Practical Fitness Profiling Using Field Test Data for Female Elite-Level Collegiate Soccer Players: A Case Analysis of a Division I Team

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ABSTRACT

THIS ARTICLE WILL PROVIDE PRACTICAL EXAMPLES OF HOW FIELD TESTING DATA CAN BE PRESENTED TO HIGHLIGHT THE CHARACTERISTICS OF INDIVIDUAL SOCCER PLAYERS. AN EXAMPLE TESTING BATTERY WILL BE DESCRIBED, AS WILL THE PROCESS FOR CONVERTING TEST DATA INTO STANDARDIZED SCORES. DATA WILL BE PRESENTED TO SHOW THE STRENGTHS AND WEAKNESSES OF CERTAIN PLAYERS, AND HOW THIS INFORMATION CAN BE USED TO INFORM INDIVIDUALIZED TRAINING PROGRAMS. EXAMPLES OF DATA COMPARISONS TO NORMATIVE VALUES FOR ELITE PLAYERS WILL ALSO BE PRESENTED, IN CONJUNCTION WITH DISCUSSION AS TO HOW THIS INFORMATION CAN CONTRIBUTE TO THE PRACTICES OF THE STRENGTH AND CONDITIONING COACH.

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INTRODUCTION

Because of the physiological demands of the sport, soccer players are required to be proficient in a number of different physiological capacities. This includes aerobic capacity, repeated-sprint ability (RSA), leg power, linear acceleration and maximum speed, and change-of-direction (COD) speed and agility (5,9,23,52,60,81,82). As a result, the physiological assessment of soccer players can be extensive. It is important for the strength and conditioning coach to select tests that are valid, reliable, specific to the sport of soccer, and provide information that is useful to the coaching staff of the team (19,41,63,74,77,92). This will allow the team and strength and conditioning coaches the ability to develop optimal training sessions and programs that can address a player's weaknesses while maintaining their physical strengths (19). Test results that are easy to interpret also provide objective feedback to the individual player and potentially motivate them to improve in the areas that need development (19,40,41,74,83).

An often overlooked component of testing is how the data should be presented to a team's coaching staff. McGuigan et al. (63) stated that numbers by themselves are generally not very helpful or well understood. Therefore, the onus is on the strength and conditioning coach, sport scientist, or whomever is responsible for athlete testing and data interpretation, to present the information in such a manner that is easily understood by the other coaches and players. Jeffreys (43)

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change of direction speed; linear speed; lower-body power performance testing; standardized scores; Yo-Yo intermittent recovery test

recognized this as a key skill for the strength and conditioning coach, in that the coach must be able to coalesce the data collection, objectively analyze the data, and appropriately convey scientific information to contextualize the data such that it can be understood by a range of groups (e.g., other coaches and support staff, the athletes themselves).

In this article, a testing battery used for a collegiate soccer team will be presented. This analysis was conducted on a women's collegiate team (52), which is pertinent as there is relatively limited analysis of female soccer players, especially when compared with male players (23). The data analyzed within this article has been drawn from previously published research (52). Example data are presented as z-scores within radar plots from players within the squad to demonstrate a practical way in which test data can be made more accessible for interpretation. In addition to this, how this type of data can highlight an athlete's strengths and weaknesses will be discussed, and how players can be compared within the squad, and to elite-level benchmarks.

TESTING BATTERY AND ORDER

There are several reports that have provided recommendations for what assessments should be included in a testing battery for soccer players (19,77,92). The tests selected for soccer players should specifically assess those factors that relate to soccer match play. The battery presented was adopted for a Division I collegiate women's soccer team (52). Explanations as to why these assessments were used by this team's coaching staff are provided, and this will serve to highlight the validity of the adopted assessments, which is essential for appropriate athlete data collection (41,74). Furthermore, this particular testing battery has been adopted within formerly published scientific research, in which Lockie et al. (52) also detailed the reliability and validity of each assessment. The testing battery also followed recommendations outlined in several National Strength and Conditioning Association textbooks (41,62,74).

As noted by Lockie et al. (52), testing was conducted during the noncompetition months of February and March. Hoffman (41) stated that assessing athletes during a noncompetition period is important as the information provided can guide exercise prescription, establish training goals, and serve as a motivational tool for the athletes. The coaching staff for this team had the opportunity to space the performance assessments over 4 sessions, each separated by 48 hours. Multiday field testing has been conducted previously on field sport athletes, including female collegiate soccer players (52) and male rugby league players (24), and this approach has the advantage of limiting the influence one test may have upon another (i.e., potentiation or fatigue) (41). The testing session order was (a) jump testing, (b) speed testing, (c) Yo-Yo intermittent recovery test level 1 (YYIRT1), and (d) Yo-Yo intermittent recovery test level 2 (YYIRT2). This order followed the recommendations provided by Hoffman (41), in that the most fatiguing assessments (i.e., the YYIRT1 and YYIRT2) in a multiday testing protocol are performed last. Coaches who do not have the opportunity to space assessments over a number of sessions should follow the testing order guidelines set by the National Strength and Conditioning Association, which are explained in detail by McGuigan (62). Nonetheless, this battery also followed the directions outlined by McGuigan (62), whereby the physical capacities that were assessed included COD ability and agility, lower-body power, linear speed, and aerobic and anaerobic capacities.

THE FIELD TESTS

The characteristics (age, height, and body mass) of the players for this case analysis are shown in the Table, and discussion of the influence of these characteristics was completed by Lockie et al. (52). Although further anthropometric measurements would have been beneficial, these were precluded because of the time allocated to testing, and the cost associated with accurate body composition assessments (68). Each of these tests have been described in detail within the scientific literature and have been previously used to assess soccer players to provide support for their validity. Appropriate example sources are included for each assessment, and Lockie et al. (52) have discussed the reliability and validity for each assessment with regards to soccer. The tests were as described below.

VERTICAL JUMP

Jump tests are relatively easy to administer by a strength and conditioning coach, and they provide a valid assessment of an athlete's physical capacity (14). The countermovement vertical jump (VJ) can be measured by several methods, including a Vertec or Yardstick apparatus, jump mat, or force plate (13). Better countermovement VJ performance has been related to faster speed over 10 m in recreational field sport athletes (53) and rugby league players (21), and over 30 m in elite male and female sprinters (4). The importance of lower-body power and jump performance for soccer players was reinforced by Wisloff et al. (94), who found that the champions of the Norwegian football league (the Tippeligaen) performed better in the VJ when compared with the team that finished last. Jump height provides an indirect measure of lower-body power; the power index (power $[\mathrm{kg \cdot s^{-1}}] = \sqrt{4.9} \times$ body mass $\times \sqrt{\text{vertical jump height}}$) was used for the data analysis of the soccer players tested in this study (25,38,45,56).

STANDING BROAD JUMP

It is important for the strength and conditioning coach to understand that lower-body power is directionally specific (50,64,65). Brughelli et al. (12) asserted that when relating leg power measured via jumping to athletic performance, it should be specifically defined with regards to direction (e.g.,

Table
Age, height, and body mass of the collegiate Division I female soccer players by position investigated in this case analysis

	Age, y	Height, m	Body mass, kg
All (n = 26)	20.19 ± 1.20	1.66 ± 0.07	61.85 ± 7.36
Goalkeepers (n = 3)	20.50 ± 2.12	1.72 ± 0.09	72.50 ± 0.28
Defenders (n = 8)	20.75 ± 1.39	1.66 ± 0.05	60.09 ± 7.99
Midfielders (n = 10)	20.00 ± 1.05	1.66 ± 0.07	61.25 ± 6.30
Forwards (n = 5)	19.60 ± 0.89	1.65 ± 0.08	61.62 ± 7.45

Lockie et al. (52).

vertical, horizontal, or lateral) and the type of projection (i.e., bilateral or unilateral). Thus, performing only a VJ may not provide sufficient information about a soccer player's physical performance, and the coach should at least consider including some test of horizontal power. This is important, as horizontal power has been linked to faster linear (27,50,55) and COD (50,57) speed. The standing broad jump (SBJ) has been recommended for soccer testing (77) and provides an indirect measure of leg power in the horizontal plane (57,58,61,76). The SBJ can also be measured relative to body mass via the formula: *relative* SBJ = jump distance/body mass (51). This provides a measure of how effectively the player can explosively shift their body mass.

THIRTY-METER SPRINT

Through the use of timing gates, a 30-m sprint allows the measurement of acceleration (0–10 m interval) (53–55) and maximum velocity (0–30 m interval) (29,59,89) sprinting specific to soccer. Sprints over 10 m (52,61,81) and 30 m (52,59,89) have been used in the assessment of soccer players. Furthermore, female soccer players tend to reach their peak speed at approximately 30 m (89), and this distance is inclusive of the sprint distances female players will generally cover during a match (35). Although the volume of sprints performed during a match is relatively low (7,26), they are typically centered around important match situations such as contests for the ball (73,75) and goal scoring chances (30). This highlights the importance for soccer players to be fast.

PRO-AGILITY SHUTTLE

This test has been stated to provide a measure of power, acceleration, COD, and lateral speed (76) and is very popular for the assessment of American football players (51,56,76,78). Furthermore, the pro-agility shuttle has also been used in soccer testing (52,59,90,91). The ability to change direction is very important for soccer players (36), given the volume of direction changes (approximately 700 cuts, turns, or swerves) they need to make during a match (9). Although these data were drawn from professional male soccer players, it would be envisioned that collegiate female players would also complete a high volume of direction changes during a soccer match.

YO-YO INTERMITTENT RECOVERY TEST LEVEL 1

The YYIRT1 was designed to be a maximal exercise test specific to soccer (6). Indeed, this test heavily taxes both the aerobic and the anaerobic capacities of an athlete (6,72) and is closely related to soccer match performance (47). Better performance in the YYIRT1 has been linked to factors such as greater high-intensity and sprint distances, and total distance run, during a match (47,48). The aerobic contribution to this test is notable, as maximal aerobic capacity has been stated to be a more important factor for female soccer when compared with the men's game (48).

YO-YO INTERMITTENT RECOVERY TEST LEVEL 2

The YYIRT2 examines the capacity to perform intense intermittent exercise with a large anaerobic component, in conjunction with a notable aerobic contribution (6,72). RSA, which is the capacity to repeatedly produce maximal or near-maximal sprint efforts interspersed with brief recovery intervals (37), is particularly stressed by the YYIRT2 (72), and the capacity to complete high-intensity actions during a match is a key determinant to performance success in soccer (2,16,66,67,82). It should be acknowledged that there are several different tests of high-intensity running and RSA available for use by a coach. This includes variations of 6–12 maximal sprints completed every 20–30 seconds over distances of 15–40 m (17,34,71,79). However, considering the time constraints placed on collegiate soccer and strength and conditioning coaches, the YYIRT2 provides a low-cost, practical, and time-efficient method (i.e., the squad can be tested all at once, as opposed to testing each player individually) to assess high-intensity running performance (6,22,49). The YYIRT2 places great stress on the anaerobic capacity of an individual, shown through markedly reduced levels of creatine phosphate and high muscle and blood lactate at the end of the test (6,42,49,72). Furthermore, the YYIRT2 is reliable (49,84), and several authors have suggested that the YYIRT2 is the most valid test for assessing the high-intensity efforts required for soccer (22,42,44,72,87).

ANALYSIS OF DATA IN THE LITERATURE

As previously stated, simply presenting the numbers from a testing battery is not always the best or most appropriate way to convey this information to a coaching staff (63). This is a very important consideration when the strength and conditioning coach or sport scientist is attempting to communicate meaning of data to the head coach and support staff. Furthermore, given the large volume of information available about soccer testing, and athletic testing in general, there are relatively few specific resources for strength coaches that detail how data can be analyzed to provide meaningful and accessible results (18–20,32,63,70,85). This article will add to the pool of information available to the strength and conditioning coach. Appropriate figures can be the best way to present data because this can allow for the clear demonstration of where the athlete sits within the squad (19,63). This requires the scores to be standardized, and the process by which this can be done is by using z-scores.

Z-scores are derived via the formula: z-score = (athlete's test score − average score from the squad)/standard deviation for the particular test (18,20,63,70). McGuigan et al. (63) further recommended that z-scores should be presented as radar plots because this provides a visual representation of an athlete's strengths and weaknesses. The squad mean equates to zero on the radar plot. The z-score of the individual player then demonstrates whether they are better, similar, or worse in a specific test when compared with the rest of the squad. Where appropriate, absolute values for z-scores can be derived (e.g., the typical sprint time z-score, where a faster performance equates to a lower sprint time, leads to a negative z-score), such that a positive score above zero always represents a superior performance compared with the mean for all tests, whereas a negative score is always worse than the mean (20,70). This can make data interpretation easier for the strength and conditioning and head coach, and this information can then be used to drive training practices. Cone (19) offered some theoretical examples of this type of data for soccer players. However, this article presented actual data collected from Division I collegiate female soccer players, the volume of which has not been available to the practitioner or in the research literature.

EXAMPLE INDIVIDUAL PLAYER ANALYSES

Player analyses should be contextualized by considering the tactics and playing structure used by the coaching staff for this team. Playing structures can influence the physical capacities of the players, and vice versa (16,33). The coaches for the reported Division I team used an up-tempo, counter-attacking style of play, with a formation of 4-5 defenders, 4-5 midfielders, and a single forward. This structure demands a high work rate from players, especially from the defenders and midfielders, as they are required to play within a zone defense, and push forward during attacking opportunities. It is important to note the playing formations will change depending on the progress of a soccer match (i.e., whether the team is attacking or defending) (16). For discussion of specific needs for each position, readers are directed toward the research study published by Lockie et al. (52), which investigated the physiological characteristics of female collegiate soccer players by position. Furthermore, Lockie et al. (52) noted that the collective performance from the players in this Division I squad was commensurate with professional European female players in tests such as the VJ and SBJ, and the YYIRT1, which indicated their good physiological capacities. The focus of this section is to detail how a coach can analyze testing data of the individual relative to the squad to highlight potential strengths and weaknesses of players within a Division I soccer team. In addition to this, the mean z-score data for each position group is also presented to provide a further context for individuals (Figures 1–5, 7). For further comparisons, the data from all graphs for the field players has been overlaid in a combination radar plot in Figure 6.

Figure 1 displays a profile of our first example midfielder, who was a starter. Within this Division I team, midfield players needed to be flexible to move between different roles (i.e., outside and central, attacking, and defending) as required by the coach. This player is superior in the YYIRT1 and YYIRT2 when compared with the rest of the squad and the other midfielders as well. To an extent, her high fitness capacity should be expected, given that midfielders tend to cover the greatest distances during a game (26,67), and be the fittest players on a team (10,11,67,81). However, the weaknesses for this player are pronounced in the tests of linear (0–10 m and 0–30 m sprint) and COD (pro-agility shuttle) speed. Midfielder 1 has the capacity to cover great distances during a match, which matches the playing structure of the team. However, if her speed is less than that of other players, she may always be a step behind in important ball contests and pursuits (73,75). The coaching staff could potentially focus more on the development of acceleration and maximum speed for this player because it appears her aerobic capacity and RSA are at acceptable levels.

In contrast to midfielder 1, midfielder 2 (a player who alternated between being a starter and a substitute) performed better than the mean scores in the tests of linear speed over 10 and 30 m compared with both the squad and the other midfielders (Figure 2). It is also understandable why midfielder 2 performed well in the SBJ and relative SBJ, given the links between horizontal power and linear speed (27,50,55). However, this player's COD ability, as measured by the pro-agility shuttle, was below the squad and other midfielders. What stands out even further was that this player was below average for both the YYIRT1 and the YYIRT2. Thus, although this player has above average speed, her capacity to recover from high-intensity efforts is less than optimal. This may not be ideal for a midfielder, so improving this player's aerobic capacity, high-intensity running ability, and RSA could be a focus for the strength and conditioning coach, especially if the head coach's preference is for the player to remain as a midfielder. However, this player may be more useful as a substitute player, given that workload demands of nonstarters is clearly less than that of starting players (46). She may be able

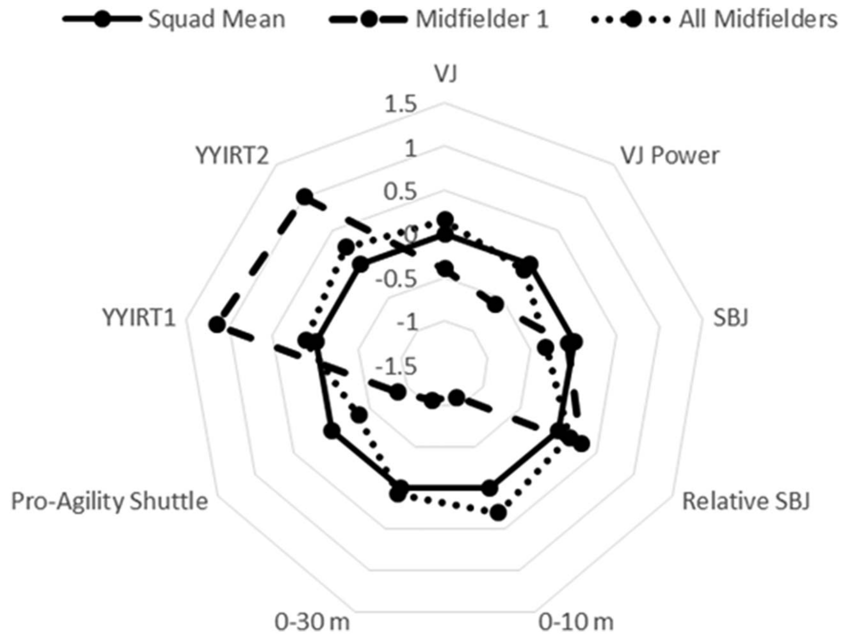

Figure 1. Profile of midfielder 1 using standardized z-scores plotted against the mean for the squad and all midfielders. Lockie et al. (52).

to take advantage of her speed during match play, without the added stress of being required to play a full match.

The profile for midfielder 3, who was a reserve player, should be concerning to the coaching staff (Figure 3). Although she appears to be comparable to the squad and other midfielders in the YYIRT1 and relative SBJ, she is deficient in a number of other areas. This includes lower-body power as measured by the VJ, linear and COD speed, and RSA and high-intensity running performance as measured by the YYIRT2. Relative to the squad and other midfielders, the profile for midfielder 3 suggests they would be slower to challenges and may not recover quickly when forced to complete a number of high-intensity efforts within a short duration during a match. Given that this player underperformed in a number of tests relative to the squad, the team's support staff should ensure there are no underlying issues that may have affected performance (e.g., unreported illness or injury). Otherwise, the presentation of these data can be used to illustrate to the player that they must improve to maintain pace with the rest of the team.

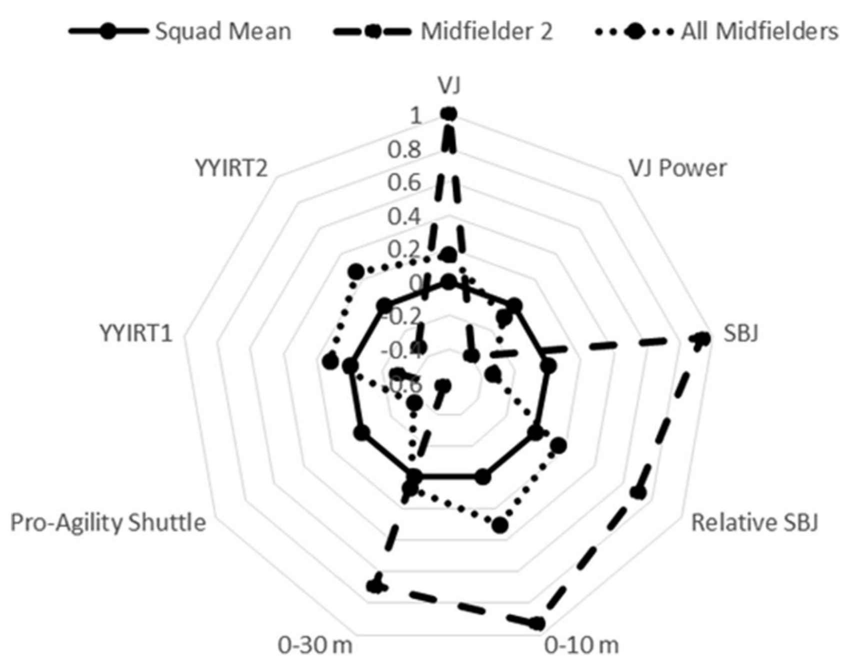

Figure 2. Profile of midfielder 2 using standardized z-scores plotted against the mean for the squad and all midfielders (52).

Figure 4 displays the profile of an example defensive player who was a starter. This player was superior within the squad and other defenders in the YYIRT1 and YYIRT2, which suggests they have good aerobic capacity, high-intensity running ability, and RSA, and all these capacities are necessary for defenders (73,90). This is because female defenders in soccer matches can cover upward of 9 km in a match, with a change in activity after every 5.8 seconds (35). She was also superior in the SBJ, had good acceleration over 10 m, and was comparable to the squad and other defenders in speed over 30 m. However, the defender's relative weaknesses were lower-body power as measured by the VJ and COD ability as measured by the pro-agility shuttle. A good VJ is necessary for defensive players so they can challenge attackers in the air for possession (39). Additionally, defenders will often need to turn and chase if attackers make a break for goal, so they require effective COD speed. Specific training could focus on lower-body power and COD ability for this defender.

Figure 5 displays the profile drawn from data for a starting forward. She was superior within the squad and compared with the other forwards in the VJ and SBJ, which both demonstrated the lower-body power that is essential for challenging for the ball while it is in the air (39). The forward from Figure 5 is also clearly superior

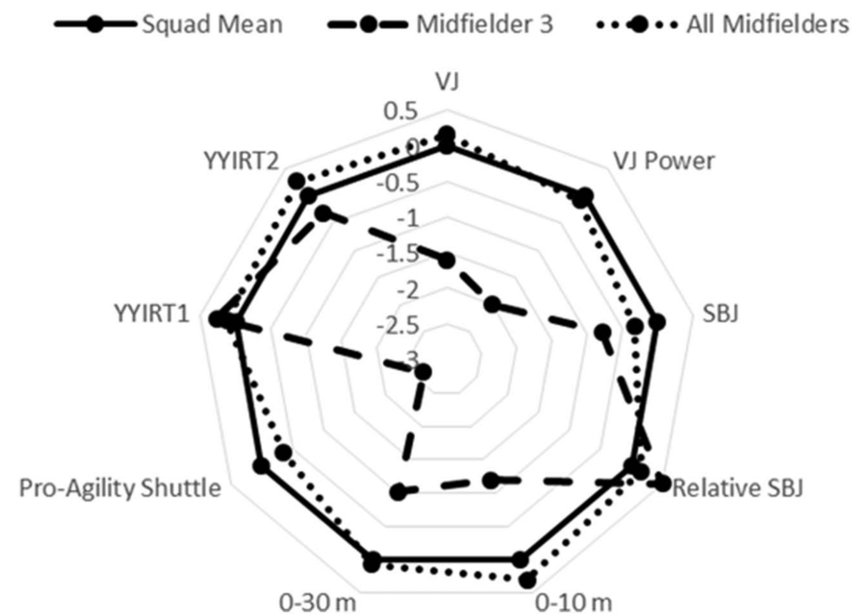

Figure 3. Profile of midfielder 3 using standardized z-scores plotted against the mean for the squad and all midfielders (52).

within the squad in the linear and COD speed tests and the YYIRT2. Forwards need to be fast to make breaks for goal (30) and elude defenders who are attempting to stop them. This was reflective of the playing structure adopted by the coaching staff, where this player was required to pursue "through-balls" (placing a greater demand on speed) during offensive play. Forwards also tend to cover the greatest sprint distances during a match (3,66,90), so this ability to complete high-intensity actions are reflected in the YYIRT2 score. However, this player did score lower in the YYIRT1 relative to the squad. Although this test does incorporate RSA, there is a larger aerobic component (47). Given the player's performance in the other more anaerobically focused tests, it is likely that their aerobic fitness is less than that from most of her teammates. However, it is plausible to consider that because of these physiological characteristics (i.e., high linear and COD speed, and good anaerobic capacity), this player was assigned as a forward. In addition to this, the team's playing structure of using a lone forward places a greater importance on this player's ability to take advantage of scoring chances by sprinting into space (30), which will further reinforce these traits.

Figure 7 displays the profiles for the 2 goalkeepers within the squad. The squad featured 3 goalkeepers; however, one was in a redshirt season and was not going to play, and these 2 goalkeepers were competing for the starting position. Therefore, both goalkeepers were analyzed. Their profiles are very typical of players from this position. Goalkeepers tend to demonstrate greater power as measured by maximal jump tests (10,36,81), as this is a requirement for covering the goal and collecting the ball in the air at its greatest height. Furthermore, as goalkeepers do not have the same movement characteristics when compared with field position players (82), they also tend to be slower in linear sprint tests (36,39,52,81) and do not perform as well in maximal exercise tests such as both versions of the YYIRT (36,49,52). This was generally the case for these 2 players. However, goalkeeper 1 performed relatively well in the linear speed tests, and both goalkeepers performed well in the pro-agility shuttle. Linear speed would be important for a goalkeeper if they needed to rapidly close space for an oncoming attacker, whereas lateral speed would allow them to cover the space in front of goal. If a coach did not wish to emphasize aerobic capacity or RSA in their goalkeepers, then prescriptive information that can be drawn

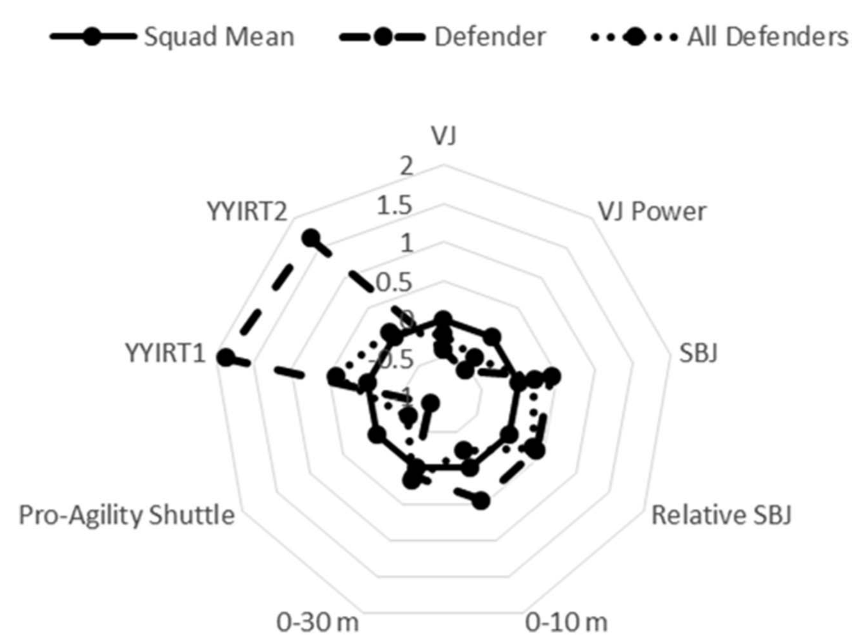

Figure 4. Profile of a defender using standardized z-scores plotted against the mean for the squad and all defenders (52).

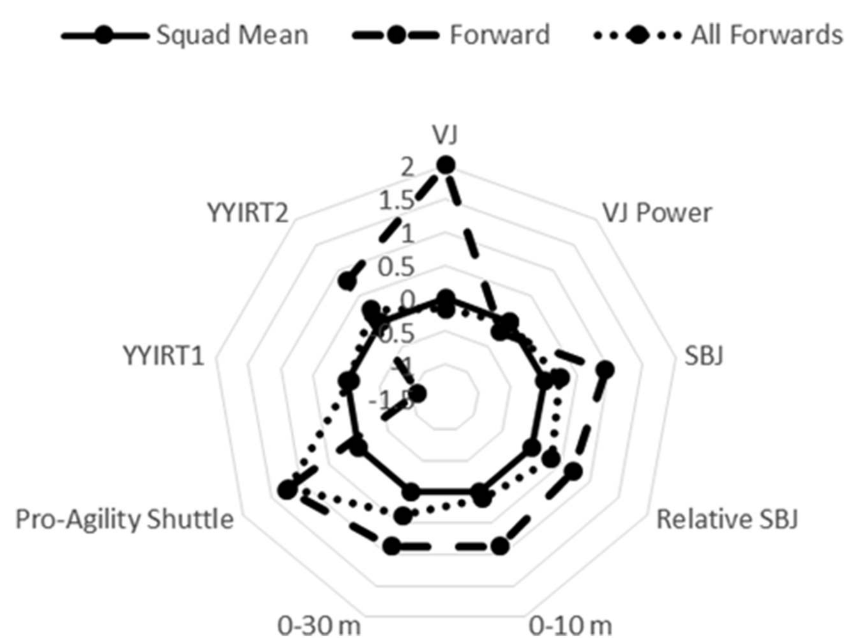

Figure 5. Profile of a forward using standardized z-scores plotted against the mean for the squad and all forwards (52).

from these profiles is to ensure all goalkeepers within a squad display similar power and speed capabilities. Thus, goalkeeper 2 could stand to improve her linear speed and acceleration.

COMPARISONS WITH NORMATIVE DATA

It is important for strength and conditioning coaches to obtain normative data for the tests that they conduct (63) because this allows a coach to understand the context of the physical conditioning of their players. Depending on availability and access to data, the values could represent a comparable population (i.e., another sample of Division I collegiate female soccer players) or elite-level athletes. However, there is very limited published data available for equivalent collegiate female soccer players. As a result, the comparisons made in this paper will be with established, scientific normative values from elite players, using the YYIRT1 (6) and 0–10 and 0–30 m sprint intervals (39). A limitation with obtaining these data, especially with female athletes, is there has been much less scientific analysis of female players when compared with male players (23). Further, the methods used for

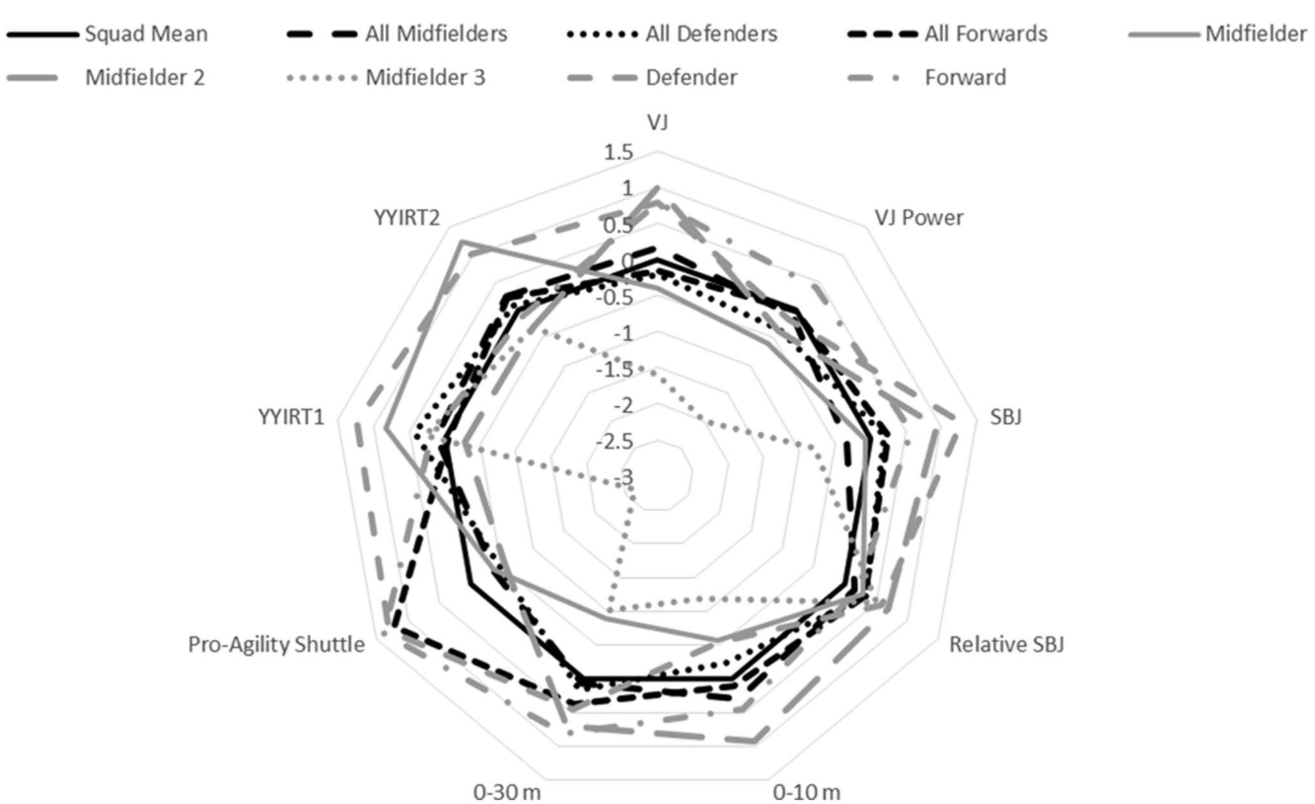

Figure 6. Profile of all the analyzed field players using standardized z-scores plotted against the mean for the squad and all midfielders, defenders, and forwards (52).

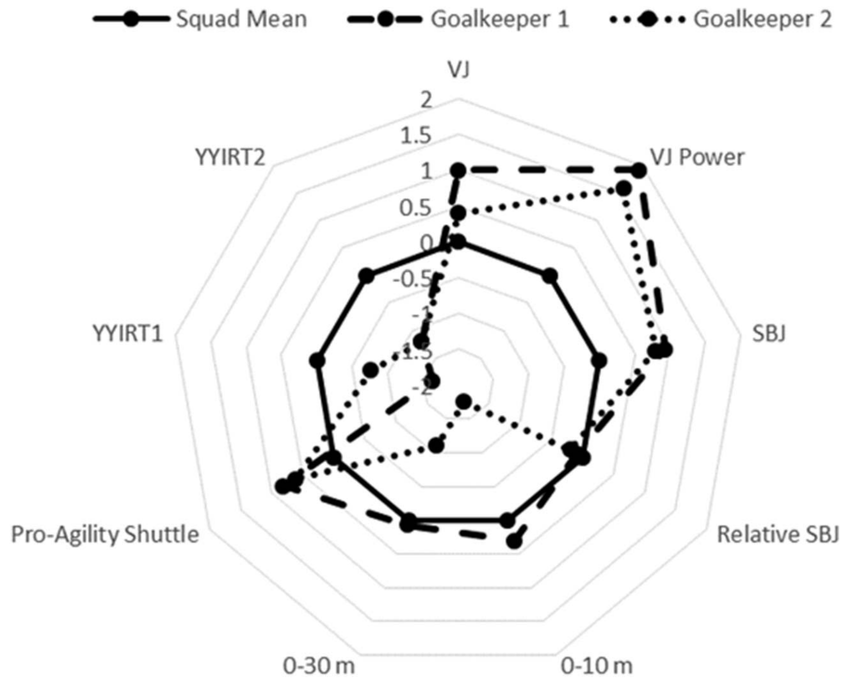

Figure 7. Profile of 2 goalkeepers using standardized z-scores plotted against the mean for the squad (52).

testing may vary (e.g., measuring VJ via a Vertec versus a jump mat versus a force plate), so practitioners should be cognizant of this when making comparisons. In addition to this, the formations used by soccer teams across the literature will vary, and this information was not provided in the studies that will be used for the normative data in this article (6,39). Thus, the analysis provided should be contextualized with that understanding, although Carling (16) did note that the physiological capacities of soccer players was generally not affected by the formations adopted by their opponents.

Nevertheless, and within the context of these limitations, we will provide some examples of how to incorporate normative data into an athlete analysis using YYIRT1 distance (6), and 0–10 m and 0–30 m sprint times (39). The use of elite populations provides players and coaches with knowledge of the physical standards that would be expected at higher levels of play. Furthermore, the YYIRT1 and 30-m sprint were selected as the example data sets because one of the key indicators of higher levels of female soccer competition is a greater capacity to complete high-intensity efforts and sprint running actions during match play (2,33). Elite female soccer players would

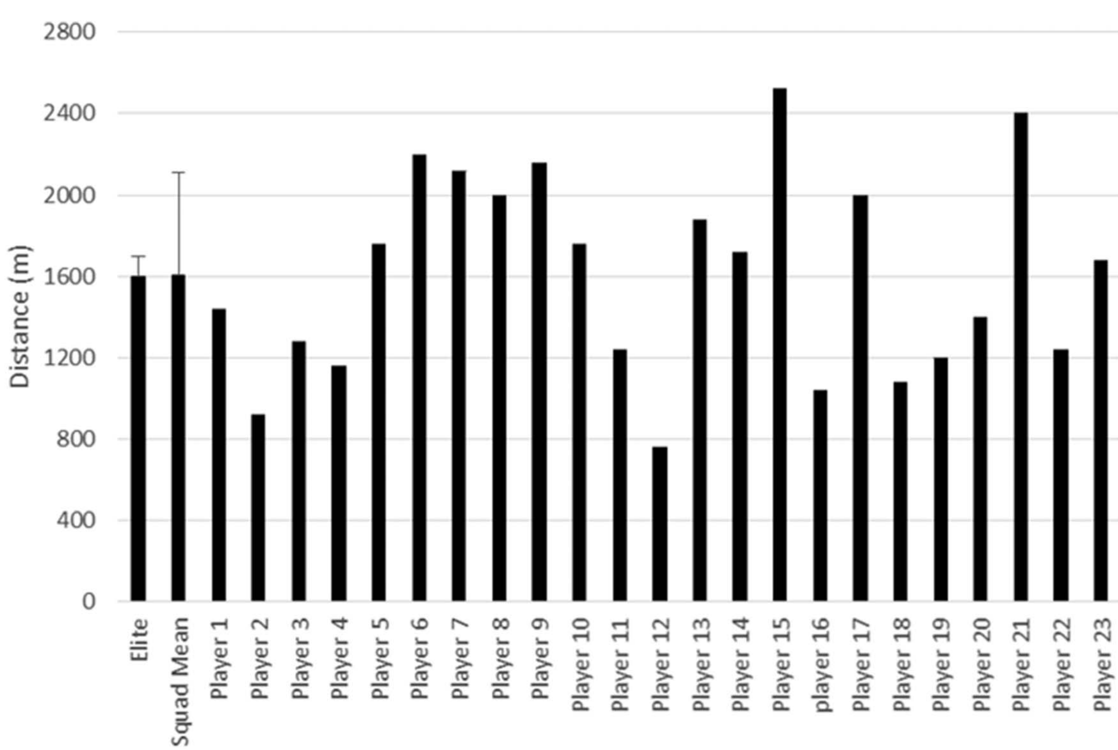

Figure 8. Squad mean and individual YYIRT1 scores for a Division I collegiate women's soccer team compared with an elite standard from Bangsbo et al. (6, 52).

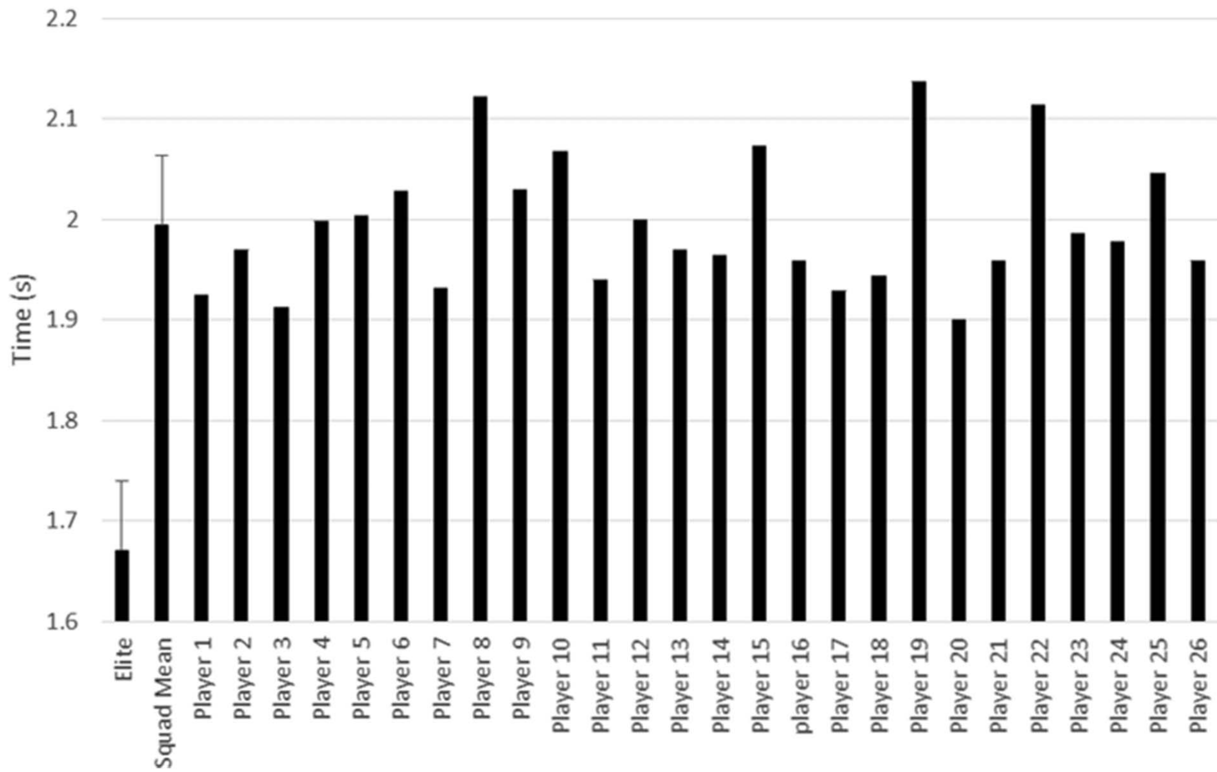

Figure 9. Squad mean and individual 0- to 10-meter sprint times for a Division I collegiate women's soccer team compared with an elite standard from Haugen et al. (39, 52).

provide the best example for these data, and both of these tests provide an indication of these capacities. The YYIRT1 (6), and 0–10 m and 0–30 m sprint interval data (39), were all obtained from elite European female soccer players.

The elite standard for the YYIRT1, the squad mean, and individual scores for this test in the collegiate squad are shown in Figure 8. Interestingly, out of the 23 players who completed the YYIRT1, 12 were above the elite standard (approximately 52% of the squad). For a collegiate strength and conditioning coach for a soccer team, this is a positive outcome, especially considering the strong relationships that superior YYIRT1 test performance has with higher workloads on the soccer pitch (47,48). The structure and formation of a soccer team will also influence performance in a test such as the YYIRT1. Although this information was not provided about the analyzed players from Bangsbo et al. (6), the data can be contextualized for the current collegiate squad. As previously stated, the coaching staff implement an up-tempo, counter-attacking style of play. This structure demands a high work rate from players, which places greater stress on aerobic capacity and high-intensity running, and the strength and conditioning coach must ensure the players' conditioning allows them to perform in this style of play. As a result, the appropriate programming of aerobic and high-intensity running training can allow collegiate female soccer players to reach close to elite levels of soccer-specific fitness, especially when it fits the playing structure implemented by the coaching staff.

In contrast to the YYIRT1 data is the linear speed data measured during acceleration (0–10 m; Figure 9) and maximum velocity (0–30 m; Figure 10). Twenty-six players completed these tests, and no player approached the standards set by the elite performers from Haugen et al. (39). These data could be interpreted in numerous ways. The strength and conditioning coach could take the view that the current collegiate squad is not international level, so therefore will never approach that high standard. A different approach is to assess what is currently being done during on-field training sessions (i.e., is there a greater emphasis on aerobic conditioning as opposed to soccer-specific acceleration and sprint training?). Although training for soccer does incorporate a great deal of running (86), given the large distances players cover during a match (2,9,35,48,66,67), the coach must know what they are targeting within a session. This is true regardless of the protocol used for conditioning (i.e., interval training versus small-sided games versus skill-based training drills). If the periods between maximal sprint efforts do not allow for full recovery, the training focus can shift from maximum acceleration and speed (55,69,80) to RSA and aerobic training (8,31,37). Coaches should build in sufficient recovery periods within their training drills if they are attempting

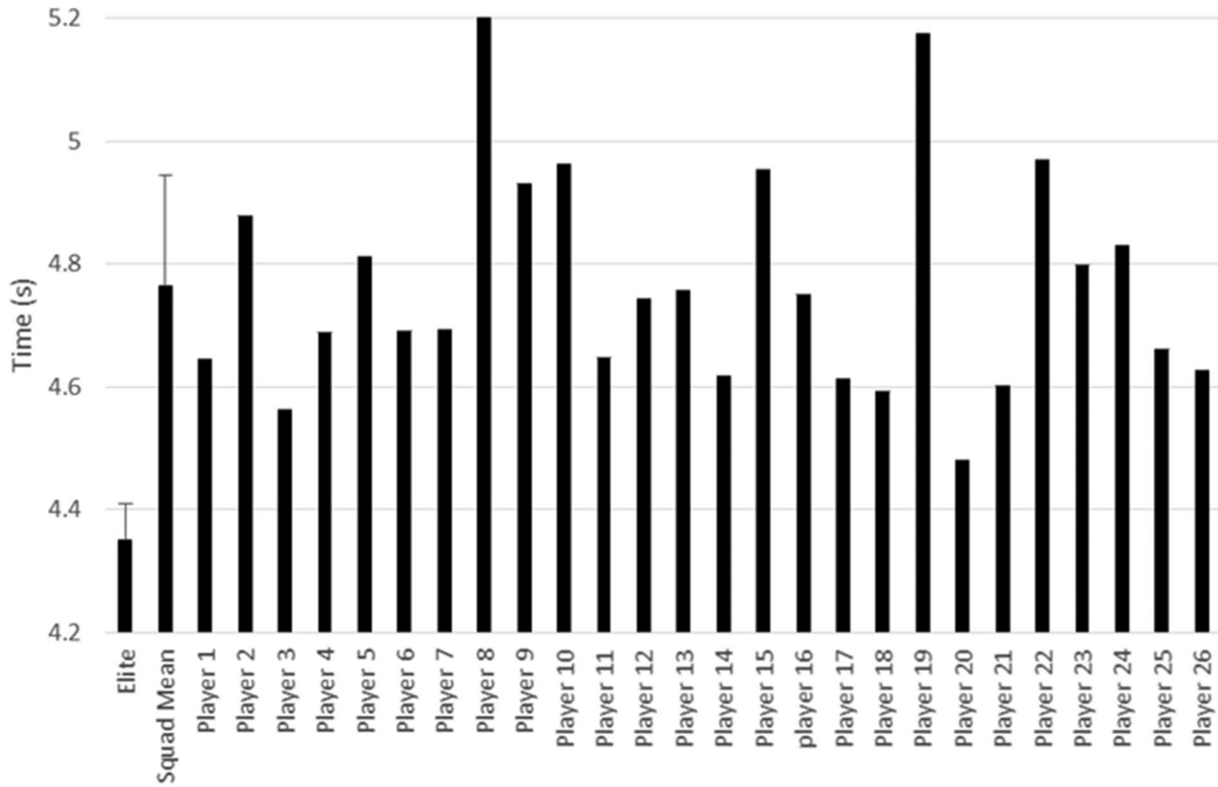

Figure 10. Squad mean and individual 0- to 30-meter sprint times for a Division I collegiate women's soccer team compared with an elite standard from Haugen et al. (39, 52).

to improve maximal linear speed and COD development in their players. If a squad is relatively better at a test such as the YYIRT1, yet relatively below standard at maximum speed tests, there may be a discrepancy in the volume of training being allocated to each.

FURTHER APPLICATION OF TEST DATA BY THE COACH

Effective test data can be used to provide objective feedback to the individual player (19,40,41,74,83). This information can also be useful in communications between the strength and conditioning coach and head coach. For example, if the strength and conditioning coach is following the directives of the head coach (e.g., "I want my players to be as aerobically fit as possible"), then this type of data could be presented to shift the training focus. As stated, the squad from this analysis have a playing style that emphasizes a high work rate to play with a high tempo. Although the players can complete a high volume of running, they may lack the explosive speed needed to take advantage of marginal chances in important tasks, such as ball contests (73,75) and goal scoring situations (30). The strength and conditioning coach can use data analysis such as that shown in this study to highlight collective strengths of the playing squad (e.g., aerobic fitness), and weaknesses that require further development (e.g., sprinting performance). The practical analysis of test data can not only inform the athlete's programs but also improve the training methods prescribed by the team's strength and conditioning staff.

It should be acknowledged that some athletes may respond differently to the presentation of test data (88), as the motivations of each athlete may be different (15). Furthermore, there may be gender-specific responses to the provision of test data, given that previous research has also established differences in motivation between male and female athletes (1,28). Although it is outside the scope of this article to provide definitive information as to a player's motivation and psychology, strength and conditioning coaches should be cognizant of the effects that superior or inferior performance within a testing battery may have on a player. This emphasizes the coach effectively communicating what the results of test data mean and how they will be used to inform training practices going forward within a season and a player's collegiate career. Moreover, the strength and conditioning coach should also be aware that this type of information may help guide the coaching process, but the other elements of soccer coaching (e.g., skill acquisition and refinement) should not be ignored. This is notable given the relative volume of information about the physiology of soccer when compared with technical or behavioral information (93). Nevertheless, appropriately analyzed data, presented in such a way that is objective and informative, may provide direction to the enhancement of a player's conditioning.

CONCLUSIONS AND PRACTICAL APPLICATIONS

The aim of this article was to provide practical examples of how to interpret test data for collegiate women's soccer players. After the selection of appropriate field tests, it is important for the strength and conditioning coach to be able to present the data to the team's coaching staff in a manner that is easy to interpret and understand. Furthermore, the strength and conditioning coach must be able to use the data to document the strength and weaknesses of their players, such that individualized training programs can be implemented. The use of standardized z-scores and radar plots is an effective method for this purpose. Strength and conditioning coaches can also compare testing data to normative values, such as those from elite athletes. Not only will this contextualize the performance of the playing squad but it may also highlight the areas of performance where the team is very competitive, and those areas that require greater improvement. This could also show the coaching staff certain physical capacities that they may have targeted at the expense of others and highlight strengths and limitations in the current conditioning practices. The correct use of data analysis can inform training practices for individual players and the team to improve physiological, and ultimately, match performance.

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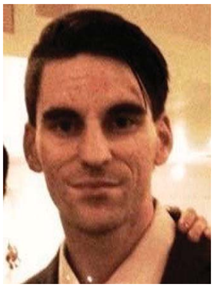

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