Title: The physical demands of professional soccer goalkeepers throughout a week-long competitive microcycle and transiently throughout match-play

Running Title: Physical demands of soccer goalkeepers

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ABSTRACT

The physical demands of English Premier League soccer goalkeepers were quantified during training and match-play in a two-part study. Goalkeeper-specific micromechanical electrical systems (MEMS) devices, profiled training and match-day activities throughout one competitive week (*n*=8; part A). Changes in MEMS-derived outputs were also profiled throughout match-play (100 matches; *n*=8, 18±14 observations per goalkeeper; part B). In part A, goalkeeping-training elicited the most dives (51±11) versus all activities (all $p \leq 0.030$) except shooting-training ($p=0.069$). Small-sided games elicited the fewest (5±3) dives (all $p \leq 0.012$). High-speed distance covered in match (103±72 m) was similar to goalkeeping-training ($p=0.484$), while exceeding shooting-training, small-sided games, pre-match shooting, and pre-match warm-up (all $p=0.012$). Most changes of direction (34±12) and explosive efforts (70±18) occurred during goalkeeping-training, with values exceeding match (both $p=0.012$). In part B, between-half reductions in total distance, but increased high-speed changes of direction and explosive efforts, occurred (both $p \leq 0.05$). Excluding the number of high jumps, all variables differed from 0-15-min during at least one match epoch, with more dives (1.3±1.4 vs 1.0±1.1) and explosive efforts (2.5±2.4 vs 2.0±1.8) performed between 75-90-min versus 0-15-min (all $p<0.05$). These data highlight the differing physical demands of various activities performed by professional soccer goalkeepers throughout a competitive week.

KEY WORDS: Goalkeeping, performance, team sport

INTRODUCTION

The physical demands of soccer have been extensively characterized, primarily with respect to the movement responses of outfield players during training and match-play (2, 15). However, comparable information relating to the unique positional demands of goalkeepers is currently lacking (26). The goalkeeper's primary role in soccer is to protect their team's goal, whilst a secondary purpose lies in ball-distribution during the initiation of an attack. As the ultimate objective of soccer is to out-score the opposition, it stands to reason that the demands placed upon goalkeepers have the potential to directly influence the outcome of a match.

Adaptive responses to training are realized through progressive manipulation of key training variables, including (but not limited to) the volume, intensity and type of exercise stimuli applied (9). Indeed, empirical observations highlight that the designs of soccer conditioning sessions are often predicated on the basis of practitioners' *a priori* knowledge of the specific demands elicited by the various components of the training and competitive week, alongside the associated recovery requirements. It is therefore likely that characterization of goalkeepers' match-play and training demands would benefit practitioners seeking to optimize training prescription for this bespoke playing population (26). Given their distinct tactical responsibilities, goalkeepers possess a bespoke skillset when compared with players occupying outfield positions (26, 27). Indeed, empirical observations suggest that professional goalkeepers conduct much of their training and preparatory activities typically under the guidance of position-specific coaches. We are aware of only one published study to have investigated the demands of goalkeeper-specific training sessions during a competitive microcycle (13). Whilst Malone et al. (13) highlighted that a professional goalkeeper covered up to ~3.7 km at ~45 $m \cdot min^{-1}$ during certain training sessions in the four days preceding a match (compared with up to ~6.9 km for professional outfield players; 12, 18), information concerning position-specific performance indicators, and details regarding the specific content of the training sessions were omitted; the authors merely presenting data as a function of a session's proximity to match-day.

It is well documented that for outfield players, indices of physical and technical performance decline progressively throughout 90-min of soccer-specific exercise (16, 21, 22), with further decrements reported during matches continuing to extra-time (i.e., 120 min; 10, 11, 24). Such declines are primarily attributed to increases in physical fatigue during the latter stages of match-play, and the existence of conscious or subconscious self-pacing strategies (2, 4, 15). However, consistent with their unique tactical role, goalkeepers appear to face vastly different match-demands when compared with their outfield counterparts. Indeed, professional goalkeepers may cover ~50% (i.e., 4-6 km) of the match-distances of outfield players, whilst performing only ~2 short (i.e., typically <10 m) sprints (6, 13, 26). To the authors knowledge, no study has investigated whether goalkeepers experience transient changes in position-specific physical demands over the course of 90-min of competitive match-play as has been reported for outfield players (7, 15, 23). This is made more surprising by the disproportionate number of goals scored during the final 15-min of a match (17), alongside empirical observations suggesting that goalkeepers are rarely substituted, except for in the case of injury.

Therefore, this two-part study used position-specific physical performance indicators to quantify the movement demands elicited during goalkeeper-specific training throughout a competitive microcyle (part A), and profiled transient changes in the movement responses of professional soccer goalkeepers during 90-min of match-play (part B). Such findings may have important implications for the preparatory and/or tactical game-management strategies employed in relation to soccer goalkeepers. Based on empirical evidence and inferring from previous literature, it was hypothesized that the movement demands would vary according to the type of the session being performed, and that transient changes in physical demands would be experienced over the course of soccer match-play.

MATERIALS AND METHODS

Study design

To quantify the movement demands, professional soccer goalkeepers were monitored via goalkeeper-specific micromechanical electrical systems (MEMS) sampling at 10 Hz (model G5, version 1.15.0; Catapult innovations Ltd., Australia) worn during normal training and on match-day during the 2017/18 season. In part A, all participants completed the demands of each activity and a within-subject design was implemented to allow comparison between the different activities performed throughout a competitive week-long microcycle. Part B assessed transient changes across 90-min of match-play using linear mixed modelling.

Subjects

Following institutional ethical approval , professional, male soccer goalkeepers (part A: n=8, age: 24 ± 7 years, stature: 1.84 ± 0.08 m, mass: 89.8 ± 6.0 kg; part B: n=8, age: 19 ± 2 years, stature: 1.84 ± 0.08 m, mass: 86.8 ± 3.0 kg) from an English Premier League soccer club (the highest tier of professional soccer in the United Kingdom) volunteered to participate. Retrospective power analyses using obtained effect sizes, alpha values and sample sizes indicated that beta values >0.8 were obtained for continuous variables in both parts A and B (G*Power version 3.1.9.2). Players were informed about the risks and benefits of participation before being invited to provide written consent (in addition to parental consent and player assent where players were <18 years of age) prior to data-collection, and all were considered by club medical staff to be healthy and injury-free throughout the duration of the study. For part A, data represents activities performed by each goalkeeper within a single week during the first half of the 2017/18 season, whilst data for part B reflects 100 matches (18 ± 14 matches·goalkeeper^{-1}).

Procedures

For part A, the activities of 'match,' 'personal pre-match warm-ups', and 'pre-match shooting' all occurred on a match-day, whilst all other activities (i.e., 'goalkeeping-training', 'shooting-traning', and 'small-sided games') were performed at the club's training facility on non-match-days. Goalkeepers' personal pre-match warm-ups included players' own self-selected activities, which typically encompassed ball handling skills, replication of match scenarios, and individual crossing and distribution preparations. Goalkeeping-training involved a group of between two and six goalkeepers who were supervised by at least one goalkeeping coach, whereas small-sided games (i.e., 7v7, 8v8 and 9v9 scenarios) and shooting-training also incorporated outfield players and coaches. All matches were ~90-min in duration and fixtures from both domestic league and cup competitions were included (i.e., under 18, under 21, FA cup, League Cup, and Southern Premier soccer competitions). For part B, the potential influence of the duration of competitive match-play on goalkeepers' movement responses were analyzed by dividing match data separately into 45-min halves and into six 15-min epochs. All data after the scheduled end of each half (i.e., stoppage time) were omitted from analysis. All training and match activities were performed on natural outdoor grass pitches in accordance with English Football Association rules.

Micromechanical electrical system (MEMS) analysis

Players' movements were monitored throughout the study using goalkeeper-specific 10 Hz MEMS units (model G5, version 1.15.0; Catapult innovations Ltd., Australia) harnessed centrally between the scapulae in a specifically designed vest designed to minimize movement artefact. Sampling at 10 Hz has demonstrated coefficient of variation (CV%) values of 2.0-5.3% for measuring instantaneous velocity (25), whilst the accelerometers within the specific devices used have produced good intra- and inter-unit reliability (CV%: 0.9-1.1) in both laboratory and field test environments (3). The MEMS units were activated according to the manufacturer's guidelines ~40-min before commencing each activity, and players wore the same device throughout the study in order to avoid inter-unit variability. Data were exported following completion of each activity using the manufacturer's specialist software (OpenField, version 1.15.0 Build #26615 - Installer Release; Catapult innovations Ltd., Australia). Eight indices of physical performance were analyzed, being; the number of dives, the number of high (i.e., >0.4 m in height), medium (i.e., 0.2-0.4 m), and low (i.e., <0.2 m) jumps, high-speed changes of direction (i.e., changes of direction at speeds >3.5 $m \cdot s^{-1}$), and explosive efforts (i.e., combined number of: high-speed changes of direction, high jumps, and instances in which a dive was followed by a goalkeeper returning to standing within 1 s), and the distance covered in total and at high-speed (i.e., >4.17 $m \cdot s^{-1}$). To support the use of such thresholds, unpublished observations suggest that in isolated performance tests, the players involved attain maximal countermovement jump heights >0.4 m (i.e., 0.50±0.06 m). When considering the high-speed running threshold that is typically employed when monitoring outfield players (i.e., >5.5 $m \cdot s^{-1}$), only ~0.8% of total distance covered by professional goalkeepers may be categorized as high-speed (unpublished observations the same professional club recruited to the study); a value which increases to ~2.6% when a modified threshold of >4.17 $m \cdot s^{-1}$ is used.

Statistical analyses

Statistical analyses were conducted using both Statistical Package For Social Sciences (SPSS; Version 21.0; SPSS Inc., Chicago, IL, USA), and R statistical software (V3.3.1). Data are presented as mean ± standard deviation (SD) unless otherwise stated. For Part A, as all players completed the demands of all activities, a Friedman's analyses of variance (ANOVA) was used to assess the influence of session-type on the specific movement demands observed. Where significant effects were identified ($p \leq 0.05$), differences between individual session-types were assessed using Wilcoxon post-hoc tests. Effect sizes (d) were calculated according to Cohen (5), and interpreted as trivial ($d < 0.2$), small ($0.2 \leq d < 0.6$), moderate ($0.6 \leq d < 1.2$), large ($1.2 \leq d < 2.0$), very large ($2.0 \leq d < 4.0$), and extremely large ($d \geq 4.0$). For part B, following removal of any outliers identified from consulting residual plots, mixed models used the lme4 package within R statistical software to estimate the effect of time on the outcome variables profiled during match-play. Due to the lack of independence between repeated measurements of players

(15-min observations, nested within matches, nested within individual players) over the course of the season, mixed effect models were used to estimate the effect of time on the movement demands observed. Time (i.e., 'epoch') was included as a fixed effect with random intercepts modelled separately for each outcome variable. Linear mixed models (b [95% CI]) were used for continuous outcomes of distance and high-speed distance, while count data were analysed using a mixed effects Poisson regression model. To assess changes in performance variables over the course of 90-min, the 0-15-min epoch was specified as the baseline comparator, and bootstrapped 95% confidence intervals (CI) were obtained for the exponentiated parameter estimates, which are expressed as incident risk ratios (RR) for count variables.

RESULTS

Part A: A comparison of physical demands throughout a week-long competitive microcycle

Table 1 indicates the physical demands elicited by different goalkeeper-specific activities. Activity type influenced all outcome variables. With the exception of goalkeeping-training ($p=0.260$), the duration of match exceeded that of all other activities (all $p \leq 0.012$, all $d \geq 9.2$; extremely large effects). Goalkeeping-training elicited the highest number of dives relative to all activities (all $p \leq 0.030$, all $d \geq 1.7$; large effects) except for shooting-training ($p=0.069$). The fewest dives were performed in small-sided games (all $p \leq 0.012$, $d \geq 2.3$; very large effects), whilst goalkeepers covered the greatest total distances in match (all $p \leq 0.017$, all $d \geq 2.1$; very large effects). For high-speed distance, match was similar to goalkeeping-training ($p=0.484$), but greater than shooting-training, small-sided games, pre-match shooting, and pre-match warm-up (all $p=0.012$, all $d \geq 1.8$; large effects). More high jumps occurred in goalkeeping-training versus all other activities (all $p \leq 0.035$, all $d \geq 1.4$; large effects) except pre-match warm up ($p=0.063$). The number of high-speed changes of direction and explosive efforts was greatest in goalkeeping-training with values exceeding match (both $p=0.012$, both $d \geq 3.0$; very large effects) by more than three and four-fold, respectively, whilst the fewest high-speed changes of direction occurred in small-sided games (all $p \leq 0.034$, all $d \geq 1.1$; moderate to large effects).

***** INSERT TABLE 1 NEAR HERE *****

Part B: Transient changes in physical demands throughout match-play

Table 2 provides mean±SD for physical performance variables per half of match-play. Between-half declines were observed for total distance, whilst the number of high-speed changes of direction and explosive efforts increased from the first to second half (both $p \leq 0.05$). High-speed distance and the number of dives were similar between halves, as was the number of high, medium, and low jumps.

***** INSERT TABLE 2 NEAR HERE *****

Table 3 shows descriptive statistics for physical performance variables throughout match-play while Table 4 presents the linear and mixed effects Poisson regression models assessing changes over time (i.e., relative to 0-15-min). Except for the number of high jumps, all performance variables differed from 0-15 min during at least one other match epoch (all $p \leq 0.05$). Relative to the 0-15-min observation, total distance covered was significantly lower in all subsequent epochs. Likewise, high-speed distance was lower for all epochs compared with 0-15-min. The number of high-speed changes of direction was higher only for 60-75-min relative to 0-15-min values, although more explosive efforts were performed between 60-75-min and 75-90-min compared with the initial 15-min of match-play. The number of dives was higher at 30-45-min, 60-75-min, 75-90-min compared with 0-15-min, whilst more medium jumps were performed between 30-45-min than 0-15-min. The number of low jumps were reduced at all time-points relative to 0-15-min values.

***** INSERT TABLE 3 NEAR HERE *****

***** INSERT TABLE 4 NEAR HERE *****

DISCUSSION

In agreement with our hypotheses, professional soccer goalkeepers experienced differing physical demands over the course of one competitive week (i.e., as a function of activity type; part A), and transient changes throughout 90-min of match-play (i.e., as a function of match duration; part B). Notably, in part A, exposure to high-intensity actions (such as dives, jumps, high-speed changes of direction, and explosive efforts) was greatest in goalkeeping and shooting-based training activities, but lowest in match-related activities such as small-sided games and competitive match-play. In part B, goalkeepers performed more dives and explosive efforts during the final 15-min (i.e., 75-90-min) of competitive matches when compared with the opening phase (i.e., 0-15-min) of play. Collectively, this comprehensive analysis of the physical demands of professional soccer goalkeepers provides novel information that will be useful to inform practitioners when planning the preparation and periodization of training and/or recovery strategies for soccer goalkeepers over the course of the competitive week.

Whilst match-play may be expected to elicit the greatest movement demands of any activity performed by soccer players throughout a competitive week, this was not necessarily the case for goalkeepers when certain position-specific performance metrics (i.e., dives, jumps, changes of direction, and explosive efforts) were considered. Notably, goalkeepers in the current study performed more dives (~51 vs ~10), high-speed changes of direction (~34 vs ~8), high (~14 vs ~1) and medium (~19 vs ~7) jumps, and explosive efforts (~70 vs ~16) during a ~79-min goalkeeping-training session when compared with 90-min of match-play. In a case study of a single professional goalkeeper, Malone et al. (13) have previously reported increases in the number of high-intensity (defined as a change in speed >3 $m \cdot s^{-2}$) accelerations and decelerations performed four days prior to a match (i.e., 'match-day minus four') when compared with match-day itself. As a lack of goalkeeper-specific performance variables, and the omission of information characterizing the type of training performed (other than proximity to match-day), limits the ability to make direct comparisons between these two studies, such observations reinforce the notion that the physical demands placed upon soccer goalkeepers appear to differ markedly dependent upon the specific type of activity being undertaken. Importantly, it remains to be determined whether the same is true with regards to the cognitive loads experience by goalkeepers throughout training and match-play.

Training sessions incorporating small-sided games are often used by practitioners to provide a match-specific physical conditioning stimulus for outfield players, and have been reported to augment the development of physiological, psychological, technical, and tactical performance whilst also facilitating the longitudinal monitoring of neuromuscular fatigue (20). However, consistent with the differences in positional responsibilities between goalkeepers and outfield players, it is possible that small-sided games may not promote the development of goalkeeper-specific physical qualities to the same extent. Indeed, fewer dives (~5 vs ~10 to ~51) and explosive efforts (~8 vs ~16 to ~70) were performed during small-sided games compared with all other activities (Table 1). That said, small-sided games may provide other benefits to the goalkeeper such as the development of tactical cues and interpersonal understanding when working with their defenders, or opportunities to consolidate technical abilities (such as dives, blocks, spreads) which may initially be practiced during isolated goalkeeping sessions. Nevertheless, although such observations are limited to one club during a single competitive week-long microcycle, and aspects relating to cognitive function were not assessed, the movement demands elicited may call into question the efficacy of small-sided games to challenge the physical development of soccer goalkeepers.

Total distance (~5100 to ~5500 m) covered was greatest in match-play versus other activity types, and the absolute values observed reflect those previously reported in relation to professional goalkeepers (6, 12, 26). However the ~100 to ~120 m of high-speed distance covered during match-play represents nearly double the values published previously (6), findings which likely reflect the differing thresholds of high-speed running categorization (i.e., >5.5 $m{\cdot}s^{-1}$ vs >4.17 $m{\cdot}s^{-1}$ in the current study). It should be noted that as part of their distributional role, goalkeepers may also perform a number high-velocity kicking actions which may substantially add to overall physical loading; particularly on match-day. In support, data from Australian Football players has reported significant reductions in the eccentric strength of the hamstring musculature following performance of 100 drop kicks (8). Unfortunately, the absence of physiological measurements in the current study, and in the goalkeeper-specific literature published to date, means the physiological and fatigue responses to goalkeeper-specific activities remain to be determined.

Di Salvo et al. (6) used a multi-camera tracking system to monitor total distance covered by 62 English Premier League goalkeepers, and reported no significant differences between the first and second halves of match-play. In contrast, as has been established in relation to outfield players (15, 16, 23), goalkeepers in the current study covered less total distance (2887 m vs 2663 m) during the second half, when compared with the opening 45-min. However, whilst outfield players experience between-half decrements in a number of other physical (e.g., high-speed distance, number of accelerations/decelerations etc.) and technical (e.g., passing speed and success) key performance indicators (16, 19, 21), this was not the case for goalkeepers. Indeed, high-speed distance and the number of dives performed remained similar between halves, whilst goalkeepers performed more explosive efforts (7.4 vs 6.4) and high-speed changes of direction (4.0 vs 3.3) from 45-90-min, compared with before half-time. Whist the reasons for such responses remain to be determined, these observations further emphasize the unique physical and technical demands associated with soccer goalkeepers, and thus highlight the need for individualized consideration of preparatory and recovery practices for this bespoke population of player.

In addition to between-half differences, for certain metrics (i.e., the number of dives, high-speed changes of direction, and explosive efforts), goalkeepers appeared to experience greater physical demands during the final 30-min (i.e., 60-75 and 75-90-min epochs) of a match, when compared with the opening 15-min. In addition to the potential influence of tactical changes and other contextual variables, such observations may plausibly reflect the performance fluctuations experienced by outfield players. Speculatively, the progressive fatigue experienced by outfield players during a 90-min match (1, 2, 15) may compromise a team's defensive structure and promote an increase in the number of scoring opportunities (e.g., shots taken and crosses played into the goalkeeping area) towards the end of a match (6, 17). If true, these changes would likely influence the physical demands experienced by goalkeepers, who may be required to respond in order to protect their goal and/or quickly re-distribute the ball to team-mates.

When interpreting the current findings, a number of limitations should be considered. It is prudent to note that although all goalkeepers were over the age of 16 years at the time of data-collection, these data do not distinguish between age-groups within the sampled population. Due to the sample of professional players used in this study, negligible statistical power would have been yielded if such an approach had been adopted. Nonetheless, novel findings have been presented, which support and extend the limited body of research documenting the physical demands of professional soccer goalkeepers. Similarly, whilst the current study used MEMS devices to quantify the physical demands faced by professional goalkeepers during a competitive week, future research should aim to highlight the cognitive, technical and physical demands that MEMS devices cannot quantify. In particular, given empirical observations that goalkeepers may experience substantial mental fatigue as a result of match-play, profiling the cognitive and/or psychological responses to different goalkeeper-specific activities would allow practitioners to better understand the total load experienced by goalkeepers and thus help to elucidate the potential mechanisms underpinning any periods of reduced physical or technical performance. Such holistic research could implement differential rating of perceived exertion (dRPE) metrics which quantify self-perceived breathlessness, leg and upper body exertion, as well as cognitive and technical demands (14).

In conclusion, soccer goalkeepers occupy a unique tactical role, yet the physical demands experienced during position-specific training and match-play activities are not well understood. The current study presents novel physical data which provide insight into the training and competitive demands of professional soccer goalkeepers, and thus may aid practitioners when seeking to devise training and recovery practices. Indeed, knowledge of the demands elicited by different activities is likely beneficial when looking to develop periodization strategies which appropriately balance stimulus and recovery across a micro, meso, and/or macrocycle. For example, the apparent lesser degree of physical loading elicited by small-sided games when compared with other activities such as goalkeeping, may suggest that small-sided games represent an appropriate activity when reductions in physical loading are desired (e.g., de-load periods or when development of other technical skills is the priority), or that small-sided games may need to be supplemented with other activities in order to ‘top-up’ the physical, and in turn technical, stimuli provided on any given day. Goalkeepers also experienced transient changes in physical demands throughout 90-min of match-play; responses which may be attributable to changes in tactics in conjunction with the progressive fatigue of outfield players towards the end of a match. Observed increases in certain position-specific movements towards the end of match-play, highlight a potential role for ergogenic interventions at specific time-points during a match, and/or requirements for goalkeeper training to ensure that players are equipped to respond to such heightened demands.

DECLARATION OF INTEREST STATEMENT

No external financial support was received and there are no conflicts of interest to declare. Authors AW and CR had their salaries paid by AFC Bournemouth at the time of submission but this organisation had no involvement in sanctioning of the study design, data analysis and interpretation nor the manuscript preparation.

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LEGENDS

Table 1: Mean (standard deviation) movement demands elicited throughout goalkeeper-specific activities performed during a competitive week

Table 2: Mean (standard deviation) physical performance variables in the first and second halves of match-play

Table 3: Mean (standard deviation) physical performance variables per 15-min of match-play

Table 4: Effect estimates showing changes from the reference value in physical performance variables per 15-min of match-play

Table 1: Mean (standard deviation) movement demands elicited throughout goalkeeper-specific activities performed during a competitive week

Variable		Activity type					
		Match (a)	Goalkeeping-training (b)	Shooting-training (c)	Small-sided games (d)	Pre-match shooting (e)	Pre-match warm-up (f)
Duration (min)		91 (4)	79 (19)	29 (9)[ab]	14 (4)[abc]	12 (2)[abc]	35 (9)[abde]
Dives (No.)		10 (1)	51 (11)[a]	39 (13)[a]	5 (3)[abc]	36 (6)[abd]	20 (3)[abcde]
Total distance (m)		5169 (705)	3154 (1182)[a]	1400 (606)[ab]	687 (194)[abc]	869 (154)[abc]	1658 (288)[abde]
High-speed distance (m)		103 (72)	88 (99)	6 (9)[a]	3 (6)[ab]	5 (9)[ab]	8 (8)[ab]
Jumps (No.)	High	1 (1)	14 (10)[a]	3 (5)[b]	0 (0)[bc]	1 (1)[bd]	5 (3)[ade]
	Medium	7 (4)	19 (3)[a]	7 (3)[b]	3 (5)[b]	7 (3)	13 (4)[acde]
	Low	7 (5)	10 (2)	7 (7)	6 (4)[b]	8 (4)	4 (3)[ab]
High-speed changes of direction (No.)		8 (3)	34 (12)[a]	23 (9)[a]	5 (2)[abc]	24 (5)[abd]	15 (3)[abcde]
Explosive efforts (No.)		16 (3)	70 (18)[a]	39 (18)[ab]	8 (3)[abc]	40 (7)[abd]	24 (4)[abcde]

[a] represents significant within-variable difference relative to match, [b] represents significant within-variable difference relative to goalkeeping, [c] represents significant within-variable difference relative to shooting, [d] represents significant within-variable difference relative to small-sided games, [e] represents significant within-variable difference relative to pre-match shooting

Table 2: Mean (standard deviation) physical performance variables in the first and second halves of match-play

Variable	Overall	First half	Second half
Dives (No.)	7 (4)	3 (3)	4 (2)
High jumps (No.)	1 (1)	1 (1)	1 (1)
Medium jumps (No.)	8 (5)	4 (3)	4 (3)
Low jumps (No.)	11 (8)	6 (4)	6 (5)
Total distance (m)	5549 (750)	2887 (384)	2663 (409) **
High-speed distance (m)	117 (60)	63 (36)	54 (42)
High-speed changes of direction (No.)	7 (4)	3 (2)	4 (3) *
Explosive efforts (No.)	17 (7)	6 (4)	7 (4) *

* difference at $p<0.05$ level relative to first half values, ** difference at $p<0.001$ level relative to first half values

Table 3: Mean (standard deviation) physical performance variables per 15-min of match-play

Variable	**Timing**					
	0-15 min	**15-30 min**	**30-45 min**	**45-60 min**	**60-75 min**	**75-90 min**
Dives (No.)	1 (1)	1 (1)	1 (1)	1 (1)	2 (1)	1 (1)
High jumps (No.)	0.2 (0.5)	0.2 (0.5)	0.2 (0.4)	0.2 (0.4)	0.2 (0.5)	0.2 (0.5)
Medium jumps (No.)	1.3 (1.4)	1.1 (1.3)	1.3 (1.5)	1.8 (1.8)	1.3 (1.5)	1.0 (1.3)
Low jumps (No.)	2.4 (2.1)	1.8 (1.5)	1.7 (1.9)	2.1 (2.5)	1.8 (2.1)	1.6 (1. 8)
Total distance (m)	1005 (135)	950 (135)	931 (160)	917 (152)	867 (151)	878 (163)
High-speed distance (m)	26 (21)	19 (15)	18 (18)	16 (16)	18 (17)	20 (25)
High-speed changes of direction (No.)	1.1 (1.1)	1.2 (1.4)	1.0 (1.2)	1.3 (1.4)	1.5 (1.3)	1.3 (1.5)
Explosive efforts (No.)	2.0 (1.8)	2.2 (2.0)	2.2 (2.1)	2.2 (2.0)	2.8 (2.0)	2.5 (2.4)

Table 4: Effect estimates showing changes from the reference value in physical performance variables per 15-min of match-play

Variable	**0-15 min**	**15-30 min**	**30-45 min**	**45-60 min**	**60-75 min**	**75-90 min**
Dives (No.)	REF	1.13 [0.86,1.48]	1.32 [1.02,1.71]*	1.06 [0.81,1.40]	1.56 [1.21,2.00]***	1.31 [1.01,1.71]*
High jumps (No.)	REF	1.00 [0.54,1.83]	0.81 [0.42,1.53]	0.86 [0.46,1.61]	1.14 [0.64,2.05]	1.14 [0.64,2.05]
Medium jumps (No.)	REF	0.86 [0.67,1.12]	1.05 [0.82,1.33]	1.40 [1.12,1.76]***	1.04 [0.81,1.33]	0.79 [0.61,1.03]
Low jumps (No.)	REF	0.74 [0.61,0.91]***	0.74 [0.61,0.90]***	0.90 [0.75,1.08]	0.77 [0.64,0.94]*	0.67 [0.55,0.82]***
Total distance (m)	REF	-54.72 [-82.63,-26.81]*	-73.66 [-101.58,-45.75]*	-87.91 [-115.82,59.99]*	-138.15 [-166.07,-110.24]*	-126.73 [-154.67,-98.82]*
High speed distance (m)	REF	-6.82 [-11.78,-1.86]**	-8.00 [-12.96,-3.04]**	-9.35 [-14.31,-4.39]***	-8.11 [-13.07,-3.15]**	-5.72 [-10.69, -0.76]*
High speed changes of direction (No.)	REF	1.08 [0.84, 1.40]	0.91 [0.70,1.19]	1.13 [0.87,1.46]	1.32 [1.02,1.68]*	1.17 [0.91, 1.51]
Explosive efforts (No.)	REF	1.07 [0.88, 1.29]	1.08 [0.89,1.30]	1.08 [0.89,1.30]	1.35 [1.13,1.62]***	1.21 [1.01, 1.45]*

Data are reported as incidence risk ratios (RR) other than for total distance and high speed distance which is b [95% CI].
p<0.05 *; p<0.01 **; p<0.001 ***. Reference value REF.