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Recovery & Regeneration Behaviours in Elite English Futsal Players

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Abstract Futsal is a high-intensity, intermittent sport where accelerations and short sprints are performed at maximal or almost maximal intensity, interspersed by brief recovery periods, during a period of time relatively long. The aim of this study was to analyse the recovery and regeneration, as well as the hydration status of the futsal players in a 1-week period (3 days out, 1 travelling day and 3 days in a camp). Twenty elite level male futsal players from a national team that compete internationally, volunteered to participate in this study. Anthropometric measures, TQR questionnaires and Urine Osmolality status were analysed. The TQR questionnaire showed that there are statistical differences ($p < 0.05$) between both periods; in and out the training camp. Also, the hydration status of the players was not the desirable. The TQR questionnaire and the analysis of the urine with a refractometer might be two good methods to give feedback to the players about the categories where they should implement an action plan with the main aim to educate them.

Keywords: *hydration, TQR, urine osmolality, team sport, indoor soccer, indoor five-a-side football*

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1. Introduction

Futsal is a high-intensity, intermittent sport where accelerations and short sprints (usually with a duration of 1 to 4 seconds) are performed at maximal or almost maximal intensity, interspersed by brief recovery periods (activities of low intensity or pauses), during a period of time relatively long (75-80 minutes) [1-6]. From this, it is deduced that, in order to improve their futsal performance, players must arrange specific futsal conditioning with some additional resistance and sprint and agility training.

Although futsal is a relatively new sport, there is a large amount of articles analysing and studying the anthropometry of futsal players, the parameters of futsal, its physiological demands and the fitness level of the teams [1-7]. However, to our knowledge, there is no study that analyses the recovery and regeneration behaviours in futsal players. This aspect is of great importance for the optimal construction of physical and sport-specific conditioning programmes to improve futsal performance and avoid the overtraining syndrome. Since the main objective for a coach is to optimise athletic performance [8], the best performance improvements come from prescribing an optimal amount of physical training with proper recovery periods to allow for the greatest adaptation before competition [8,9].

There are many methods used to measure the training process or the training load performed but few to monitor and control the recovery process. One such framework for this is referred to as the total quality recovery (TQR) process and was developed by Kenttä & Hassmén [10]. The TQR is a recovery and regeneration points system that helps the athletes to assess their own recovery and give them feedback about which aspect must be improved. Several authors have emphasised the need to identify the probable causes of staleness and the need to match these with sufficient rest, sleep, relaxation, nutrition or other needed interventions [11,12]. Among the different approaches directed towards such recovery, the 4 main categories stated by the TQR were: nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest.

Furthermore, it is well known that the replenishment of glycogen and fluid stores is necessary to tolerate frequent, intense bouts of training. This might be the most important factor in maintaining high intensity training. Fluid is necessary for more than maintaining performance capacity alone; each gram of carbohydrate requires 3g of water to bind to muscle glycogen. Insufficient fluid intake will thus inhibit performance by allowing less glycogen to be stored. To utilise an individual's carbohydrate limit (approximately 1000g), 3000g of water is needed for it to bind to muscle glycogen [13].

An easy way to know the dehydration level of a sportsman is to weigh the subject before and after practising sport. In intermittent sports that are practised for less than 3 hours and under no extreme weather conditions, the water loss through breathing is relatively low compared to the water loss through sweating [14]. A weight loss percentage higher than 1% causes a decrease in the physical performance [15,16,17,18]. When that percentage is superior to 2%, the subject's cognitive functions, such as perceptive discrimination and reaction time, start to worsen [15,16,19,20,21]. Reaction time has special relevance in futsal, since futsal is a team sport where performance is affected by both the physical capacity of the players and their cognitive skills used to solve some play demands. Therefore, the control of the hydration status of the athletes can help them to increase their recovery and regeneration and hence their performance.

Thus, the aim of this study was to analyse the recovery and regeneration, as well as the hydration status of the futsal players in a 1-week period, when players are in and out of a training camp. The hypothesis was that an exhaustive control of the recovery and regeneration together with the hydration status applied over a consecutive 7-day period would increase the self-care of the players and hence their performance.

2. Material and Methods

2.1. Subjects

Twenty elite level male futsal players from a national team that compete internationally, volunteered to participate in this study after having signed the corresponding informed consent. The anthropometric values of the futsal players participating in this study are indicated in Table 1. The TQR questionnaire (Table 2) was administrated to each player every day. Finally, the hydration status was assessed through the players' urine osmolality (U_{osm}). The study was conducted in accordance with the Declaration of Helsinki (2008) and all procedures were approved by the Research Ethics Committee at the institutional University relative to human or animal research.

Table 1. Anthropometric characteristics of the team

n	20
Age (years)	25.39 ± 4.05
Age Range (years)	19.34 ± 4.05
Height (cm)	179.75 ± 5.69
Weight (kg)	73.93 ± 7.87
BMI (m/kg2)	22.88 ± 1.88

Table 2. TQR questionnaire and guidelines given to the players (RECOVERY & REGENERATION POINTS SYSTEM)

RECOVERY STRATEGY	Possible Points	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	SCORING GUIDE ADJUSTMENTS
NUTRITION	8								
Breakfast	1								Give ½ a point for a less than full breakfast
Lunch	2								Give 1 point for a less than full lunch
Dinner	2								Give 1 point for a less than full dinner
Pre-workout snack	1								
Post-exercise refueling within 60 minutes	2								Give 1 point for delaying more than 60 min
HYDRATION	2								
Pre-exercise urine: clear or light colour	1								
Post-exercise urine: clear or light colour	1								
SLEEP & REST	4								Give 2 points for 7 to <8 hours Give 1 point for 6-7 hours
8 hours of restful sleep	3								
Nap during the day	1								
RELAXATION & EMOTIONAL STATUS	3								
Fully relaxed 60 minutes post-workout or 30 minutes of feet-up relaxation post workout	1								
No daily psycho-social stress	2								Give 1 point for mild stress
COOLDOWN/STRETCHING	3								
Adequate cooldown after exercise	2								Give 1 point for partial cooldown
Stretching & foam roller for at least 10 minutes	1								
TOTALS	20								

Fill out this guide over the course of a week to assess your recovery behaviours. The daily total reveals whether you are paying adequate attention to your physical and mental recovery needs.

2.2. TQR Questionnaire

The questionnaire (Table 2) was filled in by the players every day before bedtime. The recovery and regeneration point system grades and monitors actions (i.e. individual proactive recovery interventions) which, potentially, optimise and accelerate the recovery process. Futsal players simply scored their actions and accumulate recovery "points" over a 24-hour period from the main 4 recovery categories: nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest. Nutrition and hydration allow the accumulation of a maximum of 10 recovery points; sleep and rest a maximum of 4 points; relaxation and emotional support a maximum of 3 points; and stretching and active rest a maximum of 3 points. Thus, the maximum overall score were 20 points. The daily total revealed whether players were paying adequate attention to their physical and mental recovery needs. The overall score of the players was classified in the following three categories: 17-20 daily points is optimal; 15-16 points is good but shows room for improvement; 14 or fewer points means you need to evaluate your recovery behaviours. These three categories were not given to the players, therefore they were not able to know their classification and therefore manipulate their score.

2.3. Urine Osmolality

Players were issued with a graduated beaker every night before bedtime and instructed to record the first morning urine of the following day. An Osmocheck refractometer (Vitech Scientific Ltd, West Sussex, UK) was used to provide an indicative reading of urine osmolality (U_{osm}) pre training. The Osmocheck is a thermally compensated, digital hand-held refractometer that is calibrated from 0 to 1500 mOsml·kg^{-1}H$_2$O with a manufacturer's reported measurement accuracy of ± 20 mOsml·kg^{-1}H$_2$O [22]. The unit measures the refractive index of the urine which is directly related to specific gravity (the mass concentration of urinary solutes). It calculates osmolality (the molecular concentration) based on the empirical relationship between specific gravity and osmolality [22,23]. The manufacturer reports a correlation of 0.99 [22]. U_{osm} was measured in accordance with the manufacturer's guidelines: prior to each measurement the zero-setting procedure was performed, and the prism of the refractometer was cleaned and calibrated against distilled water. Players were instructed to collect a sample of mid-stream urine (first urine in the morning) in a small beaker before the training session. Using a Pasteur pipette 0.3 mL of urine was placed onto the prism surface of the Osmocheck and a reading was taken. Lord [23] notes that the relationship between specific gravity and osmolality may vary if glucose and protein are present in the urine. Medi-Test Combi-8 (Macherey-Nagel, Düren, Germany) reagent strips were used to assess the urine for the presence of glucose and protein. A reagent strip was briefly dipped into the beaker of urine and any excess urine was removed. A reading was taken after 45 seconds by comparing to a colour chart 8 (Macherey-Nagel, Düren, Germany). The remaining urine in the beaker was included in the participant's voided urine total. U_{osm} concentrations greater than 1200 mOsml·kg^{-1}H$_2$O are consistent with severe dehydration [24]. However, according to the manufacturer's guidelines the U_{osm} concentrations of the players were classified in three groups: good between 200-600 mOsml·kg^{-1}H$_2$O, warning if the U_{osm} was more than 600 mOsml·kg^{-1}H$_2$O and danger if the U_{osm} was higher than 1000 mOsml·kg^{-1}H$_2$O. Players were not given feedback about their hydration status.

2.4. Period analyzed

The study was carried out through 7 consecutive days (1 week) in January. The weekly schedule was as follows: the first 3.5 days (Monday, Tuesday, Wednesday and Thursday morning) players were out of the training camp. The next 3.5 days (Thursday evening, Friday, Saturday and Sunday) players were in the training camp. The urine samples were taken and analyzed on Friday, Saturday and Sunday morning.

2.5. Statistical Analyses

Descriptive statistics were performed for all the variables in order to check for the assumptions of normality. Mean ± standard deviation of the data was calculated. Normal distribution and homogeneity of the parameters were checked with Shapiro–Wilk, and Levene's test. The statistical differences were assessed using Student's t test. A P value of 0.05 or lower was considered as being statistically significant. An analysis was performed using SPSS version 16.0 (Chicago, IL, USA).

3. Results

All the variables were normally distributed. Levene's test showed no violation of homogeneity of variance. The general group characteristics were the following: they were aged 25.39 ± 4.05, had a Body Mass Index (BMI) of 22.88 ± 1.88, a weight of 73.93 ± 7.87 kg, and a height of 179.75 ± 5.69 cm. The anthropometric results for the team participating in this study are presented in Table 1.

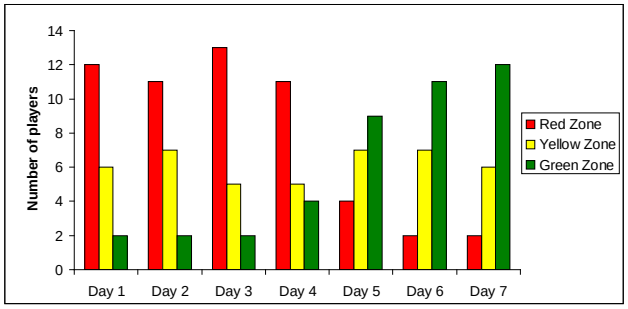

Figure 1. Number of players in each zone every day according to the TQR questionnaire. Green zone (GZ) (optimal) is 17-20 points, Yellow zone (YZ) (good but shows room for improvement) is 15-16 points and Red zone (RZ) (recovery behaviours need to be reviewed) is <14 points. Day 1: 12 players in RZ, 6 players in YZ and 2 players in GZ; Day 2: 11 in RZ, 7 in YZ and 2 in GZ; Day 3: 13 in RZ, 5 in YZ and 2 in GZ; Day 4: 11 in RZ, 5 in YZ and 4 in GZ; Day 5: 4 in RZ, 7 in YZ and 9 in GZ; Day 6: 2 in RZ, 7 in YZ and 11 in GZ; and Day 7: 2 in RZ, 6 in YZ and 12 in GZ

Figure 1 shows the results of the TQR questionnaire. The number of player in the green zone (17-20 points) and yellow zone (15-16 points) tended to increase through the

week, while on the contrary the number of players in red zone (<14 points) tended to decrease. Table 3 shows the average points achieved every day in the whole team (n=20). The points in the days 5, 6 and 7 obtained statistical differences with the points from all the others days (day 1, 2, 3 and 4) ($p<0.05$). Table 4 shows the points and the percentage obtained every day in the 4 main categories stated by the TQR: nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest. The players improved their recovery and regeneration behaviours when they were in the camp compared to when they were out the camp in all the categories. However, nutrition, relaxation and emotional support and stretching and active rest obtained the highest improvements (approximately 30% more points) (Table 4). Furthermore, day four (travelling day) was the day with the lowest total score. All the categories obtained the lowest number of points of the week as well.

Table 3. Average points, standard deviation (SD), maximum points, and minimum points obtained in each day by the players in the TQR questionnaire when they were in and out the training camp

	Camp (in / out)	Mean (points)	SD	Max (points)	Min (points)
Day 1	Out	12.36	3.24	18.00	5.50
Day 2	Out	12.39	3.09	18.00	7.00
Day 3	Out	12.13	3.02	18.00	8.00
Day 4	Out/In*	9.57	5.41	18.00	2.00
Day 5	In	16.08	1.98	19.00	13.00
Day 6	In	16.85	1.82	19.00	12.00
Day 7	In	15.42	2.02	18.00	12.00

***** The meeting up for the players in the hotel was on Thursday at 19:00 to take dinner.

Table 4. Points and percentage of the total points (20) obtained every day in each category of the TQR questionnaire

Categories and possible points	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	Points	%	Points	%	Points	%	Points	%	Points	%	Points	%	Points	%
Nutrition (8)	5.75	71.88	6.14	76.79	5.53	69.17	4.70	58.75	7.31	91.35	7.54	94.23	7.17	89.58
Hydration (2)	1.07	53.57	1.14	57.14	1.07	53.33	0.67	33.33	1.23	61.54	1.15	57.69	1.50	75.00
Sleep & Rest (4)	2.50	62.50	2.07	51.79	2.80	70.00	2.07	51.67	2.46	61.54	3.00	75.00	2.42	60.42
Relaxation & Emotional Status (3)	2.07	69.05	2.07	69.05	2.07	68.89	1.47	48.89	2.62	87.18	2.62	87.18	2.42	80.56
Cooldown/Stretching (3)	0.96	32.14	0.96	32.14	0.67	22.22	0.67	22.22	2.46	82.05	2.54	84.62	1.92	63.89
TOTAL (20)	**12.36**	**61.79**	**12.39**	**61.96**	**12.13**	**60.67**	**9.57**	**47.83**	**16.08**	**80.38**	**16.85**	**84.23**	**15.42**	**77.08**

Figure 2 shows the results in the urine tests. The players were classified according to the U_{osm} in the three zones (danger, warning and good) given by the manufacturer. Approximately, the 50% of the squad was in the warning or danger zone every day, therefore their hydration status was not adequate. Table 5 shows the mean U_{osm}, standard deviation (SD), maximum U_{osm}, and minimum U_{osm} obtained in each day. In general, it can be stated that approximately the 50% of the players were in an inadequate hydration status, and the average U_{osm} in the team was above 600 mOsml·kg^{-1}H$_2$O (warning zone) every day.

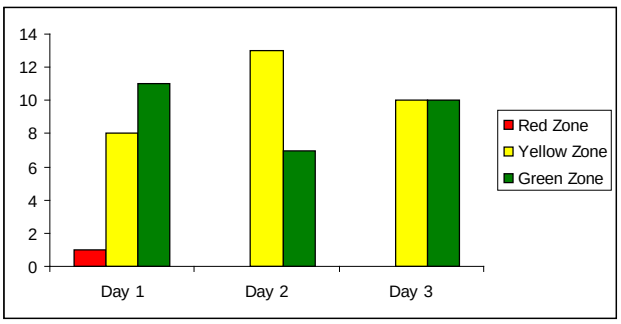

Figure 2. Number of players in each zone every day according to the U_{osm}. Red zone (RZ) (danger) is a U_{osm} more than 1000 mOsml·kg^{-1}H$_2$O, Yellow zone (YZ) (warning) is a U_{osm} higher than 600 mOsml·kg^{-1}H$_2$O and Green zone (GZ) (good) is a U_{osm} between 200-600 mOsml·kg^{-1}H$_2$O. Day 1: 1 player in RZ, 8 players in YZ and 11 players in GZ; Day 2: 13 in YZ and 7 in GZ; and Day 3: 10 players both YZ and GZ

Table 5. Mean U_{osm} (mOsml·kg^{-1}H$_2$O), standard deviation (SD), maximum U_{osm} (mOsml·kg^{-1}H$_2$O), and minimum U_{osm} (mOsml·kg^{-1}H$_2$O) obtained in each day

	Mean mOsml·kg^{-1}H$_2$O	SD	Max mOsml·kg^{-1}H$_2$O	Min mOsml·kg^{-1}H$_2$O
Day 1	619.50	202.18	1050.00	230.00
Day 2	655.00	246.10	980.00	280.00
Day 3	606.50	127.37	850.00	280.00

4. Conclusions

The purpose of this paper was to research into the recovery and regeneration, as well as the hydration status of the futsal players in a 1-week period, when players are in and out of a training camp with their national team. The hypothesis was that an exhaustive control of the recovery and regeneration together with the hydration status applied over a consecutive 7-day period would increase the self-care of the players and hence their performance.

The TQR questionnaire showed that there are statistical differences ($p<0.05$) between both periods; in and out the training camp. Basically, the data showed that the players' recovery and regeneration behaviours are very different when they are training with their own clubs compared to when they are in a camp with the national team. Camp days (day 5, 6 and 7) showed a totally different trend (Figure 1); since the number of players with poor

behaviours is decreasing significantly. Furthermore, the futsal players of this study obtained their lowest daily score (9.57) on day 4 (travelling day) (Table 3). They obtained the lowest number of points in all categories (nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest) of the week as well. Therefore, the training sessions planned and the training load for the next day (day 5) should take that into account.

Analysing the scores obtained in this study in each of the 4 categories stated by the TQR, it may be highlighted the following (Figure 3 and Figure 4):

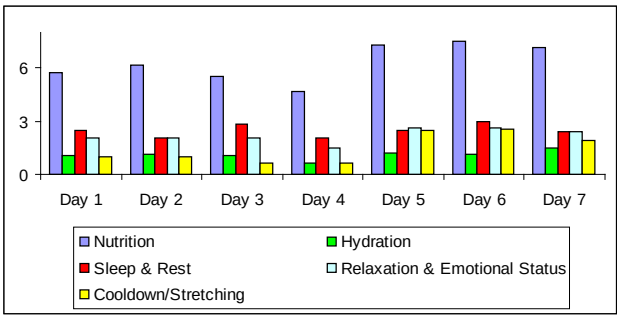

Figure 3. Points out of 20 obtained every day in each category of the TQR questionnaire

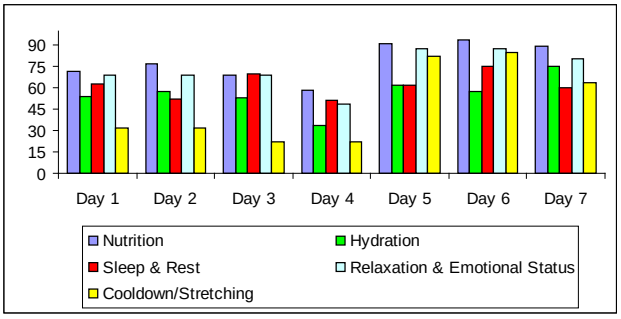

Figure 4. Percentage of the total points (20) obtained every day in each category of the TQR questionnaire

Nutrition and hydration: the futsal players of this study improved their nutrition behaviours throughout the week. They obtained between the 90-95% of the points of this category when they were in the camp compared to the 70-75% of the points when they were out of the national camp. The main reasons for these differences are: a) players used to miss any food, especially breakfast or lunch; b) players were not consistent taking the pre-workout snack; and c) players not always refueled post-exercise within 60 minutes. Following Morgan et al. [25] and Costill et al. [26] individuals failing to ingest sufficient carbohydrates to match the energy demand of heavy training have been shown to develop signs of staleness. A poor diet with an insufficient caloric and fluid intake, particularly one lacking in carbohydrates, will decrease the capacity to tolerate physiological stress (training). Kenttä & Hassmén [10] stated that the replenishment of glycogen and fluid stores is necessary to tolerate frequent, intense bouts of training. This might be the most important factor in maintaining high intensity training. Also, ingesting protein and/or amino acids are required to promote growth, repair damaged cells and tissue, synthesize hormones, and for a variety of metabolic activities. Recent evidence indicates that ingesting protein and/or amino acids can enhance recovery, immune function, and growth and maintenance of lean body mass [27].

The players in this study (90%) gave themselves the maximum points (2) in the hydration category each day. However, the U_{osm} values showed (Table 5) the opposite. The hydration status was not adequate. They were over 600 $mOsml \cdot kg^{-1}H_2O$ every day. This fact, also, showed that the players in this study were not really conscious about their fluid intake needs and urine analysis. Fluid is necessary for more than maintaining performance capacity alone; each gram of carbohydrate requires 3g of water to bind to muscle glycogen. Insufficient fluid intake will thus inhibit performance by allowing less glycogen to be stored [10,13]. Besides, a weight loss percentage higher than 1% causes a decrease in the physical performance [15,16,17,18]. When that percentage is superior to 2%, the subject's cognitive functions, such as perceptive discrimination and reaction time, start to worsen [15,16,19,20,21]. Since reaction time might have special relevance in futsal, the control of hydration status can help them to increase their recovery and regeneration and hence their performance.

Sleep and rest: Kenttä & Hassmén [10] stated that the most frequently mentioned factor for enhancing recovery is most obvious one: rest. In this sense, rest means engaging in no physical activity (passive recovery during the daytime) and obtaining sufficient sleep [13]. In this study, the results obtained showed that the futsal players' sleep and rest behaviours did not improve significantly throughout the week. Recently [28], it has also been showed that lack of sleep appears to be associated with injury risk in an adolescent athletic population. Adolescent may benefit from additional sleep as they get older to help reduce the risk of injury during sports. The science has shown that with a proper sleep tennis players get a 42% boost in hitting accuracy during depth drills, sleep extension provides swimmers a 17% improvement in reaction time off the starting block, sleep improves split-second decision making ability by 4.3%, american football players drop 0.1 seconds off their 40-yard dash times by sleeping more, and a 20-30 minutes power nap improves alertness by 100% [29].

On the contrary, the scientific studies has also shown that a chronic sleep loss can lead to a 30-40% reduction in glucose metabolism and an 11% reduction in time to exhaustion, 2 days of sleep restriction can lead to a 3x increase in lapses of attention and reactivity, the maximum bench press drops 20 lbs after 4 days of restricted sleep and perceived exertion increases 17-19% after 30 hours without sleep [29].

Relaxation and emotional support: Kenttä & Hassmén [10] insured that mental training might help to prevent staleness [30,31,32]. This effect has been explained by an increased recovery capacity or increased stress tolerance [31]. Relaxation techniques, the use of flotation tanks, massages and saunas have also been suggested by Marion [33] as proactive recovery interventions. The players who participated in this study increased significantly their % of points in this category because the facilities and equipment in the national camp allow the technical staff to plan massages' sessions, recovery sessions in the swimming pool, sauna or spa. The learning and practice of relaxation and visualisation techniques by athletes is also recommended [31,32].

Stretching and active rest: active rest, meaning low volume and low intensity training, may accelerate the recovery process [33]. Stretching has effects similar to massage and active rest, in that it increases the blood flow thorough the muscle. Also, foam rolling has been showed to improve muscular function, performance, overuse, and joint range of motion. Recently, MacDonald at al. [34] have demonstrated that an acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. This category showed significant improvements in the players' behaviours when they are in the national camp compared to when they are training with their own clubs. This category is where players in this study had more room to improve, as they did not have as a habit to perform a structured and organised cold-down.

To sum up it can be concluded that the players of this study had very different recovery and regeneration behaviours depending on if they are training with their own clubs or with the national team. Furthermore, their hydration status was not the desirable to recover and regenerate between training sessions. The TQR questionnaire and the analysis of the urine with a refractometer might be two good methods to give feedback to the players about the categories where they should implement an action plan. This would allow us to educate our players about their needs to recover and regenerate properly between training sessions and competitions.

Acknowledgement

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