



The Effect of Carbon Fiber Plated Shoes on the Running Performance of Track Athletes

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Abstract- The study of the latest technological developments in the design and materials used in the creation of running shoes has greatly aided beginner and elite runners in breaking their own records and personal bests in various local and international marathon competitions around the world. The advent of carbon fiber-plated shoes in 2016 greatly helped many runners. This improved performance is said to be directly related to recent improvements in shoe technology, which increased the elastic quality of the shoes, lowering the energy consumption of running. This study will determine how track athletes' performance is affected by shoes with carbon fiber plating. The researchers used a Stopwatch and the fitness app Strava to get the time and speed of athletes while running. Athletes undergo a test involving running in standard running shoes and carbon fiber-plated shoes in 3km running trials. The findings showed that the level of performance of collegiate athletes improved, and the results also showed a significant difference between the performance of athletes using two different types of shoes.

Keywords: Carbon Fiber Plated Shoes, Collegiate Athletes, Level of Performance, Standard Running Shoes, Running Technology

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INTRODUCTION

Running is defined as an activity of going somewhere quickly on foot as a sport or for pleasure (Cambridge University Press, n.d.). It is also a sporting event in Track and Field where competitors run different distances using their own body and strength. As a result, these athletes require running shoes that will provide them with a comfortable fit while also improving their performance in various competitions.

The latest technological developments in the design and materials used in the creation of running shoes have greatly aided beginners and elite runners in breaking their own records and personal bests in various local and international marathon competitions around the world. The advent of Carbon fiber-plated shoes in 2016 greatly helps elite runners such as Eliud Kipchoge in breaking their own limits, setting new records ranging from 5km to 42km marathons. These athletes' improved performance is said to be directly related to recent improvements in shoe technology, which increases the elastic quality of the shoe, lowering the energy consumption of running (Borja et al., 2021).

The current shoe designs for road running and recently for track running that incorporate a CFP into their midsoles appear to significantly reduce the energy costs of running (Borja et al., 2021). As a result, most long-distance road running records have been broken in the last three years by athletes wearing CFP shoes. The new Nike Alphafly features an extended leg length and spring-like pace due to the increased stack height, which enhances lower-limb length. According to Nigg (1997), "Increasing the height of running shoes shows a much better result in running economy", as it reduces energy lost through the flexing of the forefoot. This mechanism minimizes energy demands on the body during running and jumping.

These innovations led to a "more than 4% increase in running economy, corresponding to greater than 2% improvement in performance or run time" (Muniz-Pardo, 2021). This is reflected in elite runners' performance from 2017 onward. Bermon et al. (2021) observed that "the top 20 and top 100 seasonal best marathon times have significantly improved following the release of carbon fiber-plated shoes in 2016, suggesting that advanced footwear technology-particularly carbon fiber plates (CFPs), has contributed substantially to performance enhancements.

However, a gap exists in current research: most studies focus exclusively on elite athletes competing at international levels. There is limited data on the efficiency of carbon fiber-plated shoes among collegiate athletes, particularly in our country. Therefore, the aim of this study is to explore how carbon fiber-plated shoes may influence the performance of track athletes at our university.

LITERATURE REVIEW

Carbon Fiber Plate

According to a 2018 study by Kevin Quely and Josh Kartz about the recently released Nike Vaporfly shoes, which are said to improve performance by 4%, athletes can greatly improve their performance by cutting down on running time. The Vaporfly's main innovation involves a carbon fiber plate that is incorporated into the midsoles. This plate serves as an energy reservoir that releases energy with each stride, propelling the runner forward like a catapult.

Quely and Kartz conducted an analysis comparing half a million race times since 2014, utilizing reports showing records from Strava, a fitness app serving as a social networking site for athletes. Their findings indicated that runners using Vapor Fly achieved 3% to 4% faster times compared to similar runners worldwide on the fitness app, which provides information on overall time, mile splits, and route maps.

According to Gregory, Robert W., et al. (2018), utilizing carbon fiber-plated shoes in sports performance greatly boosts the athletic ability of athletes. They found out that using Carbon Fiber Insoles (CFI) in shoes improved the vertical jump height, agility, and sprinting performance of athletes who use this type of insole in their shoes. Results show that there is a 2.5% increase in their vertical jump height and 1.5% improvement in their time in a 10-yard sprint when the athletes use CFI in their shoes.

Fu, Fenggin, Wang, et al (2021) conducted research on the impact of incorporating Carbon fiber plate shoes inserted into runner midsoles. They reported that, in comparison to shoes featuring complete forefoot plate design, positive work at the knee joint and peak metatarsophalangeal joint plantar flexion velocity were significantly higher in those with

segmented forefoot plate designs. Finite element simulation results showed that, in comparison to FFC, SFC had a lower maximum pressure in the middle.

The energy and motion of running level, ascending, and descending in highly comforting carbon fiber midsole-plated shoes, specifically Saucony Endorphin Pro shoes and Saucony-type shoes. Eighteen runners are selected for the two days of testing, which comprises two trials of two shoe models and three grade conditions (uphill, downhill, and level). Results show that EP provides an overall metabolic benefit over Type A shoe, but EP does not show a greater metabolic performance during downhill running, were studied by Hunter, Lain. (2022)

Nike Vaporfly 4% plated shoes lower the metabolic running expenditure using a treadmill by 4 percent when compared to traditional racing shoes. Their lightweight design and the curved carbon fiber plate that is placed in the midsole, an extremely flexible and durable midsole foam, are responsible for the reduction. They also looked at whether wearing these shoes could lower the metabolic expenditure of mild hills that are both uphill and downhill. They investigated the null hypothesis that, in comparison to standard running shoes, highly cushioned shoes with carbon-fiber plates would save about four percent of metabolic rate during running, ascending, and descending (Whiting, Hoogkamer, & Kram, 2022)

In 2022, Hata, Keiichiro, investigated how stiff legs are when running in extremely cushioned normal footwear and shoes containing a carbon fiber plate. The leg, they determined, was not notably different when running at 20 km/h in the Nike Vaporfly shoe

as opposed to the normal shoe. Additionally, the other biomechanical factors, including mechanical loading, SL, SF, and ΔCoM , were not appreciably different depending on the shoe condition. These results show that even with the Nike Vaporfly shoes on, runners' spring-like running mechanisms would remain unchanged.

Running in shoes with different features at 70% relative VO_2 max has an impact on biomechanical parameters but has no effect on physiological parameters. According to the study, runners can reduce reaching impact forces without sacrificing endurance performance by modifying their stride mechanics to suit various shoe conditions. Specifically, runners adjust their running style to improve how well they absorb shock during the landing phase when they wear shoes with the shortest rearfoot height and highest midsole elasticity in the rearfoot. The 10 km run at 70% maximal consumption used in the study gave participants enough time to adjust to the various shoe conditions, producing accurate as well as authentic and reliable results (Kiesewetter et al., 2022).

Adidas Adizero Adios regular shoes and Nike Vaporfly 4% plated shoes were compared for metabolic rate and time trial running performance. Thirty-seven track athletes participated in this study, completing three tests in the laboratory and two field sessions. The findings revealed that Nike Vaporfly outperformed Adidas Adizero Adios in terms of metabolic rate, power, and time trial performance. However, there was no connection between shifts in metabolic rate and time trial running performance between shoes (Nielsen, Anders, 2022).

METHODOLOGY

(Include ethical permissions and technical information about the study.)

Our demonstration methodology is designed to effectively showcase the functionality, performance, and potential applications of the solution. The approach is structured into the following key phases:

1. Objective Definition

To find out the level of performance of track athletes using regular running shoes?

To find out the level of performance of track athletes using carbon fiber-plated shoes

To find out if there is a significant difference between their level of performance using two different shoes

2. Scenario Development

This research study addresses a gap in understanding the different levels of performance using two different shoes in collegiate athletes. Most studies are exclusively focused on elite athletes competing at international levels. The primary

aim of this study is to explore how carbon fiber-plated shoes may influence the performance of track athletes at a state university.

3. Setup and Configuration

A 3km performance running trial was conducted in a concrete oval inside the university, and each athlete underwent these trials using two different types of shoes to determine their level of performance.

4. Step-by-Step Execution

Step 1: The researchers first secure approval to conduct the study from the Sports Development Program Office.

Step 2: Will seek consent from the head coach of the men's track team of PUP

Step 3: Before conducting the test, the athletes will have a short brief orientation about the nature of the study and the task that are involved in the test.

Step 4: The athletes will undergo a post-testing phase where they are engaged in a 3km running trial using the standard running shoes. The researchers will be going to record their final time using stopwatch and the fitness app strava.

Step 5: The last is the athletes will undergo a pre-testing phase where same parameters are going to be applied but this time a carbon fiber plated shoe.

5. Data Collection

The data will be collected using a pre and post test performance trial testing that have 3km running distance using two different types of shoes. The final time will be recorded using a stopwatch and the fitness app strava.

6. Evaluation and Iteration

The data was analysed using paired t-tests a statistical analysis.

To determine the level of performance of the participants the researchers utilized a 3k male standardized time from Running Level a running calculator founded and develop by Michael Clark (2020)

7. Conclusion and Next Steps

The test revealed that the level of performance of the athletes using regular running shoes falls under the category of Intermediate and Pre-Intermediate level of performance. While their level of performance using carbon fiber plated shoes falls under pre-elite, pre-advanced and intermediate. The statistical analysis also revealed that there is a significant difference between the level of performance using two different types of shoes.

RESULTS & DISCUSSION

What is the level of performance using regular running shoes?

Table 1. Level of Performance using regular running shoes

Participants	Level of Performance	Time
Athlete #1	Intermediate	12 minutes 22s
Athlete #2	Pre-Intermediate	13 minutes 28s
Athlete #3	Pre-Intermediate	13 minutes 58s
Athlete #4	Intermediate	12 minutes 2s

Legends:

Level of Performance	Time
Beginner	18:24
Novice	15:21
Intermediate	13:05
Advanced	12:25
Elite	10:12

Table

1. shows the level of performance of the participants during pre-test where they are using regular running shoes. The table includes the category of the participants based on the time that it has taken them in completing the test. It shows that athlete 1 and athlete 4 share the same level of performance. They are categorized as intermediate based on their level of performance. It took them 12 minutes and 22 seconds, and 12 minutes and 2 seconds, respectively.

On the other hand, athletes 2 and 3 are labeled as pre-intermediate based on their level of performance. It took them 13 minutes and 28 seconds, and 13 minutes and 58 seconds in completing the tests using regular running shoes. Study suggests that minimalists' shoes did not affect performance of runners using these types of shoes. A study by Fuller et al. (2019) found that minimalists shoes have no significant effect on the performance, running economy stride rate, foot strike and their bone density. These findings could explain why their times are in intermediate level and no improvement in performance is observed. Another study by Sinclair (2015) also suggests that using minimalists' shoes in running may increase the risk for Achilles tendon injury. That explains why some of the participants experience a slight pain in their Achilles tendon that also affects their performance during the data gathering.

1. What is the level of performance of the participants using carbon fiber plated shoes?

Table 2. Level of performance using carbon fiber plated shoes

Participants	Level of Performance	Time
Athlete#1	Pre-Elite	10 minutes 57s
Athlete#2	Pre-Advanced	11 minutes 30s
Athlete#3	Intermediate	12 minutes 55s
Athlete#4	Advanced	11 minutes 1s

Legends:

Level of Performance	Time
Beginner	18:24
Novice	15:21
Intermediate	13:05
Advanced	12:25
Elite	10:12

Table 2 shows the level of performance of the participants during post-test, wherein they are using carbon fiber plated shoes. In the table, different levels of performance of the athletes using carbon fiber-plated shoes were shown. Athlete 1 is classified as Pre-Elite with a time of 10 minutes and 57 seconds, athlete 2 is classified as pre-advanced with a time of 11 minutes and 30 seconds, athlete 3 is classified as Intermediate with a time of 12 minutes and 55 seconds, while Athlete 4 is classified as Advanced with a time of 11 minutes and 1 seconds. Overall, the level of performance of the athletes using carbon fiber plated shoes has improved, indicating that participants perform better using carbon fiber plated shoes. Previous studies suggest that using carbon fiber plated shoes can improve performance. According to Barns et al. (2018) that using carbon fiber plated shoes can improved the performance of athletes by at least 2-3% from their previous time. These findings support the results of this study where there is an observed improvements in the time of the participants from their pretest performance. However, this result contradicts the findings of Beck, O.N., et al (2020) who observed

that adding carbon fiber plates to shoe soles slightly alters whole-body and calf muscle biomechanics but specifically improved the running economy.

1. Are there any differences between the level of performance of the participants using regular running shoes and carbon fiber plated shoes?

Table 3. Significant differences between the levels of performance

Mean	t-value	p-value	Decision	Remarks
1.42	5.9257	0.010	Reject Ho	Significant

Table 3 shows, the mean, t-value, p-value, conclusion drawn from the hypothesis testing and interpretation.

The analysis further confirmed that there is a statistically significant differences observed between the pre and post-test level of performance of the participants ($p = 0.010$). It shows that participants demonstrated a different level of performance during the pre-test where they are using regular running shoes and in post-test where they are using carbon fiber plated shoes.

This outcome supports the study of Whiting, C. S. et al (2022), who reported that using carbon fiber plated shoes (Nike Vaporfly 4%) lowers the metabolic expenditure of running by 4% compared to traditional running shoes. Nevertheless, it stands in contrast to studies such as those by Hata, Keiichiro, et al (2022), who found that there is no significant difference between the performance when running in carbon fiber plated shoes and in traditional running shoes.

CONCLUSION

According to the result of the study:

1. Level of Performance using Regular running Shoes

The level of performance of the participants during pre-test, wherein they used regular running shoes, falls under the category of intermediate and pre-intermediate.

2. Level of Performance using Carbon fiber plated Shoes

In determining the level of performance of the participants during post-test, using the carbon fiber plated shoes, an improvement is observed after they used the carbon fiber plated shoes.

3. Significant Differences between the level of performance

In interpreting the results, it showed that there is a significant difference between the performance of the athletes using regular running shoes and carbon fiber plated shoes. A one to two minutes improvement was observed in the time of athlete's performance after they have used the carbon fiber plated shoes.

RECOMMENDATIONS

The findings of this study lead to the following recommendations.

1. The Level of performance of using regular running shoes

The researchers recommend that when choosing a specific regular running shoes, it is better to consider the participants shoe size and gait analysis of the foot of the participants to accurately assess the effectiveness of this shoe in the performance of the participants.

2. The Level of performance using carbon fiber plated shoes

The researchers recommend that when choosing a specific carbon fiber plated shoes, it is better to consider the participants shoe size and gait analysis of the foot of the participants to accurately assess the effectiveness of this shoe in the performance of the participants.

3. Significant Differences between the level of performance

The researchers recommend increasing the target population of participants in the study so that we can understand better the differences between their levels of performance.

4. For Future Researchers

The researchers recommend to study thoroughly the use of carbon fiber-plated shoes compared to the regular running shoes on the performance of an athlete. Identify the gaps and explore why it's better for athletes to use carbon fiber-plated shoes. The researchers also recommend increasing the number of participants to have more accurate and reliable results. This study is also financially challenging to do because of the price of the shoes that are used in the experiment.

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