Journal of Physical Education and Sport ® (JPES), Vol. 22 (issue 2), Art 45, pp. 355 - 360, February 2022
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Acute effect of induced fatigue on passing ability in elite U-19 soccer players

ALFONSO PENICHET-TOMAS[1], VICTOR TORREBLANCA-MARTÍNEZ[2], SERGIO TORREBLANCA-MARTÍNEZ[2]
[1] Physical Education and Sport, Faculty of Education, University of Alicante, Alicante, SPAIN
[2] Sports and Computer Sciences, Pablo de Olavide University, Seville, SPAIN

Published online: February28, 2022
(Accepted for publication February 15, 2022)
DOI:10.7752/jpes.2022.02045

Abstract:
Increased fatigue may be observed during a soccer match, with a reduction of the high intensity activities owing to physical demands. These actions lead to a decline in players' performance. The aim of the study was to analyze the acute effects of induced fatigue on passing ability in elite U-19 soccer players. Twenty-three elite U-19 soccer players (17.9 ± 0.7 years; weight 69.7 ± 8.1 kg; height 177.2 ± 7.6 cm) performed the Loughborough Soccer Passing Test (LSPT) to evaluate passing ability: control, dribbling, accuracy and decision making. Repeated sprint ability (RSA) was used to induce fatigue, 12 x 30 m sprints followed by 30 s recovery time. Heart rate (HR), Borg's rating of perceived exertion (RPE), time in 5 m and 30 m, sprint decrement (S_{dec}) and the fatigue index (FI) was collected. Student's t test was applied to compare the difference between pre-test and post-test. Differences were interpreted using Cohen's d effect size. Fatigue led to a significant increase in the number of penalties in the LSPT ($p < 0.001$; $d = 0.54$) and in total time to perform the test ($p = 0.001$; $d = 0.37$). Of the different types of error, passing accuracy was the ability that declined most ($p = 0.010$ $d = 0.72$). Ball control was also affected, but to a lesser extent ($p = 0.030$; $d = 0.39$). The results shown that passing ability was affected by fatigue in elite U-19 soccer players. This study provides detailed information for football coaches and physical trainers on the effects of fatigue on passing ability, describing the decline in performance of this specific ability in soccer.
Key Words*: *fatigue, skills, repeated sprint ability, performance.

Introduction

Soccer is an intermittent sport characterised by short bursts of high intensity activity, with long periods of running, interspersed with low intensity activity and walking (Di Salvo et al., 2007; Morgans et al., 2014). Values of 70-80% maximal oxygen intake, 80-90% maximum heart rate and peaks of 12 Mmol/l blood lactate have been reported during matches,(Bangsbo et al., 2006, 2007; Mohr et al., 2005) and this obviously leads to fatigue over the 90 minutes of play.

Several studies have investigated the effect of this fatigue on soccer skills, exploring its effect on shooting (R. Ferraz et al., 2012, 2017; R. M. P. Ferraz et al., 2019; Maly et al., 2018; Radman et al., 2016; Russell et al., 2011; Stone & Oliver, 2009; Torreblanca-Martinez et al., 2017; Zemkova & Hamar, 2009), dribbling (Currell et al., 2009; Figueiredo et al., 2011; Gharbi et al., 2016; Mirkov et al., 2008; Russell et al., 2011) and, to a lesser extent, ball control (Figueiredo et al., 2011) and passing (Draganidis et al., 2013; Impellizzeri et al., 2008; Lyons et al., 2006; Rampinini et al., 2008). Although passing ability is important in soccer players (Rampinini et al., 2008), being one of the major factors involved in scoring goals in international competitions (Hughes & Franks, 2005; Mitrotasios & Armatas, 2012), few studies have investigated the effect of fatigue on passing ability and the results are inconsistent (Draganidis et al., 2013; Impellizzeri et al., 2008; Lyons et al., 2006; Rampinini et al., 2008).

At a professional level, one study of the effect of fatigue induced by moderate and high intensity strength-training exercises on various abilities, including passing, found that regardless of the exercise intensity, elite players presented a decline in post-test passing performance, specifically in time taken to perform the Loughborough Soccer Passing Test (LSPT). Intensity was determinated by different percentage of RM (Draganidis et al., 2013). Similarly, junior professional club players showed a reduction in passing performance due to fatigue during and after a game and following a high intensity exercise simulation of five minutes. In both cases, the penalty time and the total LSPT time were affected (Rampinini et al., 2008).

In another study, physically active high school students performed the LSPT after executing moderate and high intensity local muscular endurance exercises (squats in one minute), and statistically significant differences were obtained between performance without fatigue and performance following high intensity exercise. The results showed statistically significant differences in total LSPT time and penalty time in all three fatigue conditions (Lyons et al., 2006). In addition, a high intensity simulation of five minutes has been used to study the effect of fatigue on passing ability in junior soccer players, dividing them into two groups where one

Corresponding Author: VICTOR TORREBLANCA-MARTÍNEZ, E-mail: victm81@hotmail.com

did interval training and the other served as a control. The results showed an increase in penalty time following a 5 min. high intensity simulation (Impellizzeri et al., 2008). Any of the prior studies determined a fatigue variable to quantify the effect of the fatigue protocol.
Thus, given the paucity of studies investigating the effect of fatigue on passing ability and the diversity of their results, the aim of the present study was to analyze the acute effects of induced fatigue on passing ability in elite U-19 soccer players. As a novelty of the study, fatigue was induced in a controlled manner to determine its real-match effect, something that no previous study has done.

Material & methods

Participants

Twenty-three elite male players in the under-19 Spanish first division participated in the study (17.9 ± 0.7 years; maximum heart rate 195.4 ± 0.5 bpm; weight 69.7 ± 8.1 kg; height 177.2 ± 7.6 cm). We excluded players with a diagnosed lesion, in the process of recovery or who had performed high intensity physical activity in the previous 48 hours. All subjects signed a written informed consent before participation, which was approved by the research ethics committee of the University of Alicante (IRB No. UA-2018-07-24).

Procedure

The experimental procedure was conducted on the soccer field where the team usually competed and trained, always at the same time of the day and in stable weather conditions to minimize possible variations. The subjects were asked not to perform high intensity sport activity in the 24 hours prior to the test or to drink coffee or eat in the 2 hours before. The participants were familiarized with the Loughborough Soccer Passing Test (LSPT) and the repeated sprint ability (RSA) protocol prior to the experimental procedure. All the sessions were performed in the same order. The general warm-up consisted of joint flexibility exercises, dynamic stretching, changes of direction and changes of speed. The specific warm-up consisted of passing circles.

Passing ability was assessed by means of the LSPT (Ali et al., 2007; Wen et al., 2017). The participants were told to execute passes from within the passing area, between the set of marked lines, and to perform the test as quickly as possible while making the fewest mistakes. They were also informed of the possible errors and that the ball had to cross two of the inner marked lines before the next pass could be attempted. As a measure of passing ability in soccer players, the first version of this test has proved valid and reliable, differentiating between players of different levels, sex and age (Wen et al., 2017). Its validity has also been demonstrated in young players (Le Moal et al., 2014). Two tripod-mounted Canon EOS 700D cameras (Canon Inc., Shimomaruko, Tokyo, Japan) were placed at two corners of a rectangle measuring 12x9.5 m. The use of two cameras ensured that the entire area of the test was always visible, enabling us to calculate performance variables more effectively following the execution of all sessions and to avoid observational errors. We subsequently analyzed the variables of time without penalties, penalty time, total time (sum of time without penalties and penalty time) and type of penalty. Penalty time (Figure 1) was awarded when a participant committed any of the errors (Ali et al., 2007).

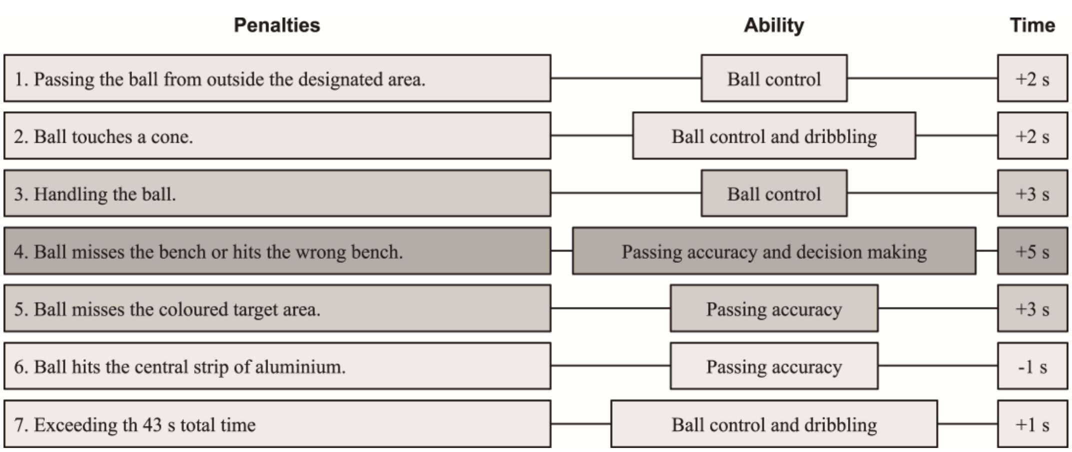

Figure 1. Loughborough Soccer Passing Test penalties.

Immediately after performing the LSPT, without any recovery time, the participants performed the RSA protocol. The protocol consisted of 12 separate 30 m sprints at maximum intensity followed by 30 s recovery time.(Morcillo et al., 2015) The players were told to perform the RSA starting from an upright position with the leading foot situated 1 m behind the first pair of photocells. Recovery between sprints consisted of walking or jogging slowly.

During the protocol, the time was measured using three pairs of Microgate Racetime 2 photocells (Microgate®, Bolzano, Italy) and a Linkgate DecRadio SF receiver (Balsalobre-Fernández et al., 2012; Gioldasis et al., 2014; Mitrotasios & Armatas, 2012; Nikolaos, 2015). These photocells comprise a transmission system for radio impulses and an interface system. In addition, heart rate was monitored throughout the session using two Polar M400 monitors (Polar Electro®, Kempele, Finland) (Al Sayed et al., 2017).

The sprint time was recorded at 5 and 30 m, using photocells placed at these distances, and subjective perceptions of effort and heart rate were recorded after completion of the sprint. We also calculated the mean sprint time. Borg's rating of perceived exertion (RPE) was used to assess the subjective perception of effort (Borg, 1998).

Sprint decrement (S_{dec}) and the fatigue index (FI) have both been proposed to determine the degree of fatigue attained (Girard et al., 2011).

$$Sdec\ (\%) = \left[1 - \frac{(S1 + S2 + S3 + \ldots + S12)}{(\text{best sprint x number of sprints})}\right] \text{x } 100$$

$$IF = \left[100 \text{ x} \frac{(\text{best sprint} - \text{worst sprint})}{\text{best sprint}}\right]$$

With respect to the RSA protocol, we analysed the heart rate, the time at 5 m, the time at 30 m, the subjective perception of effort (RPE), the sprint decrement (S_{dec}) and the fatigue index (FI).

Finally, the participants repeated the LSPT without resting. Their heart rate was measured immediately prior to starting and again after completing the LSPT.

Statistical analysis

The statistical analysis was performed using Statistical Package for Social Sciences (SPSS) v.24 (IBM, Armonk, NY: IBM Corp). Shapiro-Wilk test was used to determine whether the quantitative variables presented a normal distribution ($p < 0.05$). The Student's *t*-test was used for the variables that reached the level of significance. In addition, Cohen's d effect sizes were calculated (Cohen, 1988), categorizing values as small ($d < 0.3$), medium (d=0.3-0.5), large (d = 0.5-0.7), very large (d = 0.7-0.9) and extremely large ($d > 0.9$) (Hopkins et al., 2009).

Results

Regarding the RSA protocol, Table 1 gives a comparison of the variables of fatigue at the start and the end of the protocol. We found statistically significant differences with an extremely large effect size for the variables of heart rate difference ($p < 0.001$; $d = 7.82$), RPE ($p < 0.001$; $d = 5.94$), and time difference at 30 m ($p = 0.002$; $d = 1.04$). The time difference at 5 m presented statistically significant differences with a large effect size ($p = 0.137$; $d = 0.55$).

Table 1. Difference of fatigue variables for the RSA protocol.

	Mean ± SD	**CI (95%)**	***p***	**Effect size**	
				d	Size
HR (bpm)	53.4±13.5	47.4 – 59.4	< 0.001**	7.82	Extremely large
RPE	4.8±2.5	3.7 – 5.9	< 0.001**	5.94	Extremely large
$Time_{5m}$ (s)	0.1±0.2	-0.0 – 0.1	0.137	0.55	Large
$Time_{30m}$ (s)	0.2±0.3	0.1 – 0.4	0.002*	1.04	Extremely large
S_{dec} (s)	-3.9±0.6	-6.0 – -1.9	-	-	-
FI	-10.9±0.7	-12.9 – -9.0	-	-	-

RSA = repeated sprint ability; HR = heart rate; bpm= beats per minute; RPE = subjective perception of effort; S = sprint; S_{dec} = sprint decrement; FI = fatigue index; * $p < 0.05$;
** $p < 0.001$.

Table 2 shows the means obtained for the LSPT, comparing the results obtained with and without fatigue. We found statistically significant differences in the penalty time, with a large effect size ($p < 0.001$; d = 0.54) and in the total LSPT time, with a medium effect size ($p = 0.001$; $d = 0.37$), but not in LSPT time (p = 0.338; $d = 0.14$).

Table 1. Time results of the Loughborough Soccer Passing Test without and with fatigue.

	Without fatigue (mean±SD)	**With fatigue (mean±SD)**	**Change (mean±SD)**	**CI (95%)**	***p***	**Effect size**	
						d	Size
LSPT (s)	42.2±3.9	41.5±4.6	-0.6±3.1	-0.8 – 2.0	0.338	0.14	Small
Penalty (s)	8.1±8.4	13.6±9.9	5.5±4.8	-7.6 – -3.3	< 0.001**	0.54	Large
Total LSPT (s)	50.3±11.4	55.1±12.8	4.8±5.2	-7.2 – -2.5	< 0.001**	0.37	Medium

** $p < 0.001$

We also found statistically significant differences according to the type of penalty in the LSPT with and without fatigue, as shown in Table 3. P6 presented statistically significant differences with a very large effect size (*p*=0.01; *d*=0.72). Meanwhile, P1 (*d*=0.03; *p*=0.390) and P5 (*p*=0.460: *d*=0.02) also showed statistically significant differences with a medium effect size, whereas P3 and P7 (Figure 1) had a small effect size (*p*=0.150; *d*=0.35 and *p*=0.550; *d*=0.10, respectively).

Table 3. Differences according to type of error in the LSPT without and with fatigue.

	Without fatigue (mean±SD)	With fatigue (mean±SD)	Change (mean±SD)	CI (95%)	*p*	Effect size	
						d	Size
P1 (n)	1.3±1.7	2.1±1.9	-0.8±1.5	-1.4 – -0.1	0.030*	0.39	Medium
P2 (n)	1.3±1.2	1.7±1.3	-0.5±1.6	-1.12 – 0.3	0.150	0.35	Medium
P3 (n)	0.1±0.3	0.0±0.0	0.1±0.3	-0.0 – 0.2	0.150	0.00	Small
P4 (n)	0.0±0.0	0.1±0.4	-0.1±0.4	-0.3 – 0.2	0.080	0.40	Medium
P5 (n)	2.5±1.1	3.4±1.9	-0.9±1.5	-1.5 – -0.2	0.020*	0.46	Medium
P6 (n)	5.8±1.6	4.8±1.3	0.9±1.6	0.3 – 1.7	0.010*	0.72	Very large
P7 (n)	0.9±2.2	1.2±2.6	-0.3±1.3	-0.9 – 0.3	0.550	0.10	Small

LSPT= Loughborough Soccer Passing Test; P= penalty; * p<0.05.

Dicussion

The aim of the present study was to analyse the acute effects of induced fatigue on passing ability in elite U-19 soccer players. The differences of the fatigue variables showed differences in the heart rate ($p < 0.001$; $d = 7.82$), the RPE ($p < 0.001$; $d = 5.94$), the time at 5 m ($p = 0.137$; $d = 0.55$) and the time at 30 m ($p = 0.002$; $d = 1.04$). The existence of fatigue was also evident in the values obtained for S_{dec} (-3.9 ± 0.6 s) and the FI (-10.9 ± 0.7). Therefore, it seems clear that as a result of the RSA employed in our study, the participants performed the second LSPT under conditions of genuine fatigue, as quantified by the abovementioned variables. Previous studies have not quantified the variables of fatigue prior to the second test (Draganidis et al., 2013; Impellizzeri et al., 2008; Lyons et al., 2006; Rampinini et al., 2008); consequently, players may not actually have been fatigued when it was assumed that they were.

In the values obtained before and after fatigue induction for the different LSPT variables, the differences in LSPT time (42.2 ± 3.9 s; 41.5 ± 4.6 s) were not significant and presented a small effect size ($p = 0.338$; $d = 0.14$), but we did obtain significant differences with a large effect size ($p < 0.001$; $d = 0.54$) for penalty time (8.1 ± 8.4 s; 13.6 ± 9.9 s) and with a medium effect size ($p = 0.001$; $d = 0.37$) for the total LSPT time (50.3 ± 11.4 s; 55.1 ± 12.8 s).

Previous studies have reported similar results as regards differences in the penalty time and the total LSPT time with and without fatigue (Lyons et al., 2006; Rampinini et al., 2008), while another found the same significant difference in the total LSPT time before and after fatigue induction (Draganidis et al., 2013). Furthermore, these same studies did not find significant differences in the time without penalty (LSPT time). One study of soccer players similar in age to the mean age of our sample (Impellizzeri et al., 2008) also coincided in finding statistically significant differences in the penalty time but not in the LSPT time. However, the results obtained for total LSPT time were not statistically significant. One possible explanation for this discrepancy is that the study cited used a high intensity simulation fatigue protocol different to that used in the present study, and one that —unlike our protocol— did not simulate the specific demands of the game (Girard et al., 2011; Morcillo et al., 2015). In agreement with the results obtained in previous studies, we found a significant increase in penalty time with a large effect size when performing the LSPT following fatigue induction.

Finally, the study shows the differences in types of error made by the players without and with fatigue, as indicated by LSPT penalties. We found statistically significant differences for penalty 6 in relation to the passing accuracy, with a very large effect size ($p = 0.010$ $d = 0.72$). All the other penalties except 3 and 7 had a medium effect size and were related to decision making (penalty 4), ball control ability (penalties 1, 2, 3 and 7), dribbling (penalties 2 and 7) and passing accuracy (penalties 4, 5 and 6). These results clearly indicate that fatigue induced by the RSA exerted a negative effect on the abilities assessed by the LSPT, especially passing accuracy. Since no previous study has analyzed this aspect of the test, it represents a novelty of our study.

Conclusions

In conclusion, the results obtained in the present study show that passing ability in elite U19 soccer players is affected by fatigue induced by a RSA test. Although the time without a penalty in LSPT was unaffected, there was an increase in penalties because of fatigue, and in the total LSPT time (time and penalties). In addition, measures of fatigue ensured that second LSPT was performed in conditions of objective fatigue.

As regards the different types of error committed when performing the test under conditions of fatigue, the passing accuracy was the most strongly affected ability, but performance also declined in the variables related to dribbling and ball control.

As a practical application, following these study results, it could be advisable to program training exercises focusing on improving passing performance after fatigue situations. The study data and conclusions will help football professionals to better tailor training session activities aimed at improving passing ability, thereby contributing to improve overall sport performance.

Conflicts of interest - The authors declare no conflict of interest.

References:

Al Sayed, C., Vinches, L., & Hallé, S. (2017). Validation of a Wearable Biometric System's Ability to Monitor Heart Rate in Two Different Climate Conditions under Variable Physical Activities. *E-Health Telecommunication Systems and Networks*, *06*(02), 19–30. https://doi.org/10.4236/etsn.2017.62002

Ali, A., Williams, C., Hulse, M., Strudwick, A., Reddin, J., Howarth, L., Eldred, J., Hirst, M., & McGregor, S. (2007). Reliability and validity of two tests of soccer skill. *Journal of Sports Sciences*, *25*(13), 1461–1470. https://doi.org/10.1080/02640410601150470

Balsalobre-Fernández, C., del Campo-Vecino, J., Tejero-González, C. M., & Alonso-Curiel, D. (2012). Relación entre potencia máxima, fuerza máxima, salto vertical y sprint de 30 metros en atletas cuatrocentistas de alto rendimiento [Relationship between maximum power, maximum force, vertical jump and 30-meter sprint in high-performance four-century athle. *Apunts Educación Física y Deportes*, *108*, 63–69.

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2007). Metabolic response and fatigue in soccer. *International Journal of Sports Physiology and Performance*, *2*(2), 111–127. https://doi.org/10.1123/ijspp.2.2.111

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match- play in the elite football player. *Journal of Sports Sciences*, *24*(7), 665–674. https://doi.org/10.1080/02640410500482529

Borg, G. (1998). Borg´s perceived exertion and pain scales. In *Human Kinetics* (Issue August).

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. In *Statistical Power Analysis for the Behavioral Sciences* (Lawrence E).

Currell, K., Conway, S., & Jeukendrup, A. E. (2009). Carbohydrate ingestion improves performance of a new reliable test of soccer performance. *International Journal of Sport Nutrition and Exercise Metabolism*, *19*(1), 34–46. https://doi.org/10.1123/ijsnem.19.1.34

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, *28*(3), 222–227. https://doi.org/10.1055/s-2006-924294

Draganidis, D., Chatzinikolaou, A., Jamurtas, A. Z., Carlos Barbero, J., Tsoukas, D., Theodorou, A. S., Margonis, K., Michailidis, Y., Avloniti, A., Theodorou, A., Kambas, A., & Fatouros, I. (2013). The time-frame of acute resistance exercise effects on football skill performance: The impact of exercise intensity. *Journal of Sports Sciences*, *31*(7), 714–722. https://doi.org/10.1080/02640414.2012.746725

Ferraz, R. M. P., van den Tillaar, R., Pereira, A., & Marques, M. C. (2019). The effect of fatigue and duration knowledge of exercise on kicking performance in soccer players. *Journal of Sport and Health Science*, *8*(6), 567–573. https://doi.org/10.1016/j.jshs.2016.02.001

Ferraz, R., Van Den Tillaar, R., & Marques, M. C. (2012). The effect of fatigue on kicking velocity in soccer players. *Journal of Human Kinetics*, *35*(1), 97–107. https://doi.org/10.2478/v10078-012-0083-8

Ferraz, R., van den Tillar, R., & Marques, M. C. (2017). The influence of different exercise intensities on kicking accuracy and velocity in soccer players. *Journal of Sport and Health Science*, *6*(4), 462–467. https://doi.org/10.1016/j.jshs.2015.10.001

Figueiredo, A. J., Coelho e Silva, M. J., & Malina, R. M. (2011). Predictors of functional capacity and skill in youth soccer players. *Scandinavian Journal of Medicine and Science in Sports*, *21*(3), 446–454. https://doi.org/10.1111/j.1600-0838.2009.01056.x

Gharbi, A., Masmoudi, L., Chtourou, H., Chaari, N., & Tabka, Z. (2016). Effects of recovery mode on physiological and psychological responses and performance of specific skills in young soccer players. *The Journal of Sports Medicine and Physical Fitness*, *57*(12), 1590–1596. https://doi.org/10.23736/S0022-4707.16.06598-1

Gioldasis, A., Bekris, E., & Gissis, I. (2014). Playing Position: Anthropometric and Fitness Demands in Youth Soccer. *Sport Science Review*, *23*(3–4). https://doi.org/10.2478/ssr-2014-0009

Girard, O., Mendez-Villanueva, A., & Bishop, D. (2011). Repeated-sprint ability - part I: factors contributing to fatigue. *Sports Medicine (Auckland, N.Z.)*, *41*(8), 673–694. https://doi.org/10.2165/11590550-000000000-00000

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*(1), 3–12. https://doi.org/10.1249/MSS.0b013e31818cb278

Hughes, M., & Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer. *Journal of Sports Sciences*, *23*(5), 509–514. https://doi.org/10.1080/02640410410001716779

Impellizzeri, F. M., Rampinini, E., Maffiuletti, N. A., Castagna, C., Bizzini, M., & Wisløff, U. (2008). Effects of aerobic training on the exercise-induced decline in short-passing ability in junior soccer players. *Applied Physiology, Nutrition, and Metabolism*, *33*(6), 1192–1198. https://doi.org/10.1139/H08-111

Le Moal, E., Rué, O., Ajmol, A., Abderrahman, A. B., Hammami, M. A., Ounis, O. B., Kebsi, W., & Zouhal, H. (2014). Validation of the Loughborough Soccer Passing Test in young soccer players. *Journal of Strength and Conditioning Research*, *28*(5), 1418–1426. https://doi.org/10.1519/JSC.0000000000000296

Lyons, M., Al-Nakeeb, Y., & Nevill, A. (2006). Performance of soccer passing skills under moderate and high-intensity localized muscle fatigue. *Journal of Strength and Conditioning Research*, *20*(1), 197–202. https://doi.org/10.1519/R-17114.1

Maly, T., Sugimoto, D., Izovska, J., Zahalka, F., & Mala, L. (2018). Effect of Muscular Strength, Asymmetries and Fatigue on Kicking Performance in Soccer Players. *International Journal of Sports Medicine*, *39*(4), 297–303. https://doi.org/10.1055/s-0043-123648

Mirkov, D., Nedeljkovic, A., Kukolj, M., Ugarkovic, D., & Jaric, S. (2008). Evaluation of the reliability of soccer-specific field tests. *Journal of Strength and Conditioning Research*, *22*(4), 1046–1050. https://doi.org/10.1519/JSC.0b013e31816eb4af

Mitrotasios, M., & Armatas, V. (2012). Analysis of goal scoring patterns in the 2012 European Football Championship. *The Sport Journal*, *50*, 1–9.

Mohr, M., Krustrup, P., & Bangsbo, J. (2005). Fatigue in soccer: A brief review. *Journal of Sports Sciences*, *23*(6), 593–599. https://doi.org/10.1080/02640410400021286

Morcillo, J. A., Jiménez-Reyes, P., Cuadrado-Peñafiel, V., Lozano, E., Ortega-Becerra, M., & Párraga, J. (2015). Relationships Between Repeated Sprint Ability, Mechanical Parameters, and Blood Metabolites in Professional Soccer Players. *Journal of Strength and Conditioning Research*, *29*(6), 1673–1682. https://doi.org/10.1519/JSC.0000000000000782

Morgans, R., Orme, P., Anderson, L., & Drust, B. (2014). Principles and practices of training for soccer. *Journal of Sport and Health Science*, *3*(4), 251–257. https://doi.org/10.1016/j.jshs.2014.07.002

Nikolaos, K. (2015). Anthropometric and fitness profiles of young basketball players according to their playing position and time. *Journal of Physical Education and Sport*, *15*(1), 82–87. https://doi.org/10.7752/jpes.2015.01014

Radman, I., Wessner, B., Bachl, N., Ruzic, L., Hackl, M., Prpic, T., & Markovic, G. (2016). The acute effects of graded physiological strain on soccer kicking performance: a randomized, controlled cross-over study. *European Journal of Applied Physiology*, *116*(2), 373–382. https://doi.org/10.1007/s00421-015-3293-7

Rampinini, E., Impellizzeri, F. M., Castagna, C., Azzalin, A., Bravo, D. F., & Wisløff, U. (2008). Effect of match-related fatigue on short-passing ability in young soccer players. *Medicine and Science in Sports and Exercise*, *40*(5), 934–942. https://doi.org/10.1249/MSS.0b013e3181666eb8

Russell, M., Benton, D., & Kingsley, M. (2011). The effects of fatigue on soccer skills performed during a soccer match simulation. *International Journal of Sports Physiology and Performance*, *6*(2), 221–233. https://doi.org/10.1123/ijspp.6.2.221

Stone, K. J., & Oliver, J. L. (2009). The effect of 45 minutes of soccer- specific exercise on the performance of soccer skills. *International Journal of Sports Physiology and Performance*, *4*(2), 163–175. https://doi.org/10.1123/ijspp.4.2.163

Torreblanca-Martinez, V., Otero-Saborido, F. M., & Gonzalez-Jurado, J. A. (2017). Effects of muscle fatigue induced by countermovement jumps on efficacy parameters of instep ball kicking in soccer. *Journal of Applied Biomechanics*, *33*(2), 105–111. https://doi.org/10.1123/jab.2016-0040

Wen, D., Robertson, S., Hu, G., Song, B., & Chen, H. (2017). Measurement properties and feasibility of the Loughborough soccer passing test: A systematic review. *Journal of Sports Sciences*, *36*(15), 1682–1694. https://doi.org/10.1080/02640414.2017.1409611

Zemkova, E., & Hamar, D. (2009). The Effect of Soccer Match Induced Fatigue on Neuromuscular Performance. *Kinesiology*, *41*(2), 195–202.