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LAB-CONTROLLED SOCCER: A REVIEW OF SOCCER MATCH-PLAY SIMULATIONS

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ABSTRACT

Soccer is the most popular sport that has attracted not only participants and spectators, but also numerous researchers into studying a myriad of disciplines relating to the sport. The demands of the sport have been observed, studied, and replicated to be reproduced in a more controlled, laboratory setting in forms of various exercise protocols designed to mimic actual soccer match-play. However, the development and selection of a simulation has varied across studies. This review aims to compile and align various protocols in simulating soccer match-play to identify and evaluate the feasibility of incorporating different simulations into various studies in the sport. Overground and treadmill simulations may offer cost efficient reproduction of soccer match-play demands, with arguably the best control for uniform exertion to reduce injuries during simulations. This paper is the first narrative review to discuss numerous protocols used in research towards reproducing soccer match-play demands in a lab-controlled environment.

Keywords: *Lab Controlled Soccer, Match- Play Simulations, Match -Play demands, mimic*

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INTRODUCTION

Sports are popular for many reasons. Keeping healthy, for example, is often cited as a reason for participating in sports. Others will tell you that they do sports for recreational purposes. Sports are even more popular with people who do not necessarily participate in them, but love being spectators. With an estimated following base of 3.572 billion viewers during the 2018 FIFA World Cup (FIFA) and almost 270 million active players, soccer, or association football, is the most participated sport in the world. The prestige of the sport makes the bid for hosting the next World Cup events political in nature because of the major economic impact through the hosting the event (Baade & Matheson, 2004). With such prestige and expectations in the World Cup and other interest in soccer has propelled various studies in the research department in various branches of sport sciences from such as physiology, nutrition, conditioning, psychology, and biomechanics.

Studies in many disciplines of soccer generally explore the effects of fatigue from soccer match-play and the effects of soccer-specific exertions during match-play (Raja Azidin, 2015). According to Raja Azidin (2015), the distinction between the two is that the former generally puts their emphasis on fatigue itself, which was induced by high intensity repetitions of movements in soccer over a short bout of match-play instance, such as those displayed by Rampinini et al. (2008), Lucci et al. (2011), Bossuyt et al. (2015), and Mohd Noh et al. (2019). On the other hand, the latter puts greater emphasis on soccer-specific tasks throughout the length of a soccer match, with fatigue regarded as a by-product, or secondary effect, of the series of exertion. In the latter, the intensities of the tasks would be lower, with occasional bursts of short, high intensity activities.

Short-term, high intensity simulations could benefit researchers by highlighting physical performance decrements, which according to Mohr et al. (2003), could probably result as a consequence of an acute effect of temporary, or localized fatigue. These localized fatigue in soccer may be caused by match-play itself, but in lab-controlled studies, such fatigue were quickly replicated by virtue of changes in performances measured following high intensity activities such as sprints, plyometrics, or agility drills. Although these modifications allow time-efficient assessments for physical performance changes, the nature of the localized fatigue (peripheral fatigue), might not allow much understanding on how soccer match-play itself contributes to such decrements, in comparison to the role of fatigue on the performance changes. Thus, longer simulations, although more time consuming, may hold an edge by inducing a more central fatigue, through prolonged, intermittent soccer-specific actions.

This review aims to compile and align various soccer match-play simulations to identify and evaluate the feasibility of incorporating different simulations into various studies in the sport.

Reproducing the Demands of Soccer Match-Play in a Laboratory Setting

The initiative for a myriad of studies in soccer had to be developed from respective sport-specific demands. In soccer, the demands of the sport have been observed, studied, and replicated to be reproduced in a more controlled, laboratory setting. Advances in the technology and research has thus allowed many protocols for reproducing a certain sport

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specific demand and to provide better understanding of the effects sport-specific fatigue on their sport-specific task performance and relating to injury risk. In soccer, fatigue protocols have changed and evolved to many inputs from research such as match-play duration, activity profiles, task execution, physiological responses, and player loading.

Protocol Duration

As mentioned in the previous section, soccer simulations may allow time-savvy observations and assessments or facilitate a temporal depiction of how soccer match-play may contribute to the observed changes. Simulation protocols introduced by Rampinini et al. (2008), Lucci et al. (2011), Bossuyt et al. (2015), and Mohd Noh et al. (2019) conveniently require 5 minutes of exertions to induce localized fatigue for physical performance assessments. However, this review focuses on simulations that reproduce the demands of soccer match-play in a laboratory setting, with fatigue as secondary effect from the simulation.

Such simulations generally consume a longer duration for a singular assessment. A typical soccer match consists of two 45-minute halves, interceded by a 15-minute half time, totaling 90 minutes of match-play duration, and an additional 30 minutes of extra-time if the match is tied before resorting to penalty shoot-outs to decide a winner. This format has been observed by researchers to produce simulations of at least one half of a soccer match (Raja Azidin, Pykett, Scanlon, Baradburn, et al., 2014; Raja Azidin, Pykett, Scanlon, Bradburn, et al., 2014; Raja Azidin, Sankey, Drust, et al., 2015; Raja Azidin et al., 2013), while extra time procedures were incorporated into the simulation to suit certain research objectives as demonstrated by Harper et al. (2016) and Hamdan, Mohd Noh, et al. (2018). Most simulations address these match-play durations by virtue of a 15–20-minute activity profile, repeated consecutively to fulfil the 90 minutes of simulated match-play.

Activity Profiles

Running activity profiles in soccer have been mostly identified and categorized from standing still, walking, jogging, running or striding and sprinting occurring intermittently with the utility of backwards or sideways actions every now and then (Thatcher & Batterham, 2004). According to Reilly (1997), the intermittent activities are repeated continuously with about 44 static rest pauses (standing) at an average of 3 seconds almost every two minutes. In actual match-play, these activities are performed over a total of 90 minutes whilst superimposing various ball control actions (Robinson & White, 2005) which, according to Reilly (1997), could be influenced by the irregular volume and density of the actions throughout the course of the match. Match-play data from studies by Di Salvo et al. (2007) and Link and Hoernig (2017) have then been presented, suggesting that the activities in soccer match-play may vary across players depending on their playing position on the field (i.e. defenders, midfielders, and forwards), and the teams' playing styles (i.e. offensive and defensive). More recent simulations have thus introduced modifications to previous versions of soccer match simulations to allow more accurate representation of soccer activities throughout the simulations (da Silva & Lovell, 2020; Hamdan et al., 2020).

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Observed Parameters

It was proposed by Reilly (2005) that to measure the demands imposed by an athlete during match-play in relation to the actual demands of the game, physiological responses to the activity (i.e. heart rate (HR), rating of perceived exertion (RPE), blood lactate (BLa) and oxygen consumption (VO2)) may be used for insightful evaluation, and these information are often considered during assessments and designing injury prevention and fitness interventions (Reilly & Brooks, 1986). These physiological parameters could be used to describe the intensity of the soccer match-play simulation. Thus, most studies reported at least two, physiological responses throughout their respective simulations to be compared to actual match-play observations. Small (2008) summarized from a compilation of studies in league and friendly matches that a mean HR of 161 ± 5 beats per minute (bpm) could be observed among players throughout the course of a soccer match. Mohr et al. (2004) reported that oxygen consumption in soccer matches could reach up to 70% of a players' VO2max, with players' body mass decreasing by approximately 2% through fluid loss following increments in core body temperatures to up to 38.7 °C. The match-play simulation by Small (2008) allowed comparable physiological changes to actual soccer match-play and was adopted by subsequent researchers, each introducing slight modifications to facilitate improvement in spatial feasibility (Raja Azidin, Sankey, Drust, et al., 2015) and technical (sport-specific) validity (da Silva & Lovell, 2020; Hamdan et al., 2020).Table 1 is a summary of several selected studies reporting on the physiological responses that were reproduced from soccer specific fatigue protocols.

Table 1 : Summary of Physiological Responses to Soccer Match Simulation Protocols.

Author (year)	**Participant demographics**	**Protocol**	**Activity profiles**	**Key findings**
Nicholas et al. (2000)	Amateur Rugby and Soccer Players Male 22 ± 1 y N = 15	Loughborough Intermittent Shuttle Test Duration: Over 90 min	Standing Walking (Individual speed) Jogging (55% VO_{2max}) Striding (95% VO_{2max}) Sprinting (maximal speed)	HR: ~170 ± 4 bpm RPE_{10} (0-75 min): ~3 – 8 RPE_{10} (exhaustion): 10
Drust et al. (2000)	Collegiate Soccer Players Male 24 ± 2 y N = 7	Soccer Specific Intermittent Protocol Duration: 90 min	Standing Walking (6 km/h) Jogging (12 km/h) Striding (15 km/h) Sprinting (21 km/h)	HR: 168 ± 10 bpm RPE_{20}: 15 ± 2
Rahnama et al. (2003)	Amateur Soccer Players 23 ± 4 y N = 13	Soccer Specific Intermittent Protocol Duration: 90 min	Standing Walking (6 km/h) Jogging (12 km/h) Striding (15 km/h) Sprinting (21 km/h)	HR: N/A RPE: N/A
Thatcher and Batterham (2004)	Professional and Academy Soccer Players	Soccer Specific Exercise Protocol Duration: 90 min	Standing Walking (5 km/h) Jogging (10km/h) Running (17 km/h)	HR: 166 ± 12 bpm RPE: N/A

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	First team: 30 ± 3 y Academy: 17 ± 1 y N = 12 First team; 12 Academy		Sprinting (23 km/h)	
Greig et al. (2006)	Semi Professional Soccer Players Male 25 ± 4 y N = 10	Soccer-Specific Intermittent Treadmill Protocol Duration: 90 min	Standing Walking (4 km/h) Jogging (8 km/h) Running (12, 16 and 21 km/h) Sprinting (25 km/h)	$HR_{Initial}$: 125 ± 10 bpm HR_{Final}: 135 ± 10 bpm RPE_{20} (Initial): 9 ±1 RPE_{20} (Final): 12 ± 2
Kellis et al. (2006)	Professional Academy Soccer Players 18 ± 1 y N = 8	Acute Endurance Protocol Duration: 90 min	Walking (5.5 km/h) Sprinting (maximal effort) Jogging (50 – 60% HR_{max}) Running (80 – 90% HR_{max})	HR: 150 – 187 ± 8 bpm RPE: N/A
Sanna and O'Connor (2008) *Continued*	Division 1 Collegiate Soccer Players Female 20 ± 1 y N = 12	Intermittent Shuttle Run Duration: 60 min	Standing Walking (35% VO_{2max}) Jogging (55% VO_{2max}) Striding (95% VO_{2max}) Sprinting (maximal speed)	HR: ~170 ± 4 bpm RPE_{10}: increase from 3 ± 1 (initial) to 7 ± 1 (final)
Greig (2009)	Professional Soccer Players Male 25 ± 4 y N = 10	Soccer-Specific Intermittent Treadmill Protocol Duration: 90 min	Standing Walking (4 km/h) Jogging (8 km/h) Running (12, 16 and 21 km/h) Sprinting (25 km/h)	HR: N/A RPE: N/A
Stone and Oliver (2009)	Semi Professional Division 2 Soccer Players Male 21 ± 1 y N = 9	Modified Loughborough Intermittent Shuttle Test	Walking (5 km/h) Jogging (9 km/h) Running (14 km/h) Sprinting (maximal effort)	HR: 155 ± 12 bpm RPE: N/A
Williams et al. (2010)	Amateur Soccer Players Male 26 ± 5 y	Ball-Sport Endurance and Sprint Test	Walking Jogging/Decelerating Forward running Backpedaling	HR: 156 – 167 bpm RPE: N/A

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	N = 15	Duration: 90 min	Sprinting (75% maximum effort) Jumping Target shooting	
Small et al. (2010)	Semi Professional Soccer Players Male 21 ± 3 y N = 15	Soccer-Specific Aerobic Field Test Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: N/A RPE: N/A
Stone et al. (2011)	Semi Professional Soccer Players Male 21 ± 2 y N = 12	Soccer Simulation Protocol Duration: 90 min	Walking (5 km/h) Jogging (9 km/h) Running (14 km/h) Sprinting (maximal effort)	HR: 163 ± 14 bpm BLa: 4.9 ± 2.3
Russell, Benton, et al. (2011)	Youth Pro Soccer Players 18 ± 1 y N = 15	Soccer Match Simulation Duration: 90 min	Walking Sprinting Dribbling Jogging Striding Shooting Passing	$HR_{Trial\ 1}$: 170 ± 2 bpm $HR_{Trial\ 2}$: 169 ± 1 bpm RPE: N/A
Russell, Rees, et al. (2011)	Youth Pro Soccer Players 15 ± 1 y N = 10	Soccer Match Simulation Duration: 90 min	Walking Sprinting Dribbling Jogging Striding Shooting Passing	HR: 158 ± 4 bpm RPE: N/A
Bendiksen et al. (2012) *Continued*	Amateur Soccer Players Male 24 ± 5 y N = 12	Copenhagen Soccer Test Duration: 90 min	Standing Walking (6 km/h) Jogging (8 km/h) Running (12, 15 and 18 km/h) Backpedaling (10 km/h) Sprinting (> 25 km/h)	HR: 85 ± 1 – 86 ± 1% HR_{max} RPE: N/A
Cone et al. (2012)	Collegiate Soccer Players Male and Female 20 ± 1 y N = 12 Male; 12 Female	Individualized Soccer-match Simulation Duration: 90 min	Walking (20.4% VO_{2max}) Jogging (40.6% VO_{2max}) Running (60 – 83%, 84 – 94% and 105 – 109% VO_{2max})	HR: N/A RPE_{20}: 15 ± 3
Robineau et al. (2012)	Amateur Soccer Players Male 24 ± 5 y N = 12	Soccer Game Modelling Duration: 90 min	Standing Walking (4 km/h) Jogging (8, 10 and 12 km/h)	HR: 84 ± 6% HR_{max} RPE: N/A

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			Running (≤ 10% Maximal Aerobic Velocity) Sprinting (maximal effort)	
Lovell et al. (2013)	Semi Professional Soccer Players Male 20 ± 1 y N = 10	Soccer-specific Aerobic Field Test Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: 161 ± 8 bpm RPE: N/A
Shultz et al. (2013)	Collegiate and Club Players Male and Female Male: 20 ± 2 y Female: 21 ± 2 y N = 30 Male; 29 Female	Intermittent Exercise Protocol Duration: 90 min	Walking Jogging Running (low intensity) Running (moderate intensity) Running (high intensity)	HR: N/A RPE: N/A
Raja Azidin, Pykett, Scanlon, Baradburn, et al. (2014)	Healthy Players Female Age: N/A N = 15	Overground Soccer Match Simulation Duration: 45 min	Overground: Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: N/A RPE: N/A
Raja Azidin, Sankey, Drust, et al. (2015)	Recreationally Active Players Male 26 ± 5 y N = 20	Treadmill Soccer Match Simulation Duration: 45 min Overground Soccer Match Simulation Duration: 45 min	Treadmill: Standing Walking (4 km/h) Jogging (8 km/h) Running (12, 16 and 21 km/h) Sprinting (25 km/h) Overground: Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	Treadmill: HR: 142 ± 5 bpm RPE_{20}: 12 ± 2 Overground: HR: 160 ± 7 bpm RPE_{20}: 15 ± 2
Raja Azidin, Sankey, et al. (2015a) *Continued*	Recreationally Active Soccer Players Male 26 ± 4 y N = 14	Overground Soccer Match Simulation Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: N/A RPE: N/A
Raja Azidin,	Recreationally Active Soccer Players	Overground Soccer Match Simulation	Standing Walking (5 km/h) Jogging (10.3 km/h)	HR: N/A

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Sankey, et al. (2015b)	Male Age: N/A N = 18	Duration: 90 min	Striding (15 km/h) Sprinting (≥ 20.4 km/h)	RPE: N/A
Page et al. (2015)	Semi Professional Soccer Players Male 23 ± 4 y N = 18	Soccer-Specific Intermittent Protocol Duration: 90 min	Standing Walking (4 km/h) Jogging (8 km/h) Running (11.6, 15 and 18 km/h) Sprinting (25 km/h)	HR: 162 -172 bpm RPE_{20}: 14 ± 3 BLa: 3 ± 2 mmol/L VO_{2max}: 33.7 ± 4.7 ml/kg/min VO_{2peak}: 53 ± 8.7 ml/kg/min
Shultz et al. (2015)	Collegiate and Club Players Male and Female Male: 20 ± 2 y Female: 21 ± 2 y N = 30 Male; 29 Female	Intermittent Exercise Protocol Duration: 90 min	Walking Jogging Running (low intensity) Running (moderate intensity) Running (high intensity)	HR: N/A RPE: N/A
Barreira et al. (2016)	Recreational Players Male 26 ± 4 y N = 15	Overground Soccer Match Simulation Duration: 45 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: N/A RPE: N/A
Stone et al. (2016)	Division 1 Soccer players Male 20 ± 1 y N = 8	Soccer Simulation Protocol Duration: 90 min	Walking (5 km/h) Jogging (9 km/h) Running (14 km/h) Sprinting (maximal effort)	HR: N/A RPE: N/A BLa: Lower at 2nd Half
Harper et al. (2016)	Professional Academy Soccer Players Male 16 ± 1 y N = 8	Modified Soccer Match Simulation Duration: 120 min	Forwards running Backwards running Sideways running Sprinting Dribbling	RPE_{20} (1st half): 10 ± 4 RPE_{20} (2nd half): 12 ±4 RPE_{20} (Extra time): 15 ± 4
Hamdan, Ismail, et al. (2018)	Recreational Players Male 23 ± 5 y N = 18	Overground Soccer Match Simulation Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: 153 ± 10 bpm RPE: 12 ± 2

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Hamdan, Mohd Noh, et al. (2018)	Recreational Players Male 23 ± 5 y N = 16	Overground Soccer Match Simulation Duration: 120 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h)	HR: 150 ± 11 bpm RPE: 12 ± 2
da Silva and Lovell (2020)	University Players Male 23 ± 2 y N = 18	Technical Soccer-Specific Aerobic Field Test Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h) Jumping Shooting Passing Dribbling	%HRpeak: 85 ± 7 RPE: 18 ± 2 Body Mass Change: -1 kg Creatine Kinase: 283 ± 178 U/L Myoglobin: 203 ± 121 ng/mL Cortisol: 13 ± 5 µg/dL Leukocytes: 11250 ± 2643 /mm^3 Neutrophils: 7787 ± 2406 /mm^3 Lymphocytes: 3013 ± 1050 /mm^3
Hamdan et al. (2020)	Recreational Players Male 25 ± 2 y N = 7	Ball Oriented Soccer Simulation Duration: 90 min	Standing Walking (5 km/h) Jogging (10.3 km/h) Striding (15 km/h) Sprinting (≥ 20.4 km/h) Jumping and Heading Shooting Passing Dribbling	HR: 149 ± 8 bpm RPE: 14 ± 1

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Undoubtedly, there have been various soccer match-play simulations developed using treadmill and overground protocols to simulate soccer matches. The need to replicate the characteristics of soccer match-play activities demands the incorporation of utility movements, which are often multidirectional, and implements high accelerations and decelerations over the course of the simulation which may be found lacking in a single direction treadmill protocol with motor-controlled accelerations and decelerations (Raja Azidin, Sankey, Drust, et al., 2015). Overground protocols, on the other hand, requires greater space for various activities incorporated in the simulation to accommodate these demands. Furthermore, overground simulations have shown to elicit better representation of physiological (Raja Azidin, Sankey, Drust, et al., 2015) and accurate physical (Barreira et al., 2016) demands of actual match-play. However, not all overground match-play simulations fulfil certain ecological parameters in soccer; especially when it comes to individual ball actions and running distance. Table 2 briefly summarizes several parameters that a player covers in actual match observations in comparison to that covered in selected overground match-play simulations.

Table 2: Selected Overground Soccer Match-Play Characteristics

Item	Author	IEP	M-LIST	CST	BEAST90	SAFT90	OSMS	BOSS	T-SAFT90
Total Distance	Small et al, (2010) 11.08 km	NR	12.5 km	11.29 km	8.10 km	11.1 km	10.78 km	10.78 km	11.1 km
Distance in Possession	Di Salvo et al, (2007) 119 – 286 m	NA	NA	NR	NA	NA	NA	270 m	360 m
Individual Ball Actions	Link et al, (2017) 117 – 126	NA	36	NR	NR	NA	NA	120	48
Shooting		NA	√	√	√	NA	NA	36	12
Passing		NA	NA	√	NR	NA	NA	48	24
Heading /Jumping		NA	NA	NR	NR	NA	NA	12	12
Dribbling		NA	NA	√	NR	NA	NA	18	12

NR = Not Reported; NA = Not available

Several Soccer match simulations have been identified and reviewed. According to Small et al. (2010), the mean distance covered in soccer matches is 11.08km, which was closely replicated in the SAFT90, OSMS, CST, and BOSS. Many simulations consisted of various profiles from walking, to striding and sprinting, which were required to be performed at either a predetermined percent of maximal volume of oxygen consumption (VO2max), heart rate, or simply by covering a determined distance over a duration controlled by audio cues. Monitoring match-play simulations using physiological responses as aerobic capacity and heart rate measurements may allow accurate physiological replication of the demands during a soccer match simulation, however, the utility of audio cues to complete a distance creates a condition to fulfill both physiological and physical demands of a match play (Barreira et al., 2016). Moreover, the individual aerobic capacities among athletes and participants need to be assessed beforehand and may vary and cause discrepancies in physical distance covered during a simulation. This adds an opportunity for added information on a participants' physical condition, but it may present drawbacks such as increased assessment duration, equipment, and manpower. Whereas audio-based cues create physical and physiological demands of a soccer match (Barreira et al., 2016) as participants are instructed to complete the simulation as closely as possible (Small et al., 2010).

Spatial Considerations for Protocol Selection

Some extensions from overground soccer match-play simulations has included ball handling skills such as kicking and heading in an attempt to extend the ecological validity of the simulation such as the BEAST90 (Williams et al., 2010) and the CST (Bendiksen et al., 2012). These additions of ball actions was to reproduce movement patterns experienced in actual soccer matches (Stølen et al., 2005). The design of the BEAST90 and the CST has been done in a spacious setting such as in a sports hall or on an open field. The reason for such circumstance was because the course of the simulations set up as a battery of small soccer drills where the participants were required to move from one station to another and they included ball kicking with accuracy. Thus, a large, spacious area becomes a requirement. Whereas the OSMS and the SAFT90 were designed over a 15m (Raja Azidin, Sankey, Drust, et al., 2015) and a 20m (Small et al., 2010) course, allowing administration in smaller areas or laboratories. This makes the OSMS and the SAFT90 more versatile and a more convenient protocol to be employed. However, despite being able to reproduce physical and physiological demands of match-play, both SAFT and the OSMS lacked an ecological element of a soccer match-play: ball handling tasks.

Ecological Validity of a Soccer Match-play Simulation

Several innovations have then been introduced based on the SAFT90 and the OSMS. The technical SAFT (T-SAFT90) which was based on the SAFT90 has included jumping and technical skills (da Silva & Lovell, 2020), while a shorter, 5min-duration, high intensity variant, SAFT5 (Bossuyt et al., 2015), incorporated agility and plyometrics to reproduce high-intensity bouts of a soccer match. da Silva and Lovell (2020) reported improved external validity of the T-SAFT90 to undertake ecologically valid soccer research with the incorporation of ball handling tasks as passes, dribbles, and shots on target. However, the total frequency of ball activities reported summed up to less than half of the reported 117-126 times in actual match-play (Link & Hoernig, 2017). The ball-oriented soccer simulation (BOSS) (Hamdan et al., 2020) was a variant of the OSMS by Raja Azidin, Sankey, Drust, et al. (2015) which included ball handling tasks ranging from running with a ball (dribbling), heading, short passes and shooting (or long passes, interchangeably) tasks. The design of the BOSS was targeted to replicate the ecology of a soccer match-play where players interact with the ball up to 120 times, covering range between 120 – 286m when in possession of the ball per person

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(Di Salvo et al., 2007). Several modifications could also be considered for the BOSS to accommodate the demands of different studies and sample characteristics such as a distance reduction of the course for a younger population or conducting the simulation on-field outdoors to integrate shooting or passing accuracy tests during the simulation itself such as demonstrated by Nordin et al. (2020).

Alternatives to Soccer Match-play Simulations

To our knowledge at the time of the review, the BOSS may be the closest soccer match-play simulation available for a controlled laboratory study. Overground soccer match-play simulations may be used as a more resource efficient strategy to reproducing the demands of soccer match-play for laboratory studies. Several studies approached reproduction of soccer match-play demands by conducting simulated matches (de Oliveira et al., 2018; Freitas et al., 2016; Russell et al., 2014). These simulated matches are conducted in a manner that recreates actual match conditions where two teams of 11 players will compete on-field with full involvement by coaches and support teams. These organized matches would require increased costs of preparation, time, and human resource to be successfully executed. On the other hand, simulated matches are ideal for conducting studies on physiological and metabolic parameters as data may be collected by groups, thus allowing efficient data collection periods. Whereas overground match-play simulations are administered for one participant at a time such as for biomechanical assessments for injury risks, thus several considerations are required such as a standardized session time for all participants to account for circadian variations among participants and their training schedules.

CONCLUSION

Several soccer match-play simulations have been reviewed in this article. To our knowledge, this paper is the first narrative review to discuss numerous protocols used in research towards reproducing soccer match-play demands in a lab-controlled environment. Several key points that could be taken from this review may be as follows:

Overground and treadmill simulations may offer cost efficient reproduction of soccer match-play demands, with arguably the best control for uniform exertion to reduce injuries during simulations. These simulations may be beneficial for a myriad of study disciplines in soccer.

The several considerations should be highlighted in selecting a soccer match-play simulation, namely space, resources, ecological validity, and time efficiency.

The utility of soccer match-play simulations could allow further understanding in the biological responses of athletes during matches, therefore, it seems logical that a simulation replicates soccer specific demands of match-play, whilst being safe, feasible and controllable to be conducted in lab-controlled studies.

Practical applications of simulated soccer match-play includes using them as fatiguing protocols for soccer-specific injury risk screening and return to play assessments.

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Authors' contributions

Raja Mohammed Firhad Raja Azidin was responsible for the preliminary reviews of soccer match-play simulations, and for the review of earlier versions of the manuscript.

Muhammad Hamdan was responsible for reviewing the characteristics of simulated soccer match-play and writing up the manuscript.

Conflict of Interest

There was no conflict of interest to be reported.

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