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ABSTRACT

Purpose: To map anthropometric and physical performance profiles in Norwegian premier league female football players.

Methods: During pre-season, the physical qualities of 107 players were tested on Keiser leg press, countermovement jump (CMJ), 40-m sprint and agility. Descriptive statistics were presented as mean ± standard deviation and median ± IQR. Pearson's correlations analyses were made for all performance tests and results presented as R-value with 95% confidence intervals.

Results: The female players were 22 ± 4yr, stature 169.0 ± 6.2cm, bodyweight 65.3 ± 6.7kg; force 2122 ± 312N, power 1090 ± 140W, sprint 40-m 5.75 ± 0.21s, Agility dominant 10.18 ± 0.32s, non-dominant 10.27 ± 0.31s, CMJ 32.6 ± 4.1cm. Outfield players were faster and more agile than goalkeepers, difference for 40-m, agility of dominant-, and non-dominant leg respectively; 0.20 [0.09-0.32], 0.37 [0.21-0.54], 0.28 [0.12-45] ($p < 0.001$). Goalkeepers and central defenders were taller and heavier compared to fullbacks, central midfielders, and wide midfielders (p ranging from < 0.02) A difference was found between dominant and non-dominant leg for the agility test, showing that players are faster when changing direction with the dominant leg.

Conclusions: Our study presents anthropometric and physical performance profiles of Norwegian premier league female football players. We found no difference for the physical qualities' strength, power, sprint, agility and CMJ between any outfield playing positions in female premier league players. There was a difference between outfield players and goalkeepers for sprint and agility.

Word count: 237

Key Words: women, strength, power, speed, counter movement jump, agility

INTRODUCTION

In the last decade female football has been professionalized internationally. Players now have access to full-time training environments, improved training facilities, strength- and conditioning, and medical provision and support [1-3]. Thus, female players have increased physical demands in both training and match play[2, 4]. Football is a high-intensity intermittent sprint sport involving repeated explosive efforts [5]. It has been shown that more successful teams, classified by league position, complete more high intensity playing actions across a match, suggesting that superior levels of physical capacity are associated with improved team success [6]. In addition, it has been shown that playoff matches have greater demands than regular season matches in professional women's soccer [7]. Thus, to cope with increasing physical demands, players are required to produce high force at high velocities over short time periods and to improve physical qualities such as sprinting, jumping and strength [8, 9]. It is suggested that also repetitive sprint endurance play a major role in women's football and should be emphasized as part of the physical preparation at an elite standard [2, 10]. Specific sprint and jump training, as well as strength training, has been shown to improve players' ability to accelerate, jump higher, and increase maximal speed [11-13]. To design adequate training programs, it is vital to assess the physical qualities such as sprint, jump and strength of female players. This can be beneficial for coaches in order to determine whether physical qualities in their team are appropriate, or to what level it should be improved [2].

Even though research on female football has increased in recent years [1, 2], there is still a lack of studies providing data on physical qualities. Thus, the aim of this study was to map anthropometric and physical performance profiles of Norwegian female premier league players.

METHODS

Study design

This is a descriptive study of Norwegian premier league female players. In pre-season, January through Mid-April 2020, all 10 teams participating in the female premier league (Toppserien) were invited to and conducted the performance testing in the Norwegian FA Sports Medicine Clinic in Oslo. Teams were invited through e-mails sent from the Football Association of Norway, the Norwegian FA Sports Medicine Clinic, and the Norwegian Women's Premier League organization to all the club CEO's and their coaching staff. All teams accepted and completed physical performance tests before the competitive season started. All players provided digitally their written consent to participate in the study. The study was approved by the institutional ethical review board at the Norwegian School of Sport Sciences, reference no. 86-131218.

Participants

From the ten teams, 155 (82%) out of 189 eligible players met for physical performance testing. Of these, one team refrained from sprint testing (n = 10), and an additional 38 players (24.5%) were unable to complete one or more of the physical performance tests due to injury or return to play restrictions (figure 1). One-hundred and seven players (69%) from 9 teams completed all the test and were included in the study. Player's characteristics are presented in table 1.

INSERT FIGURE 1 APPROXIAMTELY HERE

Test setup and preparations

Player's height and weight was measured before all players completed a standardized warm-up program including 10 minutes of slow speed running followed by three progressively increasing sprints of each 40-m. After the warm-up, players were allowed 5-10 minutes recovery before progressing to testing. The warm-up program was similar in duration and intensity as most of the participating clubs general routines, and in line with recommendations of intensity, duration and recovery from Bishop, 2003[14] In addition, specific trial warm-ups were conducted at each test-station throughout the day, also in line with recommendations of Bishop, who recommend including task-specific activities[14]. All players completed the strength and jump tests in a randomized order before progressing to the 40-m sprint test followed by the agility test. In between the specific tests there was a minimum of 3 min rest and recovery period to minimize the risk of fatigue and to prevent injury[14, 15]. Below, rest and recovery between trials within each test is specified for each test. The test supervisors were the same for all testing days, RA, ST, HM, JH and MV.

Physical performance testing

Leg press power and force were measured using the seated leg press (Keiser A420, Sports Health Equipment, Inc., California, USA). The test estimate max- force and power using a repeated repetition force-velocity protocol. This means that the results presented for force and power are estimated maximal values obtained from the force-velocity profile created from all the repetitions of each participant, not peak force and power obtained in a single repetition. A computer running the Keiser A420 version 6.2.10.1 (Keiser A420, Sports Health Equipment, Inc., California, USA) logged all trials and created the force-velocity profile for each athlete. This has been proved to be a valid measure for force and power [16]. Seat position was adjusted so that both the hip and the knee were bent at 90° and the back and head was supported against the seatback. The players feet were placed at the bottom of each foot plate, with the heel resting on the rubber "lip" at the bottom of the foot plate. The players were instructed to stabilize the upper body by using the handgrips on each side of the seat.

Before the test, players performed a standardized warm-up consisting of 3 slow and 3 fast repetitions with both 60 kg and 120 kg resistance. The test started at 38 kg resistance and increased with approximately 20 kg increments between each test trial. Players were instructed and verbally encouraged to produce maximal velocity on all trials. The rest periods between trials were of increasing length, starting with 5 seconds between trials and increasing to 10 seconds after the 5th load level (approx. 118 kg). Then rest was increased by 5-6 seconds for each trial until reaching a maximum rest period of 38 seconds after the 10th trial (219 kg resistance).

Countermovement jumps (CMJ) were performed on a force platform (MuscleLab forceplate, Ergotest Innovation AS, Porsgrunn, Norway) with a time resolution of 1000 Hz and a force resolution of 0.1 N. To minimize differences in jumping technique, players were instructed to start in a standing position with the plantar part of the foot contacting the ground and with the hands on their hips. Before the test, players performed three submaximal jumps as a specific warm-up. After a stance phase to measure body weight, the subjects were instructed to jump as high as possible with a self-selected squat depth. A jump was approved if the subjects kept their hands on their hips and went directly into a negative phase (eccentric movement) at the start of the jump. The players performed three jumps with at least a 30-seconds recovery period in between each jump. The software (MuscleLab Software version 10.5.69.4823) estimated the jump height through the impulse-momentum method and was recorded to the nearest 0.1 cm. The best CMJ result was retained for analyses.

A 40 m sprint test was performed on an indoor 13-mm Polytan M synthetic surface (Polytan GmbH, Germany) using MuscleLab wireless timing gates (Ergotest Innovation AS, Porsgrunn, Norway) with infrared photocells. The photocells were connected to a computer running MuscleLab Software version 10.5.69.4823, recording time to the nearest 0.001 second. Each of the timing gates consisted of two infrared lasers, separated with about 30 cm vertical distance that worked as a pair in which both beams had to be broken to record a passing. The gates were placed approximately 1.0 m above the ground. Players started each sprint trial on their own initiative, starting from a stationary position at 0 m with the foot covering a release sensor photocell which activated a recording as soon as a foot left the ground. Each player completed three 40 m maximal sprints, with 3-minute rest periods in between trials. Time was measured every 5 m and the results at 20 m, 30 m, and 40 m from the best trial, e.g., defined from the best 40 m result, was retained for analyses.

The 40 m agility test was performed on the same surface and using the same equipment as the sprint test. The agility test included two sprints of 12.5 m, three sprints of 5 m, and four 180 degrees change of directions (figure 2). Players started each trial 30 cm behind the first photocell. Changes-of-directions were made at the two lines marked in the track, 7.5 m, and 12.5 m from the starting line. A trial was not accepted unless the planting foot crossed the given line during all change-of-directions. This was controlled by two researchers placed at each line. When crossing the finish line, the final time was recorded to the nearest 0.001 second. Players performed the test twice with a 3-minute rest period in between trials. During the first trial, all changes-of-directions were performed with the right leg crossing the line, and conversely, placing the left leg over the line in the second trial. Results from both trials were retained for analyses.

INSERT FIGURE 2 APPROXIMATELY HERE

Statistical analysis

We performed statistical analyses in IBM SPSS statistics version 26. Descriptive statistics was obtained through SPSS using the descriptive statistics analysis tool, and results are presented as mean ± standard deviation (SD). In addition, the results for estimated max force, sprint 20-m, 30-m and 40-m, as well as agility non-dominant leg are presented with median ± interquartile range (IQR) as these parameters was not normally distributed. For differences between playing positions, we conducted an ANOVA followed by an independent samples T-test for the data that was normally distributed. For the data which was not normally distributed we conducted a Mann-Whitney U Test, followed by an independent-samples Kruskal-Wallis Test. Alpha level was set at 0.05 for all analysis. To improve statistical power and reduce chance of false positives when analyzing for differences between positions central defenders (CD) and fullbacks (FB) were pooled as defenders, and central midfielders (CM) and wide midfielders (WM) were pooled as midfielders. Attackers (A) and goalkeepers (GK) was retained as separate groups. In addition, we defined all outfield playing positions as one position and analyzed any differences between outfield players and goalkeepers (GK). To identify differences between dominant and non-dominant leg in the 40 m agility test we performed a paired student's T-test with an alpha level of 0.05. Pearson's correlations analyses were made for all performance tests and results are presented as R-value with 95% confidence intervals (CI). Strength of correlations were interpreted as, strong >0.8, moderate 0.6 – 0.8, fair 0.3 – 0.5, and poor <0.3[17]

RESULTS

Player characteristics, all players pooled, and per playing position are presented in table 1. Descriptive analysis of physical performance tests for all players pooled and divided by playing positions are presented in table 2. No difference was found between outfield playing positions for any performance parameters.

Anthropometrics

There was no difference in age (range: 21 (16-37 yrs.)) between any positions. For stature, goalkeepers and defenders were taller compared to midfielders ($p < 0.02$ and $p < 0.05$ respectively). Furthermore, goalkeepers had a higher bodyweight than defenders ($p < 0.00$), midfielders ($p < 0.00$) and attackers ($p < 0.03$). In terms of body mass index (BMI) goalkeepers had a higher BMI compared to all other positions ($p < 0.02$). No other differences were found between any other playing positions for anthropometrics and BMI. BMI ranged from 18.6 – 27.5 for all players, 10 players had a BMI above 25, and no players had a BMI below 18.5.

INSERT TABLE 1 APPROXIMATELY HERE

Strength and power

No differences were found for strength and power measures between any positions (table 2). Goalkeepers produce the highest absolute force, while the lowest absolute force measured was found for Central midfielders. We found a moderate correlation between maximal power per kg bodyweight and CMJ as well as between sprint and agility measures, but apart from that, correlations were considered fair or poor (table 4).

INSERT TABLE 2 APPROXIMATELY HERE

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Sprint and agility

A difference was found between dominant and non-dominant leg for the agility test, showing that players are faster when changing direction with the dominant leg, $p < 0.01$ (table 2). A difference was also evident between goalkeepers and midfielders for non-dominant leg agility ($p < 0.01$), as well as between goalkeepers and defenders ($p < 0.01$), goalkeepers and midfielders ($p < 0.00$) and goalkeepers and attackers ($p < 0.01$) for dominant-leg agility. Between goalkeepers and all outfield players as one group we found a difference in both sprint time and agility performance, however, no differences were evident for the performance variables (table 5 and figure 3).

INSERT FIGURE 3 APPROXIMATELY HERE

INSERT TABLE 5 APPROXIMATELY HERE

DISCUSSION

The aim of the current study was to present anthropometrics and physical performance profiles of Norwegian premier league female players for key physical performance qualities; strength (force) and power, jump height, sprint, and agility. Our main findings were that outfield players performed better on agility and sprint tests compared to goalkeepers, however, no additional positional differences were observed.

Anthropometrics

Anthropometric measurements indicate that Norwegian female premier league players have characteristics in the upper end of the spectrum compared to previously reported numbers from female football elsewhere. Our study showed a stature of 169 ± 6.2 cm and bodyweight of 65.3 ± 6.7 kg. This is similar to previous ranges [2, 18] for female football players, showing averages from 161–170 cm and 57–65 kg for stature and bodyweight, respectively. Furthermore, they state that adopting specific anthropometric and body compositions targets is unjustified as there is, and has been for a long time, a heterogeneity among female players [2, 18]. This is supported by our findings showing a range of 35.5 cm in stature and 37.0 kg in bodyweight. The study by Randell et al. [18] , however, urged future researchers to determine whether specific anthropometric profiles were evident for specific playing positions. Our data does not show such specific profiles but indicates that goalkeepers and defenders tend to be taller and heavier than players in other playing positions.

Strength and power

Jumping capability has previously been reported as a measure of power in football players [2], and has been closely linked to strength [19]. Castagna and Castellini [20] indicated that CMJ height of 29.8 is a threshold for the top-level female football players, and 34.4 cm as threshold for superior jumping ability. The current results show 32.6 ± 4.1 cm for all players, which falls between the values previously reported[20]. This is higher than the Castagna and Castellini's threshold [20], and might be due to increased professionalism in all aspects of female football recently. Previous studies describe CMJ heights from 26.1 ± 4.8 cm (elite Spanish players) [21], and up to 35 ± 1.0 cm (Danish top division) [22]. A study by Vescovi et al [23] reported numbers as high as 42.0 ± 5.0 cm for 18-21 years old players. However, they measured the CMJ with a timing mat which likely overestimating height results as heights were estimated through flight-time, only [24]. A study by Garcia-Lopez[24] indicated that jump performance would be overestimated using a timing mat, as flight time is overestimated and contact time is underestimated when measuring with a timing mat compared to a force platform[24]. Fullbacks (n = 16) had a CMJ height of 35.0 ± 4.5 cm indicating that fullbacks may possess a greater jumping ability than players in other positions. As fullbacks had the lowest bodyweight, but still produced more power than some other positions, i.e., having a greater power per kg bodyweight (W/kg), it seems that this is an advantage for jumping ability. Moreover, the correlations we found between power per kg bodyweight and CMJ jump height may support this explanation. A previous study including Norwegian premier league female footballers reported CMJ height of 30.7 ± 4.1 cm and 28.1 ± 4.1 cm for national team players and premier league players respectively [8]. These findings were collected from 1995 to 2010, using a force platform with the same time resolution of 1000Hz, and compared to our findings of 32.6 ± 4.1 cm, indicating an improved performance in jumping ability among Norwegian premier league level female footballers.

To our knowledge no studies have reported specific results on force and power using a Keiser leg press in female players. This method, however, has been demonstrated to be an accurate measurement of force velocity profiles [16]. The correlation we found between power per kg bodyweight and CMJ jump (r = 0.63, 95% CI: 0.50-0.73) could emphasize the usage of CMJ as a reliable measure of power in football players. Moreover, this may advocate using CMJ, measured with force platforms, as an adequate measure assessing power. This is also supported by findings from Jimenez-Reyes et al. 2017[25]. More common strength measurements such as squats are relatively complex, although it has demonstrated a good relationship with sprint and jumping capabilities [13, 26]. Simpler strength measurement tests such as leg extension test have also been reported for top-level female football players[27]. Since football players require to move their own bodyweight and not larger amounts of external loads, acquiring reliable measurements of force and power through tests that are specific and comparable to physical playing actions taking place in matches is likely to be advantageous.

Sprint and agility

Sprint times were 3.13 ± 0.11s, 4.44 ± 0.16s and 5.75 ± 0.21s for 20-m, 30-m and 40-m sprint respectively. These results are aligned with previously published results for 20-m and 30-m in professional women's football players [28] [3, 12]. This indicates a similar level of performance in 20-m sprint for female premier league level football players across a variety of domestic leagues and nationalities. Stepinski et al [29] reported 30-m sprint times varying from 4.62 ± 0.16s to 4.49 ± 0.17s for Polish national team players over the course of one full season, slightly slower sprint speed compared to our findings. A previous study including Norwegian female players has stated that differences of 0.04 – 0.06s over a 20-m sprint is large enough to be a critical factor in 1-on-1 sprint duels [30]. We are not aware of any previous study having published 40-m results for female players. A study looking at high school and college athletes in USA reported 5.94 ± 0.28s for 40-yard dash [23], equivalent to approximately 36.5 meters, hence slower sprint results than in this study. Moreover, being high school players, the likelihood of these players having developed their full sprint potential is small. Another study by Haugen et al [8] have 40-m results, but they reported split times, only, which makes comparisons difficult. However, 40-m sprint for female players is an area which probably deserves more attention as sprints up to 40-m is likely necessary in order to measure top speed abilities [8]. It is a common misconception that top speed is not relevant to football as majority of sprints are shorter than 10-m [31]. However, most sprints are leading sprints [32, 33] and thus top speed might prove more important than stationary starting sprints of 10- or 20-m.

Comparing sprint results is challenging when different protocols for starting procedures are applied [2]. A variation from 0 to 30, 40, or even 90 cm before the first timing gate is found in different studies. Obviously, this will affect the results, and a "gold standard" protocol for

football is still missing.
Neither Scott et al. [3] or Stepinski et al [29] reported in detail the specific starting procedures, thus makes it difficult to compare with our procedure starting the sprint with an optical release sensor. Emmonds et al. [12] reported that subjects started 0.5 meters behind the initial timing gate, which is different from our starting procedure. Hence, comparisons between studies are difficult, and so far, a valid performance level of female top-level footballers for 20-m sprint does not exists.

Our study used different starting procedures for sprint and agility. The reason for this was to be able to compare results with previous studies reporting data on Norwegian female premier league players and Norway Women's A-team players. However, we would recommend future studies to use identical starting procedure for tests like sprint and agility

Sprint differences in playing positions was found between goalkeepers and outfield players, only. Although, we could not detect any differences in sprint speed between different outfield playing positions, we still provide detailed data on sprint performance of several distances and for different playing positions (table 2). This is a field of research identified with limited data available [2].

Previous studies on men have shown good correlation between leg strength and sprinting speed [26], but our results only indicate a fair correlation (r = 0.47 – 0.51) for power, and a poor correlation for est. max force (r = 0.002 – 0.015). The current study shows a moderate relationship between sprinting speed and agility performance. This is in line with previous studies using an agility test of similar length and duration[34]

Methodological considerations and limitations
A limitation in our study is that the sprint tests, even though standardized, were performed on an indoor tartan synthetic surface, not on natural grass or artificial turf, wearing running shoes and not football boots. This is likely to provide different sprint and change-of direction results compared to a real-time setting in match-play. As teams were assessed on varies time points during the pre-season, we could not assure that all teams had the same preparation prior to the testing day. Although, all teams were asked not to play any matches two days ahead of testing, it is likely that the training load and intensity varied between the teams. We ensured all teams received the same information before and at the start of the testing day, moreover, the test supervisors were the same for all testing days.

In order to avoid long waiting periods for the players between tests and to make sure we had comparable conditions, a testing team was split into two groups where half of the team performed tests in the morning, and the other half in the afternoon. As some of the teams travelled to Oslo in the morning and returned the same day, we had limited time to perform an aerobic field test due to a tight schedule.

Agility testing was performed in a designated hallway at the test center. However, this hallway was only about 2-m wide, thus restricting our possibilities when selecting our agility test. Players performed only one trial on each leg for the agility test since a similar agility test has shown high internal reliability with a Cronbach's alpha coefficient of 0.976 [35]

As a few parameters were not normally distributed, the results for these parameters need to be interpreted with caution. However, these results are presented with both mean ± SD and median ± IQ to allow for more informed interpretations and still provide an opportunity to make comparisons with similar data sets.

Perspectives

Football is a complex sport demanding technical, tactical, and physical skills. A player's strengths and weaknesses inform selection and tactical decisions, and thus a comprehensive understanding of these strengths and weaknesses is beneficial. Knowledge on physical performance qualities in female top-level players is one key aspect of strengths and weaknesses that warrants further investigation and high quality studies [1]. Researchers should aim at providing better understanding of the physical characteristics and performance demands evident in future top-level female players [18]. We think future initiatives and studies on female players ought to provide a better platform for understanding and optimizing health, training, and performance aspects. Small changes in sprint ability is shown to be decisive in one on one duels on the ball [30], and when scoring goals[5]. These small differences in key moments of a game are difficult to document scientifically, yet they often prove decisive for the outcome of a match, emphasizing that even a small improvement in sprint or jump ability may be the difference between winning or losing in female top-level football.

PRACTICAL APPLICATIONS

Our findings present a benchmark for physical qualities in female premier league players to help guide coaches to identify specific areas to target in training developing both players and team. From a coach and medical staff perspective, a foundation for physical performance reference values of female top-level players is likely useful and important when selecting physical qualities to target in training and preparation. Furthermore, we have documented that assessing power using CMJ -test can be time efficient and reliable in individual players and team squads.

CONCLUSIONS

Our study presents anthropometric and physical performance profiles of Norwegian premier league female football players. Regardless of position, no differences in physical qualities between outfield players suggests that the complexity of football create similar demands for physical performance variables such as strength, speed, and agility. In addition, it proposes that different playing positions need somewhat equality in physical attributes for the given position to match the opponent opposite, i.e., attacker vs. defender. The difference between dominant and non-dominant leg for the agility test suggests that athletes which improve their change of direction abilities on non-dominant leg may gain an advantage.

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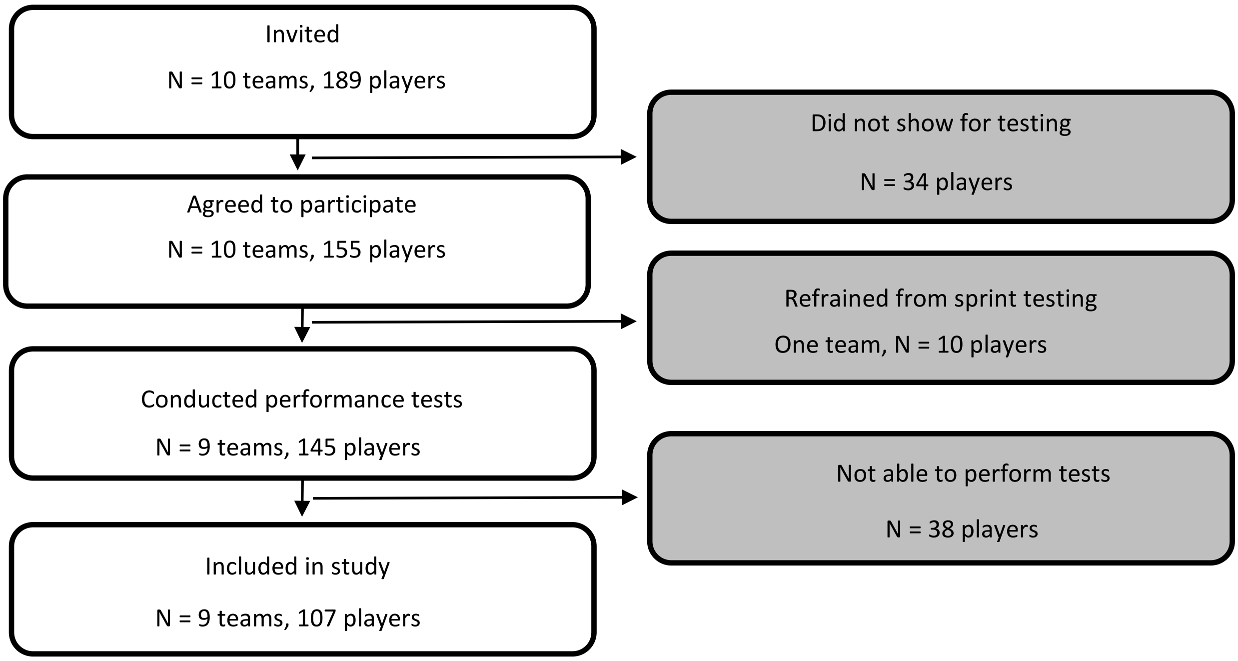

Figure 1: Flowchart of participants included in the study.

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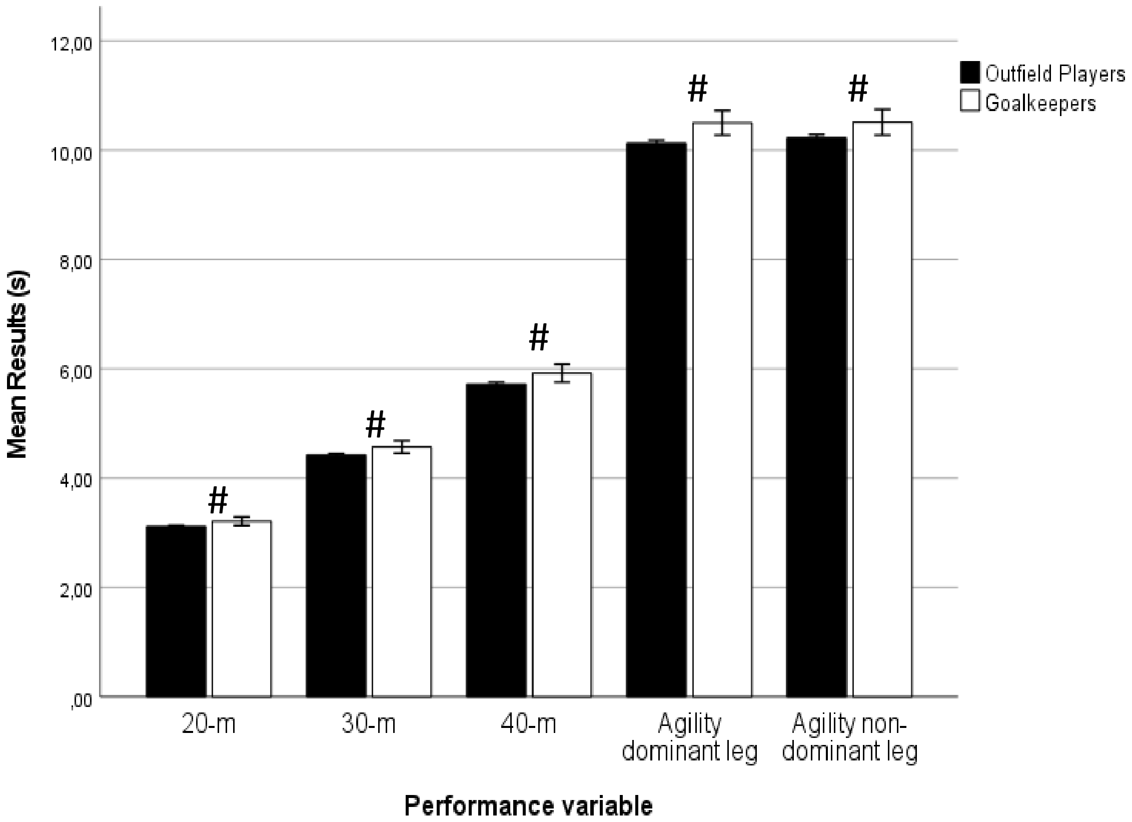

Figure 3: Sprint and agility performance for goalkeepers (n=14) compared to outfield playing positions (n=93), results presented as mean ± 95% CI. # Significant difference between groups, a < 0.05.

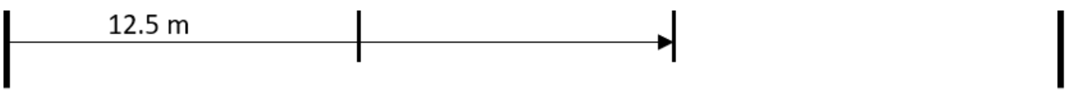

Figure 2: Overview of the agility test setup and running pattern.

Table 1: Overview of player characteristics per playing position, and pooled (n = 107), presented as mean ± SD.

	Goalkeepers (n = 14)	Central defenders (n = 20)	Fullbacks (n = 16)	Central midfielders (n = 31)	Wide midfielders (n = 12)	Attackers (n = 14)	Total (n = 107)
Age (y)	22 ± 4	23 ± 4	23 ± 4	22 ± 5	21 ± 3	22 ± 5	22 ± 4
Stature (cm)	171.8 ± 4.1	173.6 ± 4.7	165.3 ± 5.0	167.5 ± 6.6	165.8 ± 5.6	170.2 ± 5.8	169.0 ± 6.2
Weight (kg)	71.9 ± 6.8	67.8 ± 5.1	61.9 ± 4.5	63.6 ± 6.6	62.0 ± 5.4	66.1 ± 6.4	65.3 ± 6.7
BMI	24.3 ± 1.7	22.5 ± 1.4	22.7 ± 1.7	22.6 ± 1.8	22.6 ± 1.6	22.8 ± 1.6	22.8 ± 1.7

Table 2: Overview of physical performance measurements for all players (n=107) divided by playing position. Presented as mean ± SD.

	Goalkeepers (n = 14)	Central defenders (n = 20)	Fullbacks (n = 16)	Central midfielders (n = 31)	Wide midfielders (n = 12)	Attackers (n = 14)	All players (n = 107)
Est. max force (N)	2236 ± 333	2120 ± 371	2089 ± 289	2091 ± 268	2067 ± 353	2165 ± 299	2122 ± 312
Est. max power (W)	1157 ± 107	1119 ± 154	1089 ± 122	1056 ± 150	1071 ± 170	1077 ± 103	1090 ± 140
Force (N/kg)	31.1 ± 3.7	31.3 ± 4.9	33.9 ± 5.2	33.0 ± 3.3	33.4 ± 5.1	33.0 ± 4.8	32.6 ± 4.4
Power (W/kg)	16.2 ± 1.6	16.5 ± 2.1	17.6 ± 2.1	16.6 ± 1.6	17.2 ± 2.0	16.4 ± 1.6	16.7 ± 1.8
Sprint 20-m (s)	3.21 ± 0.14	3.13 ± 0.12	3.08 ± 0.09	3.14 ± 0.09	3.07 ± 0.06	3.11 ± 0.09	3.13 ± 0.11
Sprint 30-m (s)	4.57 ± 0.20	4.45 ± 0.17	4.37 ± 0.13	4.46 ± 0.14	4.35 ± 0.10	4.41 ± 0.12	4.44 ± 0.16
Sprint 40-m (s)	5.92 ± 0.28	5.76 ± 0.22	5.66 ± 0.17	5.77 ± 0.19	5.62 ± 0.15	5.71 ± 0.16	5.75 ± 0.21
Agility dominant leg (s)	10.50 ± 0.39	10.22 ± 0.34	10.06 ± 0.29	10.13 ± 0.28	10.06 ± 0.22	10.13 ± 0.26	10.18* ± 0.32
Agility non dominant leg (s)	10.51 ± 0.41	10.31 ± 0.29	10.16 ± 0.27	10.20 ± 0.24	10.19 ± 0.32	10.29 ± 0.31	10.27* ± 0.31
CMJ (cm)	32.6 ± 4.5	32.9 ± 4.9	35.0 ± 4.5	31.1 ± 2.9	34.0 ± 3.9	31.8 ± 3.2	32.6 ± 4.1

* Players are significantly faster when changing directions on their dominant foot, $p < 0.01$.

Table 3: Addition to table 2, the physical performance measurements presented as median ± IQR for the parameters which were not normally distributed (n=107). Divided by playing position.

	Goalkeepers (n = 14)	Central defenders (n = 20)	Fullbacks (n = 16)	Central midfielders (n = 31)	Wide midfielders (n = 12)	Attackers (n = 14)	All players (n = 107)
Est. max force (N)	2178 ± 409	2055 ± 490	2039 ± 401	2072 ± 359	1943 ± 363	2186 ± 375	2073 ± 415
Sprint 20-m (s)	3.19 ± 0.21	3.10 ± 0.15	3.09 ± 0.16	3.13 ± 0.15	3.05 ± 0.08	3.13 ± 0.15	3.11 ± 0.15
Sprint 30-m (s)	4.54 ± 0.31	4.42 ± 0.19	4.37 ± 0.23	4.45 ± 0.20	4.32 ± 0.16	4.43 ± 0.22	4.41 ± 0.21
Sprint 40-m (s)	5.88 ± 0.41	5.73 ± 0.25	5.65 ± 0.31	5.74 ± 0.27	5.61 ± 0.26	5.72 ± 0.29	5.72 ± 0.29
Agility non dominant leg (s)	10.55 ± 0.57	10.33 ± 0.50	10.08 ± 0.45	10.22 ± 0.33	10.12 ± 0.53	10.26 ± 0.53	10.23 ± 0.47

Table 4: Overview of correlations between all variables. Data is presented as r values with 95% CI.

	n	Max force			Max force / BW			Max power			Max power / BW			Sprint 20-m			Sprint 30-m			Sprint 40-m			Agility dominant			Agility non dominant			CMJ		
			95% CI			95% CI			95% CI			95% CI			95% CI			95% CI			95% CI			95% CI			95% CI			95% CI	
		r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper	r	Lower	Upper
Max force		-	-	-	**0,73**	*0,63*	*0,81*	**0,74**	*0,64*	*0,82*	**0,44**	*0,27*	*0,58*	**0,01**	*-0,18*	*0,20*	**0,00**	*-0,19*	*0,19*	**0,00**	*-0,19*	*0,19*	**0,08**	*-0,11*	*0,27*	**-0,06**	*-0,25*	*0,13*	**0,17**	*-0,02*	*0,35*
Max force / BW		**0,73**	*0,63*	*0,81*	-	-	-	**0,36**	*0,18*	*0,51*	**0,67**	*0,55*	*0,76*	**-0,25**	*-0,42*	*-0,06*	**-0,24**	*-0,41*	*-0,05*	**-0,21**	*-0,38*	*-0,02*	**-0,13**	*-0,31*	*0,06*	**-0,22**	*-0,39*	*-0,32*	**0,38**	*0,21*	*0,53*
Max power		**0,74**	*0,64*	*0,82*	**0,36**	*0,18*	*0,51*	-	-	-	**0,65**	*0,53*	*0,75*	**-0,16**	*-0,34*	*0,03*	**-0,17**	*-0,35*	*0,02*	**-0,17**	*-0,35*	*0,02*	**-0,13**	*-0,31*	*0,06*	**-0,24**	*-0,41*	*-0,05*	**0,33**	*0,15*	*0,49*
Max power / BW		**0,44**	*0,27*	*0,58*	**0,67**	*0,55*	*0,76*	**0,19**	*0,00*	*0,37*	-	-	-	**-0,51**	*-0,64*	*-0,36*	**-0,49**	*-0,62*	*-0,33*	**-0,47**	*-0,61*	*-0,31*	**-0,42**	*-0,56*	*-0,25*	**-0,47**	*-0,61*	*-0,31*	**0,63**	*0,50*	*0,73*
Sprint 20-m		**0,01**	*-0,18*	*0,20*	**-0,25**	*-0,42*	*-0,06*	**-0,16**	*-0,34*	*0,03*	**-0,51**	*-0,64*	*-0,36*	-	-	-	**0,99**	*0,99*	*0,99*	**0,97**	*0,96*	*0,98*	**0,65**	*0,53*	*0,75*	**0,64**	*0,51*	*0,74*	**-0,56**	*-0,68*	*-0,42*
Sprint 30-m	107	**0,00**	*-0,19*	*0,19*	**-0,24**	*-0,41*	*-0,05*	**-0,17**	*-0,35*	*0,02*	**-0,49**	*-0,62*	*-0,33*	**0,99**	*0,99*	*0,99*	-	-	-	**0,99**	*0,99*	*0,99*	**0,64**	*0,51*	*0,74*	**0,63**	*0,50*	*0,73*	**-0,56**	*-0,68*	*-0,42*
Sprint 40-m		**0,00**	*-0,19*	*0,19*	**-0,21**	*-0,38*	*-0,02*	**-0,17**	*-0,35*	*0,02*	**-0,47**	*-0,61*	*-0,31*	**0,97**	*0,96*	*0,98*	**0,99**	*0,99*	*0,99*	-	-	-	**0,64**	*0,51*	*0,74*	**0,63**	*0,50*	*0,73*	**-0,55**	*-0,67*	*-0,40*
Agility dominant		**0,08**	*-0,11*	*0,27*	**-0,13**	*-0,31*	*0,06*	**-0,13**	*-0,31*	*0,06*	**-0,42**	*-0,56*	*-0,25*	**0,65**	*0,53*	*0,75*	**0,64**	*0,51*	*0,74*	**0,64**	*0,51*	*0,74*	-	-	-	**0,81**	*0,73*	*0,87*	**-0,34**	*-0,50*	*-0,16*
Agility non dominant		**-0,06**	*-0,25*	*0,13*	**-0,22**	*-0,39*	*-0,32*	**-0,24**	*-0,41*	*-0,05*	**-0,47**	*-0,61*	*-0,31*	**0,64**	*0,51*	*0,74*	**0,63**	*0,50*	*0,73*	**0,63**	*0,50*	*0,73*	**0,81**	*0,73*	*0,87*	-	-	-	**-0,40**	*0,23*	*0,55*
CMJ		**0,17**	*-0,02*	*0,35*	**0,38**	*0,21*	*0,53*	**0,33**	*0,15*	*0,49*	**0,63**	*0,50*	*0,73*	**-0,56**	*-0,68*	*-0,42*	**-0,56**	*-0,68*	*-0,42*	**-0,55**	*-0,67*	*-0,40*	**-0,34**	*-0,50*	*-0,16*	**-0,40**	*0,23*	*0,55*	-	-	-

Table 5: Physical qualities for goalkeepers (n=14) compared to all outfield playing positions pooled (n=93). Results and differences presented as mean + 95% CI. P-value from ANOVA and Mann-Whitney-U test dependent on the parameter being normally distributed or not.

	Goalkeepers (n = 14)	Outfield players (n = 93)		
	Mean [95% CI]		Mean difference [95% CI]	P-value
Max force (N) §	2235 [2043, 2428]	2105 [2042, 2168]	131 [-45, 307]	0.14
Max power (W)	1157 [1096, 1219]	1080 [1051, 1109]	77 [-2, 155]	0.06
Force / BW (N/kg)	31.1 [29.0, 33.3]	32.8 [31.9, 33.7]	-1.7 [-4.2, 0.8]	0.18
Power / BW (W/kg)	16.2 [15.3, 17.1]	16.8 [16.4, 17.2]	-0.6 [-1.7, 0.4]	0.23
Sprint 20-m (s)§	3.21 [3.13, 3.29]	3.12 [3.10, 3.14]	0.10 [0.04, 0.16]	< 0.01*
Sprint 30-m (s) §	4.57 [4.45, 4.69]	4.42 [4.39, 4.45]	0.15 [0.07, 0.24]	< 0.01*
Sprint 40-m (s) §	5.92 [5.76, 6.08]	5.72 [5.68, 5.76]	0.20 [0.09, 0.32]	< 0.02*
Agility dominant (s)	10.50 [10.28, 10.73]	10.13 [10.07, 10.19]	0.37 [0.21, 0.54]	< 0.01*
Agility non dominant (s) §	10.51 [10.28, 10.75]	10.23 [10.17, 10.29]	0.28 [0.12, 0.45]	< 0.01*
Countermovement jump (cm)	32.6 [30.0, 35.2]	32.6 [31.8, 33.5]	0.00 [-2.3, 2.3]	0.99

* Significant difference between groups, a = 0.05
§ parameter is not normally distributed