# Relationship Among Repeated Sprint Tests, Aerobic Fitness, and Anaerobic Fitness in Elite Adolescent Soccer Players

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## Abstract

Meckel, Y, Machnai, O, and Eliakim, A. Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. *J Strength Cond Res* 23(1): xxx–xxx, 2009—The purpose of the study was to examine the relationships among aerobic fitness, anaerobic capacity, and performance indices of 2 different repeated sprint test (RST) protocols in a group of 33 elite adolescent soccer players (age range 16–18 years). All participants performed 4 tests: an aerobic power test (20-m shuttle run), the Wingate Anaerobic Test (WAnT), and 2 different RST protocols (12 × 20 and 6 × 40 m). Significant correlations ($p < 0.05$) were found between the fastest sprint ($r = 0.618$), total sprint time ($r = 0.709$), and performance decrement (PD; $r = 0.411$) of the 2 RST protocols. A significant negative correlation was found between the PD in the 12 × 20-m RST and calculated peak $\dot{V}O_2$ ($r = -0.60$, $p < 0.05$). There was no significant correlation between PD of the 6 × 40-m RST and calculated peak $\dot{V}O_2$ ($r = -0.32$, $p = 0.09$). The mean power in the WAnT was significantly correlated with the fastest sprint and the total sprint time of the 6 × 40-m protocol ($r = -0.42$ and $-0.45$, respectively) and with the total sprint time of the 12 × 20-m protocol ($r = -0.47$). There were no correlations between other indices of the WAnT and the 2 RSTs. Despite identical total work, different RST protocols represent different physiological implications. The aerobic system plays a significant role in the maintenance of intensity level during a soccer game, which is characterized by short bursts of activities. Anaerobic performance of repeated brief efforts imposes different physiological stress than a single prolonged activity and, thus, may reflect different physiological capabilities. Therefore, anaerobic testing procedures should consist of specific protocols that mimic the athlete's specific sports activity pattern.

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## Introduction

The sport of soccer is characterized by numerous explosive short exercise bursts interspersed by brief recovery periods over an extended period of time (90 minutes). In this situation, the activation of both energy systems, the aerobic and the anaerobic, is needed to fulfill the muscle energy demands during the game. It is also suggested that energy demands and physiological characteristics are related to the field position of the player (6).

Traditional tests for the evaluation of aerobic and anaerobic capabilities usually use a single continuum effort that lasts from a few seconds to several minutes. One of the most popular and reliable anaerobic test is the Wingate Anaerobic Test (WAnT), which measures a continuous, 30-second, all-out exercise (2). This test was used previously to assess the anaerobic capabilities of multisprint athletes (17); however, the physiological application of this test for intermittent-type sports, such as soccer, is questionable (1). Therefore, it seems that more specific tests are needed to characterize prolonged, intermittent-type sport events. Indeed, several test procedures that evaluate the individual's anaerobic capacity by repeat, short, maximal efforts have been developed; these are termed repeated sprint tests (RSTs). The different protocols for these tests consist of 8–10 repetitions of 5-second sprints starting every 30 seconds (4), 6 × 40-m maximal sprints starting every 30 seconds (5), and 12 × 20-m sprints starting every 20 seconds (24).

It has also been suggested that a high level of aerobic fitness is a prerequisite for increased anaerobic performance during sustained intermittent activities (14,18,23). However, results of correlation analyses between $\dot{V}O_2$max and performance indices of RST have been inconsistent, and although some authors have reported significant correlations between the two (5), others have failed to do so (24). One of the reasons for this inconsistency probably results from variations in RST protocols.

In recent years, the participation of children and adolescents in competitive sports has increased, and competitive soccer is one of the most popular sports among this population. In addition, exercise in children is characterized by very short bursts of mild to intense efforts (20,22). Thus, an examination of the relationship between the WAnT and measurements of peak $\dot{V}O_2$ with performance indices of the RST is even more challenging in children and adolescents. Surprisingly, however, very few studies have focused on these relationships in this unique population.

Therefore, the aim of the present study was to examine the relationships among aerobic fitness (determined by measurements of peak $\dot{V}O_2$), anaerobic capacity (determined by the WAnT), and performance indices of 2 different RST protocols in a group of elite adolescent soccer players. One RST protocol consisted of long sprints ($6 \times 40$ m), and the other one consisted of shorter sprints ($12 \times 20$ m). Because short sprints are more frequent during soccer (22), we hypothesized that the shorter RST protocol would better simulate the activity type of youth during a soccer game.

## Methods

### Experimental Approach to the Problem

The movement pattern in soccer is complex and is characterized by a mix of very short, and relatively few long, bursts of mild to intense efforts. This type of activity demands anaerobic capabilities. However, to maintain the activity for 90 minutes, high aerobic capacity is needed as well. Traditional tests for the evaluation of anaerobic and aerobic fitness are continuous and, therefore, do not mimic the movement pattern of soccer. In the present study, we compared the traditional WAnT test with 2 protocols of RSTs. To simulate the complexity of soccer movement, one RST protocol consisted of long sprints ($6 \times 40$ m), and the other consisted of shorter sprints ($12 \times 20$ m). In addition, we correlated $\dot{V}O_2$ measurements with the 2 RST protocols. We used the 20-m shuttle run test for the evaluation of aerobic capacity because the back and forward run in this test resemble the movement pattern of soccer. We used both short and long RST protocols, hypothesizing that because short sprints, especially in youth, are more frequent during soccer (22), the shorter RST protocol would better correlate with aerobic capacity.

### Subjects

Thirty-three late adolescent, trained soccer players (all men; age range 16–18 years), members of 2 teams from the first-division Israeli youth league, participated in the study. These teams were consistently ranked among the first 5 teams in the league. Six of the players were members of the Israeli national youth soccer team that qualified for the European youth championship in 2007. The players trained 5 days every week and competed during the weekend. The study was performed in the middle of the soccer season, when the players were assumed to be in their top physical shape. Most training sessions at this time of the year are devoted to specific tactic drills and game skills with the use of balls. No resistance training sessions were performed at that time.

Standard calibrated scales and stadiometers were used to determine height and body mass. Skinfold measurements at 4 sites (triceps, biceps, subscapular, and suprailiac) were used to calculate percent body fat using standard equations (18). Pubertal status was assessed by Tanner stage for pubic hair, and all the players were late pubertal (Tanner stages 4–5). The study was approved by the institution's ethical committee, the testing procedure was explained to the players, and a written informed consent was obtained from the players and their parents.

### Procedure

The subjects performed 4 tests in random order, separated by about a week from each other and at least 48 hours before or after a match. The 4 tests consisted of an aerobic power test, the WAnT, and 2 different protocols of RSTs.

To prevent unnecessary fatigue accumulation, players and coaches were instructed to avoid intense exercise for the 24-hour period before each testing session. The aerobic power test and the RST were performed on a grass training field, using regular soccer shoes, to replicate playing conditions. All tests were performed in the afternoon, 3 hours after lunch. The participants were instructed to drink 500 ml of water 30 minutes before each test. None of the participants were taking any food supplements. A comfortable average air temperature of about 20° C existed in all tests. Before each test, subjects performed a standard 20- to 30-minute warm-up.

### Performance Tests

*Aerobic Power Test—Twenty-Meter Shuttle Run Test.* The 20-m shuttle run test is a field test that predicts aerobic fitness ($\dot{V}O_2$max) and has been shown to be a reliable and valid indicator (19) of aerobic power in various populations (14). The main reason for the use of this test for the evaluation of aerobic fitness in the present study, and for its great popularity among soccer coaches, is that the back and forward runs performed in the test mimic the movement pattern of soccer. The test consisted of shuttle running at increasing speeds between 2 markers placed 20 m apart. A portable compact disc (Sony CFD-V7) dictated the pace of the test by emitting tones at appropriate intervals. Each subject was required to be at one end of the 20-m course at the signal. A start speed of 8.5 $km \cdot h^{-1}$ was maintained for 1 minute, and thereafter the speed was increased 0.5 $km \cdot h^{-1}$ every minute. The test score achieved was the number of 20-m laps completed before the subject either withdrew voluntarily from the test or failed to arrive within 3 m of the end line on 2 consecutive tones. Each subject's $\dot{V}O_2$ was derived by the formula, $y = 6.0x - 24.4$, where y equals the predicted $\dot{V}O_2$max and x equals the maximum speed achieved (19).

*The Wingate Anaerobic Test.* Anaerobic work responses were obtained using a Monark 834k cycle ergometer (Monark, Stockholm). Seat height was adjusted to each participant's satisfaction, and toe clips with straps were used to prevent the feet from slipping off the pedals. During the warm-up, participants pedaled at a constant pace of 60 rpm for 5 minutes against a light load of 1 kg. This was followed with 2 run-up practices of 3 seconds, during which the actual test load was imposed to accustom the participants to the resistance. For the actual test, each participant cycled as fast as possible for 30 seconds against a constant resistance of 0.075 $kg \cdot kg^{-1}$ body weight. The participants were instructed before the test that they should pedal as fast as possible throughout the 30-second test period. Participants were also verbally encouraged during the test to maintain their maximum pedal rate.

The WAnT measured the peak power output (PP), the mean power output (MP), and the fatigue index (FI). All power outputs measurements are based on 5-second averages that were calculated by the WAnT computer software; they are reported in watts per kilogram. The PP was calculated from the highest 5-second work output. The MP was calculated as the MP throughout the 30 seconds of the test. The FI was calculated as the percentage of power output drop throughout the test from the maximal power output (2).

*Repeated Sprint Tests.* Two protocols of RSTs were performed by the subjects. Each protocol included a series of short, maximal running with short rest periods between runs. The 2 protocols consisted of the following parameters:

1. 6 × 40-m run, departing every 30 seconds.
2. 12 × 20-m run, departing every 20 seconds.

These specific test variables were chosen as movement patterns typically performed in the game of soccer (16,20). Each subject performed all-out sprints of 20 and 40 m after warming up for the 12 × 20-m and the 6 × 40-m protocols, respectively. The time for each sprint was used as the criterion score during the subsequent RST. In the first sprint of each RST, each subject was required to achieve at least 95% of his criterion score. If 95% of the criterion score was not achieved, the subject was required to start the RST again.

A photoelectric cell timing system (Alge-Timing Electronic, Vienna, Austria) linked to a digital chronoscope was used to record each sprint and rest interval time with an accuracy of 0.001 seconds. During the recovery period between sprints, subjects tapered down from the sprint just completed and slowly walked back to the next start point. Two sets of timing gates were used, working in opposite directions, to allow subjects to start the next run from the same end at which they had finished the preceding sprint, thus eliminating the need to hurry back to a common starting point. A standing start, with the front foot placed 30 cm behind the timing lights, was used for all sprints. Timing was initiated when the subject broke the light beam. An experimenter was placed at each end of the track to give strong verbal encouragement to each subject at each sprint. Subjects were instructed before the test to produce maximal effort for each sprint and to avoid pacing themselves.

The 3 measures for each RST (6 × 40 and 12 × 20 m) were the fastest 40- or 20-m sprint time (FS), the total accumulated sprinting time (TS) performed during the 6 or 12 sprints, and the performance decrement (PD) during each test. The TS was calculated by summing all the sprint times of each test. The PD was used as an indication of fatigue and was calculated by dividing the sum of the sprinting times for each of the 6 or 12 sprints by the best possible total score and then multiplying by 100 (7). The best possible total score was calculated as the best 40- or 20-m sprint time multiplied by 6 or 12, respectively. The test-retest reliability of the RST is 0.942 for total running time and 0.75 for the PD (7).

Blood lactate concentration was measured by finger prick 2 minutes after the completion of each RST and the 30-second WAnT, using a portable lactate analyzer (Accusport, Boehringer Mannehein, Germany). Heart rate was measured using a Polar heart rate monitor (Polar Accurex Plus, Polar Electro, Woodbury, NY) immediately on completion of each run in both RSTs and at the end of the 30-second WAnT. Rate of perceived exertion (RPE) was determined using the modified Borg scale (3) at the end of each RST and at the end of the 30-second WAnT.

### Statistical Analyses

A paired *t*-test was used to compare differences between the 2 different RSTs. Pearson correlations were computed between the calculated peak $\dot{V}O_2$, fitness indices of the WAnT, and performance indices of the 2 different RSTs. Data are presented as mean ± *SD*. The significance level was set at $p \leq 0.05$.

## Results

Anthropometric characteristics of the study participants and the results of the WAnT and the peak $\dot{V}O_2$ are summarized in Table 1. Performance indices of the 2 different RST protocols are summarized in Table 2. The total sprint time, total rest time, and total practice time were significantly higher in the 12 × 20-m protocol than in the 6 × 40-m protocol. Maximal heart rate was significantly higher in the 12 × 20-m protocol, whereas RPE score was significantly higher in the 6 × 40-m protocol. There were no significant differences in the PD and the end test blood lactate concentration between the 2 protocols.

The correlations between the calculated peak $\dot{V}O_2$ and performance indices of the RSTs are summarized in Table 3. A significant negative correlation was found between the PD in the short RST test (12 × 20 m) and calculated peak $\dot{V}O_2$ ($r = -0.602$, $p < 0.05$). However, there was no significant correlation between the PD in the long RST test (6 × 40 m) and calculated peak $\dot{V}O_2$ ($r = -0.322$, $p = 0.09$). No correlations were found between the fastest sprint or total accumulated sprint time and peak $\dot{V}O_2$.

The correlations between performance indices of the 2 RST protocols are summarized in Table 4. Significant correlations were found in the fastest sprint ($r = 0.618$), total accumulated sprint ($r = 0.709$), and PD ($r = 0.411$) between the 2 RST protocols. Significant correlations were also found

**Table 1.** Anthropometric measures, Wingate Anaerobic Test (WAnT) results, and peak $\dot{V}O_2$ of the study participants ($N = 33$).

| Parameters | Mean ± *SD* |
|---|---|
| Age (y) | 17.4 ± 0.8 |
| Body height (m) | 1.75 ± 0.04 |
| Body weight (kg) | 66.7 ± 6.7 |
| Body fat (%) | 10.8 ± 1.9 |
| Peak anaerobic power ($W \cdot kg^{-1}$) | 10.6 ± 0.9 |
| Mean anaerobic power ($W \cdot kg^{-1}$) | 8.7 ± 0.4 |
| Fatigue index (%) | 36.3 ± 7.4 |
| Lactate concentration ($mmol \cdot L^{-1}$) | 10.1 ± 2.1 |
| Peak $\dot{V}O_2$ ($ml \cdot min^{-1} \cdot kg^{-1}$) | 54.1 ± 3.1 |

between the fastest 20-m sprint time and the total 6 × 40-m time ($r = 0.622$) and between the fastest 40-m sprint time and the total 12 × 20-m time ($r = 0.598$). No correlations were found between any other indices of the 2 protocols.

The correlations between the WAnT and performance indices of the 2 RSTs are summarized in Table 5. The mean power in the WAnT was significantly correlated with the fastest sprint and the total sprint time of the 6 × 40-m protocol and with the total sprint time of the 12 × 20-m protocol. No correlations were found between any of the other indices of the WAnT and the 2 RSTs.

## Discussion

The present study examined the relationships among aerobic fitness, performance indices of 2 different RST protocols, and anaerobic capacity determined by a continuous anaerobic test (WAnT) in a group of adolescent soccer players. Table 2 presents the differences in performance indices and characteristics of the 2 RST protocols. Although the total running distance in both protocols is identical, the total sprint time, total rest time, and total practice time are significantly higher in the short-sprint protocol (12 × 20 m) compared with the long-sprint protocol (6 × 40 m). These differences are the result of the higher number of runs and rest intervals in the 12 × 20 m. There were also significant differences in the heart rate and RPE scores and nonsignificant differences in lactate levels at the ends of the 2 protocols. Furthermore, correlations between matched performance indices of the 2 RST protocols in the present study revealed, at best, only moderate correlations (see Table 4). The physiological responses to intermittent exercise depend primarily on the subject's ability to recover from periods of work and on the specific protocol used. Thus, performance depends on the duration of repetitions, duration of rest periods, and number of repetitions performed in a given work session. Therefore, it seems that although they used the same repeated activity pattern, the RSTs in the present study are different from one another and may represent different physiological entities. These findings emphasize the need for a selection of an appropriate RST protocol–one that will match the work-rest pattern and physiological demands of the relevant sport. The selection of the appropriate protocol should be made not only according to the type of sport involved but also to the age and gender of the participants.

The relevance of the aerobic energy system to power maintenance during intermittent activity was evaluated in the present study by a correlation coefficient analysis between the PD in each RST and the calculated peak $\dot{V}O_2$ values of the participants. A significant correlation ($r = -0.602$, $p < 0.05$) was found between PD in the short RST protocol (12 × 20 m) and peak $\dot{V}O_2$. In contrast, no correlation was found between PD and peak $\dot{V}O_2$ in the long RST protocol ($r = -0.322$, $p = 0.09$).

The assumption that the aerobic energy system is an important determinant in recovery rate from intense activity and therefore assists in power output maintenance during the

**Table 2.** Performances indices (mean ± *SD*) and protocol characteristics of the 2 RSTs.

| Indices | 6 × 40 m ($N = 33$) | 12 × 20 m ($N = 33$) |
|---|---|---|
| Fastest sprint (s) | 5.6 ± 0.26 | 3.10 ± 0.10* |
| Total sprint time (s) | 35.1 ± 1.5 | 38.8 ± 1.2* |
| Performance decrement (%) | 4.8 ± 1.9 | 5.0 ± 2.0 |
| Total run distance (m) | 240 | 240 |
| Total rest time (s) | 150 | 220* |
| Total practice time (s) | 185.1 ± 1.5 | 258.9 ± 1.2* |
| Lactate concentration ($mmol \cdot L^{-1}$) | 11.3 ± 2.5 | 10.5 ± 1.8 |
| Maximal heart rate (bpm) | 178.7 ± 7.6 | 183.8 ± 7.8 * |
| RPE score | 4.9 ± 1.4 | 4.0 ± 1.3* |

*$p < 0.05$ for between-test differences. RPE = rate of perceived exertion.

**Table 3.** Relationships between calculated peak $\dot{V}O_2$ and performance indices in the 2 repeated sprint tests (RSTs).

| RST protocol | Performance indices | Calculated peak $\dot{V}O_2$ |
|---|---|---|
| 6 × 40-m RST | Fastest sprint time (s) | 0.048 (0.0023) |
| | Total sprint time (s) | −0.095 (0.009) |
| | Performance decrement (%) | −0.322 (0.104) |
| 12 × 20-m | Fastest sprint time (s) | 0.164 (0.027) |
| | Total sprint time (s) | −0.194 (0.038) |
| | Performance decrement (%) | −0.602 (0.362)* |

Data presented as *r* and ($r^2$) values.
*Significant correlation at $p < 0.05$.

RST relies on the fact that creatine phosphate resynthesis occurs primarily by oxidative processes (12). However, the results of previous studies have been inconsistent and have reported nonsignificant to moderate correlations ($0.42 < r < 0.52$) between peak $\dot{V}O_2$ and PD in intermittent types of activity (9,11,13,24). One possible reason for these differences may come from the fact that these studies used different protocols with large variations in the number and length of repetitions and the time of rest periods. Although the different protocols all used repeated activity patterns, the differences between the protocols may change the energy demands and, therefore, the physiological responses during the RSTs. Only when an RST protocol is specific to the sport involved and truly represents its movement pattern can a valid conclusion be made concerning the relationship between $\dot{V}O_2$ and PD and the importance of aerobic fitness to power maintenance in the sport. However, if the movement pattern of a given sport is complex (as in soccer) and an appropriate protocol is difficult to identify, 2 protocols should be tested, as was done in the present study.

To the best of our knowledge, no other study has tested and compared the results of 2 different RST protocols on the same group of young players. The application of this procedure in the present study enables us to examine the relevance of each RST protocol to different physiological and performance indices. The findings of our study suggest that the involvement of the aerobic system in the energy regulation of intense, repeated activity is more important in a short interval protocol than in a long interval protocol. The fact that the typical activity pattern in soccer, especially when played by children or adolescents, is characterized by short bursts of sprints (22) rather than by long sprints, suggests that aerobic fitness is important to performance maintenance throughout a soccer game. Indeed, it should be noted that professional soccer players tend to have higher $\dot{V}O_2$max than recreational players (10,17) and that $\dot{V}O_2$max has been shown to be positively correlated with the distance covered during a game (16).

Gatanos et al. (8) have suggested that the aerobic energy system contribution to the total energy provision increased significantly and was more important (compared with glycolysis) in power output maintenance during a long series of repeated sprints. They speculate that during the last sprinting efforts glycolysis was inhibited and that the contribution of the aerobic system to ATP resynthesis was more significant when more repetitions were performed. The higher number of repetitions and rest intervals, the longer total sprint and practice times of the short interval protocol (12 × 20 m) in the present study, and our finding of significant correlation between PD in this RST and the calculated peak $\dot{V}O_2$ seem to be consistent with this theory. However, further research is needed before such a view can secure greater credence. Thus, if a typical activity pattern in soccer is better replicated by a short RST, then the aerobic energy system must play a major role in the performance of soccer players. Nevertheless, because the correlation between peak $\dot{V}O_2$ and PD in the short RST was only

**Table 4.** Relationship between performance indices in the 2 repeated sprint test (RST) protocols.

| RST protocol | | 6 × 40 m | | |
|---|---|---|---|---|
| 12 × 20 m | Performance indices | Fastest sprint time (s) | Total sprint time (s) | Performance decrement (%) |
| | Fastest sprint time (s) | 0.622 (0.387)* | 0.598 (0.358)* | −0.195 (0.038) |
| | Total sprint time (s) | 0.598 (0.358)* | 0.709 (0.503)* | −0.034 (0.001) |
| | Performance decrement (%) | −0.183 (0.033) | −0.014 (0.0002) | 0.411 (0.169)* |

Data presented as *r* and ($r^2$) values.
*Significant correlation at $p < 0.05$.

**Table 5.** Relationships between fitness indices of the Wingate Anaerobic Test (WAnT) and performance indices in the 2 repeated sprint tests (RSTs).

| Performance indices | | WAnT Peak power ($W \cdot kg^{-1}$) | WAnT Mean power ($W \cdot kg^{-1}$) | WAnT Fatigue index (%) |
|---|---|---|---|---|
| 6 × 40-m RST | Fastest sprint time (s) | −0.313 (0.098) | −0.418 (0.175)* | −0.160 (0.026) |
| | Total sprint time (s) | −0.235 (0.055) | −0.446 (0.199)* | −0.031 (0.001) |
| | Performance decrement (%) | 0.268 (0.072) | 0.073 (0.005) | 0.331 (0.110) |
| 12 × 20-m RST | Fastest sprint time (s) | −0.131 (0.017) | −0.311 (0.097) | 0.134 (0.018) |
| | Total sprint time (s) | −0.047 (0.002) | −0.467 (0.218)* | 0.292 (0.085) |
| | Performance decrement (%) | 0.162 (0.026) | −0.170 (0.029) | 0.215 (0.027) |

Data presented as $r$ and ($r^2$) values.
*Significant correlation at $p < 0.05$.

moderate ($r = -0.602$), additional factors are likely to be important for recovery and power output maintenance in the intermittent activity of young players.

Relationships between anaerobic indices of the WAnT and performance indices of the 2 RSTs in the present study demonstrated nonsignificant to low correlations (see Table 5). These results may be somewhat surprising because both types of tests–the WAnT and the RSTs–are supposed to measure the same anaerobic capabilities of the subjects. Moreover, both are supposed to measure similar performance indices (highest work output, total work output, and FI) reflecting similar physiological properties (muscle maximal power and endurance). Also, the total activity times of both tests are very similar (30 vs. 35 and 38 seconds). However, although the WAnT is a continuous, single, all-out effort, the RSTs consist of a series of short efforts interspersed by brief recovery periods. Therefore, it seems that despite the similarity between the 2 types of tests, each one imposes different physiological stress on the working muscles and, thus, may reflect different performance capability. In line with our findings, Aziz and Chuan (1) have found only modest correlations between the WAnT relative mean power and the RST total sprinting time ($r = -0.46$) and between the 2 tests' FI values ($r = 0.46$) when studying the relationship between RST (8 × 40 m, with 30 seconds of rest in between) and the WAnT in team sport players. No significant correlations were found between WAnT absolute mean power and total sprinting time. The authors concluded that there is limited support for the use of the WAnT for determining anaerobic capabilities in athletes who are involved in team sports. It therefore seems that the results of the WAnT may apply to sports events such as track and field or swimming, in which performance is completed in a single trial of a continuum. Indeed, significant moderate to high correlations of $r = -0.69$ to $-0.91$ were found between various forms of WAnT power output and sprint running performance of 50–300 m (15,21). However, the application of the WAnT to intermittent types of sports such as soccer seems less convincing. For this sport, a repeated-activity type of test that mimics the activity pattern during a soccer game would probably be more suitable.

The low correlations between the 2 types of tests may also reflect the differences in the mode of exercise. Whereas the RSTs activate large muscle groups during sprinting, the WAnT uses only the leg muscles, and subjects may experience feelings of local fatigue. This is probably the reason for the large differences in PDs of both tests (36 and 4.8% in the WAnT and RSTs, respectively), although blood lactate levels were similar at the ends of the 2 tests (10.1 vs. 11.1 − 10.2 $mmol \cdot L^{-1}$ in the WAnT and RSTs, respectively). Also, soccer players are more familiar with running exercises than with bicycling, suggesting that a cycle ergometer should not be used as an instrument to measure the maximal power of running athletes.

## Practical Applications

Despite the identical total work, RSTs of different repetition and rest intervals demonstrate different physiological implications. The aerobic system is more related to power maintenance in an intermittent activity with a high number of short repetitions (12 × 20 m) than to one with a low number of long repetitions (6 × 40 m). Therefore, the aerobic system plays a significant role in intensity level maintenance during soccer games, which are characterized, particularly in children and adolescents, by short bursts of activity. Anaerobic performance of repeated efforts imposes different physiological stress than a single prolonged activity, and thus it may reflect different performance capability. Therefore, anaerobic testing procedures should consist of specific protocols that replicate the athlete's specific sports activity pattern.

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