Optimal Footwear for Cycling: A Comparative Study of Cycling Shoes, Crocs, and Running Shoes

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Math Senior Seminar
May 2024

Abstract

For everyday cyclists, the expense of equipment and gear is intimidating. This study examined the performance of a single cyclist with differing shoe types to see if specialized cycling shoes are more effective. We expected that there would be differences in speed, distance, and heart rate among rides with cycling shoes, crocs, and athletic shoes, with rider preference possibly playing a role in the performance results. One rider completed 15 total trials of three minutes on a stationary bike, with each shoe type tested five times. We found no significant differences in performance across the three types. The Crocs produced the largest variability in foot position and both the Crocs and running shoes had the shoe farther forward. Our data suggests that, for the casual cyclist, everyday shoes may be just as sufficient.

Cycling is a very complex and expensive sport, but how much of that expense helps a cyclist perform at their best? It's a common thought in the cycling community that having the best bike and the best shoes will make you the best cyclist (1). But what if that wasn't true? Studies have shown that the alignment of the bike and the proper positioning of the feet are key to performance (2). Some elite athletes can perform at the highest level in their everyday shoes such as Birkenstocks (3). It is important to consider if everyday athletes need expensive cycling shoes. In this study, we tested one amateur cycling-wearing running shoes with flat pedals, crocs with flat pedals, and cycling shoes with cleated pedals on an indoor trainer to measure their maximum speed, average speed, and power during repeated 3-minute trials.

When people begin to cycle they obsess over having the best gear, the best bike or the most expensive cycling cleats, thinking it makes them perform their best. But what if that wasn't the case and that the best way to better performance would be to prioritize the alignment of the body and position of one's foot? Researchers argued that seat height should be 98% of the length of the rider's leg and horizontal seat position should be so that the rider's knee is over their pedal when their feet are even and horizontal (2). These requirements will minimize pain and injury while increasing performance, regardless of the experience, ability, shoe type, or pedal type (2). This is important to our experiment because if we want to see if shoes are a factor, we have to make sure the bike fits well. This is especially true for less experienced cyclists who don't know all of the options for their bikes.

In addition to seat placement, another factor in cycling performance is the alignment of a rider's foot (4). Researchers conducted an experiment where 2 experienced male cyclists rode for 3 and a half minutes at a cadence of 90 rpm generating 200 watts of power. The main objective of the study was to measure the muscle activation of the two cyclists with their cleats positioned at different places on the foot: heel, arch, ball of foot, and toe. They found that using the heel and toe had the highest muscle activation, while the arch had the least (4). This suggests the most efficient position for endurance might be the middle of one's foot. This relates to our topic because it emphasizes what specific parts of your body are used the most while cycling and which will ultimately give the best cycling performance. Since we have an understanding of which foot position has the most and least muscle activation resulting in the athlete tiring out faster for our project we will want to pay attention to where cyclists put their feet when they have the option to move their foot, like a croc or running shoe.

There are many different pedal types on bikes all around the world for different levels of experience and comfort. Typically, flat pedals come with almost every pre-assembled bike, while other riders use clip or clipless (cleat) pedals. A study was created to determine which pedal type increased the performance of cyclists and which had the most muscle activation in their legs (5). They conducted their study by having 37 triathletes ride on a stationary bike at a cadence of 76-90 rpms. They found that across the board cyclists using the clipless pedals had the least amount of muscle activation, Ultimately making it so that these cyclists would have a higher endurance than those who used other pedal types. For our experiment, our participant has years of experience using flat pedals. We will determine if that pedal type is simply better for certain cyclists or if our participant is used to using the flat pedal.

Clipless (cleat) Pedal

Clipped Pedal

Flat Pedal

Figure 1: Common types of pedals

Many cyclists are unaware, but the movement of your joints while cycling plays a huge role in performance. Researchers have discovered that there is a larger knee movement when the ankle moves in a dorsiflexed motion which results in more muscle activation when using a flat pedal (6). This might decrease performance because higher activation of muscle results in decreased endurance. On the other hand, they found that when the ankle moves in a plantarflexed motion with a clipless (cleat) and clipped pedal, this maximum plantarflexion happens with better timing on the way back around the pedal stroke. This allows the use of different muscles in the cycle and could lead to better performance. In our study, we expect that our cyclist might be faster with a clipless pedal, but are unsure if their lack of experience with the system might be a factor.

There are multiple factors that go into efficient cycling. For instance, as previously discussed, the placement of your foot in comparison to the location of the knee and the height of your seat to the height of your body. But what does that truly translate to and what does that mean for you as a cyclist? Well, an experiment was created to find how much power each kind of pedal helps cyclists generate and how it helps to increase a cyclist's velocity (7). This relates to my topic because this is exactly what I'm trying to find just with different variables such as the experience of the cyclist and their comfort with different kinds of pedals. The researchers found that on average the cyclist produced 9.44W/kg of power on flat pedals. Then using running shoes with cycling clips they produced 10.23 w/kg of power. Then lastly when using cycling cleats and clip pedals they produced 10.96 w/kg of power. Moving on to on average their velocities varied significantly starting with flat pedals which on average allowed cyclists to have an average velocity of 30.2kmph, clip pedals allowed for a velocity of 31.4km h, and clipless pedals allowed for a velocity of 32.9 km h. This goes to show that the change in shoe type had a significant change in cyclist performance on different pedals.

Many people have the belief that there is a perfect shoe for cycling. This study has come to the consensus that rigid-soled cycling shoes are the best for people hoping to increase their performance (8). The study focused on how much power cyclists can generate in both their upward and downward strokes. A study was conducted to test the efficiency claims of cycling-specific shoes coupled with clipless pedals made by cyclists, coaches, and equipment manufacturers. The study measured the metabolic cost of cycling at sub-maximal power outputs and found no significant differences in metabolic power consumed for pedaling at 50, 100, and 150 W between three different shoe-pedal combinations tested. The shoe-pedal combinations tested were Nike Free 3.0 running shoes with flat rubber pedals, Nike Free 3.0 running shoes

with classic aluminum quill pedals, toe clips, and straps, and the cyclists' own rigid-soled, cleated cycling shoes with corresponding clipless pedals. The study concluded that while cycling shoes may have comfort or safety benefits, they do not enhance efficiency. This relates to my topic because it correlates to previous sources and gives important information about how certain cycling shoes work, specifically rigid-soled cycling cleats.

Overall, the research says that in addition to bike-fit pedal types and cycling shoes are important to help increase a cyclist's performance and endurance, however, studies are mixed on whether clipless pedals are better than platform pedals (4, 2, 5). This study contributed to an understanding of how shoe choice affects experienced cyclist performance with everyday shoes. One experienced cyclist used an indoor cycling trainer riding on a stationary bike adjusted to their bike fit to test their maximum and average speed, heart rate, and distance, they will complete this exercise 3 times. Once with Crocs, once with running shoes, and once with cycling cleats. We hypothesized that there will be differences in performance. Second, we expect the pedal type is related to differences in foot position on the pedal.

Materials and Methods

A high school student-athlete (the primary author) who attends the Neighborhood Academy in Pittsburgh Pennsylvania participated in the study. The student has completed 1000+ miles cycling across The United States and has participated in their school's cycling club where they bike through the city of Pittsburgh. The study was conducted using one 18-year-old male. This participant has expressed that they primarily cycle in Croc clogs.

The experiment was conducted using a focus AX road bike, a Coospo heart rate monitor, a Cat Eye Velo 7 cycling computer, and a stationary bike trainer. The heart rate monitor provides maximum and average heart rates. The cycling computer provides maximum speed, average speed, and distance. The tension applied to the bike wheel by the bike trainer remained consistent for all sessions. The flat pedals used were Redline BMX pedals with a platform measuring 8.5cm by 9.5cm and the clipless pedals used were Coda SPD pedals, with clipless shoes.

The participant was measured from the acetabulofemoral joint (hip) to the sole of their foot both with and without shoes. After finding their measurements, the bike was adjusted so that the cyclist had proper plantar and dorsiflexion and proper range of motion in their knee.

Before each trial, the participant warmed up for 1 minute at a gentle pace. Then, their data was recorded for three minutes. The participant was asked to go as fast and far as they could, and received a time update every 60 seconds The rider would be oblivious to their heart rate, distance, and speed. The participant was asked to pedal seated only and on the flat pedals, they could move their feet anywhere they wished. A short video of their pedaling position was taken in order to take notice of their foot position in each shoe type. Each of the three phases took place on a different day to give the participant time to recover. The cleat position of the participant was measured by recording a video for the duration of the trial and taking screenshots of the cleat position at 15-second intervals. Once the screenshot was obtained we used a photo-measuring website to find the position of the cleat from the heel of the foot to the spindle of the pedal (9).

Differences in performance were analyzed using a one-way ANOVA test for correlated samples. Differences in performance for preferred and nonpreferred were calculated using a T-test for correlated samples. Individual differences were found using a Tukey post-hoc test. The abbreviation M is the mean, and SD is the standard deviation. All tests were calculated using vassarstats.net with a 0.05 significant threshold.

Results

This is a research study conducted by a student and The Neighborhood Academy to solve the age-long mystery of whether expensive cycling equipment can make you a better cyclist. In this study we expected the participant to perform better with cycling cleats. We also believed that the personal shoe preference of the participant would allow them to perform better with the shoes they prefer such as crocs or athletic shoes. Ourgeneral hypothesis was based on howshoe type could affect performance. We also expected it would affect the foot position on the pedal.

Initially, when beginning this study we had thought that there would be differences in performance for different shoes. We tested the participant's max and average heart rates (HR). For maximum heart rate, cycling shoes (M=162.6, SD=10.9), Crocs (M=148.8, SD= 27.0), and athletic shoes (M= 159.2, SD= 16.1) did not produce statistically significant differences (p=0.40). There was also no difference in average heart rate between cycling shoes (M= 131.8, SD=131.3), Crocs (M= 110.2, SD= 11.4), and athletic shoes (M=113.0, SD= 8.0, p = 0.32).

There were also no differences in maximum speed (p=0.15), average speed (p=0.32), or distance (p=0.29) for the three shoe types. These results are summarized in Table 1.

	Max HR	Avg HR	Max Speed	Avg Speed	Distance
Crocs	148.8 (27.0)	110.2 (11.3)	22.72 (1.52)	17.2 (0.54)	0.86 (0.03)
Cycling Shoes	162.6 (10.9)	131.8 (7.6)	25.36 (1.41)	15.8 (1.28)	0.79 (0.07)
Athletic Shoes	159.2 (16.1)	113 (8)	28.32 (6.1)	15.78 (2.44)	0.79 (0.12)
p-value	p = 0.40	p = 0.32	p = 0.15	p = 0.32	p = 0.29

Table 1. *The table above shows The Max and Average speed and HR calculated during this study. As well as the distance participants traveled throughout the trials. The first number is the mean and the second number is the standard deviation*

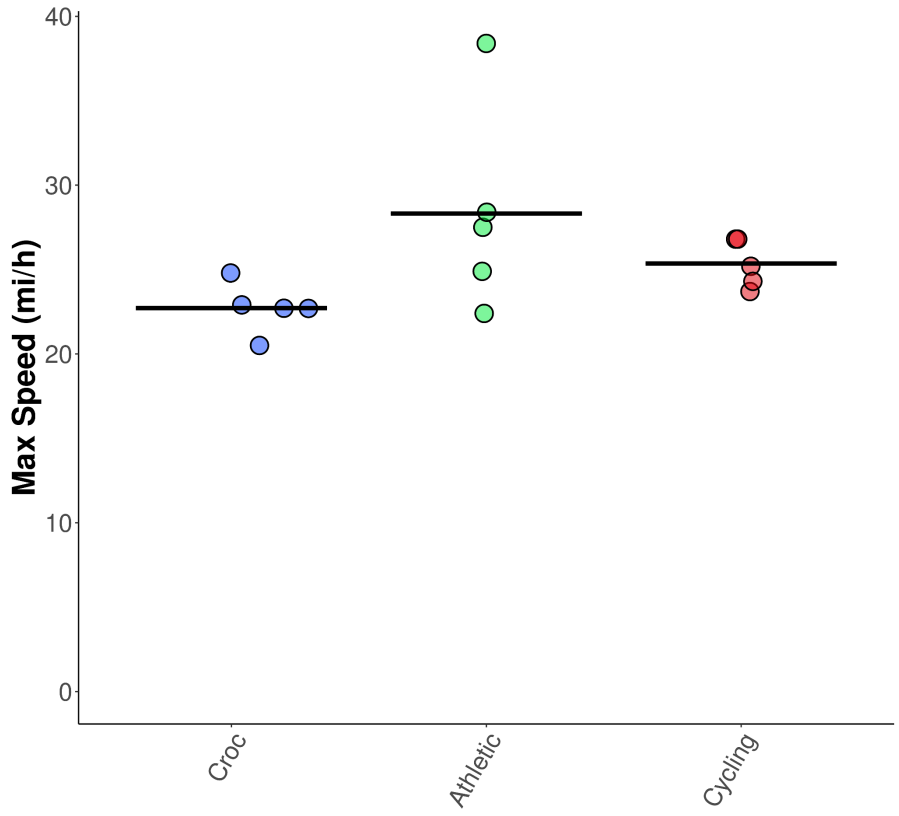

Figure 1. No difference in Max speeds amongst different shoe types. *The dot plot shows the mean Max speeded in miles per hour for Crocs, athletic shoes, and cycling shoes (n=5). Max speed is determined by a computer assessing the maximum speed reached during the trial. One-way ANOVA for correlated samples p>0.05*

Because there were no significant differences in performance for the shoe types, we decided to look into any differences in how the shoes are used in connection to the pedal. Cleat distance was measured from the back of the foot to the spindle of the pedal. The cycling shoe had a fixed distance of 21 cm while the other shoes were measured using a photo-measuring website (9). The trials were videotaped and screenshots were taken at 15-second intervals to measure the position of the shoes to the spindle of the pedal. A 1-sample t-test found a significant difference between Crocs (M=24.735, SD=4.3374) and cycling cleats (p-value= 0.01). In addition, another trial was videotaped and screenshots were taken at 15-second intervals to measure the position of the running shoes to the spindle of the pedal. A 1-sample t-test found a significant difference between athletic shoes (M=23.7812, SD=5.4109) and cycling cleats (p-value= 0.02). This suggests that there is a significant difference in the placement of the foot in comparison to the spindle on the pedal. For both athletic shoes and Crocs, the pedal was farther forward on the foot than if the rider was using a cycling shoe.

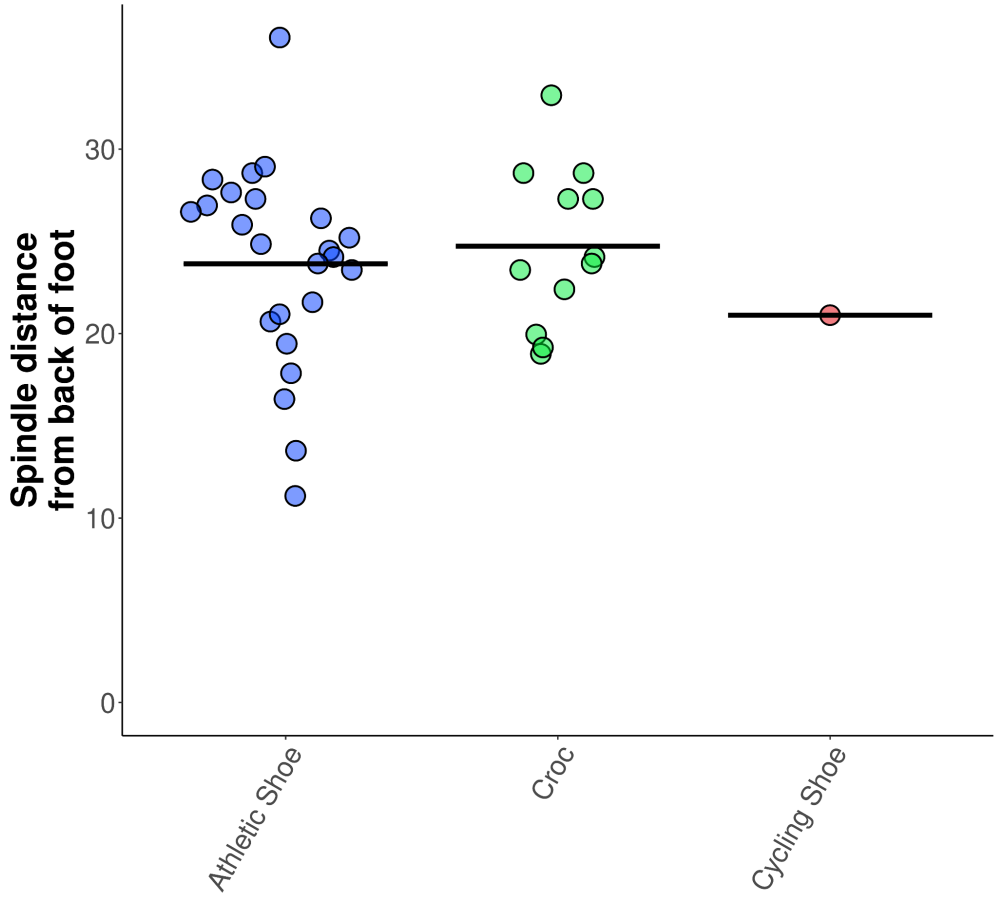

Figure 2. The difference in foot position between shoe types. *The dot plot shows the mean placement of the foot in comparison to the spindle of the pedal for Crocs, athletic shoes, and cycling cleats(N= 25). Foot position was determined by a video measuring website to observe where the back of the shoe was compared to the spindle in the middle of the pedal. One-way ANOVA for correlated samples $p<0.05$*

Discussion

In this study, we found no significant difference in performance across shoes while riding bikes, Our first hypothesis was that performance would vary by shoe type. Some research suggests cycling cleats are best, while rider preference might also play a role. This was partially supported by the cyclists producing their highest average max speed with athletic shoes, and producing their highest average speed with crocs, which were expressed to be the preferred shoe type (Table 1). However, cycling shoes had the highest max HR and average HR, but this did not produce a larger average speed. However, none of these differences are significant. Additionally, we looked at foot position and found athletic shoes produced the most variability and both athletic shoes and Crocs tended to gravitate closer to the toes (Figure 2).

Our results are consistent with other studies by Kram and Straw (8). Kram found that cycling shoes produce very similar results to Nike-free athletic shoes when cycling on an indoor trainer. Our study found that there was no significant difference in the performance of the athlete with the different shoe types as well. This study helps to support the idea that there are far more factors that go into a rider's performance than shoe type. Additionally, the preference of the rider and comfortability they feel is a key factor that should be researched further. Research has yet to prove that cycling shoes are better than any other shoe type when it comes to the performance of non-elite athletes.

However, our results are inconsistent with another study by Kram (7). Kram found that when cyclists sprint uphill, cycling shoes helped improve their 100m average speed and maximum sprint power output. Our study did not find this difference largely because we did not conduct any test outside as well as any sprinting test at all. This is logical because when standing up there are more muscles activated which could lead to an increase in performance. In our study, we did not have this liberty and were only able to test the participant while sitting down. Therefore cycling shoe choice may also be based on the condition in which they are being used.

Our study had several limitations, one being the limited number of participants. It was hard to prove the significance of the performance of one shoe type because we were only able to conduct the test on one participant. Our suggestion for other researchers would be to have a larger sample size. Another limitation was the amount of tests conducted on the participant. We were not able to prove anything because we did not have large enough trials for each test. Our suggestion would be to conduct additional tests for each shoe type. Another future improvement could be to improve the equipment, such as using a cycling trainer that would allow the cyclist to stand up and activate different muscle groups. We also considered for future studies, if there is a local cycling track that is accessible, using a more realistic environment with sprints, hills, and turns. This may help to improve the results of the study and give athletes more opportunities to perform at their best. The last suggestion we have is to use a wide range of different participants differing in age, experience, and athleticism. This would make for a variety of different results which could allow us to examine performance in different types of riding.

According to our research, there is no significant difference in cycling performance when using Croc clogs, athletic shoes, and cycling cleats. Other studies have suggested that in certain situations, cycling cleats have the ability to help improve a cyclist’s performance. However, to the everyday person who just happens to ride a bike, there is not enough evidence to suggest that cycling cleats are needed for optimal performance. Therefore, it is completely acceptable for the average person to wear their preferred shoes while cycling.

Works Cited

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