https://doi.org/10.7251/SSH2102161E
UDC: 796.035:613.72/.73
Original scientific paper
Originalni naučni rad

Improvement of Repeated Sprint Ability for a male amateur football team through the Cometti concatenations method

Francesca D'Elia[1], Giovanni Esposito[1], Sara Aliberti[1], Tiziana D'Isanto[2], Gaetano Raiola[2]
[1]Department of Human, Philosophical and Education Sciences, University of Salerno, Fisciano, Salerno, Italy
[2]Department of Political and Ssocial Studies, University of Salerno, Fisciano, Salerno, Italy

Correspondence:
Sara Aliberti, Department of Human, Philosophical and Education sciences, University of Salerno, Fisciano, Salerno, Italy, s.aliberti17@studenti.unisa.it

Abstract: *This study aimed to examine the improvement of the Repeat Sprints Ability (RSA), during a competitive season in amateur football players (Italian 4th Division, 2019-2020) through the use of the Cometti concatenations method. Twenty (n=20) amateur footballers, participated in this study (age: 23 ± 0.3; height: 184.4±5.5; body weight: 80.92±3.4; training experience: 8 ± 0.3 yrs), without goalkeepers. In the pre-season (4 weeks, from July to August), the players performed Capanna test, to evaluate the RSA before the start of the season. Every player has been analysed with a K-GPS Live device 50Hz (K-Sport Universal STATS, Italy). After 12 weeks of training (in-season), based on specific workouts of Cometti method, the same players repeated Capanna test to check performance improvements and verify whether the training programme is effective. After 12 weeks of training, the difference between the first trial (pre-season) and the second one (in-season) is statistically significant ($p<0.05$). The results obtained, suggested that the strength work was optimized as well as work times, and the RSA was improved. In addition, thanks to better physical shape, which resulted in better performances of individual players, the team in the last period of the championship achieved more positive results in the matches played.*
Keywords: *Sprint Performance, Physical Preparation, Capanna Test, Aerobic Evaluatio.*

Introduction

The training of repeated sprint ability in football is well documented, since the performance of the competition is characterized not only by intermittent efforts often carried out at high intensity, but also by the presence of accelerations and decelerations that are determined in the frequent changes of direction and sense. The latter made by the players to determine useful disturbances to the game's economy. For RSA (Repeated Sprint Ability) is meant the ability to repeat sprint with reduced decrease of performance (Barbero-Álvarez et al., 2010). It is considered the ability to produce the best average performance over a series of short sprints (≤ 10 seconds), separated by short recovery periods (≤ 60 seconds), with a minimum decrease in maximum performance (Bravo et al., 2008; Castagna et al., 2020). Some benefits of RSA include improved VO2 max, maximum aerobic speed and improved distance on the football specific yo-yo intermittent recovery test (YYIRT). A recent meta-analysis indicated that a repeated sprint training (RST) is useful for improving high intensity intermittent running and sprint performance (Martin et al., 2018; Faude et al., 2012). These training modes usually include continuous aerobic training, aerobic interval training, or explosive leg training (Izzo et al., 2020). The scientific literature in relation to the conditional preparation of the player, has produced descriptive training studies in various forms, reporting extremely interesting results for the training practice. In addition, the game analysis (time-motion analysis) has shown that the presence of attack and counterattack actions, supported by high intensity phases produced without interruption, are increasingly frequent and decisive for the outcome of the matches (Alptekin et al., 2013; Carling et al., 2012). In the topic relating to the RSA, two implementation arguments are distinguished, that of production and maintenance, which are characterized by continuity of exercise and recovery between exercises. Specifically, we talk about maintenance RSA, when the work and recovery ratio is less than 1: 5; while it refers to production RSA, when the ratio is equal or higher (> 1: 5). The experimentation both on the field and in the laboratory, has identified in the production mode the most effective method for the physiological development of the player's anaerobic capacity. In football, therefore, aerobic capacity is an essential skill, and the RSA methodology plays a decisive role, as it not only promotes metabolic improvement, but also neuromuscular development (Calandro et al., 2020; D'Isanto et al., 2019). The player must improve the same

muscle groups as the sprinter and add the football training to the ball which consists of a throw of the free leg. In the case of football, and especially during the competitive season, it is necessary to improve maximum strength with caution; it is therefore necessary to create combinations that match pre-fatigue and isometry. Cometti concatenations method is a widely used method in football for strengthening the lower limbs (Spencer et al., 2011). This method of work is based on the combination of the various contraction regimes (eccentric, concentric, plyometric, isometric, and gesture-specific work). These contractions, in this case, may not even be analyzed separately. According to Cometti, the concatenations make it possible to couple situations very close to the competition needs with strength exercises, with the aim of transferring the new muscular stresses into the technical gesture, working on technical and conditional aspects (Cometti et al., 2001). The same author suggests several examples of concatenations carried out with general and specific exercises and even gesture-specific exercises. This working principle can be applied during the training session by alternating series of different contraction regimes or performing repetitions with different contractions within the same series (Raiola, 2017). Concatenations are therefore combined exercises to work both on technical aspects and on conditional aspects which, if well designed, allow to optimize the work of force and optimize the working times. It is certainly a very particular exercise methodology, as indeed all strength exercises with or without overloads, but above all, it must be proposed to athletes suitable to withstand such loads (Impellizzeri et al., 2007). To improve the synchronization of the drive units, it is necessary to work with heavy loads close to the maximum, indeed higher than the maximum, as in the case of eccentric work. The ability to repeat the sprint (RSA), can be evaluated through various types of field tests. However, the main field tests are the Capanna - Sassi test and the 5x30m test. The Capanna-Sassi test consists of repeating a 20 + 20-meter shuttle line sprint 6 times, with a change of direction after 20m and a recovery of 20 seconds between one sprint and the next. In a recent study, all players in a Scandinavian National League were tested with both the Yo-Yo Intermittent recovery Test level 1 (Yo-Yo IR1) and with the RSA 7x30m 30 "recovery test (Intermittent Endurance and Repeated Sprint Ability in Soccer Players). The study showed that intermittent high intensity endurance and the ability to repeat sprints should be considered semi-independent physical abilities. The group that achieved the highest Yo-Yo IR1 test values showed a decrease in the lowest RSA test. In addition, the group with the lowest results on the Yo-Yo IR1 test had the fastest decreases on the RSA test. In fact, a good strategy could be to train these two physical skills with two different and specific protocols. The purpose of this study is to verify whether a training mesocycle based on the Cometti concatenations method, carried out for twelve weeks, produces a significant improvement of the RSA.

Methods

Subjects

Twenty (n=20) amateur football players participated in this study (age: 23 ± 0.3; height: 184.4±5.5; body weight: 80.92±3.4; training experience: 8 ± 0.3 yrs) without goalkeepers. All athletes are free from musculoskeletal injuries, participated in ≥ 95% of training sessions per year. All athletes are amateur players by Italian football championship. To be included in the study, subjects had to 1) ensure regular participation in all the training sessions, 2) have competed regularly during the previous competitive season, and 3) possess medical clearance. Before entering the study, participants were fully informed about the study aims and procedures, and they provided written informed consent before the testing procedure. The study protocol was conformed to the code of Ethics of the World Medical Association (Declaration of Helsinki). The football team trained for approximately 1h three times per week (always on Monday, Wednesday, and Friday) plus the official match played on Saturday or Sunday. The study was conducted during the 2019–2020 competitive season (i.e., from July to October). Before and after 12 weeks, each player completed Capanna test on the same grass surface.

Design

Each participant had the following evaluation. In the pre-season, after anthropometric measurements, all 20 players underwent the Capanna field test. This test is one of the most popular in football for investigating the lactic acid characteristics of players. The test consists in repeating a shuttle sprint of 20 + 20 m six times, with a change of direction after the first 20 m and recovery of 20 seconds between one sprint and the next. The test is preceded by a 15-minute warm-up and a single maximum sprint that provides a reference data (criterion). It allows to measure

the travel times of each individual sprint using a stopwatch connected to a system of photocells. From the data it was then obtained the time of the best test expressed in seconds (RSAbest), the average time related to all the tests (RSAmean) and the decrease in performance percentage (RSAdec) obtained from the ratio between the average time related to all the tests (RSAmean) and the best time of the test (RSAbest). The tests carried out followed the original test protocols present in the literature. Multiple athletes cannot be tested simultaneously. After that, specific workouts based on the Cometti concatenations method were carried out over a period of twelve weeks. These workouts after a general activation of about 25 minutes with the ball, initially involved a shuttle run performed at maximum speed on 4 sections of 20 meters each. Three sets were performed with a four-minute recovery time between them. The second exercise consisted of running pace at an active recovery for a 30-meter stretch. Running pace at active recovery speed is approximately 65% of Maximum Aerobic Speed; for a mid-level player (with a VAM of 17 km / h) it is a question of covering 30 meters in about 10 seconds. Also, in this case, the same series number of the previous exercise were provided, with a similar recovery time between one series and another. The third exercise involved the execution of five to six semi-squat jumps for each of the four series, with a load equal to 30-35% of the maximum load. The fall could be performed in two ways: either by keeping the legs straight (without causing stiffening of the muscles of the lower limbs), with minimal angular variations (approximately 170 ° of the knee angle in the cushioning-inversion of movement) and short contact; or where the position of departure and arrival on the ground must always take place with the lower limbs in a semi-short stance (90-110 ° knee angle). With this exercise, the extensor muscles of the foot are stressed more. Finally, the final part of the session was dedicated to shooting on goal. Each player had six shots available to be executed at maximum executive power, compatible with the request to direct the ball at a specific target. In this case the distance of the shot was variable and at the discretion of the coach. Some variants included a series of sprints with stop and instant change of direction (20m + 10m + 20m), or even the execution of a narrow slalom with the ball, at maximum speed, on a 15 m stretch with the cones spaced 1.5 m apart, or 4 repetitions of ½ squats performed with a load relative to 70% of the maximum, which allowed a maximum of 11 repetition maximum (RM). After 12 weeks of training based on specific workouts based on the Cometti concatenations method (in season), the same players repeat Capanna test to check performance improvements and verify whether the training programme is correct. The first element was to determine whether the improvement in distance covered during a test is better, the same, or worse with respect to the pre-season.

Statistical analysis

Quantitative variables are presented using their mean and standard deviation and qualitative variables with their absolute frequencies and percentages. Furthermore, the normality of the distributions with the Shapiro Wilk test was determined, a dependent sample t-test was conducted to combine the results obtained from the tests before the start of the specific training mesocycle, and at the end of it, after twelve weeks. The analyses were performed with 95% confidence interval and $p \leq 0.05$. Statistical analysis were performed with SPSS Statistics version 23.

Results

The RSA results of the six shuttles of the Capanna test administered on entry and divided by role are shown in Table 1.

Table 1. *The results obtained in the first Capanna test (pre-season)*

Players	RSA_{best}	RSA_{mean}	RSA_{dec}	RSA_{change}	RSA_1	RSA_2	RSA_3	RSA_4	RSA_5	RSA_6
Defenders	7.27	7.73	6.20%	10.90%	7.32	7.50	7.60	7.83	7.93	8.12
Midfielders	7.29	7.69	5.40%	9.00%	7.35	7.49	7.58	7.87	7.94	8.03
Strikers	7.18	7.65	6.60%	11.90%	7.21	7.39	7.58	7.75	7.91	8.09
Mean	7.24	7.69	6.00%	10.60%	7.29	7.46	7.58	7.78	7.92	8.08
SD	±0.05	±0.04	±0.01	±0.01	±0.07	±0.06	±0.01	±0.06	±0.01	±0.04

Note: RSAchange $= (RSA_{last} - RSA_{first} / RSA_{first}) \times 100$; **RSAmean** $= (RSA_1 + RSA_2 + RSA_3 + RSA_4 + RSA_5 + RSA_6)/6$; **RSAdec** $= [(RSA_{total} / RSA_{best} \times 6) \times 100] - 100$

The RSA results of the six shuttles of the Capanna test administered on exit and divided by role are shown in Table 2.

Table 2. *The results obtained in Capanna test (in-season)*

Players	RSA_{best}	RSA_{mean}	RSA_{dec}	RSA_{change}	RSA_1	RSA_2	RSA_3	RSA_4	RSA_5	RSA_6
Defenders	7.24	7.58	4.60%	8.60%	7.27	7.38	7.52	7.64	7.77	7.91
Midfielders	7.11	7.55	4.70%	8.00%	7.24	7.36	7.50	7.63	7.73	7.85
Strikers	7.12	7.51	5.30%	9.40%	7.17	7.28	7.45	7.58	7.72	7.85
Average	7.19	7.54	5.00%	8.70%	7.22	7.34	7.49	7.61	7.74	7.87
SD	±0.07	**±0.03**	**±0.03**	**±0.07**	**±0.05**	**±0.05**	**±0.03**	**±0.03**	**±0.02**	**±0.03**

Note: ***RSAchange***$= (RSA_{last} - RSA_{first} / RSA_{first}) \times 100$; **RSAmean**$= (RSA_1 + RSA_2 + RSA_3 + RSA_4 + RSA_5 + RSA_6)/6$; **RSAdec** $= [(RSA_{total} / RSA_{best} \times 6) \times 100] - 100$

The improvements found between RSA time values between entry and exit test divided by role are shown in Table 3.

Table 3. *The improvement found, in terms of duration, in the execution of the two tests.*

Players	RSA_{best}	RSA_{mean}	RSA_1	RSA_2	RSA_3	RSA_4	RSA_5	RSA_6
Defenders	0.03	0.15	0.05	0.12	0.08	0.19	0.16	0.21
Midfielders	0.08	0.13	0.11	0.13	0.08	0.14	0.21	0.18
Strikers	0.06	0.14	0.04	0.11	0.13	0.17	0.19	0.24
Average	0.05	0.15	0.07	0.12	0.09	0.17	0.18	0.21
SD	**±0.02**	**±0.01**	**±0.03**	**±0.01**	**±0.02**	**±0.02**	**±0.02**	**±0.03**

A significant difference found between RSA values before and after a specific training mesocycle is shown in Table 4.

Table 4. *Dependent sample t-test results* (RSA_{best})

	N	Mean	SD	SE	t	p
Pre-season	20	7.69	004	0.46	8.54	0.00
In-season	20	7.54	0.03	0.45		

The total difference between RSA on entry and exit of the Capanna test without division by role is shown in Figure 1.

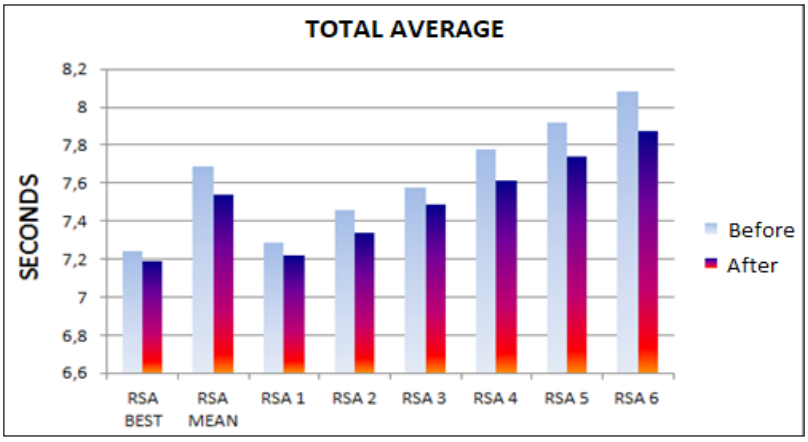

Figure 1. *Results of Capanna Test pre-season and in-season*

Discussion

From the results, the hypothesis of the study regarding the effectiveness of the Cometti method can be confirmed, as it effectively allows to improve the Repeated Sprint Ability by positively influencing motor performance. By observing the results of the group of players, it is possible to understand how to obtain a correct execution of the most important technical gestures, it is necessary to enable the players to respond to the multiple requests that constantly occur in the game. As shown in the tables, the data obtained by the players was grouped by position (7 defenders, 8 midfielders, 5 forwards). The results of these studies demonstrate the possibility of practically applying this operational monitoring tool presented as valid for the individual evaluation of players, since it has a real and significant impact on the result of the game. This study offers itself as a further contribution to strengthen the methodology presented since it produces greater effects than the training process to which the survey group was subjected. Different studies have highlighted repeated-sprint ability as important physical fitness components for soccer players (Rosch et al., 2000; Campa et al., 2019; Izzo et al., 2020). Moreover, similar studies (Helgerud et al., 2001; Rampinini et al.,2009), reported improved soccer performance, assessed by the number of sprints and the number of involvements with the ball, after the implementation of an 8-week aerobic power training program. As regards the use of the Cometti concatenations method, several authors believe that if well designed, it allows to optimize the working time for competitive athletes, often engaged in long and daily physical training sessions. In many cases, it also allows to vary the monotony of the exercises and to insert valid metabolic tasks that create the fatigue necessary to optimize individual recovery qualities (Ali, 2011; Altavilla et al., 2017). It must be said, however, that this form of training certainly does not contribute to refining the tactical and mental aspects, which are decisive for the leap in football quality, but it can well combine two secondary elements that support the player: conditional qualities and the specific gestures (Buchheit et al., 2010; Padulo et al., 2017). For the athlete not motivated to repeat the same training methods every day, it is preferable, however, to suggest other training solutions, more engaging and with adequate psycho-physical commitment (Wragg et al., 2000). Regarding the cognitive aspect, this work acquires a special meaning because it is the essence of a sports game (Chamari et al., 2005; Izzo et al., 2020). The ability to adapt a learned behaviour quickly and effectively can only be acquired when the player is subjected from the beginning, and up to the high-performance phase, to a systematic development of his mental abilities (Helgerud et al., 2001). These are considered, more than in the past, as the fundamental and essential skills for good performance. Obviously, there is not just one training method that can be recommended to best improve RSA and all the factors believed to be responsible for performance decrements during repeated sprint tasks. This is not surprising, as RSA is a complex fitness component that depends on both metabolic and neural factors, among others (Buchheit et al., 2010; Dellal et al., 2013). Regarding practical applicability, as many studies to date have used amateur players, we consider that future research will have to recruit highly skilled team sports athletes and be extended to sport-specific test contexts with, in parallel, a high level of standardization and reliability of measures.

Conclusion

The results obtained suggest o the strength work is optimized; the work times have been optimized and the RSA is improved thanks to the feedback obtained through the comparison of the averages of the times obtained during the execution of the tests. In addition, thanks to better physical shape which resulted in better performances of individual players, the team in the last period of the championship achieved more positive results in the matches played.

Announcement
We announce that the authors have equally contributed to this paper.

Conflict of interests
There is no conflict of interests among the authors themselves.

References

Ali, A. (2011). Measuring soccer skill performance: a review. Scandinavian journal of medicine & science in sports, 21(2), 170–183. https://doi.org/10.1111/j.1600-0838.2010.01256.x

Alptekin, A., Kilic, O., & Marvis, M. (2013).The effect of an 8-week plyometric training program on sprint and jumping performance. Serbian Journal of Sports Sciences, 7(2), 45-50.

Altavilla, G., Riela, L., Tore, A. D., & Raiola, G. (2017). The Physical Effort Required from Professional Football Players in Different Playing Positions. Journal of physical education and sport, 17, 2007-2012.

Barbero-Alvarez, J. C., Coutts, A., Granda, J., Barbero-Alvarez, V., & Castagna, C. (2010). The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (RSA) in athletes. Journal of science and medicine in sport, 13(2), 232–235. https://doi.org/10.1016/j.jsams.2009.02.005

Ferrari Bravo, D., Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. (2008). Sprint vs. interval training in football. International journal of sports medicine, 29(8), 668–674. https://doi.org/10.1055/s-2007-989371

Buchheit, M., Mendez-villanueva, A., Simpson, B. M., & Bourdon, P. C. (2010). Repeated-sprint sequences during youth soccer matches. *International Journal of Sports Medicine*, 31(10), 709–716. https://doi.org/10.1055/s-0030-1261897

Buchheit, M., Mendez-Villanueva, A., Delhomel, G., Brughelli, M., & Ahmaidi, S. (2010). Improving repeated sprint ability in young elite soccer players: repeated shuttle sprints vs. explosive strength training. *Journal of Strength and Conditioning Research*, 24(10), 2715–2722.

Calandro, A., Esposito, G., & Altavilla, G. (2020). Intermittent training and improvement of anthropometric parameters and aerobic capacity in youth football. *Journal of Human Sport & Exercise*, 15(3), 656-663.

Campa, F., Semprini, G., Júdice, P. B., Messina, G., & Toselli, S. (2019). Anthropometry, Physical and Movement Features, and Repeated-sprint Ability in Soccer Players. *International Journal of Sports Medicine*, 40(2), 100–109. https://doi.org/10.1055/a-0781-2473

Carling, C., Le Gall, F., & Dupont, G. (2012). Analysis of repeated high-intensity running performance in professional soccer. *Journal of Sports Sciences*, 30(4), 325–336. https://doi.org/10.1080/02640414.2011.652655

Chamari, K., Hachana, Y., Kaouech, F., Jeddi, R., Moussa-Chamari, I., & Wisløff, U. (2005). Endurance training and testing with the ball in young elite soccer players. British journal of sports medicine, 39(1), 24–28. https://doi.org/10.1136/bjsm.2003.009985

Cometti, G., Maffiuletti, N. A., Pousson, M., Chatard, J. C., & Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer players. International journal of sports medicine, 22(1), 45–51. https://doi.org/10.1055/s-2001-11331

Dellal, A., & Wong, d. (2013). Repeated sprint and change-of-direction abilities in soccer players: effects of age group. Journal of strength and conditioning research, 27(9), 2504–2508. https://doi.org/10.1519/JSC.0b013e31827f540c

D'Isanto, T., D' Elia, F., Raiola, G., & Altavilla, G. (2019). Assessment of sport performance: Theoretical aspects and practical indications. Sport Mont, 17(1), 79-82.

Faude, O., Koch, T., & Meyer, T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. Journal of sports sciences, 30(7), 625–631. https://doi.org/10.1080/02640414.2012.665940

Helgerud, J., Engen, L. C., Wisloff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. Medicine and science in sports and exercise, 33(11), 1925–1931. https://doi.org/10.1097/00005768-200111000-00019

Ferrari Bravo, D., Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. (2008). Sprint vs. interval training in football. International journal of sports medicine, 29(8), 668–674. https://doi.org/10.1055/s-2007-989371

Izzo, R., Raiola, G., D'Isanto, T., Cejudo, A., & Giovanelli, G.M. (2020). Modelling an adequate profile for a more targeted work methodology, with dedicated technologies, for elite-level footballers: Comparison between sub 17 vs sub 19, highlights and shadows. Sport Science, 13(1), 36-42.

Izzo, R., Altavilla, G., Cejudo, A., Raiola, G., D'Isanto, T., & Giovannelli, M. (2020). Performance improvement in yo-yo intermittent recovery test Level 2 and during official matches: The role of speed endurance training production in Élite football players. Sport Mont, 18 (3), 61-66.

Izzo, R., D'Isanto, T., Raiola, G., Cejudo, A., Ponsano, N., & Varde'i, C.H. (2020). The role of fatigue in football matches, performance model analysis and evaluation during quarters using live global positioning system technology at 50hz. Sport Science, 13 (1), 30-35.

Martin, V., Sanchez-Sanchez, J., Ramírez-Campillo, R., Nakamura, F. Y., & Gonzalo-Skok, O. (2018). Validity of the RSA-RANDOM Test for Young Soccer Players. International journal of sports medicine, 39(11), 813–821. https://doi.org/10.1055/a-0637-2094

Padulo, J., Attene, G., Ardigò, L. P., Bragazzi, N. L., Maffulli, N., Zagatto, A. M., & Dello Iacono, A. (2017). Can a Repeated Sprint Ability Test Help Clear a Previously Injured Soccer Player for Fully Functional Return to Activity? A Pilot Study. Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine, 27(4), 361–368. https://doi.org/10.1097/JSM.0000000000000368

Raiola, G. (2017). Motor learning and teaching method. Journal of Physical Education and Sport, 17, 2239-2243.

Rampinini E, Sassi A, Morelli A, Mazzoni S, Fanchini M, Coutts AJ. Repeated-sprint ability in professional and amateur soccer players. Applied Physiology, Nutrition, and Metabolism. 2009; 34(6); 1048-1054.

Rösch, D., Hodgson, R., Peterson, T. L., Graf-Baumann, T., Junge, A., Chomiak, J., & Dvorak, J. (2000). Assessment and evaluation of football performance. The American journal of sports medicine, 28(5 Suppl), S29–S39. https://doi.org/10.1177/28.suppl_5.s-29

Spencer, M., Pyne, D., Santisteban, J., & Mujika, I. (2011). Fitness determinants of repeated-sprint ability in highly trained youth football players. International journal of sports physiology and performance, 6(4), 497–508. https://doi.org/10.1123/ijspp.6.4.497

Wragg, C. B., Maxwell, N. S., & Doust, J. H. (2000). Evaluation of the reliability and validity of a soccer-specific field test of repeated sprint ability. European journal of applied physiology, 83(1), 77–83. https://doi.org/10.1007/s004210000246

Primljen: 02. juli 2021. / Received: July 02, 2021
Prihvaćen: 06. oktobar 2021. / Accepted: October 06, 2021