported in the present study, may not be associated with other adverse symptoms of negative adaptations. In addition, in futsal, microcycles with TLs with magnitudes up to 4235 U.A. are not sufficient to cause a large increase in blood concentration of CK.

Another speculated resultwas an increase in blood cortisol level and a drop-in testosterone and T/Cr after the microcycle with the highest ITL. This behaviour is commonly reported in athletes with symptoms of overreaching (A. J. Coutts, P. Reaburn, et al., 2007; Papacosta & Nassis, 2011). However, in the present investigation, cortisol levels and T/Cr increased, regardless of the ITL applied. A decreasein cortisol levels and increase in T/Cr were reported after a pre-season with futsal players, suggesting a positive adaptation in the anabolic environment of the players (Nogueira et al., 2018). Thus, the results of the present study suggest that in futsal, both microcycles, independent of load, provided positive adaptations in anabolic and catabolic hormones.

Conclusions

The results found allow us to conclude that the training weeks analysed promoted similar increases in TQR, RESTQ stress and recovery indicators and enzymatic markers of muscle damage,as well as improvementinthe anabolic/catabolic balance of futsal players, regardless of the magnitude of ITL applied.

Conflicts of interest

The authors declare no conflicts of interest regarding the publication of this work.

References

Aubry, A., Hausswirth, C., Louis, J., Coutts, A. J., & Y, L. E. M. (2014). Functional overreaching: the key to peak performance during the taper? *Med Sci Sports Exerc, 46*(9), 1769-1777. doi: 10.1249/MSS.0000000000000301

Brancaccio, P., Lippi, G., & Maffulli, N. (2010). Biochemical markers of muscular damage. *Clin Chem Lab Med, 48*(6), 757-767. doi: 10.1515/CCLM.2010.179

Brancaccio, P., Maffulli, N., & Limongelli, F. M. (2007). Creatine kinase monitoring in sport medicine. *Br Med Bull, 81-82*, 209-230. doi: 10.1093/bmb/ldm014

Cadegiani, F. A., & Kater, C. E. (2017). Hormonal aspects of overtraining syndrome: a systematic review. *BMC Sports Sci Med Rehabil, 9*, 14. doi: 10.1186/s13102-017-0079-8

COSTA, L. O. P., & SAMULSKI, D. M. (2005). Processo de Validação do Questionário de Estresse e Recuperação para Atletas (RESTQ-Sport) na Língua Portuguesa.*R. bras. Ci e Mov., 13*(1), 79-86.

Coutts, A., Reaburn, P., Piva, T. J., & Murphy, A. (2007). Changes in selected biochemical, muscular strength, power, and endurance measures during deliberate overreaching and tapering in rugby league players. *Int J Sports Med, 28*(2), 116-124. doi: 10.1055/s-2006-924145

Coutts, A. J., Reaburn, P., Piva, T. J., & Rowsell, G. J. (2007). Monitoring for overreaching in rugby league players. *Eur J Appl Physiol, 99*(3), 313-324. doi: 10.1007/s00421-006-0345-z

Coutts, A. J., Wallace, L. K., & Slattery, K. M. (2007). Monitoring changes in performance, physiology, biochemistry, and psychology during overreaching and recovery in triathletes. *Int J Sports Med, 28*(2), 125-134. doi: 10.1055/s-2006-924146

de Freitas, V. H., Nakamura, F. Y., de Andrade, F. C., Pereira, L. A., Coimbra, D. R., & Bara-Filho, M. (2015). Pre-competitive physical training and markers of performance, stress and recovery in young volleyball athletes. *Rev Bras Cineantropom Desempenho Hum, 17*(1), 31-40.

Faude, O., Kellmann, M., Ammann, T., Schnittker, R., & Meyer, T. (2011). Seasonal changes in stress indicators in high level football. *Int J Sports Med, 32*(4), 259-265. doi: 10.1055/s-0030-1269894

Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., . . . Dodge, C. (2001). A new approach to monitoring exercise training. *J Strength Cond Res, 15*(1), 109-115.

Freitas, V. H., Miloski, B., & Bara-Filho, M. G. (2012). Quantification of training load using session RPE method and performance in futsal. *Revista Brasileira de Cineantropometria & Desempenho Humano, 14*(1), 73-82.

Freitas, V. H., Nakamura, F. Y., Miloski, B., Samulski, D., & Bara-Filho, M. G. (2014). Sensitivity of physiological and psychological markers to training load intensification in volleyball players. *J Sports Sci Med, 13*(3), 571-579.

Hug, M., Mullis, P. E., Vogt, M., Ventura, N., & Hoppeler, H. (2003). Training modalities: over-reaching and over-training in athletes, including a study of the role of hormones. *Best Pract Res Clin Endocrinol Metab, 17*(2), 191-209.

Johnston, R. D., Gibson, N. V., Twist, C., Gabbett, T. J., MacNay, S. A., & MacFarlane, N. G. (2013). Physiological responses to an intensified period of rugby league competition. *J Strength Cond Res, 27*(3), 643-654. doi: 10.1519/JSC.0b013e31825bb469

Kellmann, M., & Kallus, K. W. (2001). The Recovery-Stress Questionnaires: User Manual. *Champaingn, Human Kinetics.*

Kelly, V. G., & Coutts, A. J. (2007). Planning and Monitoring Training Loads During the Competition Phase in Team Sports. *Strength and Conditioning Journal, 29*(4), 32–37.

Kentta, G., & Hassmen, P. (1998). Overtraining and recovery. A conceptual model. *Sports Med, 26*(1), 1-16.

Kraemer, W. J., French, D. N., Paxton, N. J., Hakkinen, K., Volek, J. S., Sebastianelli, W. J., . . . Knuttgen, H. G. (2004). Changes in exercise performance and hormonal concentrations over a big ten soccer season in starters and nonstarters. *J Strength Cond Res, 18*(1), 121-128.

Meeusen, R., Duclos, M., Foster, C., Fry, A., Gleeson, M., Nieman, D., . . . American College of Sports, M. (2013). Prevention, diagnosis, and treatment of the overtraining syndrome: joint consensus statement of the European College of Sport Science and the American College of Sports Medicine. *Med Sci Sports Exerc, 45*(1), 186-205. doi: 10.1249/MSS.0b013e318279a10a

Miloski, B., de Freitas, V. H., & Bara-Filho, M. G. (2012). Monitoramento da carga interna de treinamento em jogadores de futsal ao longo de uma temporada. *Revista Brasileira de Cineantropometria & Desempenho Humano, 14*, 671-679.

Miloski, B., de Freitas, V. H., Nakamura, F. Y., de, A. N. F. C., & Bara-Filho, M. G. (2016). Seasonal Training Load Distribution of Professional Futsal Players: Effects on Physical Fitness, Muscle Damage and Hormonal Status. *J Strength Cond Res, 30*(6), 1525-1533. doi: 10.1519/JSC.0000000000001270

Miloski, B., Freitas, V. H., & Bara-Filho, M. G. (2014). Psychophysiological responses to long-term training load in futsal preliminary season. *Gazzetta Medica Italiana Archivio per le Scienze Mediche, 173*, 491-497.

Moreira, A. (2010). The training periodization and the emerged questions: the team sports' case. *Rev Andal Med Deporte, 3*(4), 170-178.

Nederhof, E., Zwerver, J., Brink, M., Meeusen, R., & Lemmink, K. (2008). Different diagnostic tools in nonfunctional overreaching. *Int J Sports Med, 29*(7), 590-597. doi: 10.1055/s-2007-989264

Noce, F., Costa, V. T., Simim, M. A. M., Castro, H. O., Samulski, D. M., & Mello, M. T. (2011). Analysis of Overtraining Symptoms During Training and Rehabilitation Periods: A Case Study of Superleague Women´S Volleyball Team 2003/2004. *Brazilian Journal of Sports Medicine, 17*(6), 397-400.

Nogueira, F. C., De Freitas, V. H., Nogueira, R. A., Miloski, B., Wernek, F. Z., & Bara-Filho, M. G. (2018). Improvement of physical performance, hormonal profile, recovery-stress balance and increase of muscle damage in a specific futsal pre-season planning. *Revista Andaluza de Medicina del Deporte, 11*(2), 63-68.

Papacosta, E., & Nassis, G. P. (2011). Saliva as a tool for monitoring steroid, peptide and immune markers in sport and exercise science. *J Sci Med Sport, 14*(5), 424-434. doi: 10.1016/j.jsams.2011.03.004

Wilke, C. F., Ramos, G. P., Pacheco, D. A., Santos, W. H., Diniz, M. S., Goncalves, G. G., . . . Silami-Garcia, E. (2016). Metabolic Demand and Internal Training Load in Technical-Tactical Training Sessions of Professional Futsal Players. *J Strength Cond Res, 30*(8), 2330-2340. doi: 10.1519/JSC.0000000000001321