

Conference abstract

Comparison of indoor and outdoor riding ability

Li-En Chou¹, Yin-Shin Lee², Chen-Chang Tsai³, Yen-Nien Lu⁴, Jyun-Siang Hsu⁴, Tzyy-Yuang Shiang^{2,3*}

¹Department of Physical Education and Sport Sciences, National Taiwan Normal University, Taipei, Taiwan

²Department of Athletic Performance, National Taiwan Normal University, Taipei, Taiwan

³LOHAS Executive Master of Business Administration, National Taiwan Normal University, Taipei, Taiwan

⁴Technology Integration & Product Design, ICRC, Industrial Technology Research Institute, Nantou, Taiwan

* Correspondence: tyshiang@ntnu.edu.tw

Abstract: Indoor and outdoor environments profoundly influence cycling performance, highlighting the significance of riding ability assessment. Functional Threshold Power (FTP) captures peak performance while comparing indoor and outdoor settings reveals crucial distinctions. Therefore, this study seeks to compare FTP test results obtained from outdoor and laboratory settings, aiming to gain a deeper understanding of whether environmental settings influence cycling performance. Methods: Thirty participant underwent a 20-minute FTP test both in a laboratory setting and while exerting maximum effort on an outdoor ride. Subsequently, their FTP results were collected and subjected to correlation analysis. Results: The FTP values obtained from indoor and outdoor tests demonstrated moderate to high correlation ($r = 0.83$). Despite the presence of unavoidable variables that may influence participants' riding performance, these variables could potentially represent real-world riding conditions with higher ecological validity. The outdoor FTP protocol employed in this study may serve as a viable indicator for evaluating outdoor cycling abilities.

Keywords: Functional Threshold Power (FTP), Indoor Cycling, Bike Training, Actual Riding

1. Introduction

Pedaling power serves as a pivotal metric in assessing a cyclist's riding prowess due to its direct correlation with riding ability and precision. It reflects the combined influence of cadence and pedaling force, offering insights into the cyclist's physiological response. Over recent years, various training indicators have emerged, leveraging pedaling power data to enhance performance evaluation [1]. Functional Threshold Power (FTP) stands out as a significant index derived from the trend of pedaling power. FTP signifies the highest power output achievable under the lactate threshold and is widely acknowledged as the cycling performance indicator [2].

The comparison between indoor and outdoor cycling environments provides valuable insights into the nuanced aspects of riding capabilities. Laboratory settings offer controlled conditions that minimize external factors, allowing for precise measurement of pedaling power. However, replicating real-world riding conditions is challenging, as factors like wind resistance, terrain variations, and road surface can significantly impact performance [3]. On the other hand, outdoor ride provides a more authentic representation of cycling dynamics, offering a holistic view of the rider's abilities in diverse environmental conditions.

By examining the differences between indoor and outdoor FTP results, this research aimed to shed light on the contextual nuances that influence cycling performance. Insights gained from this comparative analysis can inform the

development of more comprehensive performance evaluation protocols, enabling cyclists to optimize their training and competition strategies with greater precision.

2. Materials and Methods

Thirty subjects (18 males, 12 females) with cycling experience, but are not professional athletes. Subjects with lower limb injuries within six months were excluded. Using ergometer (CYCLUS 2, RBM elektronik-automation GmbH, DE) for indoor testing collecting power, this power meter has been extensively utilized and validated as reliable under typical cycling conditions [4]. The FTP test protocol was suggested by Allen & Coggan [2]. Power meter pedals (Vector3, Garmin, TW) was used to collect outdoor pedaling power. Subjects were required to go all out without safety concerns in a 20km river bank ride.

Indoor FTP was calculated by multiplying the average power from a 20-minute maximum effort indoor cycling test by 0.95, a method suggested by previous studies [2]. Outdoor FTP is determined by calculating the moving average of outdoor cycling power every 1200 seconds. The highest matching average power value to indoor FTP is multiplied by 0.95 to obtain outdoor FTP.

Pearson's correlation coefficients were utilized to analyze the correlation between the indoor and outdoor FTP variables. Additionally, a paired sample t-test was employed to evaluate the disparities between indoor and outdoor FTP values. The significance level for all tests was set at $\alpha = .05$.



3. Results

In Figure 1, we notice that indoor-outdoor FTP result is highly correlated ($r = 0.83$) with certain deviations ($RMS = 34.12$ W), but show no significant difference between two methods ($p = 0.29$). Which means that outdoor riding FTP might also be a riding ability indicator. Based on the outcome, we can presume that there might still exist some differences between each individual, and there are several factors that may denoted to these differences.

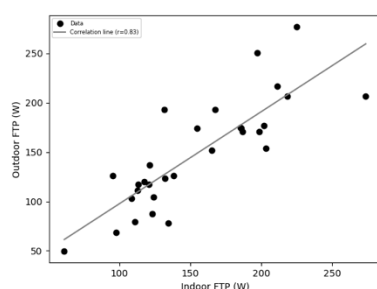


Figure 1 Indoor-Outdoor FTP correlation

Table 1: Indoor-outdoor FTP difference

Field Test	Lab Test	Mean Difference	Paired Samples T-Test
Mean Power	Mean Power	Between Test	<i>p</i> Value
112.84 W	117.41 W	4.56 W	0.29

4. Discussion

Eight out of thirty participants recorded higher FTP values when riding outdoors, attributing the difference to difficulties adapting to indoor ergometers. Consequently, indoor results may underestimate their riding ability. This underscores the notable contrast in power output between indoor and outdoor cycling in previous study, with outdoor cycling displaying a remarkable 30% increase in power output compared to indoor conditions [5].

Additionally, variations between laboratory and field tests persist, with potential differences of up to 20%, despite meticulous control of temperature and humidity indoors [6]. While indoor conditions excel in replicating optimal slopes for maximum power output, outdoor tests encounter additional factors such as traffic and temperature fluctuations. Although efforts have been made to minimize external influences, these differences may bridge the gap between laboratory and field-based results.

Moreover, previous studies suggest that utilizing closed-field or more optimized outdoor routes could serve as a compromise between indoor and outdoor testing environments [7]. These findings underscore the complex interplay between environmental factors and cycling performance, emphasizing the need for nuanced

approaches in evaluating and optimizing cycling abilities.

Riders and coaches can adjust training plans based on these research findings. If a cyclist performs better outdoors, increasing the proportion of outdoor training sessions could be beneficial. Riders can also pay attention to their perceptions and experiences indoors and outdoors, and adjust their riding strategies as needed.

5. Practical Applications.

The results of this study reveal that, aside from past indoor FTP assessments, outdoor FTP can also to some extent reflect the abilities of cyclists. Additionally, field testing is an important component in monitoring training progress allows for more frequent monitoring of performance metrics. Outdoor FTP can assist coaches in tracking the effectiveness of training more promptly or in devising different race strategies. It can also help cyclists understand their abilities or optimize planning for specific ride.

6. Conclusions

The results of our study indicate a strong correlation between outdoor FTP and indoor FTP. This suggests that both indoor and outdoor testing methods are suitable for assessing riding ability. Such findings can contribute to accommodating various circumstances and needs within cycling evaluations.

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