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Invited Commentary for FIFA issue

Improving the value of fitness testing for football

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Abstract

One of the challenges for the sports scientist working in football is to balance the needs for routine fitness testing with daily fatigue and well-being monitoring to best manage the physical preparation of players. In this commentary we examine contemporary issues of fitness testing in football to identify ways of improving the value of routine testing and monitoring. A testing program must be well planned and organised to ensure the results are useful. Different tests can be employed for younger and older players. A rigorous approach to analysis and interpretation of results is desirable, and database management must address both short- and long-term requirements of players, staff and programs.

Keywords: aerobic fitness, sprints, fatigue, training monitoring

Fitness testing is a visible part of many junior and senior football programs. In recent years the emergence of daily monitoring via smart sensor technology and self-reported well-being measures has challenged the traditional place of fitness testing particularly with senior level players. The challenge for sports science staff is to combine traditional fitness testing with new age daily monitoring to ensure the best possible preparation of players for competition. The aim of this commentary is to examine the contemporary issue of fitness testing for football and highlight ways to improve its value to the team, coach, support staff and individual players.

General purpose of fitness testing

Most sports scientists can cite the typical applications of fitness testing for football including profiling fitness to identify strengths and weaknesses, talent selection, evaluating effects of training or nutritional interventions, monitoring return to training and prescribing individualized or small-group training. The various codes of football played around the world have much in common in terms of their physical demands, and correspondingly the importance of fitness testing, but some differences may warrant a more code-specific approach. The challenge is then using the results of fitness testing to inform the prescription of training programs. A multi-component approach that emphasizes sports-specific demands, movement skills, long- and short-term progressions, and rest and recovery, derived from fitness and related testing should form the basis of the physical conditioning program.¹

Some critics may argue that not much is new, and that is often true, but the added value of doing the basics better cannot be overlooked. Part of the basics is just that – simple fitness testing of key attributes such as speed, endurance, strength, power and agility – but broader issues on the management, governance, cost-benefits, staff accreditation, evaluation and delivery of the fitness testing results should not be neglected. Scientific staff induction, training and management are important.² The program and scheduling of fitness testing should also form part of the end-of-season review.

Issues of validity, reliability, sensitivity and specificity

The validity and reliability of different tests are critical measures but often overlooked once a busy pre-season gets underway. A high priority is given to tests that relate to match performance.³ Somewhat surprisingly other metrics of test quality, sensitivity and specificity, are not widely reported in the literature on fitness testing, nor discussed on the ground when working with players and coaches. Sensitivity and specificity have much more prominence in the clinical (medical) setting than in athlete testing.⁴ For routine testing of fitness the measures of validity and reliability are more the issue. However, where testing is being undertaken for diagnostic purposes, for example to identify or confirm an athlete is suffering from fatigue, functional and non-functional overreaching or overtraining then sensitivity and specificity of test measures is important.⁵ Sensitivity (or the true positive rate) measures the proportion of actual positives which are correctly identified as such (e.g. the percentage of functionally overreached athletes who are correctly identified as being in that state). In contrast, specificity measures the proportion of negatives which are correctly identified as such (e.g. the percentage of healthy athletes who are correctly identified as not being non-functionally overreached or overtrained). It is prudent management to ensure that testing staff are recognisant of these metrics to ensure that severely fatigued athletes can be identified and managed.

Which are the best fitness tests in a given sport? Well there are a couple of ways to think about this question. Of course the priority is to select tests that are relevant to the

match situation.³ In other words fitness tests require high construct validity so that inferences drawn from observations or measurement tools actually represent or measure the characteristic being investigated.

Other considerations

A perennial question is the balance between physiological and performance testing. Some commentators question the need for undertaking physiological testing when direct measures of training and competitive performance can be readily obtained. It is prudent to focus on performance measures of training load and fitness but valuable insights can be gained from physiological testing. Physiological testing can provide valuable insights on the factors that contribute to and regulate exercise performance, and is thus complementary rather than competing with performance testing. For example, submaximal heart rate testing using standardized protocols can be utilized for frequent, time-efficient and non-exhaustive testing of intermittent exercise capacity of high-level football players.⁶

Most teams employ a policy where rookie contracted players (typically the 17-20 y olds) and veteran players (>30 y) are put on a modified training program to ensure that training loads are managed within tolerable limits for both developing and aging bodies. In a similar way, the testing and monitoring program also needs to accommodate these requirements with more frequent monitoring or testing, or possibly the inclusion of more specific tests as required. Younger players might require more frequent assessment of body composition and strength and power measures, whereas older players probably require more focus on recovery and regeneration. In young players (11-18 y) fitness testing can be useful in tracking progress in basic measures of fitness through the adolescent years.⁷

Another consideration is the timing of fitness testing in different phases of the season. It is readily apparent that the emphasis on fitness testing is greatest during the pre-season period when players are working extensively and intensively on their physical preparations. During the competitive season it is often difficult to schedule testing when the focus is on match preparation and recovery. However fitness can deteriorate over a long season when game demands are high and the time spent on conditioning is reduced. It can be difficult to distinguish between increasing fatigue and declining fitness as a long season draws to a close. In this period careful interpretation of load monitoring and selective fitness testing is required to ensure that players are well prepared physically for major tournaments and/or the final series of league competitions.⁸

The inclusion of strength and power measures will depend on the code of football. Codes with a high degree of physical contact, for example the NFL, Rugby Union and Rugby League, and Australian Football, have extensive strength and power training programs, and therefore warrant a well-constructed strength and power testing program. Regular testing within and between seasons is useful for determining which players may need additional attention in one or more specific areas of strength, speed and power development.⁹ Recent work has shown the utility of using jump testing to monitor neuromuscular fatigue in football players during a season.⁸ Fatigue appears to limit the influence of the aerobic and anaerobic qualities of players and their ability to regulate running pace.

Fitness testing or training monitoring

In the last decade the widespread usage of smart sensor technology such as global positioning motoring (GPS)¹⁰ and digital media has underpinned the move away from routine fitness testing to training monitoring. The first generation of GPS research describing basic movement patterns in different velocity zones¹¹ has now passed. Sports scientists should be recognisant of differences in GPS devices between units, models and

software updates.¹² Second generation research is describing temporal patterns of accelerations, decelerations and repeat sprints in games and presumably training activities.¹³ Future developments in radio frequency (RF) tracking will complement GPS-based movement analysis.

The scheduling of testing and monitoring occupies a substantial amount of time in planning. In the pre-season where training loads are high a combination of both intermittent testing and daily monitoring is suggested.¹⁴ At this early stage of the seasonal plan it is common to conduct fitness testing in parallel with anthropometric assessment, medical and musculo-skeletal screening, dietary review, vision testing, cardiovascular risk, and concussion testing. Tests must be easy to implement in practical settings¹⁵ and take minimal time out of the program to avoid conflicts with coaching staff. One perennial challenge is whether players are fresh and willing to test to get a true picture of underlying fitness, or whether testing is undertaken in a fatigued state to assess their current condition. Both approaches have merit but need to be discussed beforehand with both players and team coaches to ensure adequate compliance.

The other major development in the last decade is the use of daily health and well-being measures. A range of measures including fatigue, muscle soreness, ratings of perceived exertion, presence of illness, mood state, and sleep quality and duration, are commonly recorded. Of course these data are typically self-reported which always has limitations and serve primarily as a filter or screening mechanism prior to support staff intervention. Although some support staff have developed in-house methods to analyse and interpret these data, only a few published reports have put these details into the public domain.¹⁶ One suspects that a lot of data are recorded but only sparingly interpreted or analysed in a systematic way.

Interpreting results

There are several ways to interpret the results of fitness testing. A player's test score can be simply compared to the team, squad or cohort mean value to determine the relative ranking in the group (percentile ranking). A player's test score can be rated using established quantitative criteria and a Likert scale with appropriate plain-language descriptors (e.g. poor, average, good, very good, and excellent). None of these are new approaches but the practice of simply reporting test results without some sort of comparative assessment and interpretation is more common than it should be. Modeling the variability and progression in anthropometry and fitness provides a useful framework for interpreting changes from phase to phase within a season, and from season to season, in a particular team or cohort.

It is largely about interpretation of individual player's results and within-subject change scores as a season progresses. There are several analytical approaches for interpreting individual athlete test results, using magnitude-based inferences and sports-specific reference ranges¹⁷ or more classical single subject research designs.¹⁸ The concept of signal to noise ratio¹⁹ is a useful means of determining the usefulness or utility of tests in identifying smallest worthwhile changes or differences in fitness test scores.²⁰ Interpretation of results of fitness testing should account for the presence of illness, injury and/or fatigue, as well as the level of motivation of the player. Clearly a player not motivated to perform at their best in a physical fitness test is unlikely to yield a valid estimation of that particular performance measure.

In a number of codes there are published reference ranges for selected fitness test scores of football players. Casual inspection of these data indicates the cohorts are often junior or emerging players rather than senior or international level. It is understandable that national team programs, and teams playing in continental or national leagues, are

reluctant to share information that might provide a competitive advantage to their opponents. The heterogeneity of players in different playing positions has prompted the development of position-specific reference ranges.^{20,21} Staff should record playing position and other demographic details for subsequent analysis.

Database management is a rather mundane issue for coaches and players but important for the support staff in everyday monitoring and player support. Even at the highest echelons of football the long-term security of fitness testing results is often haphazard, particularly as management teams (coaches, managers and support staff) move on at the end of their contract if not sooner. Sporting organisations, professional teams and individual staff have the responsibility of ensuring that testing data do not disappear on someone's laptop at the end of the season, leaving little information for the incoming staff.

A final consideration is the timing and form of feedback of results to the player, coach and officials. Timing is everything - where possible it is always best to give verbal feedback of results and their brief interpretation at the time of testing. Players' interest will wane quickly if they are tested or monitored but don't hear back on the results. Coaches can also be informed verbally at the time of testing and their presence at a fitness testing session - the so-called Hawthorne effect - can make a substantial difference to the player's commitment and level of motivation. Digital management of results and feedback is essential in contemporary football. Programs that don't employ a fully featured web-based system that generates group and individual reports, with overlay charts, reference ranges, an accessible interface or dashboard, and automated alerts via e-mail, SMS text, or social media, are probably off the pace. That said, a hard copy version of results is often welcomed by coaches and players.

Concluding comments

Improving the value of fitness testing lies primarily with the sports science staff but the close cooperation of coaches, players and officials makes a substantial difference. Fitness testing needs to be well-planned, executed and managed. A combination of performance and physiology testing is warranted in most situations. Sports scientists must balance the needs of rigorous analytical approaches in interpreting data with the need for concise plain language feedback.

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