

EVIDENCE-BASED RECOVERY STRATEGIES IN FUTSAL: A NARRATIVE REVIEW

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Review

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Abstract:

Futsal (FT) can be defined as a multiple sprint sport with intermittent high-intensity activities. It could be considered one of the most demanding team sports due to the FT player's heart rate mean of approximately 90%, work to rest ratio of 1:1 and activity changes every three seconds. Besides, unlimited number of substitutions, size of the pitch, a smaller ball and constant proximity of the opponent that puts extremely high demands on FT players are the main characteristics of the game. With studies reporting that participating in a FT match provokes muscle damages and inflammations, with a high injury incidence, it is of vital necessity to examine the most efficient methods providing fast recovery of FT players between practice sessions and matches played. Research studies focused on recovery methods in other team sports such as basketball, volleyball, and rugby, among others, reported benefits of passive recovery (massage, water therapy, stretching), active recovery and nutritional techniques. However, for the best of the authors' knowledge, a limited number of recovery methods has been provided for the game of FT. The most effective recovery methods for FT players are only found to be photobiomodulation therapy and optimal sleeping regimen. Thereby, the main aim of the current narrative review is to present available scientific literature of recovery methods that may have positive effects on FT players.

Key words: *futsal, recovery methods, fatigue*

Introduction

The futsal (FT) sport (the official name for five-a-side indoor soccer) was introduced in 1933, when professor Juan Carlos Ceriani Gravier decided to enable his students to play soccer in restricted spaces (on basketball courts). Rapidly, over the last decade, FT increased in popularity. This sport is played worldwide, in more than 100 countries among more than 12 million registered players all over the world (Beato, Coratella, & Schena, 2016). Organizing body of FT remains FIFA (Federation International de Football Association) from 1989. The rules of FT make it unique and puts high demands on players due to physical, psychological, technical, and tactical aspects of the game performance (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008). The FT match is played in two 20-minute periods, with the clock stopped every time the ball goes outside the pitch. This usually means that the game lasts 75-85% longer than the scheduled 40-minute time, for example 72.8 ± 5.7 minutes in the first Brazilian league, with average playing time of 34.2 ± 18.1 minutes per player (Rodrigues, et al., 2011), depending on how

many court cleanings, time-outs, penalties, injury assistances and other interventions there have been. The game is played on the court of 40x20 meters, with two teams comprised of five players (the goalkeeper and four on-court athletes), and with unlimited number of substitutions with players on the bench (the maximum number of players involved in one match per team is 12 or 14, depending on the competition rules prescribed) according to the FIFA futsal laws of the game. It is the possibility of unlimited number of substitutions that makes FT the game of high intensity and rhythm, which does not decline as the match progresses (Medina, Gimenez, Corona, & Manonelles, 2002). The proper evolution of FT based on changes in the rules presents the tactical, technical, psychological and physical specificity of the FT players (Rodrigues, et al., 2011). Furthermore, research has shown that somatotype characteristics plays a key role in success of team sports players (Figueiredo, Gonçalves, Coelho Silva, & Malina, 2009). In particular, FT players are 172-178 cm height, with body mass between 70 and 77 kg (Abate, Schiavone, & Salini, 2012; Medina, Gimenez, Corona, & Manonelles, 2002; Barbero-

Alvarez, D'Ottavio, Granda Vera, & Castagna, 2009; Boullosa, et al., 2013; Castagna & Barbero Alvarez, 2010; Castagna, D'Ottavio, Granda Vera, & Barbero Alvarez, 2009; De Moura, et al., 2012; Dogramaci, Watsford, & Murphy, 2011; Gorostiaga, et al., 2009; Milanez, et al., 2011; Miloski, Hugo de Freitas, & Bara Filho, 2012; Pedro, Milanez, Boullosa, & Nakamura, 2013; Šamija, Sporiš, Jerković, & Jozak, 2010; Vieira, et al., 2011), with lower values in Brazilian youth players of 66.63 ± 8.48 kg, found in the study by Levandoski et al. (2009). Regarding the load and the activity structure, FT presents aerobic and anaerobic metabolic demands (Castagna, et al., 2009). Some research (Hernandez, 2001; Reilly & Thomas, 1976; Van Gool, Van Gerven, & Boutmans, 1988) have reported that players during the FT match spend: 9% of the total playing time walking, 41% jogging, 29% medium-intensity running, 13% high-intensity running, and 8% sprinting, sideways and backwards activities included. Players also, during the game, perform a total of 468 ± 77 movement activities, slightly more in first halves comparing to the second ones, and change activity every 8-9 seconds (Dogramaci, et al., 2011). On the other hand, total distances covered by FT players have been reported to be from 3,133 to 6,535 m (Barbero-Alvarez, 2008; Bueno, et al., 2014; Castagna, et al., 2009; Vieira, et al., 2016). Total distance covered surely is not a variable that can be taken as performance indicator in indoor team sports with unlimited number of substitutions such as FT. A more precise information can be delivered by the relative distance (distance covered per minute per player: m/min) which can differ due to the following: playing role, match characteristics, and standard of the opposing team, or tactics, among others. In this sense, some studies have shown average distances per minute from 113 m/min (Nogueira Ribeiro & Pena Costa, 2006) to 117.3 m/min (Barbero-Alvarez, et al., 2008). Some studies (Baroni & Leal Jr., 2012; Castagna, et al., 2009) have reported players' need for highly developed aerobic capacity, with maximum oxygen consumption values (VO_{2max}) between 55 and 65 ml/kg/min⁻¹, with lower values of 50.15 ± 2.46 ml/kg/min⁻¹ found in the study by Vieira et al. (2016), and higher values of 71.5 ± 5.9 ml/kg/min⁻¹ in the Brazilian FT players in the study by Rodrigues et al. (2011). High values of VO_{2max} are important indicators and are associated with training loads, where some studies (Milanez, et al., 2011; Miloski, et al., 2012) showed high aerobic fitness (>60 ml/kg/min⁻¹) was negatively associated with internal training load ($r = -0.75$) and lower perception of effort during a daily session, mesocycles, etc.

On the other hand, measurements of heart rate (HR) are in strong correlation with energy expenditure (Rodrigues et al., 2011). In the study by Barbero-Álvarez et al. (2008) the range of 170 to

190 beats·min⁻¹, or the maximum work zone, was found during 85-95% of the match. Also, the mean HR and percentages of HR_{max} that were recorded during the FT match in the previous study were higher than those recorded for basketball and soccer players during matches (McInnes, Carlson, Jones, & McKenna, 1995; Shearer, Jones, Kilduff, & Cook, 2015).

From a relative point of view, HR of a FT player remains above 85% of HR_{max} for 80 to 90% of the total playing time (Barbero-Alvarez, et al., 2008; Castagna, et al., 2009), which indicates very vigorous activity performed for more than 80% of the actual playing time. In contrast to other team sports such as soccer, basketball or handball, HR in FT players rarely falls below 150 beats·min⁻¹, mainly due to short and incomplete rest periods.

Futsal could be defined as a multiple-sprint sport with an intermittent high intensity activity and could be considered one of the most demanding team sports due to its high HR mean (HR_{mean}) around 90%, high relative distances (around 115-120 m/min), and work-to-rest ratio of 1:1, with a locomotor activity change every 3.28 seconds with short recovery time (20-30 s) between the sprint bout sequences (3-4 bouts) (Barbero-Alvarez, et al., 2008). Besides, high-intensity play during the FT match is also caused by technical and tactical demands of the game itself, presenting a great impact on capability and performance provoked by the ball (number 4), which demands more precise and faster performance and better ball control (Burns, 2003; Goncalves, 1998). In fact, the pitch size provokes constant pressure and proximity of the opponent, meaning FT players are constantly marked in situations one versus one (Vaeyens, Lenoir, Williams, & Philippaerts, 2007). Dimensions of the pitch and constants turnovers during the match push players to a fast decision making, to the manifestation of speed and capability for correct timing under pressure during both the attacking and defending phases. One of the most important variables of performance efficiency in FT is the time a player needs to perform (Nicoletti & Borghi, 2007). Haneishi et al. (2007) have shown, on a sample of female soccer players, greater postgame cortisol responses than postpractice responses. Decreased self-confidence levels, at least after a game lost, have also been noticed, whereas the levels were increased during practice. The official competition FT matches also provoke a higher play intensity and technical-tactical involvement when compared with the friendly matches (Vieira, et al., 2016). Decrease in technical performance (total passes per minute, possession, ball touches, and successful passes per minute) has also been noted from the first to the second half of the match, which indicates possible both the metabolic and neuromuscular fatigue process (Castagna & Barbero-Alvarez,

2010; Vieira, et al., 2016). A study by De Moura et al. (2012) has shown that participating in a FT match provokes muscle damages and inflammations. Most usual injuries among FT players are contusions (in approximately 40% of cases), followed by ligament strains (20%) and muscle fiber sprains (18%) (Abate, et al., 2012; Junge & Dvorak, 2010; Nemčić, Sporiš, & Fiorentini, 2016), lower extremity injuries such as ankle sprains, knee ligament and meniscus lesions and upper leg sprains (Hernandez, 2001) followed by fractures, especially of the toes. Furthermore, a great number of ankle and knee injuries, as well as the Achilles tendon injury occurrences has been found in a study by Abate et al. (2012) as the result of a hard playing surface and game characteristics, both of which present great stress on the ankle and knee joints (Junge & Dvorak, 2010; Noguiera Ribeiro & Pena Costa, 2006). Prolonged and intermittent sprinting with many CODs, specific for indoor team sports, provokes disturbances in skeletal muscle structure and function that are associated with reduced contractile function, increases of inflammatory responses, perceived soreness, and delayed return to optimal physical performance (Molina, 1992).

In order to maximize athletes' recovery, different methods have been used. Studies investigating recovery methods are focusing on the effects of physiological (active recovery, rest, and sleep), physical (stretching, massage, water therapy), psychological methods, and ergo nutritional (ergogenic aids and supplements) methods on recovery in team sport players (Calleja-Gonzalez, et.al., 2016). Some of the most important parameters of recovery strategies maximization after exercise are related to carbohydrate (CHO) and fluid intake. Being hydrated can be achieved with regular and adequate water drinking, as well as high muscle glycogen concentrations can be achieved by high CHO consumption plus protein plus leucine (Koopman, et.al., 2005). Besides, researchers presented efficient recovery methods such as cold-water immersion to reduce delayed-onset muscle soreness (DOMS) up to 24 hours post-match; cold water and massage combined in order to enable recovery immediately after the match (Delextrat, et.al., 2013), as well as numerous factors such as regular sleep, balanced and healthy diet with high glycaemic index before bed-time and red-light treatments to improve sleep itself (Abate, et al., 2012). Some of the effective strategies to reduce delayed-onset muscle soreness are cold-water immersion and contrast therapy (Bleakley, Bieuzen, Davison, & Costello, 2014). To improve sleep a high glycaemic index diet before bed-time and well-balanced healthy diet can be suggested, as well as individual programs and sleeping time strategies (Terrados, Mielgo-Ayuso, Delextrat, Ostojic, & Calleja-González, 2018). Recovery methods generally remain an underrepresented topic in

the literature on team sports. In fact, some recent reviews have considered recovery protocols in other team sports: basketball (Calleja-Gonzalez, et.al., 2016), volleyball (Calleja-Gonzalez, Mielgo-Ayuso, Sánchez-Ureña, Ostojic, & Terrados, 2019b; Closs, Burkett, Trojan, Brown, & Mulcahey, 2020) and rugby (Calleja-Gonzalez, et.al., 2019a). However, for the best of the author's knowledge, no previous review about the recovery of FT players has been published.

Therefore, the main aim of this narrative review is to present the recently published literature that pertains to recovery strategies in FT. The second purpose is to suggest application of the reviewed strategies of FT players' recovery to practice to help practitioners and coaches.

Methods

This narrative review describes the recovery methods in FT. It was done by following the preferred reporting elements for the meta-analysis guidelines (PRISMA 2009 Flow Diagram) by Moher et al. (2009).

Information sources were a computer-based scientific literature structured search, completed for the years 1900 to December 2020. The following information databases were searched: Medline (PubMed), Web of Science, the Cochrane Collaboration Database, Cochrane Library, Evidence Database (PEDro), Evidence-Based Medicine (EBM) Search review, National Guidelines, EMBASE, Scopus and Google Scholar. The following keywords were included such as: "futsal", "fatigue", "nutrition recovery", "ergogenic", "sleep", "active recovery", "massage", "stretching", "foam roll", using Boolean operators 'and' or 'or'. Furthermore, the next narrative review was described based on the Preferred Reporting Items for Review Statement by Stewart et al. (2015). The terms are related to recovery in FT. No filters were used to increase the power of the analysis. Through this equation, we obtained relevant articles in this field by applying the snowball strategy. Cross-references were made to all titles and abstracts of the search to identify duplicates and possible missing studies. The titles and abstracts were selected for a later revision of the full text. The search for published studies was conducted independently by two authors (T.N. and J.C-G.) over the period of six months and disagreements over the results were resolved by the third person, external non-author.

Study inclusion criteria

One author (T.N.) searched the titles and abstracts of all articles considered for inclusion. The main criteria for allocations in the articles were satisfied. The articles' full text was selected to ascertain that the publication satisfied the inclusion criteria. In addition, the reference sections of the

selected articles were searched to identify possible other relevant articles. Finally, for the current review only the studies focusing on the effect of recovery methods on FT players were included. The inclusion criteria were applied to each study: the data on the study source (including the authors and the year of publication), the study design, administration of the supplement (dose and time), the sample size and the characteristics of the participants (level, race, and sex). Finally, two authors (T.N. and J.C-G.) independently extracted the final results of the searches using a spreadsheet (Microsoft Inc, Seattle, WA, USA). Subsequently, disagreements were resolved by discussion until a consensus was reached, or the third, non-author party adjudication was complied with.

Study exclusion criteria

Other team sports were not considered, and duplicated articles were deleted. Also, abstracts, non-peer reviewed papers and book chapters were excluded.

Study selection

Through the search in the databases, two authors identified the studies included in this review (T.N. and J.C-G.). From the articles identified by the search strategy, the titles and abstracts were analyzed and then a complete text review was performed, and duplicate essays were identified with the cross-referencing technique. Subsequently, all those publications that, after being evaluated for their eligibility, were considered relevant, were recovered and the full report on them was reviewed by the authors (T.N. and J.C-G.). In addition, the snowball strategy was applied to review the reference sections of all the highlighted studies. According to the information included in the full texts, inclusion and exclusion criteria were applied with the aim of selecting those articles suitable for inclusion in this review.

Results

The initial search of the literature detected (Table 1) 36 articles related to recovery in FT; nevertheless, 29 were excluded after a thorough in-depth analyses of full texts for being unrelated to recovery in FT or failure to fulfil the inclusion criteria, or both. A total of final seven studies (De Marchi, et al., 2019; Dos Santos, et al., 2020; Nunes, et al., 2020; Rahimi, Amani-Shalamzari, & Clemente, 2020; Tessitore, et al., 2008; Wilke, et al., 2019; Wilke, et al., 2020) were included.

Recovery methods in futsal

- 1) Wilke et al. (2019) investigated faster and slower recovery profiles of FT players before and immediately post training as well as three, 24 and 48h

post training as manifested in: countermovement jump (CMJ), 10-m sprint, creatine kinase (CK) values, total quality of recovery (TQR) and Brunel Mood Scale (fatigue and vigor). Better (lower) area under the curve (AUC) in 10-m sprint has been presented in faster recovery (FR) comparing to slower physiological recovery (SLphy; $p=.001$) or slower perceptual recovery (SLperc; $p=.008$), with better (higher) TQR in FR comparing to SLphy ($p=.018$) and SLperc ($p=.026$). Better AUC has been presented in CMJ of SLperc than in SLphy ($p=.014$). However, SLperc presented worse fatigue AUC than SLphy ($p=.014$) and FR ($p=.008$). AUC of CK was worse in SLphy than in FR ($p=.01$) and SLperc ($p<.001$). Furthermore, FR were slower in 10-m sprint than SLphy ($p=0.003$) and SLperc players ($p=0.013$) and they tended to have higher maximal oxygen consumption than SLphy.

- 2) Another study by Wilke et al. (2020) investigated whether recovery could be explained with faster (FR) and slower recovery (SL) profile classification, or with other factors such as: self-reported sleep, acute training load and/ or phase of the microcycle. Nineteen elite male futsal players have been located in either FR, SLphy or SLperc group. Before each practice players reported the number of sleep hours, perceived quality of sleep the night before and their perception of recovery through Total Quality of Recovery Scale (TQR). Results showed TQR was not significantly influenced with the recovery

Table 1. Flow diagram of study selection (PRISMA 2009 Flow Diagram; Moher, et al., 2009)

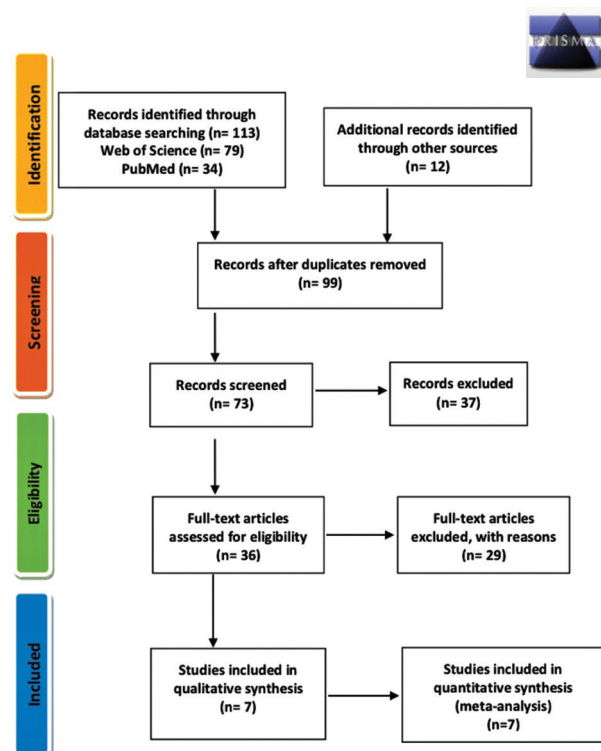


Table 2. Recovery methods in futsal/ Research review: sample (N), method, variable measured, time duration of the study, conclusion and effects

No.	Research	N	METHODS	VARIABLE MEASURED	TIME DURATION	CONCLUSION	EFFECTS
1.	Wilke et al., 2019.	22 male futsal players	Before, immediately after, 3, 24, and 48 h post training	*CMJ *TQR *10-m sprint *Creatine kinase *Brunel Mood Scale (fatigue and vigor)	Data non provided	Different post training recovery profiles exist in futsal players, possibly influenced by their physical abilities and age/ experience.	Neutral
2.	Wilke et al., 2020.	19 elite male futsal players	3 Recovery-classification groups: 1. faster recovery 2. slower physiological 3. slower perceptual	*TQR *Number of hours of sleep *Perceived quality of sleep the night prior	4 week preseason	Higher TQR was evident with better self-reported sleep quality, whereas lower values were associated with phases of the training week.	Neutral
3.	De Marchi et al., 2019.	6 professional players	Photobiomodulation therapy (PBMT) a randomized, triple-blinded, placebo-controlled, crossover clinical trial	*CK *LDH *Oxidative damage to lipids *Proteins	2 futsal matches over period of 2 weeks	Pre-exercise PBMT can enhance performance and accelerate recovery of high-level futsal players.	Positive
4.	Tessitore et al., 2008.	10 players	Seated rest, supine electrostimulation, low-intensity land exercises, and water exercises	*CMJ *Bounce jumping, *10-m sprint *Hormones: Salivary cortisol, and urinary catecholamine *RPE, *Leg muscle pain, *RestQ Sport, *10-point Likert scale *Hours of sleep of futsal players	4 futsal games	No significant difference was found between recovery interventions for anaerobic performances, hormones, muscle pain, and RestQ Sport.	Positive
5.	Nunes et al., 2020.	20 elite players	Far-infrared emitting ceramic materials (cFIR) Bio ceramic-BIO (n = 10) Placebo pants-PL (n = 10)	*SJ *CMJ *Sprints 5, 10, 15m *Interleukin 10-IL10 *Tumor necrosis Factor alpha-TNF- α , *Thiobarbituric acid-reactive species (TBARS), *Carbonyl, *Superoxide dismutase (SOD), *Catalase (CAT)	2 week preseason	Daily use of cFIR clothing could facilitate recovery, especially on perceptual markers during the early phases of an intensive training period.	Positive
6.	Dos Santos et al., 2020.	13 female players	Photobiomodulation therapy (PBMT) or placebo (SHAM); 5min after passive rest. Counterbalanced randomized cross-over design	*CMJ *Illinois agility test *Yo-Yo intermittent recovery test level 1 *Perceived recovery status/ muscle soreness (0-10 scale) *Blood lactate concentration/HR/RPE	Data non provided	The acute application of PBMT does not influence high-intensity nor intermittent exercises performance, neither psychological responses.	Neutral
7.	Rahimi et al., 2020.	16 youth players	Foam roll: calf, quadriceps, hamstrings and gluteus maximus (5 min after match; 40:20sec work/rest)	*Yo-Yo intermittent recovery level 2 *Repeated sprint ability *Vertical jump *PRO agility tests	5 days 3 simulated futsal matches	Use of foam roll during compact competitions expedites physical performance recovery and increases blood lactate clearance	Positive

classification of players, training load, or self-reported hours slept; however, perceived sleep quality ($p < .01$) and phases of the microcycle ($p < .01$) were significantly associated with TQR ($r^2 = .41$). Higher TQR is associated with better self-reported sleep quality, while lower values were associated with phases of a training week.

3) De Marchi et al. (2019) analyzed photobiomodulation therapy (PBMT) effects on futsal players' performance and recovery in a non-controlled field environment. The study was conducted in two different team matches in a time interval of approximately two weeks between the first and the second intervention. Six professional

- FT players were treated with phototherapy 40 minutes before the match, with blood samples taken before treatments, immediately after the end of the match, and 48 hours after, and videos were analyzed to quantify players' time spent on the pitch with distances covered. PBMT significantly increased players' time on the pitch, with no significant differences in the covered distance. Furthermore, PBMT showed significant improvements in all the biochemical markers evaluated: creatin kinase (CK), lactate dehydrogenase (LDH), blood lactate (BL), oxidative damage to lipids, and proteins.
- 4) Tessitore et al. (2008) analyzed the effects of active and passive recovery strategies, such as: electrostimulation, seated rest, water exercise and low-intensity land exercises after four FT matches, on anaerobic performance (CMJ, bounce jumping and 10-m sprint), subjective ratings (rate of perceived exertion – RPE, leg muscle pain on a 10-point Likert scale, Questionnaire of Recovery Stress for Athletes-RestQ Sport), hormones (salivary cortisol, urinary catecholamine) and hours of sleep. Results demonstrated significantly increased benefit from electrostimulation (7.8 ± 1.4 points) and water exercise (7.6 ± 2.1 points) compared with dry exercises (6.6 ± 1.8 points) and seated rest (5.2 ± 0.8 points). No significant differences have been found between recovery interventions in anaerobic performance, muscle pain, RestQ Sport and hormones.
 - 5) Nunes et al. (2020) studied the effects of far-infrared emitting ceramic materials (cFIR) on recovery of 20 elite FT players. One group ($n=10$) wore bio ceramic – BIO during sleep, another group ($n=10$) wore placebo pants – PL. After the first and second week of training, performance (CMJ, squat jump – SJ, sprints on 5, 10 and 15-m) and biochemical markers (tumor necrosis factor alpha – TNF- α , interleukin 10-IL-10, thiobarbituric acid-reactive species – TBARS, carbonyl, superoxide dismutase – SOD, catalase – CAT) were obtained, with delayed-onset muscle soreness (DOMS) and training strains monitored. Results showed higher changes in CMJ and SJ in BIO group, as well as better results in 10-m sprint. Both groups showed better results in 5-m sprint after the second week. Values of $\% \Delta$ TNF- α , $\% \Delta$ IL-10, $\% \Delta$ TBARS and $\% \Delta$ Carbonyl showed to be likely higher in BIO group, as well as lower training strains ($p=.021$) and DOMS, which indicated the far-infrared emitting ceramic materials clothes facilitated recovery.
 - 6) Dos Santos et al. (2020) evaluated in their research the effect of prior acute application of photobiomodulation therapy (PBMT) on high-intensity and intermittent exercise performance, muscle oxygenation and physiological indicators in 13 female futsal players. Fifteen minutes of PBMT or placebo has been applied. PBMT consisted of: 1.30 minute on each muscular point, with five (5) points in each lower limb: quadriceps (2 points), hamstrings (2 points) and gastrocnemius (1 point). Results showed no difference between the two protocols (PBMT and SHAM) in: the perceived recovery scores (8.48 vs 8.46), muscle soreness (0.84 vs 1.23), CMJ pre- and post-testing (19.3; 19.3 vs 18.5; 18.9), agility test total time (58.9 vs 58.7), distance covered in the YYIR1 (195 vs 191) or blood lactate concentration post YYIR1 (11.1 vs 13.5).
 - 7) Rahimi et al. (2020) investigated the efficacy of recovery using a foam roll (FROLL) on performance, physiological and psychological parameters on the sample of 16 youth futsal players, in a simulated futsal tournament. The FROLL recovery protocol consisted of five repetitions of 40s on calf, quadriceps, hamstrings and gluteus muscles, with 20 s rest between, done for five minutes after each match. Although not statistically significant, results showed FROLL recovery was slightly more beneficial when compared to passive recovery decrements in aerobic (-1.6% vs -9.7%) and anaerobic performance (-4.5% vs -1.3%), vertical jump (-1.6% vs -3%) and change of direction (-2.1% vs 4.3%). The use of foam roll decreases blood lactate values and enables faster psychological regeneration.

Discussion and conclusion

This narrative review aimed to describe the current published literature related to recovery strategies in FT in order to give applied information to practitioners, FT coaches. For the best of the author's knowledge, currently, only seven studies examined recovery methods on the samples of FT players (De Marchi, et al., 2019; Dos Santos, et al., 2020; Nunes, et al., 2020; Rahimi, et al., 2020; Tessitore, et al., 2008; Wilke, et al., 2019; Wilke, et al., 2020). The main conclusions propose different post practice recovery profiles among FT players, which are possibly influenced by their physical abilities and age/ sport experience (Wilke, et al., 2019). However, it has been demonstrated that FT players performance and faster recovery can be ensured with the pre-exercise photobiomodulation therapy (De Marchi, et al., 2019), and increased benefit can be taken from electrostimulation and water exercise after the match (Tessitore, et al., 2008). Furthermore, far-infrared emitting ceramic materials clothes (cFIR) can decrease training strains and delayed-onset muscle soreness (DOMS) (Nunes, et al., 2020).

In order to increase performance and enhance recovery process, FT players commonly apply numerous methods. Recovery methods are often implemented pre-, per- or post-competition; thus, within this review they have been classified as positive effects.

Photobiomodulation therapy

The photobiomodulation therapy (PBMT) is a form of light *therapy* that utilizes non-ionizing forms of light sources, including lasers, LEDs, and broadband light, in the visible and infrared spectrum (Anders, Lanzafame, & Arany, 2015); a treatment that uses specific wavelengths of red and near-infrared light to help the body heal. The use of this therapy significantly improves sprint time, decreases fatigue index and blood lactate levels (de Oliveira Rosso, et al., 2018) and perceived fatigue in rugby players (Pinto, et al., 2016), while increases players' time on the pitch in FT (De Marchi, et al., 2019). The PBMT presents beneficial effects on the recovery of nerve lesions, especially when related to a faster regeneration and functional improvement, despite the variety of parameters (de Oliveira Rosso, et al., 2018). Scarce is scientific evidence about the effect of this therapy on FT players. Future research is needed in order to identify optimal protocols with FT players.

Timing:
before training/competition

Rest and sleep

Critical segment of recovery refers to rest/sleep, especially in recovery from intense exercise and/ or competition (Fullagar, Skorski, Coutts & Julian, 2015). Some studies demonstrated that sleep deprivation post-match may negatively affect cognitive and physical performance and recovery in other team sports (rugby players) (Shearer, et al., 2015) since reduced sleep has been shown in both home (Eagles, Mclellan, Hing, Carlsson, & Lovell, 2014) and away matches (Fowler, Duffield, Lu, Hickmans, & Scott, 2016). One night sleep deprivation may also reduce exercise performance in volleyball players, by decreasing exercise minute volume and time to exhaustion (Azgoy & Kaygisiz, 2009). The importance of sleep has been shown in the study by Mah, Mah, K.E., Kezirian, and Dement (2011) who reported extended sleep likely contributes to improved athletic performance, reaction time, shooting percentage, sprint time, and mood indicating that optimal sleeping habits allows basketball players to reach their peak athletic performance. For the improvement of sleep, a 14-day whole-body irradiation with red-light treatment has been suggested for female basketballers (Zhao, Tian,

Nie, Xu, & Liu, 2012). Their study confirmed positive effects of red-light therapy on improved sleep, serum melatonin levels and endurance performance (12-minute run) and offered a non-invasive and nonpharmacological therapy to prevent sleep disorders after activity. More attention should be put on the development and implementation of individualized sleeping regimes, adequate post-match sleep patterns and training adjustments in order to optimize recovery, training and performance (Eagles, et al., 2014).

In particular, higher TQR values were evident with better self-reported sleep quality, whereas lower values were associated with phases of the training week in FT (Wilke, et al., 2020).

Timing:
after and before training/competition

Research in this field of FT is quite scarce; only recently the number of scientific articles in this sport has improved. There are only seven studies related to recovery process in FT. Nowadays, the most effective recovery methods for FT players are related to pre-exercise PBMT therapy and optimal sleeping regimen.

Practical implications

Coaches, sport scientists and strength and condition coaches should consider pre-exercise PBMT therapy and optimal sleeping regimen during FT practice and matches in order to enable their players' faster recovery, among other recovery methods based on 1a level of evidence. The most relevant technique integrated in these tools among medical doctor is shown to be PBMT up to 30 minutes before the match; 1.5 minute of each muscular point for five muscular points in each lower limb.

Future research lines

Definitive investigation is needed of potential effects of different recovery methods on FT players and personalization of the approach based on athletes' specific needs. One of the most challenging tasks would be individualization of the recovery process. For the future studies, practical rules for the diagnosis, intervention and evaluation of recovery are needed as well as the examination of effects of different recovery methods combined with each other. It is important to investigate specific mechanisms of fatigue in FT players and team sports in general to enable appropriate monitoring of training loads in order to collect the most important information about training regimen for the creation of the most useful combined recovery strategies.

References

- Abate, M., Schiavone, C., & Salini, V. (2012). High prevalence of patellar and Achilles' tendinopathies in futsal athletes. *Journal of Sports Science and Medicine*, *11*, 180-181.
- Anders, J.J., Lanzafame, R.J., & Arany, P.R. (2015). Low-level light/laser therapy versus photobiomodulation therapy. *Photomedicine and Laser Surgery*, *33*(4), 183-184.
- Azgoj, O., & Kaygisiz, Z. (2009). Effects of sleep deprivation on cardiorespiratory functions of the runners and volleyball players during rest and exercise. *Acta Physiologica Hungarica*, *96*(1), 29-36.
- Barbero-Alvarez, J., Soto, V.M., Barbero-Alvarez, V., & Granda-Vera, J. (2008). Match analysis and heart rate of futsal players during competition. *Journal of Sports Sciences*, *26*(1), 63-73.
- Barbero-Alvarez, J.C., D'Ottavio, S., Granda Vera, J., & Castagna, C. (2009). Aerobic fitness in futsal player of different competitive level. *Journal of Strength and Conditioning Research*, *23*(7), 2163-2166.
- Baroni, B.M., & Leal Jr., E.C.P. (2012). Aerobic capacity of male professional futsal players. *Journal of Sports Medicine and Physical Fitness*, *50*(4), 395-399.
- Beato, M., Coratella, G., & Schena, F. (2016). Brief review of the state of art in futsal. *Journal of Sports Medicine and Physical Fitness*, *56*(4), 428-432.
- Bleakley, C.M., Bieuzen, F., Davison, G.W., & Costello, J.T. (2014). Whole-body cryotherapy: Empirical evidence and theoretical perspectives. *Journal of Sports Medicine*, *10*(5), 25-36. doi: 10.2147/OAJSM.S41655
- Boullosa, D.A., Tonello, L., Ramos, I., de Oliveira Silva, A., Simoes, H.G., & Nakamura, F.Y. (2013). Relationship between aerobic capacity and Yo-Yo IR1 performance in Brazilian professional futsal players. *Asian Journal of Sports Medicine*, *4*(3), 230-234.
- Bueno, M.J.O., Caetano, F.G., Pereira, T.J.C., De Souza, N.M., Moreira, G.D., Nakamura, F.Y., Cunha, S.A., & Moura, F.A. (2014). Analysis of the distance covered by Brazilian professional futsal players during official matches. *Sports Biomechanics*, *13*(3), 230-240.
- Burns, T. (2003). *Holistic futsal: A total mind-body-spirit approach*. New York: Lulu.
- Calleja-González, J., Mielgo-Ayuso, J., Ostojic, S.M., Jones, M.T., Marques-Jiménez, D., Caparros, T., & Terrados, N. (2019a). Evidence-based post-exercise recovery strategies in rugby: A narrative review. *The Physician and Sports Medicine Journal*, *47*(2), 137-147. doi: 10.1080/00913847.2018.1541701
- Calleja-González, J., Mielgo-Ayuso, J., Sánchez-Ureña, B., Ostojic, S.M., & Terrados, N. (2019b). Recovery in volleyball. *Journal of Sports Medicine and Physical Fitness*, *59*(6), 982-993. doi: 10.23736/S0022-4707.18.08929-6
- Calleja-González, J., Terrados, N., Mielgo-Ayuso, J., Delextrat, A., Jukic, I., Vaquera, A., Torres, L., Schelling, X., Stojanovic, M., & Ostojic, S.M. (2016). Evidence-based post-exercise recovery strategies in basketball. *The Physician and Sports Medicine Journal*, *44*, 74-78.
- Castagna, C., & Barbero Alvarez, J.C. (2010). Physiological demands of an intermittent futsal-oriented high-intensity test. *Journal of Strength and Conditioning Research*, *24*(9), 2322-2329.
- Castagna, C., D'Ottavio, S., Granda Vera, J., & Barbero Alvarez, J.C. (2009). Match demands of professional futsal: A case study. *Journal of Science and Medicine in Sport*, *12*(4), 490-494. doi: 10.1016/j.jsams.2008.02.001
- Closs, B., Burkett, C., Trojan, J.D., Brown, S.M., & Mulcahey, M.K. (2020). Recovery after volleyball: A narrative review. *The Physician and Sports Medicine Journal*, *48*(1), 8-16. doi: 10.1080/00913847.2019.1632156
- Delextrat, A., Calleja-González, J., Hippocrate, A., & Clarke, N.D. (2013). Effects of sports massage and intermittent cold-water immersion on recovery from matches by basketball players. *Journal of Sports Science*, *31*(1), 11-19.
- De Marchi, T., Leal-Junior, E.C.P., Lando, K.C., Cimadon, F., Vanin, A.A., da Rosa, D.P., & Salvador, M. (2019). Photobiomodulation therapy before futsal matches improves the staying time of athletes in the court and accelerates post-exercise recovery. *Lasers Medicine Science*, *34*(1), 139-148.
- De Moura, N.R., Cury-Boaventura, M.F., Santos, V.C., Levada-Pires, A.C., Bortolon, R., Fiamoncini, J., Pithoni-Curi, T.C., Curi, R., & Hatanaka, E. (2012). Inflammatory response and neutrophil functions in players after a futsal match. *Journal of Strength and Conditioning Research*, *26*(9), 2507-2514.
- de Oliveira Rosso, M.P., Buchaim, D.W., Kawano, N., Furlanette, G., Pomini, K.T., & Buchaim, R.L. (2018). Photobiomodulation therapy (PBMT) in peripheral nerve regeneration: A systematic review. *Bioengineering (Basel)*, *5*(2), 44. doi: 10.3390/bioengineering5020044
- Dogramaci, S.N., Watsford, M.L., & Murphy, A.J. (2011). Time-motion analysis of international and national level futsal. *Journal of Strength and Conditioning Research*, *25*(3), 646-651.
- Dos Santos, I.A., de Paiva Lemos, M., Maciel Coelho, V.H., Moura Zagatto, A., Marocolo, M., Nogueira Soares, R., Barbosa Netom O., & Mota, G.R. (2020). Acute photobiomodulation does not influence specific high-intensity and intermittent performance in female futsal players. *International Journal of Environmental Research and Public Health*, *17*(19), 7253. doi: 10.3390/ijerph17197253
- Eagles, A., McLellan, C., Hing, W., Carloss, N., & Lovell, D. (2014). Changes in sleep quantity and efficiency in professional rugby union players during home-based training and match-play. *Journal of Sports Medicine and Physical Fitness*, *56*(5), 565-571.
- Figueiredo, A.J., Gonçalves, C.E., Coelho e Silva, M.J., & Malina, R.M. (2009). Characteristics of youth soccer players who drop out, persist or move up. *Journal of Sports Science*, *27*(9), 883-891. doi: 10.1080/0264041090294646

- Fowler, P.M., Duffield, R., Lu, D., Hickmans, J.A., & Scott, T.J. (2016). Effects of long-haul transmeridian travel on subjective jet-lag and self-reported sleep and upper respiratory symptoms in professional rugby league players. *International Journal of Sports Physiology and Performance*, *11*, 876-884.
- Fullagar, H., Skorski, S., Coutts, A.J., & Julian, R. (2015). Sleep and recovery in team sport: Current sleep-related issue facing professional team-sport athletes. *International Journal of Sports Physiology and Performance*, *10*(8), 950-957. doi: 10.1123/ijsp.2014-0565
- Goncalves, J.T. (1998). *The principles of Brazilian soccer*. Spring City: Reedswain.
- Gorostiaga, E.M., Llodio, I., Ibanez, J., Granados, C., Navarro, I., Ruesta, M., Bonnbau, H., & Izquierdo, M. (2009). Differences in physical fitness among indoor and outdoor elite male soccer players. *European Journal of Applied Physiology*, *106*, 483-491. doi: 10.1007/s00421-009-1040-7
- Haneishi, K., Fry, A.C., Moore, C.A., Schilling, B., Li, Y., & Fry, M.D. (2007). Cortisol and stress responses during a game and practice in female collegiate soccer players. *Journal of Strength and Conditioning Research*, *21*(2), 583-588.
- Hernandez, J. (2001). Analisis de los parametros espacio y tiempo en el futbol sala. La distancia recorrida, el ritmo y direccion del desplazamiento del jugador durante un encuentro de competicion: Los casos de J. Gay (defensa), C. Marrero (cierre), J. Beto (pivote), J. Limones (ala) y J. Clavería (portero). [Analysis of time and space parameters in futsal. Distance covered, the rhythm and direction of the player's movement during a competition match: The cases of J.Gay and C. Marrero (defense), J. Beto (pivot), J. Limones (wing) and J. Claveria (goalkeeper)]. *Apunts. Educación Física y Deportes*, *65*, 17-25.
- Junge, A., & Dvorak, J. (2010). Injury risk of playing football in Futsal World. *Journal of Sports Medicine*, *44*, 1089-1092.
- Koopman, R., Wagenmakers, A.J.M., Manders, R.J.F., Antoine, H.G.Z., Senden, J.M.G., Gorselink, M., Keizer, H.A., & van Loon, L.J.C. (2005). Combined ingestion of protein and free leucine with carbohydrate increases postexercise muscle protein synthesis in vivo in male subjects. *American Journal of Physiology – Endocrinology and Metabolism*, *288*(4), E645-E653.
- Levandoski G., Cieslak, F., Santos, T.K., Carvalho, F.K., Rocha, A.M.B., & Ogg, F. (2009). Body composition and physical aptitude of athletes of masculine futsal from Ponta Grossa. *Fitness and Performance Journal*, *8*(1), 27-31.
- Mah, C.D., Mah, K.E., Kezirian, E.J., & Dement, W.C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep Research Society*, *34*(7), 943-950.
- McInnes, S.E., Carlson, J.S., Jones, C.J., & McKenna, M.J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences*, *13*, 387-397.
- Medina, J.A., Gimenez, L., Corona, P., & Manonelles, P. (2002). Necesidades cardiovasculares y metabólicas del fútbol sala: análisis de la competición. [Cardiovascular and metabolic requirements of futsal: Competition analysis.]. *Apunts. Educación Física y Deportes*, *67*, 45-53.
- Milanez, V.F., Pedro, R.E., Moreira, A., Boulosa, D.A., Salle-Neto, F., & Nakamura, F.Y. (2011). The role of aerobic fitness on session rating of perceived exertion in futsal players. *International Journal of Sports Physiology and Performance*, *6*, 358-366.
- Miloski, B., Hugo de Freitas, V., & Bara Filho, M.G. (2012). Monitoring of the internal training load in futsal players over a season. *Brazilian Journal of Kinanthropometry and Human Performance*, *14*(6), 671-679. doi: 10.5007/1980-0037.2012v14n6p671
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & the PRISMA group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med*, *6*(7), e1000097. doi: 10.1371/journal.pmed1000097
- Molina, R. (1992). *Futsal: Um estudo das capacidades aerobica e anaerobica do jogadores e das actividades em jogo*. [Futsal: A study of the aerobic and anaerobic capacities of the players and of the activities in the game. In Spanish.] Monografía Universidad Estadual Paulista. Rio Claro: UNESP.
- Nemčić, T., Sporiš, G., & Fiorentini, F. (2016). Injuries among Italian female futsal players. *Acta Kinesiologica*, *10*(1), 56-61.
- Nicoletti, R., & Borghi, AM. (2007). *Il controllo motorio*. Bologna: Il Mulino.
- Nogueira Ribeiro, R., & Pena Costa, L.O. (2006). Epidemiological analysis of injuries occurred during the 15th Brazilian Indoor Soccer (Futsal) Sub20 Team Selection Championship. *Revista Brasileira de Medicina do Esporte*, *12*(1), 1e-4e.
- Nunes, R.F.H., Cidral-Filho, F.J., Flores, L.J.F., Nakamura, F.Y., Rodriguez, H.F.M., Bobinski, F., De Sousa, A., Petronilho, F., Danielski, L.G., Martins, M.M., Martins, D.F., & Guglielmo, L.G.A. (2020). Effects of far-infrared emitting ceramic materials on recovery during 2-week preseason of elite futsal players. *Journal of Strength and Conditioning Research*, *34*(1), 235-248.
- Pedro, R.E., Milanez, V.F., Boulosa, D.A., & Nakamura, F.Y. (2013). Running speeds at ventilatory threshold and maximal oxygen consumption discriminate futsal competitive level. *Journal of Strength and Conditioning Research*, *27*(2), 514-518.
- Pinto, H.D., Vanin, A.A., Miranda, E.F., Tomazonni, S.S., Johnson, D.S., Albuquerque-Pontes, G.M., Aleixo, I.O.J., Grandinetti, V.D., Casalechi, H.L., de Carvalho, P.T., & Leal-Junior, E.C. (2016). Photobiomodulation therapy improves performance and accelerates recovery of high-level rugby players in field test: A randomized, crossover, double-blind, placebo controlled clinical study. *Journal of Strength and Conditioning Research*, *30*, 3329-3338.

- Rahimi, A., Amani-Shalamzari, S., & Clemente, F.M. (2020). The effects of foam roll on perceptual and performance recovery during a futsal tournament. *Physiology and Behavior*, 223. doi: 10.1016/j.physbeh.2020.112981
- Reilly, T., & Thomas, V. (1976). A motion analysis of work rate in different positional roles in professional football match-play. *Journal of Human Movement Studies*, 2, 87-97.
- Rodrigues, V.M., Ramos, G.P., Mendes, T.T., Cabido, C.E.T., Melo, E.S., Condessa, L.A., Coelho, D., & Garcia, E. (2011). Intensity of official futsal matches. *Journal of Strength and Conditioning Research*, 25(9), 2482-2487.
- Shearer, D.A., Jones, R.M., Kilduff, L.P., & Cook, C.J. (2015). Effects of competition on the sleep patterns of elite rugby union players. *European Journal of Sport Sciences*, 15(8), 681-686.
- Stewart, L.A., Clarke, M., Rovers, M., Riley, R.D., Simmonds, M., Stewart, G., & Tierney, J.F. (2015). Preferred reporting items for systematic review and meta-analyses of individual participant data: The PRISMA-IPD statement. *JAMA*, 313(16), 1657-1665.
- Šamija, K., Sporiš, G., Jerković, M., & Jozak, H. (2010). The differences in morphological characteristics between soccer players and futsal players. *Hrvatski Športskomedicinski Vjesnik*, 25, 28-34.
- Terrados, N., Mielgo-Ayuso, J., Delextrat, A., Ostojić, S.M., & Calleja-González, J. (2018). Dietetic-nutritional, physical and physiological recovery methods post-competition in team sports. A review. *The Journal of Sports Medicine and Physical Fitness*, ahead of print. doi: 10.23736/S0022-4707.18.08169-0
- Tessitore, A., Meeusen, R., Pagano, R., Benvenuti, C., Tiberi, M., & Capranica, L. (2008). Effectiveness of active versus passive recovery strategies after futsal games. *Journal of Strength and Conditioning Research*, 22(5), 1402-1412.
- Vaeyens, R., Lenoir, M., Williams, A.M., & Philippaerts, R.M. (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: An analysis of visual search behaviours. *Journal of Motor Behaviour*, 39, 396-408.
- Van Gool, D., Van Gerven, D., & Boutmans, J. (1988). The physiological load imposed on soccer players during real match play. In T. Reilly, A. Lees, K. Davids & W.J. Murphy (Eds.), *Science and football* (pp. 51-60). London: E & FN Spon.
- Vieira, L.H.P., Dogramaci, S.N., Milioni, R., Moura, F.A., Adrade, V.L., Cesar, G.M., & Santiago, P. (2016). Preliminary results on organization on the court, physical and technical performance of Brazilian professional futsal players: Comparison between friendly pre-season and official match. *Motriz: Revista de Educação Física*, 22(2), 80-92.
- Wilke, C.F., Fernandes, F.A.P., Martins, F.V.C., Lacerda, A.M., Nakamura, F.Y., Wanner, S.P., & Duffield, R. (2019). Faster and slower post training recovery in futsal: Multifactorial classification of recovery profiles. *International Journal of Sports Physiology and Performance*, 14(8), 1089-1095.
- Wilke, C.F., Wanner, S.P., Santos, W., Penna, E.M., Ramos, G., Nakamura, F.Y., & Duffield, R. (2020). Influence of faster and slower recovery profile classifications, self-reported sleep, acute training load and phase of microcycle on perceived recovery in futsal players. *International Journal of Sports Physiology and Performance*, 15(5), 648-653. doi: 10.1123/IJSPP.2019-0201
- Zhao, J., Tian, Y., Nie, J., Xu, J., & Liu, D. (2012). Red light and the sleep quality and endurance performance of Chinese female basketball players. *Journal of Athletic Training*, 47(6), 673-8.

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