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November 3, 2024

Foot Posture Effects on Lower Extremity Running Injuries and Orthotics Effect on Comfort Levels, Injury Reduction Rate, and Performance

Part One: Foot Posture Effects on Lower Extremity Injuries: A Literature Review

Abstract:

Overuse injuries are common in physically active populations. Chronic lower extremity injuries can have both short- and long-term consequences on health and pose a burden to physically active people. Various predictions have been proposed to be causes of the incidence of lower extremity injuries, one being foot posture. This review compares ten different articles to examine neutral, pronation, supination, high arch, and flat foot posture to determine the effects on lower extremity injuries. It was concluded that foot posture does play a role in the likelihood of experiencing a lower extremity injury with any abnormal foot type increasing these odds. However, it was determined that a supinated foot had the biggest impact on the likelihood of experiencing these injuries, with supination following not far behind.

Introduction:

Running has become one of the most popular physical health activities in our modern society. It provides a practical workout without any required equipment making it realistic for many members. All that is needed is your body, a pair of shoes, and the outdoors. However, with the increase of people running, also creates the increase in running related lower extremity injuries including foot pain, knee pain, and hip alignment. It is estimated that the average runner will have one to two lower extremity injuries per year .[1] Due to these high statistics, researchers are aiming to determine what is causing these injury rates. Knowing the cause is the first step in determining preventative measures for these runners. One of the causes that has been being explored is foot posture and gait analysis. Foot posture is the anatomy of how your foot is positioned and strikes the ground. This is specific to each person's body due to genetic, body composition; including height and weight, and their behaviors.

Foot posture is described in many key terms, many implying the same meaning. In terms of the is review the words pes cavus will be used for describing a high arch and pes planus will be used to describe low arch height. Pronation will be used to describe foot inversion, or concaving of a foot while supination will be used to describe foot eversion. Navicular height is used to describe the height of the navicular joint along the arch, which is a high indicator of foot pronation. Another key word that must be addressed is the ‘kinetic chain’. In this article this refers to the way that parts of the body, particularly joints and muscles, interact, work and affect one another.

The main assessment used to determine foot posture is the Foot Posture Index (FPI-6). This index looks at the talar head position, supra and infra lateral malleoli curvature, calcaneal frontal plane position, prominence in the region of TNJ, congruence of medial longitudinal arch, and the abduction/adduction of the forefoot on rearfoot.[2] The six criteria in this index have been tested and found to be an accurate assessment of foot posture according to a recent study used for testing the validity of the FPI-6 index in adults.[3]

Despiste the theories of foot posture effects on lower extremity injuries, it is still unclear how different foot types affect these high injury rates. This review's aim is to thus synthesize and review research on neutral pronation, and supination foot postures and their effects on injury rates in runners. This will allow for a better knowledge base of these injuries and work toward the next goal of finding preventative measures for these long distance runners.

Search Strategy and Results:

Terms Used to Guide Search Strategy

1. Patient/Client Group: *Runner*
2. Comparison: *Foot Posture: Neutral, Pronation, Supination*
3. Outcome: *Lower extremity injury* **OR** *Lower limb injury*

Sources of Evidence Searched

1. Library discovery tools that included multiple databases
    - PubMed
    - Academic Search Premier
    - Sportdiscus

Inclusion and Exclusion Criteria

Inclusion

1. Studies that investigated the effect of foot posture and the effect on lower extremity injury or pathology
2. Studies that included runners, defined by being a participant in (1) training at regular intervals, (2) individual or team athletics or sports, or (3) high-level physical performance.
3. Studies that included adults ≥ 18 years old

4. Studies that reported in English
5. Studies published within the last ten years(2013-2023)

Exclusion

1. Studies that did not investigate injuries
2. Studies that evaluated non-lower extremity injuries such as back or upper extremity injuries
3. Studies that included a post-surgical concern such as ankle reconstruction or ACL tear.

Strength of Recommendation

Grade B evidence is available to determine whether foot posture affects lower extremity injury rates.

Neutral foot

A neutral foot is defined when the a talar head equally palpable on the lateral and medial side, both infra and supra malleolar curves roughly equally, a vertical estimates at five degrees inverted, area of TNJ flat, Arch height normal and concentrically curved, and medial and lateral toes equally visible according to the FP1-6.[2] This would be considered the ideal or perfect foot. In a recent study with 100 adults, Vicon cameras were used to show that normal feet were shown to have less distinct motion to planus feet with straight angles during pre-swing, initial contact, and mid stance.[4] This describes the movement of the foot in a straight line with equal weight distribution. Having this straight pattern in the foot allows for less chance of problematic issues further up the kinetic chain. If the feet are in a straight line with even distribution, the knees and hips are also more likely to be in alignment. If everything is in alignment with equal distribution, injury rates are predicted to drastically decrease. However, if the foot is not in alignment, issues are to be expected further up the kinetic chain to compensate for this abnormality and any discomfort it may cause.

Arch Height:

While a foot type can be neutral, the arch height can still vary. Most often a pes cavus arch implicates supination and pes cavus are often implicated with pronation. However, this is not always the case. Looking at arch height therefore is also necessary. According to study, arch flexibility could be used to assess injury probability rates.[5] One study done with a survey of 274 runners, lower navicular drop was associated with increased injury rates. In contrast, pes cavus was associated with lower balance. Having lower balance leads to less stability and control creating a greater likelihood of injury. [6]

Supination

The foot posture index has two rankings for supination below a neutral foot, a -1 ranking and a -2 ranking depending on the severity of abnormality.[2] In the study of six hundred runners using the foot posture index, it was shown that supination also increased the rate of injury by 86% in -2 supination and 60.8% in -1 supination.[7] Supination was also found to increase in a study with 143 recreational runners through an online questionnaire.[8] Both of these sources state how supination greatly increases the odds of injury in two different measuring tools. The first examines these findings through a scientific measurement and observation. The second is from an online questionnaire relying on participant honesty. Online questionnaires are unable to show cause and effect relationships, however they can show that relationships are present and account for placebo effects that occur. This questionnaire mixed with the findings of a true experimental research study provides a sense of validity and reliability.

Pronation:

The foot posture index has two rankings for pronation above a neutral foot, a +1 ranking and a +2 ranking depending on the severity of abnormality**.**[2] In a study of six hundred runners measuring foot posture index, it was found that high pronation, +2 pronation was associated with 96.3% higher odds of injury. Moderate pronation, +1 pronation, was associated with 60% injury rate.[7] Research was also conducted on 143 recreational runners using an online questionnaire about running. Using this research design it was still concluded that pronation led to an increase in running related injuries.[8] In another survey of 359 participants it was indicated that foot pronation increased running related injuries.[9] Three articles showing these results with high numbers of participants and different measurement tools validate these articles and determine the reliability of them. In a study using the FPI, pronation was also found as an early indicator of increased lower joint loading. This is important as an increase in joint loading is damaging and unhealthy to the joints causing deteriorating tissue causing bones to rub against each other. This causes discomfort and damage to the bones causing injuries.[10] Furthermore, pronation created greater impulses found in a cross-sectional study with biomechanical testing.[11] These impulses generate greater joint loading and pressure on the joint cavities in the lower extremity. In running this particularly is in the ankles, knees, joints, and hips. Due to these large numbers of studies showing increase in injury or signs indicating injury will occur, pronation does appear to affect high effects of injury. The pronation amount is also shown to increase from before to after exercise. [12] This was also demonstrated in a study of 24 recreational runners, showing arch index increasing after the intervention period. [13] This point is important to mention as pronation is expected to increase the likelihood of injuries but also shown to increase in severity with exercise, the mix between pronation and exercise becomes even more problematic in terms of increasing injury rates in runners.

Pronation versus Supination

While it is supported that both pronation and supination affect lower extremity injury rates, one may be more impactful than the other. In a study of six hundred runners using the foot posture index, it was shown that supination also increased the rate of injury by 86% in -2 supination and 60.8% in -1 supination. In the same study, it was found that high pronation, +2 pronation was associated with 96.3% higher odds of injury. Moderate pronation, +1 pronation, was associated with 60% injury rate.[4] In another study supination had OR levels of 4.51 while pronation had levels of 3.55.[13] This study supports that spination has greater injury rates than pronation. Therefore, a conclusion can not be made on which one has a greater impact.

Conclusion:

Research supports that foot posture does affect lower extremity injury rates. Arch height, pronation, and supination play a role in predicted injury amounts. Having a neutral foot and neutral arch is supported to have the lowest injury rates.

However, these studies do contain valid limitations that need to be addressed. All studies focused on healthy adult participants, other populations were not explored. Future research needs to consider other populations to make this argument valid to broader populations, The difference in show type worn or use of orthotics was not discussed. This could cause a big impact as if the runners were wearing orthotics or foot wear that accounted for their foot type, this could vary the injury rates that occur. In some studies, injuries were self reported. These studies must note errors in participant honesty. Intensity and duration of training was also not always controlled which could affect chances of injury. More training allows for more time that injury could occur while less training means less adaptations, creating higher injury rates. Training plans or reasons for training, such as a race, were not discussed can affect intensity of training. Other risk factors such as health conditions, running surface, and previous training were not considered. In addition, types of injuries that occurred were not explored.

Now that a relationship between foot posture and lower extremity injuries has been supported by current research, the next step is to begin looking at preventive measures. Future research should explore the roles of shoe type, usage of orthotic preventive devices, foot strengthening programs, and braces as impactful prevention tools and strategies.

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Part Two: Orthotics Affect on Comfort Levels, Injury Reduction Rate, and Performance: A Literature Review

Abstract:

Overuse injuries are common in physically active populations. Chronic lower extremity injuries can have both short- and long-term consequences on health and pose a burden to physically active people. Various approaches have been proposed to reduce the incidence of lower extremity injuries, one being the use of an orthotic insole. However, additional factors may diminish the likelihood of continued use, specifically comfort, and impact on performance. This review compares five different articles to examine the comfort levels, injury rates, and performance levels when runners wear orthotics. It was concluded that comfort levels and performance levels increased with runners, while injury rates decreased.

Introduction:

Running has become one of the most popular physical health activities in our modern society. It provides a practical workout without any required equipment making it realistic for many members. All that is needed is your body, a pair of shoes, and the outdoors. However, with the increase of people running also comes an increase in running-related injuries including foot pain, knee pain, and hip alignment. It is estimated that the average runner will have one to two lower extremity injuries per year [1]. Due to these high incidence rates, researchers are investigating ways to help runners prevent the rate of injuries and regain strength after injury, while still increasing the comfort levels of the runner, and performance times. One intervention being explored is using orthotics while running. Orthotics are inserts that are placed into a shoe. They begin in the back of the shoe at the heel and can run midfoot just past the arch or the whole length of the bottom of the shoe. There are many different types of orthotics, custom-made and off-the-shelf, hard and soft orthotics, and correction or maintaining orthotics. The use of orthotics can help correct the alignment of the lower leg, create cushioning, and provide arch support [2]. Research is currently being conducted on whether orthotics help prevent injury and if they are comfortable to run in.

Search Strategy and Results:

Terms Used to Guide Search Strategy

1. Patient/Client Group: *Runner*
2. Intervention:*Orthotics* **OR** *orthoses*
3. Comparison: *No insole*
4. Outcome: *Lower extremity injury* **OR** *Lower limb injury* **OR** *Comfort* **OR** *Performance*

Sources of Evidence Searched

1. Library discovery tools that included multiple databases
    - PubMed
    - Academic Search Premier
    - Sportdiscus

Inclusion and Exclusion Criteria

Inclusion

1. Studies that investigated the use of orthotics or orthoses and the effect on lower extremity injury or pathology
2. Studies that included runners, defined by being a participant in (1) training at regular intervals, (2) individual or team athletics or sports, or (3) high-level physical performance.
3. Studies that included adults ≥ 18 years old
4. Studies reported in English
5. Studies published within the last ten years(2013-2023)

Exclusion

1. Studies that did not investigate injury prevention
2. Studies that evaluated non-lower extremity injuries such as back or upper extremity injuries
3. Studies that included a post-surgical concern such as ankle reconstruction or ACL tear.

The research was conducted in the fall of 2023. Following the search strategy, 4 studies met the inclusion and exclusion criteria that are considered the best available evidence to help answer the question. All studies are presented in Table 1.

Author	Eggold	Jastifer	Fortune, Sims, Rhodes, Ampat	Nevers, Conceicão, Lucareli, Barbosa, Viera, ect.
Participants	300 runners, 146 responded, competitive and noncompetitive		23 participants intervention group, 24 in control group, conducted on volunteer basis, all participants 18 years or older with no history of foot surgery, foot pain, or health conditions	Systematic review and Meta analysis used search engines: Medicine/PubMed, Physiotherapy Evidence, Scielo, and Cochrane Central for randomized Control Trials
Interventio n	discussed effectiveness of orthotics in controlling symptoms and recurrence of injuries	Review of relevant functional anatomy, gait patterns in running, orthotics, and theory of body movements	Complete runs and provide quantitative data regarding comfort, time, distance, and RRI over 8 weeks. Wore Aetrex L700 speed orthotic for intervention group. Comfort was self reported on a scale from one to ten.	Calculated 95% confidence intervals from 12 studies compared runners with orthoses to ones with no orthoses

Primary Outcome	40% reported knee pain, 78% resumed running with an orthotic, increased success rate with careful measurement, diagnosis, casting, and orthotic construction. Problems: blisters, irritation, heel slippage. Some concern with weight of orthotic.	Runners will adopt their running style to minimize internal forces despite shoe wear. High treatment effects of placebo/sham orthotics. Little evidence to support the routine use of orthotics in runners	Intervention group reported higher comfort zones (8.001 ± 1.41 vs 6.96 ± 2.03), faster running speeds (6.27 ± 1.03 vs 6.00 ±1.34) and lower RRI rates (.7 ± 1.01 vs 1.21 ± 1.53) than control group. significant for comfort and speed.	Control group 37% injuries, orthoses group 24% injuries with a reduction in lower limb injuries, 40% reduction rate
Main Finding	Orthotic control can be a significant therapeutic value in treating abnormal function and preventing recurrence	Science behind anatomy, gait, and common injuries. Discusses placebo effect with orthotics.	Evidence that Aetrex L700 increases comfort and speed significantly.	Foot orthoses may help incidence of lower limb injuries

Strength of Recommendation

Grade B evidence is available to determine whether orthotics are effective in improving comfort, injury prevention, and increased performance.

Comfort:

Comfort is one of the biggest concerns when it comes to putting someone into an orthotic. If a runner is uncomfortable, they are not going to invest in this piece of corrective devices. According to a recent research study, where 47 active runners were researched, twenty-three in a control group and twenty-four were put into an orthotic for eight weeks. Comfort was measured on a ten-point scale. From this data collection, it was reported that participants who wore the orthotic reported a comfort mean of 8.00 with a standard deviation of 1.81 whereas people who were not wearing an orthotic reported comfort of 6.27 with a standard deviation of 2.03. The p-value showed these results were significant with a value of less than .0001. Therefore, it was proven that there is a significant difference in the type of orthotic used to improve comfort rates[2]. Similarly, it was found that non custom orthotics improved comfort, and reduced pain when standing, and about half of the patients stated they would choose to wear the orthotic insoles as opposed to their normal footwear [3]. This research, while not directly related to running, shows people's preference for wearing orthotics due to comfort compared to their normal shoes. In Eggnold's research, it was found that orthotics may provide discomfort from stiffness, but once the orthotic has been worn, it softens. It is important that orthotics are slowly broken in and while originally there may be some discomfort, long term they will decrease pain allowing for more comfort. In addition, the foot adjusts to the orthotic as well. However, it is suggested that if discomfort persists, many times a layer of soft material on top of the orthotic will solve the problem [4]. From this research, it can be concluded that orthotics do not hinder comfort but instead increase comfort in many people. They help reduce pain which in turn could help runners perform better if a runner is feeling pain and discomfort, they run slower.

Injury Prevention:

One of the main reasons orthotics are recommended to runners is to reduce injury rates. If a runner is injured, they are unable to perform and exercise. Therefore, it is important to explore new strategies in order to decrease injury rates in runners. Neves' study determined that the non-control group experienced a thirty-seven percent injury rate while the orthotic group experienced a twenty-four percent injury rate demonstrating that wearing orthotics decreases injury rates [1]. Similarly in Fortune's research, the injury rate of the intervention was .7 with a standard deviation of 1.01 and the control group had an average of 1.21 with a standard deviation of 1.52. This was not a significant value as the p-value was .18 [2]. However, when looking directly at the results it is shown that the injury rate is smaller in the intervention group compared to the control group. These results may not be statistically significant but show clinical significance reflecting the impacts on applicational practice. In a study done by Jastifer, there is a high placebo effect of orthotics found [3]. The placebo effect means that because athletes believe they are wearing an orthotic, the injury rate decreases. Running is a very mentally challenging sport. If an athlete feels more confident in injury prevention mentally by wearing an orthotic, this is beneficial. This further shows that even if orthotics are not statistically significant, they are clinically significant benefitting the runner even if the scientific number states otherwise. While orthotics may or may not be the actual reason injuries decrease, they are shown to decrease injuries either from wear or from the placebo effect of wearing them.

Performance Effects:

Analyzing performance effects is important if the orthotic is hindering performance, runners will not think of it as a good solution. In these studies, runners measure performance by speed, looking at how long it takes them to run a distance. It was shown in Fortune's research that performance was significantly impacted positively when wearing the orthotic. The intervention group speed was 6.27 miles per hour with a standard deviation of 1.03 and the control group had an average of 6 miles per hour with a standard deviation of 1.54 [2]. Therefore, the p-value of .013 shows these results are significant. Performance may be increasing due to the decrease in pain. As discussed earlier in this review, it was shown that comfort increases with orthotic usage. Therefore, if there is a decrease in pain and an increase in comfort, athletes are not distracted by pain when running and instead are able to focus on their performance. Heil's research shows that pain decreases performance due to the psychological aspects at work[5]. Heil's research illustrates how the increase in comfort yields an increase in performance, which is demonstrated by Fortune's research. However, using orthotics also has its disadvantages. In a study of three hundred runners, it was found that side effects of blisters, skin irritation, and heel slippage occur [4]. This cause of pain would decrease performance. Another limitation is discussed in Jastifer's research that orthotics are difficult to generalize as people's body composition varies so greatly in runners. In addition, orthotic fitting is highly dependent on the practitioner [3]. Orthotics must be fitted properly. To fit an orthotic properly range of motion, pronation and supination, choice of footwear, activity levels, current shoe inserts, gait patterns, and natural biomechanics must be considered. If not fitted correctly, not only could it create an increased risk of side effects, but also could affect their biomechanics negatively. A runner may alter their gait pattern due to incorrect position if the arch of the orthotic is in the incorrect place, altering performance rates negatively. However, the positives of wearing orthotics seem to outweigh these risks as shown by runners who have worn orthotics improve in performance as Fountaine's research claimed.

Recommendations:

Despite the limitations of orthotics, the benefits far outweigh the cons for runners who deal with pain and injuries while running. With proper use and fit orthotics can decrease injury rates, and lead to improved comfort rates and increased performance, specifically in terms of speed, which may be important to a competitive runner. Even though side effects exist, if fitted properly by a specialist they are less likely to occur. In addition, side effects are even less likely to occur if the orthotic is slowly broken into by gradually increasing the wear time. This can be done by wearing the orthotic for 15 minutes at a time and slowly increasing this number. This allows the foot to adjust to the new position gradually instead of being shocked into a new position and gait pattern abruptly.

Future Research:

There is much that still needs to be explored in the world of orthotics. One limitation of this study is looking at orthotics as a whole. There are many types of orthotics including over-the-counter, custom-made, hard, and soft or flexible, and how long do these orthotics last while maintaining the benefits. In addition, more research needs to be done to confirm the findings of injury prevention and look into what specific injuries are being decreased. The effects of the knee, ankle, and pronation verses supination need to be investigated. Furthermore, more research must be done to determine how an athlete's biomechanics and movement patterns change in an orthotic.

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Part Three: Orthotics as an Intervention for Distance Runners Protocol

Purpose:

This research strives to understand the use of orthotics on performance, comfort levels, and injury rates in runners.

Introduction:

Running has become one of modern society's most popular physical activities. It provides a practical workout without any required equipment making it affordable and realistic. The increase in running also comes with an increase in running-related injuries. The average runner is estimated to have one to two lower extremity injuries per year [1]. Due to these high incidence rates, this study will investigate ways to help runners prevent injuries, while increasing the comfort for the runner and performance times. One intervention being explored is the use of orthotics while running. Orthotics are inserts that are placed into a shoe beginning in the heel and can run midfoot just past the arch or extend the length of the bottom of the shoe. The use of orthotics can help correct the alignment of the lower leg, create cushioning, and provide arch support [2]. Therefore, this study aims to help determine if orthotics are an effective device in decreasing injuries while increasing comfort level and performance.

Currently, there is a gap in research on orthotics used as an injury prevention tool in runners. A literature review was done on foot posture and lower extremity injuries, showing foot posture and irregularities in gait are a leading cause of lower body running-related injuries. However, when taking the next step and performing a literature review on orthotics as a preventive measure for long-distance runners, only four studies could be found using PubMed, Academic Search Premier, and Sportdiscus that examined orthotics comfort level, performance, and injuries in adult runners as seen in Figure 1. This review aims to close this gap in research by performing a couch to 5k protocol with runners in a properly fitted orthotic to show if there are benefits to injury prevention, comfort, and performance.

Hypothesis:

It is hypothesized that the orthotics will show increased injury prevention, comfort levels, and performance.

Research Methods:

Research questions:

1. How do orthotics affect injury rates in long-distance runners
2. How do orthotics affect the comfort levels of long-distance runners
3. How do orthotics affect performance levels in long-distance runners

A quantitative research study will be conducted using a questionnaire on perceived comfort levels on a scale of 1-10, tracking any reported injuries through the OSTRC Overuse Injury Questionnaire, and timing performance to see improvements. This questionnaire was chosen as it pre-defines conditions on athletic performance in sports and it has shown validity and utility to explore self-reported injuries[3]. This study will compute the results of five to ten participants. Participants will include volunteer college students 18-25 years of age. All data will remain confidential to protect participant privacy and participants will have free will to leave the study at any time.

This study will follow the ‘Start to Run’ protocol fitting the participants with the power step orthotic for their foot posture. Orthotic assignments for these participants will be made using the foot posture index (FPI-6) and measuring the participant's navicular tuberosity to determine the navicular height. These measurements will determine the appropriate orthotic. In addition to orthotic fitting, participants' height, weight, sex, previous running experience, and injury history will be recorded prior to the intervention period via interview.

A pretest 5k will be performed assessing the time of completion, comfort levels on a scale of 1-10, and completing the OSTRC Overuse Injury Questionnaire. Then for six weeks participants will follow the ‘Start to Run’ protocol, in Figure 2, with the selected intervention. After each session, participants will rank comfort on a scale of 1-10 and assess for injury using the OSTRC Overuse Injury Questionnaire. After the six-week period, participants will complete a post-test 5k assessing the time of completion, comfort levels, and injury using the OSTRC Overuse Injury Questionnaire. Data will then be analyzed to decipher any differences in comfort, injury rates, and performance improvement between the control and intervention groups.

Implications:

The implications of this research could indicate whether implementing orthotics into runners' footwear would be an effective injury prevention tool, as well as increasing comfort rates and performance times.

Budget:

Funds will be needed to purchase orthotics in this study. One set of power step orthotics is $48. This study would hope to purchase 5 pairs of orthotics, estimating the need for $240.

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Appendix:

Figure 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
The use of orthotics or orthoses and the effect on lower extremity injury or pathology	Studies that did not investigate injury prevention
runners, defined by being a participant in (1) training at regular intervals, (2) individual or team athletics or sports, or (3) high-level physical performance.	Studies that evaluated non-lower extremity injuries such as back or upper extremity injuries
Studies that included adults ≥ 18 years old	Studies included a post-surgical concern such as ankle reconstruction or ACL tear.
Studies reported in English	
Studies published within the last ten years(2013-2023)	

Figure 2. The 5 km ‘Start to Run” Protocol Training Schedule

Week	Training in Group Day 1	Training on your own Day 3	Training on your own Day 5 (Optional)
1	Runs: 8 to 12 x 1 min (zone 1) Walk between runs = 3 min	Runs: 4 to 6 x 1 min (zone 1) Walk between runs = 1 min	Runs: 3 to 5 x 2 min (zone 1) Walk between runs = 2 min
2	Runs: 8 to 10 x 2 min (zone 1) Walk between runs = 3 min	Runs: 3 to 5 x 2 min (zone 1) Walk between runs = 2 min	Runs: 3 to 5 x 3 min (zone 1) Walk between runs = 3 min
3	Runs: 3 to 4 x 5 min (zone 1 + R) Walk between runs = 3 min	Runs: 2 x 5 min (zone 1 + R) Walk between runs = 3 min	Runs: 2 x 7 min (zone 1 + R) Walk between runs = 3 min
4	Runs: 10-10-12 min (zone 2) Walk between runs = 10 min	Runs: 1 x 15 min (zone 1)	Runs: 2 x 10 min (zone 1 + R) Walk between runs = 5 min

5	Runs: 3 x 10 min (zone 2) Walk between runs = 5 min	Runs: 3 x 10 min (zone 1) Walk between runs = 3 min	Runs: 10-8-6-4-2 min (zone 2) Walk between runs = 5-4-3-2 min
6	Test run of running 3-4 km continuously (20 to 25 minutes)	Test run of running 3-4 km continuously (20 to 25 minutes)	Test run of running 3-4 km continuously (20 to 25 minutes)

Figure 3 Overuse Injury Questionaire and Start to Run Protocol .pdf
Figure 4 Recruitment Material
Figure 5FOOT-POSTURE-INDEX_ACMT-Rete.pdf
Figure 6 Consent Form
Figure 7 Device: PowerStep_ClinicalStudy_2021.pdf
Figure 8 IRB Form

Part Four: Contextualization of Work

This research will help advance the field of study in the prevention of running related injuries within the exercise science field of work. Currently, only four studies have begun to look at orthotics as a preventative measure of injuries. It is also important to understand their effects on performance and comfort levels as well. Much more research needs to be done on orthotics before confirming this is as a preventative measure. In addition, this study addresses the further needs of research including the many types of orthotics including over-the-counter, custom-made, hard, and soft or flexible, and how long these orthotics last while maintaining the benefits. In addition, more research needs to be done to confirm the findings of injury prevention and look into what specific injuries are being decreased. The effects of the knee, ankle, and pronation versus supination need to be investigated. Furthermore, more research must be done to determine how an athlete's biomechanics and movement patterns change in an orthotic. The research done in this study is important to address and discuss the importance and limitations currently of orthotics as a preventative measure.

This research is important to the community as running has become one of modern society's most popular physical activities. It provides a practical workout without any required equipment, making it affordable and realistic. The increase in running also comes with an increase in running-related injuries. The average runner is estimated to have one to two lower extremity injuries per year. Due to these high incidence rates, this study investigates finding solutions to help runners prevent injuries, while increasing the comfort for the runner and performance times that will help keep runners safer and healthier.