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SUITABILITY OF SOCCER TRAINING DRILLS FOR ENDURANCE TRAINING

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ABSTRACT. Little, T., and A.G. Williams. Suitability of soccer training drills for endurance training. *J. Strength Cond. Res. 20(2):316–319. 2006.*—Recent evidence suggests that certain soccer drills produce exercise intensities suitable for physical conditioning. However, it remains debatable whether soccer drills can provide a sufficiently unified exercise intensity among different players and on repetition of a drill, because movement patterns cannot be externally controlled during soccer drills. Good reliability and low variability of exercise intensity would enable all players to receive an appropriate training stimulus. The purpose of this study was to investigate intersubject variability and intrasubject reliability in exercise intensity during soccer drills. It was hypothesized that soccer drills that involve the highest exercise intensities would demonstrate the lowest intersubject variability and the highest intrasubject reliability. Heart rates of 23 professional soccer players were recorded during a range of soccer training drills. The drills consisted of 2 vs. 2 to 8 vs. 8 normal scoring games and 2 further possession games. Heart rate responses were examined for variability, reliability, and suitability for soccer endurance training. Coefficients of variation across players were less than 3% for all drills. Paired *t*-tests showed no significant differences in heart rate on repetition of the drills and 95% ratio limits of agreement were 1.8–3.8%. There were no significant correlations between exercise intensity and the statistical measures of variability and reliability. Several drills produced exercise intensities suitable for soccer endurance training with mean heart rate responses ranging from 87–91% HRmax. Soccer drills such as those used in the present study appear to be an adequate substitute for physical training without the ball and thus provide simultaneous skill and fitness training. The increase in training time spent developing technical ability and/or a reduction in total training time required may be useful for soccer teams.

KEY WORDS. football, fitness training, team training

INTRODUCTION

Football performance is dependent on a multitude of factors. Of these, technical skill and endurance capacity are known to exert a major influence on match performance. If both these capacities could be trained simultaneously using soccer games, it would be an extremely effective use of training time and physical load. Nevertheless, endurance capacities of soccer players have been traditionally trained using running drills without a ball. A major reason for this was that soccer games were not believed to provide sufficient exercise intensity to effectively improve the physiological mechanisms important in soccer endurance (6, 13). However, recently researchers (2, 7) have observed exercise intensities deemed appropriate for soccer endurance training (4) during various small-sided soccer games. Furthermore, in a preliminary conference abstract, Reilly and White (11) reported that training for 6 weeks using either 5 vs. 5 (five players per team) games or an interval running program resulted in similar improvements in endurance performance.

A remaining obstacle concerning the use of soccer drills for endurance training relates to the variability of training load between individuals and on repetition of a drill. In a group training environment, it is often desirable that all individuals work at similar intensities. In this manner, all persons receive the same training load, and optimal training parameters (repetitions and duration of work and rest) for a given training intensity can be administered. Traditional running drills (without a ball) allow precise control of work intensity by specifying the rate at which distances are covered or by using feedback from heart rate monitoring. On the contrary, movements in soccer drills are sporadic and cannot be externally controlled. Consequently, when using soccer drills, there is a risk that the variability of intensity between players and on repetition of a drill may lead to some players training at inappropriate exercise intensities.

High intensity soccer drills generally require more continuous involvement in play, resulting in movement patterns that are less tactical-zonal. This is likely to create a more similar movement pattern among players and thus less variation between players in exercise intensity within a given training session. Similarly, a high intensity soccer drill is more likely to provide a reliable training stimulus when a drill is repeated by the same players. However, little fully published research (there are some preliminary conference abstracts that contain some relevant data [1, 5, 12]) has addressed the issue of variability or reliability of exercise intensity during soccer drills.

Therefore, the purpose of this study is to investigate intersubject variability and intrasubject repeatability in exercise intensity during soccer drills. It is hypothesized that soccer drills that involve the highest exercise intensities will show lower variation of work intensity both between players and between repetitions and, therefore, will be particularly suitable for combined physical and technical training.

METHODS

Experimental Approach to the Problem

Recent findings (7) indicate that heart rate monitoring is a valid indicator of exercise intensity for soccer drills. Consequently, professional soccer players were assessed for heart rate responses to a variety of commonly used soccer training drills. All soccer drills and structures (exercise periods) were chosen from pilot work, with the intention of producing a moderate to high exercise intensity. Each soccer drill was administered twice and then was examined for intersubject variability and intrasub-

TABLE 1. Characteristics of soccer drills used as training sessions.*

Drill	Structure	Pitch dimensions (yds)
2v2	4 × 2 min, 2-min rest periods	30 × 20
3v3	4 × 3 min, 1.5-min rest periods	40 × 30
4v4	5 × 3.30 min, 2-min rest periods	50 × 30
5v5	3 × 5 min, 1.5-min rest periods	55 × 30
6v6	3 × 6 min, 1.5-min rest periods	60 × 40
8v8	3 × 10 min, 1.5-min rest periods	70 × 45
5v5 pr	5 × 2 min, 2-min rest periods	60 × 35
6v6 pr	5 × 2 min, 2-min rest periods	65 × 30

* pr = pressure half switch.

ject reliability of heart rate responses. The exercise intensity of each drill also was compared with current recommendations in the literature regarding suitability for soccer endurance training.

Subjects

Twenty-three professional soccer players from an English Division I club volunteered for the study. Mean (*SD*) age, height, and body mass were 22.8 (4.5) years, 180.6 (7.4) cm, and 79.2 (5.6) kg. All participants gave their informed consent and the study was approved by the Sport, Health, and Exercise ethics committee at Staffordshire University. All participants were familiar with all procedures used prior to the study.

Procedures

In the 2-week period before the first training drill was administered, maximal heart rates for each player were established using an incremental maximum heart rate field test and were confirmed with a maximal Yo-Yo Intermittent Endurance Test, both described by Bangsbo (3).

Participants took part in the training drills as part of their normal training. To encourage maximum effort participants were informed of the drill structure and the simultaneous aims of skill and fitness training. Coaches were present and provided encouragement during all drills. As is usual in professional football clubs, no vigorous training drills were utilized within 24 hours of competition. Participants were asked to maintain their normal diet, which emphasized high fluid and carbohydrate intakes.

The soccer training drills used were those that pilot work had shown to involve a moderate-to-high work intensity and are shown in Table 1. All normal games (ranging from 2 vs. 2 to 8 vs. 8) involved goalkeepers with normal scoring rules. Pressure half-switch games involved pressurizing a team within one half of a pitch and, on gaining possession, switching play to the opposite half of the pitch. Pilot work was utilized to estimate the most appropriate pitch size and structure (duration, repetitions, and rest) for each training drill. It was ensured that there were minimal stoppages in play during all drills by maintaining an abundance of soccer balls around the pitch and encouraging quick restarts in play. All drills took place in the morning. Repetition of the drills for reliability measures usually took place within 2 weeks of the initial drill. However, for 1 drill (5 vs. 5) there was a 4-week period between the 2 repetitions of the drill.

Heart rate was monitored telemetrically using 5-second intervals during the drills (Polar Electro, Kempele, Finland). Mean percentage of maximum heart rate (% HRmax) during the working periods was calculated for each participant during each drill. Rest periods between exercise bouts were excluded from the analysis.

Statistical Analyses

Interindividual variability in the heart rate response to each drill was quantified using the coefficient of variation (standard deviation divided by the mean, expressed as a percentage). Intraindividual reliability of the heart rate response to each drill was assessed using the ratio limits of agreement method (9) and 2-tailed paired *t*-tests. Pearson correlation analysis was performed to examine the relationships between exercise intensity of the different drills (% HRmax) and the various statistical results from the variability and reliability analyses. All data analyses were performed using SPSS, version 11.5.0 (SPSS Inc., Chicago, IL).

RESULTS

For the 23 participants, HRmax was 194 ± 7 $b \cdot min^{-1}$. The mean ± *SD* responses of % HRmax to all drills are shown in Table 2. The highest % HRmax was observed in response to the 2 vs. 2 drill, with a gradual reduction in % HRmax as the number of players and the pitch size increased (for the normal-sided games).

Variability and Reliability

The interindividual variability in heart rate response to the first of the 2 repeated administrations of each drill is shown in Table 2. Coefficients of variation were less than 3% for all drills.

The reliability measures for the 2 administrations of each drill also are shown in Table 2. Paired *t*-tests showed no significant differences ($p > 0.1$) on repetition of a drill for all drills. Ratio limits of agreement showed drills to exhibit 95% error limits of 1.8–3.8%.

Relationships of Variability and Reliability Statistics with Exercise Intensity

The Pearson correlation between the mean soccer drill exercise intensities (% HRmax) and the interindividual coefficients of variation of % HRmax for the different drills was $r = -0.17$ ($p = 0.68$). The correlation between mean exercise intensity and the intraindividual 95% error limits of % HRmax for the different drills was $r = -0.54$ ($p = 0.16$). The correlation between mean exercise intensity and the p values from the *t*-tests for comparisons of % HRmax during repetitions of the different drills was $r = -0.23$ ($p = 0.58$). Thus, there were no significant relationships between exercise intensity of the different drills and the various statistical results from the variability and reliability analyses.

DISCUSSION

Traditionally, many soccer teams have used running drills to improve the endurance fitness of players. The perceived advantage of using running drills is that the work rate of players can be precisely controlled. A precise control of exercise intensity will allow the application of chosen training parameters to produce intended physiological and performance adaptations. In a group training environment it is important all subjects receive a similar training load to prevent under- or overtraining effects.

TABLE 2. Interindividual variability (standard deviation [*SD*] and coefficient of variation [CoV]) and within-subject intertest reliability (paired *t*-tests and ratio limits of agreement) of % HR_{max} during the soccer drills.*

Drill	2 vs. 2	3 vs. 3	4 vs. 4	5 vs. 5	6 vs. 6	8 vs. 8	5 vs. 5 pr	6 vs. 6 pr
n	4	17	13	11	16	16	12	13
Mean HR ($b \cdot min^{-1}$)	176	175	175	173	169	170	174	175
Mean % HRmax	90.8	90.6	90.2	89.3	87.5	87.6	89.9	90.5
Variability								
SD	1.7	1.3	2.1	2.5	2.0	1.2	1.4	0.9
CoV (%)	1.9	1.4	2.3	2.8	2.2	1.3	1.5	1.0
Reliability								
n	4	16	10	6	12	16	12	13
Bias	1.003	1.001	1.001	0.996	1.002	1.009	1.004	0.995
95% error limits (%)	2.1	2.7	3.4	1.8	3.0	3.8	2.0	2.1
t-test (*p*)	0.64	0.84	0.84	0.36	0.67	0.15	0.22	0.11

* pr = pressure half switch.

The results of this study suggest that a number of soccer training drills can also produce consistent work rates that may be appropriate for endurance training. The low coefficients of variation (all less than 3%) demonstrate only small differences in heart rate responses between players in each of the training drills used. Hoff et al. (7) have reported similar low variability (standard deviation) values during a small-sided game. Good reliability will again aid in a unified training load for all subjects and will allow for the provision of a progressive training load over time. Using the ratio limits, the preferred method of assessing reliability in the sports sciences (9), it would be appropriate from our results to state that all the soccer drills tested show good reliability. None of the biases were statistically significant and all error limits were small. Even the drill with the poorest test-retest reliability (i.e., the 8 vs. 8 drill) showed a nonsignificant bias and 95% error limits of just 3.8% (± 6 $b \cdot min^{-1}$ of the target heart rate). This is the first published study to report reliability data for soccer training drills.

Correlation analysis showed no significant relationship between soccer drill exercise intensity and the various measures of variability and reliability. Therefore, the hypothesis that soccer drills which elicit higher exercise intensities will result in the most unified exercise intensities cannot be supported from our data. This may be due to the relatively small range of exercise intensities observed during the soccer drills we have used (3.3% HRmax). A more significant relationship may emerge if soccer drills with a greater range of exercise intensities were used.

The various soccer drills tested appear to demonstrate sufficiently good reliability and low variability of exercise intensity for effective use when training groups of soccer players. To be useful as an endurance training mode, in addition to having consistent and repeatable work intensities, a soccer drill should produce exercise intensities that are deemed appropriate for soccer endurance development. Helgerud et al. (6) discussed how training-induced gains in $\dot{V}O_2$max and lactate threshold are critical to improvements in soccer endurance. Evidence suggests that high intensity aerobic interval training is optimal for improving $\dot{V}O_2$max (4). This type of training involves bouts at intensities that are the minimum that will elicit $\dot{V}O_2$max (~90–95% HRmax). Several drills examined in the present study elicited heart rates between 90 and 95% HRmax (2 vs. 2, 3 vs. 3, 4 vs. 4, and 6 vs. 6 pressure half switch) and therefore, are potentially suitable for improving $\dot{V}O_2$max. Training intensities at, or slightly above, the 'individual anaerobic threshold' (85–90% HRmax; [10]) appear to be effective in improving lactate threshold parameters, with well-trained athletes probably requiring greater exercise intensities than moderately trained or sedentary individuals (8). The heart rate responses of the 5 vs. 5, 6 vs. 6, 8 vs. 8, and 5 vs. 5 pressure half switch drills, were indicative of exercise intensities suitable for improving 'threshold' parameters.

It should be noted that the present study was conducted using a single squad of professional players. Differences in heart rate response may exist between different standards of players or players with different training histories, and consequently the potential applications may not be transferable to certain groups. Practical application of our results would require that the conditions used here be adopted, including the presence and involvement of coaches and the provision of strong verbal encouragement during drills. If these conditions are adopted and players participate in soccer drills such as those investigated here, our results suggest that coaches can be confident that all those involved will receive a fairly uniform training stimulus as defined by the heart rate response. However, it would probably be good practice to verify the heart rate responses in a particular squad regularly, using a telemetric monitoring system.

PRACTICAL APPLICATIONS

The findings of the present study suggest that a number of soccer training drills elicit consistent heart rate responses to allow optimized group physical training. Furthermore, the heart rate responses indicate the drills were performed at intensities considered suitable to produce the physiological adaptations required for soccer endurance. Consequently, soccer drills such as those used here may be useful as a substitute for at least some of the physical training typically conducted without the ball, and thus provide simultaneous skill and fitness training.

The increase in training time spent actually using a football and, or a reduction in total training time required may be useful for elite and nonelite soccer teams.

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