INJURY PREVENTION TRAINING IN FOOTBALL

TIME TO CONSIDER TRAINING UNDER FATIGUE?

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Muscle injuries often occur towards the end of each half and this has been associated with fatigue[1]. Current practice often means injury prevention training is performed at the start of the session. The hypothesis is that when training is performed in a fresh state it allows players to demonstrate better form. In this article we will look at fatigue, fitness and training order to question this existing practice and build a case for performing injury prevention at the end of practice, when in a fatigued state.

DEMANDS OF FOOTBALL

Football is a sport where players perform bouts of high intensity activity interspersed with periods of lower intensity. The demands are increased by having to execute complex movements such as accelerating and decelerating, changing direction, jumping and tackling, parts of which are likely to impact on the characteristics of the match[2]. To do this players need an appropriate level of fitness, namely moderate-to-high aerobic and anaerobic power, good agility, flexibility and muscular development and the ability to generate power during fast movements. Although players may not excel across all of the physical components, they should possess levels that will allow them to remain competitive for the whole match.

It is clear that physical qualities are not the only determinant of match performance. The outcome of a match depends on the complex interaction of several physical, psychological, technical and tactical factors. The work rate of a player in a match is also dependent on many other factors. Some of these are:

- the quality of the opposition,
- changes in positional role,
- the effects of previous and/or forthcoming game commitments,
- environmental conditions,
- dehydration,
- cultural differences and other intrinsic and extrinsic factors.

One example of the complexities is the distance covered. In the English Premier League players from less successful teams cover significantly greater distances in high-intensity activities than their more successful counterparts[3]. The opposite was found in Italy where players of the most

successful teams from the Italian Serie A perform more high-intensity activities during a game when in possession of the ball compared with players of less successful teams[4]. It is improper to suggest that superior fitness and/or players'/teams' levels will manifest in higher amounts of effort during any given match.

FATIGUE

Given the demanding nature of football, players will likely experience a degree of transient or accumulated fatigue at some stage of the match. The oversimplification of interpreting this with time-motion analysis is that players tend to experience this fatigue or/and impaired performance mainly after short-term, intense periods in both halves and towards the end of the match[5]. However, basing assumptions regarding physical fitness and fatigue purely on activity profile statistics is flawed; particularly given that our understanding of physiological responses during match activity remains limited. For example, it is still unknown to what extent the dynamic responses to match demands (such as accumulation of metabolites in muscles, plasma osmolality, substrate availability, body temperature and dehydration) prevent total breakdown of any single peripheral physiological system, either prematurely or in the final periods of the match[6].

Fatigue has become a hot topic in football despite being regarded as a complex and multi-factorial entity. There is growing interest as to how fatigue relates to recovery, player fitness and effort during matches. To avoid exhausting themselves before the final whistle, players are likely to adopt a pacing strategy that allows them to be involved in demanding and critical moments, even during the final stages of a match. The regulation of self-chosen high intensity activity is also an important product of training, as players need to learn to adopt pacing strategies that will allow a high effort even during the final stages, or when required. For example, an early sending off might increase the overall work rate of outfield players. Hence, there is likely a demand to cover more distance in order to counteract the numerical disadvantage. This may result in higher levels of fatigue towards the end of the game[6]. The large match-to-match variability of individual player work rates, particularly high intensity activity, as a representation of time-motion analysis means players are unlikely to perform to their maximal capacity during most matches.

FITNESS

When planning training sessions, coaches should take into account that playing and training affect each individual player differently. One of the objectives of a fitness test battery is to identify differences in players' physical characteristics. A variety of fitness tests are currently used to monitor performance and evaluate training response. Unfortunately, there is no exact measure for 'physical performance' in a football match. This stresses the fact that individual performance in fitness tests should not be used to directly predict performance in competition. Nonetheless, player fitness should be considered as a factor that contributes to match result. This means that using fitness tests together with physiological data might be useful for monitoring performance measure changes and directing training prescription. If testing and/or monitoring are not done often, coaches might not detect adaptations, which can occur faster than the time between tests. From an applied perspective,

this remains a challenge, as coaches are sometimes reluctant to sanction frequent testing within the season. This is despite the fact that routine monitoring may aid periodisation strategies, prevent under/overtraining and maintain players in optimal condition.

A relevant question when planning training sessions relates to fatigue. This is important as muscle injuries (e.g. hamstring strains, the most prevalent muscle injuries in football) typically occur in the latter stages of a match[7]. Interestingly, fatigue during the match has been associated with decreased eccentric strength and flexibility[7]. Most joint sprains also occur towards the final stages of each half of the match. We think that this might be associated with fatigue-related changes in neuromuscular control, joint dynamic stability, and postural control. This may result in players performing 'different' movement patterns than when they are fresh. Fatigue may lead to players using potentially injurious landing and turning techniques that occur during the later stages of football activity. Evidence to support this theory was seen using a 90-minute intermittent exercise protocol, representative of football match play. During the protocol, players had time-dependent impairments in sprinting kinematics, peak eccentric hamstring torque, functional strength ratio and overall sprint performance during the latter stages of the test[7]. Such research supports our hypothesis that fatigue is a major injury risk factor of match play.

Low fitness level is thought to be an injury risk factor for players[3]. Therefore, practitioners often try to elevate physical fitness in the belief that this will reduce the incidence of fatigue and accompanying injury. It cannot be overlooked, however, that players with greater physical fitness will simply work at a greater, rather than reduced, relative intensity, the implication being players may still suffer from fatigue. Players tend to perform less physical work and fewer skilled actions in the second half of a match compared to the first, regardless of ability. However, given that players may rarely perform to the maximum capacity in a match, the relationship between maximal (test) performance, fitness and injury occurrence is far from simple. This is likely to have profound implications for conditioning as part of the training programme. Despite such knowledge, there appear to be few time-related guidelines on when to embed injury prevention training into the practice sessions.

Resistance to fatigue is a key factor for a player to continually perform throughout the whole match. Indeed, the player's performance in response to training can be estimated from the balance between a negative (fatigue) and positive function (fitness). There is a fine line between improving fitness and negatively overloading the player, which could cause injury. There is now growing emphasis placed on monitoring training loads (using global positioning systems, heart rate monitors, time-motion analysis and subjective scales such as rate of perceived exertion) to allow teams to better manage and monitor training loads. Such tools are commonly used within the applied setting and are deemed important to develop performance-enhancing training guidelines.

TRAINING ORDER

The issue of training order is considered an important factor in the design of training programmes. Generally, this concept has been considered with regards to the order of endurance and strength training and a possible interference effect[8]. Either order of training has its advantages and disadvantages. This means it is important to consider the objective of the training session. For example, residual fatigue from the endurance component of concurrent training may compromise the ability to develop tension during the strength element of concurrent training. Essentially, there appears a likely trade-off that needs to be considered in view of the training goal.

SPECIFICITY

The law of training specificity states that the specific nature of a training load produces its own specific response and adaptations[9]. By inference, it would seem training in a fatigued state may improve performance in a fatigued state, too (Figure 1). In terms of injury prevention training, it seems the general approach is to perform drills earlier at the start of the session, often in a non-fatigued state. The justification is that players perform efforts in a 'fresh condition' that allows the musculature to produce the appropriate responses of protective function in maintaining stability, balance and body control. We propose some injury prevention training would be effective when performed after rather than before fatigue sets in. The reality of the match means that players will execute specific tasks in both non-fatigued and fatigued conditions. Hence, it would

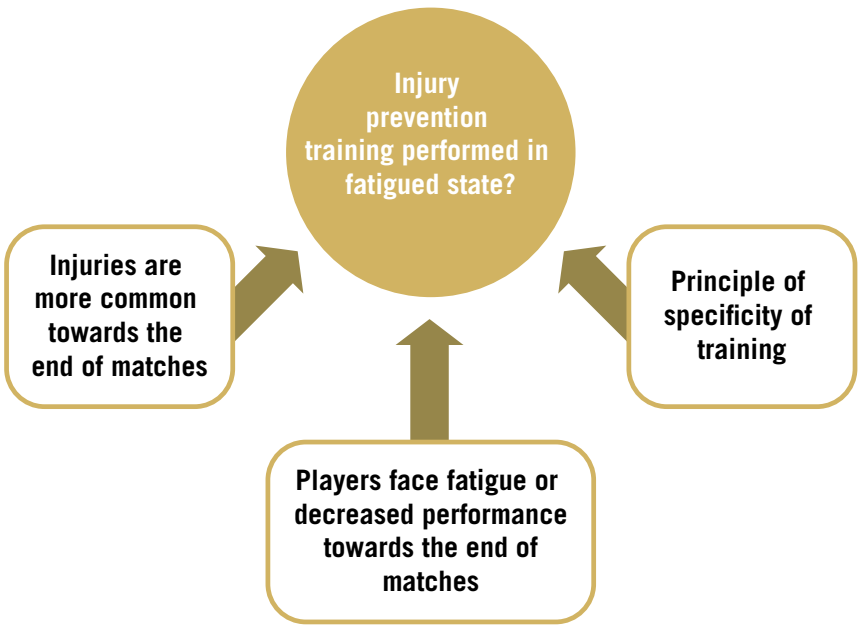

Figure 1: Rationale for training under fatigued conditions.

> ***training in a fatigued state may improve performance in a fatigued state***

seem training in both conditions might benefit the players.

Research has started to examine the effect of injury prevention training under fatigued conditions. The limited number of studies available have mainly been conducted in semi-professional football players and more studies in professional players are needed. In one study, eccentric strength training conducted post-training was shown to significantly reduce the negative influence of fatigue on hamstring strength[9]. Following the 8-week intervention, players who performed the training fatigued, compared to non-fatigued, showed better maintenance of eccentric hamstring strength and preserved functional eccentric hamstring to concentric quadriceps strength ratio during an intermittent test. A real life significant reduction in match-play hamstring injury rate in Australian Rules football was shown following an intervention strategy, including a football-specific eccentric hamstring strength drill, performed in a fatigued state[10]. The protective qualities may apply to other intrinsic factors that can be trained. For instance, a greater improvement in balance ability was observed when balance training was performed after, rather than before, football training[11]. This means that training in a fatigued state could also be applied to proprioception. Intuitively, the application of this as a training strategy is largely dependent on the trainers' objective within the session. However, we recommend that the timing for injury prevention training, including eccentric strength training, core stability, neuromuscular control and balance drills, should vary between training sessions as a strategy to improve adaptability to the specific demands of the game.

CONCLUSION

In conclusion, we recommend practitioners consider performing injury prevention training in a fatigued state too. By exposing the player to training under fatigue, we can better prepare them for the demands of the match. This strategy might assist in reducing the match fatigue-related injuries.

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