American Journal of Sports Science
2024; 12(1): 1-5
http://www.sciencepublishinggroup.com/j/ajss
doi: 10.11648/ajss.20241201.11
ISSN: 2330-8559 (Print); ISSN: 2330-8540 (Online)

Correlating WattbikePro Cycle Ergometer Tests with Field Tests During College Football Preparation Period

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To cite this article:
Haruka Kawabata, Naoya Matsumoto, Yuki Iguchi, Yasuko Takeuchi, Fumiaki Onishi et al. (2024). Correlating WattbikePro Cycle Ergometer Tests with Field Tests During College Football Preparation Period. *American Journal of Sports Science*, *12*(1), 1-5.
https://doi.org/10.11648/ajss.20241201.11

Received: January 11, 2024; **Accepted**: January 29, 2024; **Published**: February 5, 2024

Abstract: Athletes across various sports perform cycle ergometer tests, because cycle ergometers provide a system for evaluating power and endurance by combining intensity and duration. However, cycle ergometers must be used with consideration for the specific characteristics of the sport in which the athlete seeks to improve performance. This study examined the effectiveness of the WattbikePro cycle ergometer test in comparison with a field test used by many soccer players. The study involved 21 male participants, who were members of a university soccer team. The participants were aged 19.5 ± 0.9 years. With heights and weights of 172.7 ± 4.2 cm and 66.8 ± 3.0 kg, respectively. During the first preparatory phase of their annual training plan, the participants underwent fitness tests, including a 50 m sprint, Cooper test, Counter movement jump (CMJ) test, 6 s peak power test, 30 s sprint test, and 3 min aerobic test. Correlation coefficients between the tests were calculated, and significant correlations were found between the CMJ and 6 s peak power tests ($r = 0.73$; $p < .05$) and between the Cooper and 3 min average power tests ($r = 0.62$; $p < .05$), indicating that introducing WattbikePro into fitness testing and training is effective for conditioning soccer players.

Keywords: Cycle Ergometer, Soccer, Power, Aerobic

1. Introduction

WattbikePro (Wattbike Ltd., Nottingham, United Kingdom) is a cycle ergometer equipped with electromagnets and air brakes. This device has a great advantage as it does not require a power supply, and it can be installed anywhere. Furthermore, it is used for fitness testing, training, and rehabilitation in soccer, rugby, and other sports. Training and fitness testing with cycle ergometers are less likely to involve technical factors. Hence, controlling the experimental conditions is easier. In addition, the reliability and validity of the instrument have been reported to be high [1–7]. WattbikePro has presets for 6 s peak power, 30 s sprint, and 3 min aerobic tests to evaluate multiple performances. Test histories are stored on the device, and the data can be exported to a PC or smartphone via a dedicated app. The ability to share exported data quickly within a team is extremely beneficial.

Soccer players often undergo conditioned via a periodization training program [8, 9] that divides the year into preparation, competitive, and transition phases. This program is often complemented by tests that can evaluate speed, power, and endurance [10–12]. In the college soccer teams that we

supported, we regularly evaluated improvements in speed, power, and endurance according to the annual training plan by conducting a 50 m sprint, Yo-Yo IR2 test [13], Cooper test [14], and CMJ test.

Soccer competitions have a congested game schedule, posing challenges in maintain conditioning throughout the year. This is particularly evident during the initial preparation period following the transition phase after the season, when the body is not fully prepared. In such circumstances, fitness tests become essential, as the players and coaches need to be aware of the baseline physical capabilities of the players. If the college soccer teams we support incorporate WattbikePro as a training tool, it could facilitate the integration of training and fitness testing to create individualized menus. However, evidence regarding the relationship between fitness testing with WattbikePro and field testing conducted in conditioned soccer players is limited; therefore, examining the effectiveness of fitness testing with WattbikePro on soccer players is necessary.

Hence, this study aimed to examine the relationship between various fitness tests—such as the 50 m sprint, Yo-Yo intermittent test, Cooper test, CMJ, 6s peak power test, 30 s sprint test, and 3 min aerobic test—conducted using WattbikePro during the preparation period. Specifically, the study sought to investigate the relationship between CMJ and WattbikePro.

2. Methods

2.1. Subjects

Table 1. *Field test order.*

CMJ Test	Recovery ←30sec→	CMJ Test	Recovery ←10min→	50m Sprint Test	Recovery ←5min→	50m Sprint Test	Recovery ←10min→	Cooper Test

Table 2. *Cycle ergometer test order.*

6sec Peak Power Test	Recovery ←2min→	6sec Peak Power Test	Recovery ←2min→	30sec Average power Test	Recovery ←4min→	3min Average power Test

The study included 21 male participants with an average age of 19.5±0.9 years, height of 172.7±4.2 cm, and weight of 66.8±3.0 kg. All participants were members of a university soccer club. Their team was relegated from the first division of the regional league to the second division in 2021 but was promoted back to the first division in 2022. Participants reported no physical issues or injuries during the experimental period. The participants were fully informed of the content and risks of the study, both orally and in writing, and their informed consent and participation were obtained in writing. This study was approved by the Research Ethics Committee of the Osaka Metropolitan University Faculty of Liberal Arts, Sciences, and Global Education.

2.2. Procedures

The participants warmed up sufficiently before the test and participated with maximum effort. The cycle ergometer and field tests were conducted on separate days in February, 2022. The testing period was the first preparatory phase of the team's annual training plan. The order of the field tests is shown in Tables 1 and 2, all participants completed them.

2.3. Tests

2.3.1. Field Tests

1) 50 m running sprint test

Measurements were taken using a Dashr (Dashr Systems, USA), connected via Bluetooth to a doublet terminal with an installed measurement application. Gates were placed at the starting point and 50 m mark. The initial posture involved a 3-point stance with both legs positioned alternately, with the front foot and opposite hand touching the ground. An adequate rest period of at least 5 min was provided between trials.

2) CMJ test

Measurements were taken using a Multi Jump Tester II (Q'sfix, Japan) connected to a PC via a USB. The PC was equipped with the necessary measurement application. The participants were instructed to jump with their hands on their hips and with their knees extended in the air. The jumping height (CMJ-H) was calculated based on dwell time, and the better record of two trials was considered the representative value. The rest time between the trials was no longer than 30 s.

$$\text{Jumping height (H)} = 1/8gT2$$

g: Gravitational acceleration; T: Dwell time.

3) Cooper Test

In the Cooper test [14], the running distance was measured for 12 min on a 400 m track, with markers placed at 5 m intervals along the track. Start and stop cues were provided by an examiner, who informed the participants of the elapsed time per lap. The test consisted of a single trial.

2.3.2. Cycle Ergometer Tests

1) 6 s peak power test

Each participant adjusted the handlebars and saddle of the WattbikePro according to their body size. The saddle height was adjusted such that the lower limbs were aligned when the participant placed their heels at the bottom dead center of the pedals. The handlebars were adjusted to match the saddle height. Throughout the test, the participants did not move

from the saddle.

After inputting their body weight into a watt bike, the participants adjusted the gear to the recommended value displayed on the monitor. Subsequently, their peak power (W) was recorded while pedaling at maximum effort. Two trials were conducted with a two-minute break, and the better record was considered the representative value.

2) 30 s sprint test

Using a WattbikePro adjusted to the participant's body size, the participant set the recommended gear value as in the 6s peak power test. The average power (W) was recorded for 30 s while pedaling at maximum effort. The test consisted of only a single trial.

3) 3 min aerobic test

On a WattbikePro adjusted to the participant's physique, the participant set the gear value to "7" and maintained a cadence of 100 rpm for 3 min. When the participant's cadence during the test fell below 100 rpm, the examiner lowered the load appropriately to allow the participant to maintain a speed of 100 rpm. The test was performed in a single trial, and the average power (W) was recorded.

3. Statistical Analysis

Pearson's correlation coefficients were calculated to examine the relationships between the tests. Means were compared using ANOVA, and Tukey's HSD was used for multiple comparison tests. The significance level for statistical hypothesis testing was set at 5%. The statistical analyses were performed using SPSS Statistics25 software.

4. Results

Table 3 presents the means, standard deviations, and 95% confidence intervals for each test.50 m sprint time: 6.74 ± 0.20 s, with 95% CI [6.65, 6.83]; CMJ: 38.5 ± 3.6 cm, with 95% CI [36.8,40.0]; Cooper test: 3357.1 ± 65.5 m, with 95% CI [3326.6, 3387.7]. 6 s peak power test: 967.0±125.5 w, with 95% CI [908.5, 1025.5]; 30 s mean power: 605.8±52.6 w, with 95% CI [584.7, 640.2]; 3 min aerobic power: 309.1±30.2 w, with 95% CI [295.0, 322.2].

Table 3. *Mean value, standard deviation, and 95% confidence interval for each test.*

	Mean	Standard deviation	95%CI	
			Lower	Upper
1. 50m Running Sprint Test (sec)	6.74	0.20	6.65	6.83
2. CMJ Test (cm)	38.5	3.6	36.8	40.0
3. Cooper Test (m)	3357.1	65.5	3326.6	3387.7
4. 6sec Peak Power test (w)	967.0	125.5	908.5	1025.5
5. 30sec Average power test (w)	605.8	52.6	584.7	640.2
6. 3min Average power test (w)	309.1	30.2	295.0	323.2

Table 4 shows the correlation coefficients between the field and cycle ergometer tests. Significant correlations were found between the CMJ and 6 s peak power tests ($r = 0.73$; $p < .05$) and between the Cooper and the 3 min average power tests ($r = 0.62$; $p < .05$).

Table 4. *Correlation coefficient between field and cycle ergometer tests.*

	50m Running Sprint Test	CMJ Test	Cooper Test
6sec Peak Power test	-0.35	0.73*	0.06
30sec Average power test	-0.37	0.41	0.18
3min Average power test	0.24	-0.20	0.62*

* p<.05

Figure 1 shows a comparison within the cycle ergometer tests. An analysis of the variance and multiple comparison tests showed that the order of decline was 6 s peak power test > 30 s average power test > 3 min average power test.

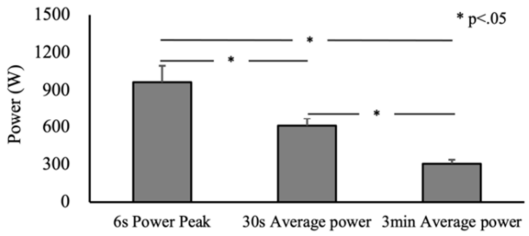

Figure 1. *Comparison within the cycle ergometer tests.*

5. Discussion

Correlations were found among the 6 s peak power test, CMJ, 3 min aerobic test, and Cooper test. This finding suggests that a cycle ergometer can be used to improve and assess the high-intensity power and continuous endurance of soccer players.

5.1. 6s Peak Power Test and CMJ

Performance in the 6s peak power test and CMJ test involves the gluteus, rectus femoris, and gastrocnemius muscles [15, 16] and requires ballistic muscle contraction; however, the postures and movements during the test are different. In the 6 s peak power test, the upper body is tilted forward such that the hip angle remains fixed, while in the CMJ, the lower leg muscle groups are engaged in a coordinated manner. Additionally, during the CMJ, the lower extremity musculature in both legs simultaneously switched from eccentric to concentric contraction. CMJ is a stretch-shortening cycle (SSC) that is employed for training and field testing various athletes, not just soccer players [17, 18], because the increased mechanical output due to the storage and release of elastic energy from the SSC produces more force than a squat jump [19]. However, the strength of a stronger muscle is reduced when the muscle strength is exerted bilaterally simultaneously, compared to when one side is moved independently. This is called bilateral dysfunction. Unilateral

squatting has been reported to have a greater peak ground reaction force than bilateral squatting [19]. In addition, a meta-analysis summarizing the effects of unilateral versus bilateral training [20] reported that jumping performance is more effective with unilateral training than with bilateral training. Although CMJ is expected to exert less muscle power than is exerted in the 6s peak power test, the correlation coefficient between the two is stronger than 0.7, so we do not need to consider the effect of bilateral hypofunction in this study.

Based on the above, the introduction of a cycle ergometer as a fitness test or training machine can be effective in improving and evaluating the lower limb muscle power of soccer players.

5.2. 3Min Aerobic and Cooper Tests

The Cooper and 3min average power tests are both used to evaluate continuous endurance; however, the modes of movement and muscle contraction in both tests are different. In the Cooper test, eccentric muscle contractions of the lower extremities occur when the feet touch the ground, whereas the 3 min average power test has no phase in which eccentric muscle contractions occur. The Cooper test is a whole-body exercise, whereas the 3 min average power test is a lower-limb exercise. However, the 3 min average power test can elicit VO2max despite its short duration [3], and the Cooper test has a strong correlation with maximal oxygen uptake [21]. In this study, the participants completed both tests close to all-out, and a moderate correlation coefficient (0.62 between the two, even with differences in exercise modalities.

Because training using a WattbikePro can improve cardiopulmonary function without accumulating physical strain as compared with running, WattbikePro can be an effective means of assessing and improving the continuous endurance of soccer players.

6. Conclusions

The 6 s peak power and 3 min aerobic tests using WattbikePro revealed a strong relationship between the lower limb muscle power and continuous endurance of soccer players, suggesting that introducing a WattbikePro into fitness testing and training would be effective for conditioning soccer players.

Funding

This study was funded by an internal grant from the Momoyama Gakuin University.

Collaborative research project: Effects of the off-feet test in university soccer players (21kyo282)

Abbreviations

CMJ: Counter Movement Jump

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Conflicts of Interest

The authors declare no conflicts of interest.

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