

AN INVESTIGATION OF THE EVOLUTION OF THE MINIMALIST SHOE  
THROUGH A REVIEW OF RESEARCH LITERATURE

by

SAMANTHA L. SOMMARVONG

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Thesis Chair: Thomas J. Fisher, Ph.D., CSCS, LMHC

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## **Abstract**

As an investigation of the evolution of the minimalist shoes, the purpose of this thesis was to examine popularity trends of the rise and fall of the minimalist movement. By evaluating the history and research behind the designs of the minimalist shoes, this thesis viewed the peak in popularity when minimalist shoes first made their debut. Initially, footwear sales skyrocketed upon its introduction. Its popularity grew due the prospective effects of improving athletic performance and the possibility of decreasing the prevalence of running-related injuries. To understand the sales trends of the footwear industry, various shoe examples from the different categories of footwear padding were also examined. Hence, after learning more about each type of footwear, it is crucial to understand how to transition safely and without injury. Injury prevalence has been suggested to be associated with the change in biomechanics involved with changing a runner's footwear.

Through the review of research literature on the subject, 33 sources of peer-reviewed studies, found via Google Scholar or EBSCOHost using select key word searches, were taken into account. After reviewing the results and conclusions, a common finding suggest that more research is needed to come to clear consensus. There is not enough evidence to suggest that the use of minimalist shoes either lowered the risk of injury or improved performance. Hence, the decline of minimalist movement may have been due to the unfulfilled benefits that were proposed. After consumers did not reap the benefits of transitioning to minimalist shoes, sales trends continued to fall.

## **Dedication**

For my father, who has always been my rock, supporting me in everything that I do since the day I was born. There is no one else that is rooted so deeply into my heart. You have molded me into the woman I am today and all that I achieve is because of what you've taught me. Words cannot describe how thankful and blessed I am.

For my love, Chase, for your unending encouragement and love. You challenge me to be the best I can be and whenever I am at my weakest, you've been there to give me the motivation and strength to continue. I am truly grateful and blessed to call you mine.

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## Table of Content

Chapter One: Introduction .....	1
Background.....	3
Purpose of Study .....	4
Chapter Two: Review of Literature.....	7
History of the Minimalist Running.....	7
Christopher McDougall's Born to Run .....	9
Sales Analysis .....	10
The Spectrum of Footwear.....	15
Barefoot Running.....	15
Vibram Five-Fingers .....	18
Nike Free .....	20
Traditional Shod .....	23
Changes in Biomechanics.....	24
Importance of Proper Transitioning .....	28
Other Uses for Minimalist Shoes.....	30
Chapter Three: Methodology.....	32
Data Sources .....	32

Study Selection .....	33
Chapter Four: Results .....	34
Chapter Five: Synthesis and Discussion .....	40
References .....	43

## List of Figures

<i>Figure 1 Footwear Sales Comparing 2011 and 2012</i> .....	14
<i>Figure 2 Biomechanical and Neuromuscular Risk Factors Associated with Major Running-Related Injuries and the Possible Theoretical and Clinical Implications Barefoot (BF) Running May Have on Them” (Tucker, Noakes, Wilson, &amp; Tam, 2014)</i> .....	17
<i>Figure 3 Vibram Five-Fingers</i> .....	18
<i>Figure 4 Nike Free</i> .....	20
<i>Figure 5 Nike Free Options</i> .....	22
<i>Figure 6 Asics GT-2160 (Traditional shod running shoe)</i> .....	23
<i>Figure 7 Different Footstrike Patterns</i> .....	26
<i>Figure 8 Prevalence of Injury by Location</i> .....	28
<i>Figure 9 “Level of Evidence for Outcome Categories” (Perkins, Hanney, &amp; Rothschild, 2014)</i> .....	39



## **List of Tables**

<i>Table 1 Twelve Study Results and Conclusions by Publication Date.....</i>	<i>38</i>
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## **Chapter One: Introduction**

Today, perhaps more than in any other time, people are seeking to become more physically active and live a “healthier lifestyle.” One of the most popular forms of physical activity is cardiovascular exercise, more specifically walking, jogging, and running (Rothschild, 2012). Over the past decade, there has been a substantial increase in popularity of running in the United States (Perkins et al., 2014).

Nonetheless, typically one’s physical performance in running may be improved by altering the two main factors: the runner’s stride length and stride frequency (Hollander et al., 2015; Schubert, Kempf, & Heiderscheit, 2014). However, it has also been suggested that the simplest and most effective way of improving performance is to change elements of the runner’s environment, especially running surface and shoes (Hollander et al., 2015; Schubert et al., 2014).

Humans have evolved running for transportation, recreation, and even survival (Johnston, 2011). Humans ran barefoot until the invention of sandals and moccasins, with the purpose to protect the feet from the terrain and environment (Rothschild, 2012). From there, shoes have evolved from simple protective footwear to today’s high-tech cushioning and performance-enhancing footwear (Rothschild, 2012). Recently, the popularity of minimalist running started to make a comeback, primarily led by those of who believed that runners were created to run without shoes (Boudway, 2011) (Hollander et al., 2015; Johnston, 2011; Tucker et al., 2014).

Minimalist running can be defined as the use of minimal or no shoes for running (Bowles, Ambegaonkar, Cortes, & Caswell, 2012; Johnston, 2011). Thus, minimalist style shoes that incorporated very little support or cushioning soon became common for serious runners, everyday joggers, and casual wear alike. In the last decade, minimalist running shoe production had grown into a \$500 million industry (McCartan, 2013). But like most trends, the fad appeared to have waned to the point that many footwear and sporting goods stores do not carry minimalist shoes (Germano, 2014a). Minimalist shoes, as its own category of footwear, was the only style of footwear to decline by more than a third of total sales (Germano, 2014a). Thus, the “fad” of minimalist shoes arrived and faded from the public eye in a matter of a few years.

With such a dramatic spike and fall in popularity over a short period of time, this thesis investigated why the minimalist shoe trend came about and why it appears to have ended so quickly. In just a few short years, minimalist shoes went from the “fastest growing segment in running”, to plunging 47% of sales the very next year (Germano, 2014b). While attempting to explain for this decline, ideas that supported the invention of the minimalist style shoe were analyzed. Possible detrimental side effects of the shoes were also investigated, including injuries associated with transitioning to and from a minimalist style shoe. Finally, an exploration of running shoes in general, from barefoot through minimalist to more traditional running shoes, assessed the pros and cons of switching to a minimalist running shoe. In order to explore and understand the research behind the minimalist movement and its effects on

the footwear industry, the history, and background of the minimalist shoe itself must first be examined.

## **Background**

Before investigating the trends of the rise and fall of the “minimalist shoe”, the definition of the minimalist style shoe must be determined. The components that define a shoe are the drop, stack, flexibility, and weight. The drop may be defined as “the difference between the height of the forefoot and the rearfoot”; whereas, the stack is the “total thickness of the heel” (McCartan, 2013). Flexibility of a shoe is a general term to describe the stiffness and the ability to bend and stretch with the runner’s foot. The overall weight of the shoe is important when comparing footwear; the lighter the shoe, the less resistance when running. While these components make up a running shoe, the minimalist shoe is categorized by having very little support and weight. Minimalist shoes also have little to no drop and stack and are known to be very flexible and very lightweight (Bowles et al., 2012; McCartan, 2013). Therefore, a minimalist shoe may be defined as “shoes with heel material equal in thickness slightly thicker than forefoot material, with minimal or no support materials in heel or arch area” (Smith et al., 2015). The main difference between a minimalist shoe and a traditional shoe is the amount of padding and support at the heel and forefoot.

Along with the understanding of what minimalist shoes are, it is important to determine where and when minimalist running was introduced. Minimalist running is defined as “running in either minimalist shoes or barefoot” (Bowles et al., 2012). In the

past few years, there was a spike in popularity for runners transitioning to a barefoot or minimalist running style, forming a following of minimalist footwear enthusiasts (Holsomback & Peak, 2012). From 2003 to 2010, the minimalist shoe movement developed into a \$500 million industry. Brands such as Vibram, Feelmax, Terra Plana, and Nike lead the trend releasing early minimalist-inspired shoes (McCartan, 2013). However, this spike was soon diminished by a drop in sales by more than a third (Germano, 2014a).

This short-lived movement is exactly what this thesis is meant to question and investigate. Earlier discussed was only a background synopsis, a brief outline of the minimalist movement. As this thesis continues, it investigates deeper into the causes and effects of the minimalist shoe's rise and fall in popularity. Upon examining more research later in this thesis, it is crucial to understand the objective. The purpose and usefulness of this thesis is explained further.

## **Purpose of Study**

This study investigated the evolution of the minimalist shoe movement and analyzed the rise and fall in popularity. The development of the minimalist shoe and the research behind the invention was questioned. The study compared research pertaining to the biomechanical changes and injury prevalence that resulted from the use of or transition to minimalist shoes. At the beginning of the minimalist running movement, less-supportive footwear was believed to prevent running injuries. By the

end of the minimalist trend, many of those who had tried minimalist shoes converted back to a traditional shoe. However, it was believed that it was the transition to the minimalist style shoes that became so crucial. Research on the biomechanical changes during transition was analyzed. Longitudinal studies that followed long-distance runners who originally wore traditionally padded shoes and over time, converted over to a minimalist shoe were compared. Additional attention was focused on the research addressing foot-strike patterns and the changes that occur during the transition. This involved runners changing from a heel-striking pattern to a more mid-foot or forefoot strike. This is thought to be one of the most common causes for injury. The research was specifically investigated for prevalence of injury in the transitioning period of changing running shoes.

As theorized earlier, at the height of the minimalist movement, many runners tried to convert to minimalist shoes, but reverted back to traditional shoes after failed attempts at transitioning. Consequently, the recorded sales of minimalist style shoes should display a similar trend, an increase in sales of minimalist footwear, followed by a marked decrease. The market trends for minimalist and traditional running shoes were evaluated to confirm the rise and fall of product sales. Specifically comparing the sales of both traditional and minimalist shoes, alike, during the boom year of the minimalist movement. This required investigating the sales of specific shoe companies of each category such as Nike, Asics, Brooks, Vibrams, Born2Runs, and New Balances. Further, the sales of specific shoes were analyzed (Vibram Five-Fingers, Nike Frees,

and overall sales of shod running shoes). Another consideration was the stock value of major shoe companies and the trends from the minimalist movement to present day.

In attempting to explain the rise and fall in popularity, it has been suggested that despite the spike in popularity, those who tried minimalist shoes were not satisfied with the results. With the introduction of minimalist shoes, most runners were looking for something to prevent injuries and increase their performance. When they realized that the change in running mechanics brought about their own mechanical problems, they reverted back to traditional shod running shoes. To study this hypothesis, the opinions of major shoe company representatives were analyzed together with the opinions of long-distance runners. These valued opinions and surveys were analyzed to discern any public dissatisfaction with either the minimalist shoe or the process of transitioning to it.

Because this is all hypothesized, the next step was to investigate and examine all the research available for evidence. The best way to examine the research thoroughly is to understand the background of the subject. In this case, it took an exploration of the definition of minimalist shoes and the history behind it. The next chapter, the review of research literature, is intended to further examine the background of the minimalist movement.

## **Chapter Two: Review of Literature**

Before continuing the research of the minimalist shoe movement, it is best to understand the history and development of minimalist style shoes. The history behind minimalist shoes includes major events that spiked minimalist popularity and literature or publications that advanced the attractiveness of the movement. Upon learning what major events brought about the minimalist movement, it is necessary to understand the difference between what is considered “minimalist” when compared to other footwear. On a lineage of footwear, ranging from most to least supportive, minimalist shoes would lie between conventional running shoes and barefoot running. It is also appropriate to investigate how different types of shoes change a runner’s biomechanics. Additionally, it would be prudent to examine the proper way to transition from one type of shoe to another. After considering these factors, reasons for the rise and fall of the minimalist shoe movement were revealed.

### **History of the Minimalist Running**

The history of minimalist running examined all of the subsets of minimalist footwear, including wearing no shoes at all. Although the concept of running barefoot has been around since before the invention of shoes, the modern popularity of barefoot running did not arise until the Summer Olympics of 1960 in Rome, Italy (Johnston, 2011; Leung, 2009; Pearl, 2009). Because the rudimentary running shoe was introduced during this decade, it was the 1960 Olympic marathon that an athlete was seen competing barefoot (Holsomback & Peak, 2012). Ethiopian men’s marathoner,



Abebe Bikila, shocked the world when he not only ran the Olympic marathon barefoot, but won the gold medal (Leung, 2009; Odenberg, 2009; Pearl, 2009). As recorded in Bikila's biography, it was said that on the day before the Olympic marathon race, Abebe had tried to find shoes to wear for the race but was unable to find any that fit his feet; his feet were "as hard as corn" and his "big toes were too large and his outside toes too small" (Rambali, p. 135). Furthermore, it was detailed during Bikila's pre-Olympic training that "over a distance of 32 kilometers, Abebe was a minute and a half faster without shoes" (Rambali, p. 116). Bikila not only won the Olympic gold medal running barefoot, but he also had set the world record time at 2 hours, 15 minutes, and 16 seconds. (Holsomback & Peak, 2012; Johnston, 2011; Odenberg, 2009). It was this global event that precipitated an interest in, barefoot running and the use of minimalist style running shoes.

As defined earlier, a minimalist shoe is a shoe with minimal padding in the heel and arch, but equal thickness of padding at the forefoot and heel (Smith et al., 2015). Although sandals and moccasins, some of the world's first shoes ever created, were made in a minimalist fashion, the minimalist footwear of today was originally created in the mid-2000s. The original "traditional" running shoe, however, was introduced in the 1970s (Bowles et al., 2012; Tucker et al., 2014). The category of footwear known as minimalist shoes did not exist until 2008 (Boudway, 2011). From there, a "running-shoe boom" started, backed by a group of people who believed that humans were meant to run barefoot or with minimal protection (Boudway, 2011). One of the leading and most

popular supporters of barefoot and/or minimalist running is, book author, Christopher McDougall (Boudway, 2011). Relevant to the history of the minimalist movement, his work and publication greatly affected the popularity of minimalist running.

### Christopher McDougall's *Born to Run*

In 2009, author Christopher McDougall published his book entitled *Born to Run* (Boudway, 2011). This book is often referred to as the barefoot running enthusiasts' "bible" that seemed to have contributed to the rise in popularity for barefoot running. It is also known as the "catalyst for the barefoot boom" (Boudway, 2011). The renowned book is recognized as a contributor to the "exponential growth" of the minimalist shoe trend (Boudway, 2011; McCartan, 2013; Pearl, 2011). In the celebrated book, Christopher McDougall, himself, traveled to the Copper Canyons of Mexico and sought the Tarahumara Indians for answers to his podiatric questions (McDougall). The Tarahumara Indians are also known as the "Rarámuri – the Running People" (McDougall, p. 16). In his book, it was reported that the Tarahumara Indians would run hundreds of miles in a simple sandal, used only for protection against foreign objects (Leung, 2009). After spending some time with the Tarahumara, McDougall concluded that the Indians were a group of "ultra-distance runners" with "superhuman talent" and "uncanny health and serenity" (Boudway, 2011; McDougall). Christopher McDougall drew this conclusion from their ability to run 48 hours non-stop. They did this without the use modern athletic advances such as high-tech running shoes, "electrolyte-rich sports drinks", and "protein bars" (McDougall, p. 16). McDougall also noted that the

Tarahumara Indians would be considered: “in terms of diet, lifestyle, and belly fire, ...a track coach’s nightmare” (McDougall, p. 16). After seeing the footwear and lifestyle of the Indians, McDougall questioned the modern day running shoe. He later claimed that “running shoes may be the most destructive force ever to hit the human foot” (Leung, 2009, p.1).

It has been indicated that Mr. McDougall had a crucial contribution to the reason for the popularity of the minimalist movement (Boudway, 2011; Leung, 2009). Furthermore, it has been suggested that the boom of the movement took place soon after the publication of his book *Born to Run*. This can be demonstrated by simply looking at the jump in minimalist shoe sales immediately following the release of *Born to Run* (Boudway, 2011). Hence, it would be most appropriate to examine the sales trends of the minimalist movement. The analysis of minimalist shoe sales will illustrate the rise and declines of the minimalist movement.

### *Sales Analysis*

Another observable aspect of the history of minimalist shoes are the overall sales trends and revenue. While examining the sales trends throughout the years of the minimalist movement, it is also important to consider the prices of the shoes under investigation. As an example, the Vibram Five-Finger drove the majority of the sales at the start of the movement (Billhartz-Gregorian, 2011; Boudway, 2011; Ryan, 2012). Each pair of Vibram Five-Fingers costs from \$75 to \$160 (Alsever, 2012). Conversely, a competitor, the popular Nike Free, sold for approximately \$125 per pair (Boudway,

2011). It has been advocated that pricing has the power to propel or cut market trends, especially in a consumer-centered market like footwear (Pearl, 2011). According to Pearl, market research has “suggested that the \$95 price point was attractive to would-be purchasers” in the minimalist footwear industry (Pearl, 2011).

It is important to remember that footwear is a consumer-driven industry, and a product’s sales trends will reflect on its popularity to the public. When Vibram first launched its “Five-Fingers” shoe in 2006, the company was estimated to have sold \$430,000 to \$450,000 in its first year (Billhartz-Gregorian, 2011; Boudway, 2011). Although Vibram was one of the leading manufacturers of minimalist footwear, the company’s profits in 2006 only accounted for a small fraction of sales in the footwear industry (Billhartz-Gregorian, 2011; McCartan, 2013). It was not until 2008 that “minimalist” became its own category of shoes (Boudway, 2011). By that time, Vibram had accounted for almost 10% of the market (Boudway, 2011). This demonstrates that, in Vibram’s first year of sales, they took the majority of minimalist shoe sales (Boudway, 2011; Ryan, 2012). Vibram carried this momentum into the next years as sales almost tripled, following the publication of Christopher McDougall’s *Born to Run* book (Boudway, 2011). The popularity for barefoot and minimalist running generated by the book had sales up from approximately \$11 million to \$54 million (Boudway, 2011).

However, according to sales records and trends, it was not until 2011 that minimalist footwear sales reached their zenith (Ryan, 2012). In 2011, the footwear categories of “minimalist” and “barefoot/natural” shoes displayed the greatest rise in

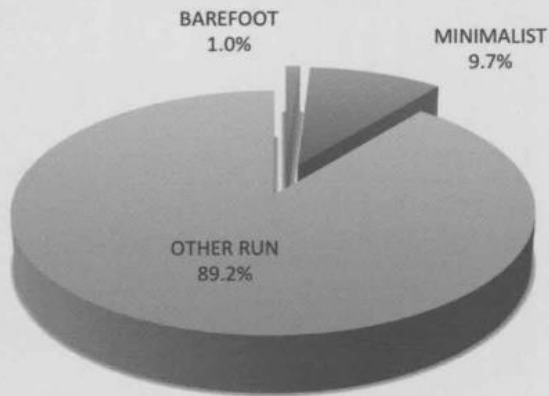
sales (Ryan, 2012). By this time, Vibram was not the only major company competing in minimalist footwear. It appeared that every major footwear company had released a minimalist style shoe line of their own, including Nike, Reebok, New Balance, Saucony, and Asics (Boudway, 2011; Ryan, 2012). Although overall sales for minimalist shoes were growing, sales for minimalist-pioneer company, Vibram, were dropping, this may have been due to the growing number of competitors and counterfeiters to the industry (Alsever, 2012; Ryan, 2012). Regardless of the competition, Vibram had shown a \$160 million fiscal year in 2011. However, this was only a fraction of what Vibram's sales were when they first released their Five-Fingers shoe (Billhartz-Gregorian, 2011; Boudway, 2011; Ryan, 2012). If Vibram had kept pace with its sales trends from the previous years, it was projected to have had about \$350 million in sales in 2011 (Boudway, 2011).

With 2011 being such a breakout year for the minimalist footwear movement, some of the sales momentum continued into 2012 (Ryan, 2012). According to a *SportScanInfo* report (see Figure 1), sales seemed to have stayed up modestly until the end of March of 2012 (Ryan, 2012). However, it is important to note that this report included the popular "Nike Free" shoe line under the minimalist footwear category (Ryan, 2012). The "Nike Free" accounted for the majority of the minimalist footwear sales. Without including the "Nike Free," minimalist sales would only have been about 3% of the footwear industry (Ryan, 2012). By 2013, "minimalist footwear was the only major category to shrink" in sales (Germano, 2014a, 2014b). The sales reports had

dropped as much as a third of previous years, with minimalist style shoes only accounting for \$220 million of the \$17 billion footwear industry (Cortese, 2009; Germano, 2014a, 2014b). Continuing the downturn, minimalist shoe sales had plummeted approximately 47% before May of 2014, bringing the minimalist movement to an abrupt halt (Germano, 2014a, 2014b).

# PERCENTAGE OF RUNNING SALES

## YEAR-TO-DATE 2012\*



## YEAR-TO-DATE 2011\*



Source: SportScanInfo

\*Nine-week period ended March 31

*Figure 1 Footwear Sales Comparing 2011 and 2012*

Just like that, the minimalist movement had come to stop. After such a lively start and spike in sales, the trend seemed to have only take its toll for a few short years. Climbing its way up in popularity quickly, it only seem fit that its popularity dropped as quickly as it started. However, in a consumer industry like footwear, the fall of the sales of minimalist shoes is correspondent to the rise in sales for other types of footwear. To further understand what exactly those other types of footwear are, a spectrum of footwear is described next. This will elucidate where minimalist shoes lie on a scale of footwear ranging from least to most support.

### **The Spectrum of Footwear**

One way to examine the footwear industry is through the spectrum of differing styles. On one end of the spectrum are the highly-padded traditional shod running shoes. On the opposite end is no footwear at all, reflecting the barefoot running movement. Then, all points in between display everything from the minimalist style, five-fingered shoes to lighter padded traditional running shoes. Each shoe category will be described and analyzed to compare against the others. Starting with the least supportive footwear, or in this case, lack of footwear, is barefoot running.

#### *Barefoot Running*

Beginning with the most minimalist “footwear”, this trend seemed to have been inspired by the Abele Bikila’s victory at the 1960 Olympics (Leung, 2009). Simply, barefoot running is wearing no footwear at all. Enthusiasts of barefoot running tend to believe that “humans should run with bare feet as ancestors did thousands of years



ago” (Perkins et al., 2014). Famous marathoner, Ken Bob Saxton or “Barefoot Ken Bob” had preached that shoes “imprisoned our feet, weakening them through lack of use” (Leung, 2009, p.1). Opinions like Ken Bob’s fueled the trend of barefoot running, claiming that running without shoes prevented injuries, enhanced running efficiency, and improved overall performance (Perkins et al., 2014). However, no evidence to date has been found to support these claims (Rothschild, 2012). Most of the recent literature and research has been inconclusive about the specific risks and benefits of barefoot running (Perkins et al., 2014). Table 1 lists possible benefits of implementing barefoot running. Several research studies suggested that running barefoot would have “theoretical and clinical implications” on the most common running-related injuries (Tucker et al., 2014). However, more research should be conducted to find consensus of the possible benefits and consequences of running barefoot (Rothschild, 2012).

Variable/injury	Changes associated with injury in published literature	Changes associated with BF running <sup>18, 28</sup>	Theoretical implication	Summary and potential clinical outcomes (if known)
Stress fractures of the tibia Ref. <sup>29, 30</sup>	Increased hip adduction	Unknown	Unknown	Potential to reduce risk of tibial stress fractures, but only if impact forces are lower, may depend on other factors. Clinical case series suggests increased risk early during adaptation
	Increased rearfoot eversion	Increased rearfoot eversion	Increased risk	
	Increased free moment	Unknown	Unknown	
	Increased impact peak	Decreased impact peak in some runners	Reduced risk	
Stress fractures of the metatarsals Ref. <sup>21, 31, 32</sup>	Increased ground reaction force	Decreased ground reaction force in some runners	Reduced risk	BF running may increase risk of metatarsal stress fractures as greater application of force for both initial contact and propulsion is experienced
	Increased peak pressure under metatarsal head	Increased peak pressure under metatarsal heads	Increased risk	
	Decreased peak pressure heel, midfoot and hallux	Unknown	Unknown	
Patellofemoral pain Ref. <sup>20, 33-35</sup>	Earlier peak rearfoot eversion	Unknown	Unknown	BF running may reduce forces experienced by the knee
	Increased forefoot loading	Increased forefoot loading	Increased risk	
	Increased impact peak	Decreased impact peak	Decreased risk	
	Increased eccentric load on knee	Unknown for BF but conscious forefoot strike may decrease eccentric load	Decreased risk	
Achilles tendinopathy Ref. <sup>36-38</sup>	Poor gluteal strength	Unknown	Unknown	BF running may result in greater eccentric loading on the ankle. Chronic high velocity eccentric loading during running may increase the risk of injury. However, eccentric loading may be beneficial in relieving Achilles tendinopathy if controlled <sup>35</sup>
	Hamstring inflexibility	Unknown	Unknown	
	Increased rearfoot eversion	Increased rearfoot eversion	Increased risk	
	Increased ankle dorsiflexion at impact	Increased ankle plantarflexion at impact	Decreased risk	
	Decrease leg abduction	Unknown	Unknown	
	Decreased knee range of motion	Decreased knee flexion at ground contact	Increased risk	
Plantar fasciitis Ref. <sup>39</sup>	Decreased tibialis anterior, gluteus medius and rectus femoris activity	Increased gastrocnemius activity	Unknown	BF running may aid in attenuating the associated risk factors. However, these beneficial changes may be acquired only after habituation to BF running in some individuals
	Early pronation	Unknown	Unknown	
	Increased vertical ground reaction force	Decreased ground reaction force in some runners, significantly increased in others	Risk dependent on individual response to BF running	
	Increased loading rates	Decrease loading rates in some runners, increased in others	Beneficial	
	Lower medial longitudinal arch	Raised medial longitudinal arch	Decreased risk	
	Increased foot pronation	Unknown	–	
	Decreased ankle dorsiflexion range of motion at impact	Decreased ankle dorsiflexion range of motion at impact	Increased risk	

*Figure 2 Biomechanical and Neuromuscular Risk Factors Associated with Major Running-Related Injuries and the Possible Theoretical and Clinical Implications Barefoot (BF) Running May Have on Them” (Tucker, Noakes, Wilson, & Tam, 2014)*

### *Vibram Five-Fingers*



*Figure 3 Vibram Five-Fingers*

Another type of minimalist footwear is the “Five-Fingers” or “toe-shoes” made originally by the footwear company Vibram. Vibram, an Italian shoe company, first launched its Five-Fingers shoe in 2006 at the famous Boston Marathon. They named the shoe *Bikila*, after the previously noted, world record-holding marathoner, Abebe Bikila (Alsever, 2012; Boudway, 2011; Johnston, 2011; Ryan, 2012). Five-Fingers were described as a “cross between a sandal and a glove for feet, with individual slots for each toe” (Alsever, 2012; Leung, 2009; Smith et al., 2015). This unique design, originally acquired from a design student, bridged the gap between running in shoes and running barefoot (Alsever, 2012; Leung, 2009; Smith et al., 2015). When the Five-Finger shoe was developed, Vibram’s chief executive officer revealed to their “biggest sole customers” to ask if they would like to form a partnership on the product. The customers declined the partnership offer. They reasoned that the Five-Finger design was “a little too strange” (Boudway, 2011). Vibram’s own website defined the Five-

Fingers as “a 5- toed lightweight and flexible shoe, without cushioning and arch support” (Smith et al., 2015, p. 2). Described as a “armored toe sock,” this is considered one of the minimalist shoes with the least amount of padding (Colleran, 2010). The shoe was designed to mimic the movement and flexibility of running without shoes at all, while still offering some surface protection (Perkins et al., 2014; Smith et al., 2015). The Five-Fingers shoes were advertised to give the runner “the ability to experience the sensation and freedom of going barefoot with the added protection to endure in the ‘modern environment’” (Holsomback & Peak, 2012).

According to Vibram, the Five-Fingers shoe made the company one of the recognized leaders in running shoes, representing the minimalist trend. Vibram’s stated the purpose for releasing the Five-Fingers shoe was to have their customers “healthier, happier, and more connected to their body” (McCartan, 2013). The Five-Fingers shoe was even named one of the best health innovations of the year in 2007 by *Time* Magazine (Alsever, 2012). Furthermore, Vibram’s release of the Five-Fingers brought over \$400,000 in sales in the first year, and grew substantially (Boudway, 2011). It was not until the release of McDougall’s *Born to Run* book in 2009 that sales for Five-Fingers jumped from \$11 million to about \$55 million (Boudway, 2011). Vibram, as a leading company in the minimalist movement, continued to grow steadily for the next few years. By 2012, Five-Fingers reached a 54% increase in sales, or about \$160 million (Ryan, 2012). However, Vibram’s growth came to an abrupt halt after a class-action lawsuit over the unsupported claims was made about the Five-Fingers having the

ability to “strengthen muscles and prevent injury” (Germano, 2014a, 2014b). To resolve the lawsuit, Vibram settled by reimbursing customers approximately “\$94 for every pair they have purchased” (Germano, 2014a, 2014b). After settling the controversial lawsuit, Vibram USA Chief Executive Mike Gionfriddo said that Vibram was always “appreciative of consumer feedback” and that their shoes were “a matter of personal preference” (Germano, 2014a, 2014b).

### *Nike Free*



*Figure 4 Nike Free*

The next shoe to consider is the Nike Free. Because Nike is one of the largest athletic footwear manufacturers in the world, it is inevitable that they would cater to the minimalist shoe trend (Cortese, 2009). It has been suggested that Nike Inc. has been “credited with inventing the running shoe as we know it today” (Boudway, 2011; Holsomback & Peak, 2012; Leung, 2009; McCartan, 2013). It could also be argued that Nike had predicted the minimalist running trend and initiated the popularity of the movement with the release of their Nike Free in early 2004 (Boudway, 2011; Holsomback & Peak, 2012; Leung, 2009; McCartan, 2013). Because of its rather early

introduction during the minimalist boom, the Nike Free has been considered the “first mass-market ultrathin-soled shoe” (Germano, 2014a, 2014b). The Nike Free was designed to “resemble a sock with laces and a deeply notched rubber sole” (Leung, 2009). It was advertised to give runners a more “natural motion” of running with increased flexibility and lightness in weight (Boudway, 2011). Derek Kent, Nike spokesperson, noted that “if you want that sensation of barefoot running, there is the Free, but if you want a product with a little more cushioning and support, we have that too” (Cortese, 2009, p. 5). Supporting this statement, the Nike Free came in several different levels of cushioning, from the Nike Free 3.0 with the least amount of cushioning to the Nike Free 7.0 with the most cushioning (McCartan, 2013). With all of these design features, the Nike Free was advertised to “offer a good deal of versatility, providing many options for different sports and cross-training” (McCartan, 2013).



*Figure 5 Nike Free Options*

The original design of the Nike Free shoe was inspired by a respected track and field coach, Vin Lavanna, of Stanford University who incorporated barefoot running into the team's training (Cortese, 2009; Pearl, 2009, 2011). After seeing the cross-training of collegiate athletes incorporating both shod and barefoot running, researchers conduct a study with students using the newly designed Nike Free (McCartan, 2013; Pearl, 2009). It had been developed that after six months of integrating the Nike Free into their training routine, the athletes had "greater flexibility and strength in the foot" (McCartan, 2013; Pearl, 2009). The Nike Free was originally designed to "mimic the kinematics of barefoot running" (Nigg, 2009; Pearl, 2011). Although, it had been suggested that the wide heel and flexible forefoot design was intended to "force the foot to be more active than in a conventional shoe" (Nigg, 2009). From this research, the Nike Free was designed as a cross-training shoe, making it an appropriate choice for all

sports and all training levels (McCartan, 2013). When Nike spokesman Derek Kent was asked about the Nike Free, he replied that “the key is to offer a range of options, because every runner has different needs” (Cortese, 2009, p.5). With the growing popularity of minimalist style shoes in the early 2000s, the Nike Free shoe line had grown to represent approximately 70% of Nike’s minimalist platform (Ryan, 2012). Although the Nike Free technically had a more minimal design, it has gained additional popularity as a “fashionable” athletic shoe (Germano, 2014a, 2014b; Ryan, 2012).

### *Traditional Shod*



*Figure 6 Asics GT-2160 (Traditional shod running shoe)*

The next category of footwear to consider is the traditional shod shoe when analyzing the amount of support in a shoe. “Shod” running may be defined as running in traditional, modern running shoe, with a thick heel and adequate support (Holsomback & Peak, 2012; McCartan, 2013). Originally created and popularized in the 1970s, conventional running shoes were designed with the intent to prevent chronic



injuries (Tucker et al., 2014). Countless shoes fit into this category. The traditional running shoe has typically accounted for the majority of footwear sales, even when the minimalist shoe movement was at its peak (Holsomback & Peak, 2012; McCartan, 2013). The design of a traditional shoe usually includes a sole with more cushioning in the heel than in the forefoot, also known as the drop (Boudway, 2011). It has been found that traditional shod running shoes have “12 millimeters more cushioning in the heel than in the forefoot,” the “drop” (Boudway, 2011; McCartan, 2013). Because there is such a disparity of the padding in the forefoot and the heel, it is recommended shod runners test their shoes for proper support. This may be accomplished by bending the shoe near the ball of the foot, noting if the shoe maintains its “shape at the arch” and ability to “prevent torsional forces” (McCartan, 2013). The purpose of most traditional shoes is to protect the runner’s foot from surfaces, while providing cushion for shock distribution and traction (Rothschild, 2012).

### **Changes in Biomechanics**

After reviewing all of the different footwear, it is recommended that proper transition is required for a runner to adapt to a new running shoe (Hollander et al., 2015; Rothschild, 2012). This may be due to one’s running mechanics being changed between footwear (Hollander et al., 2015). Running form is one of the first aspects that change when one transitions footwear (Hollander et al., 2015; Rothschild, 2012). Maintaining proper form and posture while running is difficult regardless of what type of

shoes being worn (Fredericks et al., 2015; Pearl, 2011). Another factor is fatigue. Especially important in endurance runners, an athlete's running economy is the "ability of the muscles to store and release energy" (Ridge et al., 2015). Factors that influence a runner's economy include stride length, kinematics, strength, velocity, and distance (Ridge et al., 2015). When transitioning to a differently padded shoe, the lower extremities may need to use more energy to maintain the same movements, resulting in premature fatigue and potential for injury (Ridge et al., 2015; Smith et al., 2015).

Perhaps the most important factor when examining a runner's biomechanics is the runner's foot strike, also referred to as footfall pattern (Lieberman et al., 2015). The data has indicated that runner's using traditional shod running shoes have the tendency to contact the ground with the heel first (Hollander et al., 2015; Lieberman et al., 2015; Perkins et al., 2014; Rothschild, 2012). This is known as a rearfoot heel strike (Hollander et al., 2015; Lieberman et al., 2015; Perkins et al., 2014; Rothschild, 2012). According to Lieberman et al., "more than 85% of habitually shod runners typically rearfoot strike" (Lieberman et al., 2015). However, among barefoot or minimalist style runners, athletes tend to strike the ground first with the balls of the feet. This is known as a forefoot striking pattern (Hollander et al., 2015; Lieberman et al., 2015; Perkins et al., 2014; Rothschild, 2012). These two footfall patterns are the most common exhibited by runners (Perkins et al., 2014). However, it has been suggested that if an individual grew up running in a particular type of footwear, the coordinating foot strike pattern would be preferred regardless of the footwear currently being worn (Perkins et al.,

2014). Some factors related to these differences include “kinematics, changes in ground reaction forces, loading, joint movements and power, joint range of motion, muscle activation patterns, and running economy (Rothschild, 2012). When analyzing footstrike pattern, another consideration are the fundamental components of stride length and stride frequency (Hollander et al., 2015). It has been demonstrated that a runner changing their strike pattern to a forefoot strike, lowers the impact and decreases the runner’s stride length while stride frequency increases (Hollander et al., 2015; Perkins et al., 2014).



*Figure 7 Different Footstrike Patterns*

Because rearfoot and forefoot strike patterns are so different, changes may precipitate injuries unique to each type of foot strike (Bowles et al., 2012; Lieberman et al., 2015). In a study of self-reported injuries, lower extremity injuries typically vary by location, not only for traditional shod runners, but for minimalist runners as well (see Figure 8 for the breakdown of prevalence by injury site) (Goss & Gross, 2012).

Although the two most common injuries are patellofemoral pain and tibial stress fractures, there are several other common injuries frequently associated with each footstrike pattern (Willson et al., 2014). For example, because heel striking runners

tend to have higher ground reaction forces, injuries related to heel impact, as well as injuries to the Achilles tendon due to high loading and little ankle range of motion are common (Bowles et al., 2012; Perkins et al., 2014). It is also because of the high loading and impact, researchers have related rearfoot striking patterns to repetitive stress fractures, possibly due to “overstriding and extended knees at landing” (Lieberman et al., 2015). Conversely, barefoot or minimalist runners would not suffer from these same injuries because forefoot strikers tend to land with “flexed knees and hips” (Johnston, 2011; Lieberman et al., 2015). This does not only increase the runner’s step frequency, but lowers the chances of overstriding and causing stress fractures (Johnston, 2011; Lieberman et al., 2015). However, runners that have transitioned to minimalist style shoes from traditional shod have suffered forefoot-related injuries, such as metatarsal stress fractures and plantar flexor pain (Bowles et al., 2012; Perkins et al., 2014; Rothschild, 2012). Another common injury associated with forefoot striking runners is Achilles tendinopathy, an ankle overuse issue most likely due to the change in range in motion at the ankle (Bowles et al., 2012; Perkins et al., 2014). With all of these known common injuries, a change in runner’s biomechanics is necessary when investigating both traditional shod and minimalist footwear.

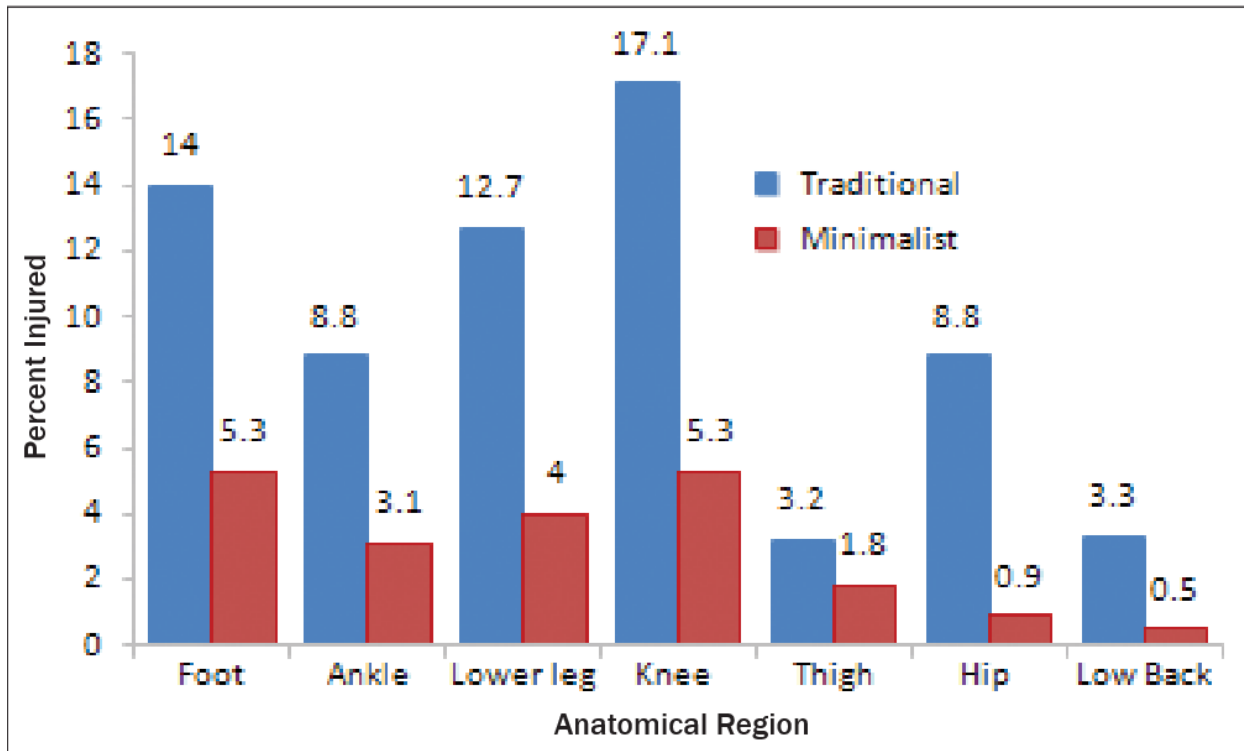


Figure 8 Prevalence of Injury by Location

### Importance of Proper Transitioning

When a runner is transitioning from using one type of shoe to another, proper precautions should be taken to prevent injuries and allow the lower extremities to properly adjust to the new footwear (Rothschild, 2012). Forcing a runner’s feet and complete lower body biomechanics to adjust to a differently padded shoe must take time. Research has suggested that four to eight weeks are needed for a proper transition (Rothschild, 2012; Smith et al., 2015). This will allow an appropriate amount of time for the muscles to adapt to training under new conditions (Rothschild, 2012; Smith et al., 2015). This gives enough time to adjust to the “plantar sensitivity, foot strike pattern, lower extremity proprioceptive ability, ankle joint flexibility, intrinsic foot

strength, and eccentric strength of the lower limb to control impact forces” (Rothschild, 2012). For each of these adjustments, there has been research on specific drills that may help with the transition (Rothschild, 2012; Smith et al., 2015). The drills should include both running and non-running activities to ensure an all-around transition (Rothschild, 2012; Smith et al., 2015). The transitioning program should also progressively increase distance over time, starting with running short distances (Rothschild, 2012; Smith et al., 2015).

Another consideration while transitioning between shoes is the environment. When changing footwear, a runner should consider the actual running surface (Lieberman et al., 2015). When learning to run with less protection on the soles of the feet, a runner should take proper time for the plantar sensitiveness to adapt and toughen (Rothschild, 2012). Therefore, a runner should practice running both indoors and outdoors, on soft surfaces and eventually harder surfaces (Rothschild, 2012). This process of adjusting from softer indoor surfaces to harder outdoor surfaces should take about three to four weeks (Rothschild, 2012). About thirty minutes of barefoot running daily should be included if attempting to transition to a more minimalist shoe (Rothschild, 2012). Barefoot drills in the grass may be beneficial in the transition before running on hard surfaces (Rothschild, 2012). Hard running surfaces may be one of the causes for maladaptation to minimalist style shoes (Smith et al., 2015). Research suggests that the forefoot is not accustomed to hard impact forces and the subsequent bone remodeling (Smith et al., 2015). One way of facilitating this transition is switching

between shod and minimalist shoes slowly throughout the transition period (Rothschild, 2012; Smith et al., 2015). This is recommended if the goal is to transition to barefoot running (Rothschild, 2012; Smith et al., 2015). Despite these suggestions, there is no evidence that supports that there is one specific routine to transition to minimalist shoes (Willson et al., 2014).

### **Other Uses for Minimalist Shoes**

With the growing popularity of minimalist footwear in running and walking, its attractiveness spread into other areas of fitness. It has been reported that “an increasing number of athletes are now utilizing barefoot and barefoot-inspired footwear, such as Vibram five-fingers, during training” (Sinclair, McCarthy, Bentley, Hurst, & Atkins, 2014). One study specifically tested the use of minimalist shoes in weightlifting kinematics and muscle activation in male athletes during a barbell back squat, while wearing shod, barefoot, and minimalist footwear (Sinclair et al., 2014). It was postulated that squatting barefoot, as opposed to wearing thickly padded shod or slightly padded minimalist shoes, would “provide increased lower limb stability and force generation” (Sinclair et al., 2014). Coaches had also been implementing barefoot training into their training in the belief that it “improves strength of the overall muscular system and that barefoot training trains all of the muscles, including both the large muscles...as well as the small muscles” (Nigg, 2009). It has been reported that barefoot or minimalist training resulted in strengthening “the small muscles crossing the ankle joint” which is known to be an injury-prone joint (Nigg, 2009; Sinclair et al., 2014).

As a result, in basic weightlifting moves, such as the back squat, minimalist shoes started to become a trend, attempting to increase power generation and overall muscle strength (Sato, Fortenbaugh, & Hydock, 2012; Sinclair et al., 2014). Before the popularity of minimalist shoes, most weightlifters, both recreational and competitive, used either shod running shoes or weightlifting shoes (Sato et al., 2012). Weightlifting shoes are designed to protect “the lifters’ feet and provide a stable, firm stance” (Sato et al., 2012). Weightlifting shoes have a stiff and unbending sole with rather thick padding in the heel, similar to that of the traditional shod running shoe (Sato et al., 2012). Biomechanically, the raised heel in the shoes demand a higher activation of muscles, specifically in the knee extensors (Sato et al., 2012). This is contradictory to the claims that the research behind minimalist or barefoot training had intended. Further, research data suggests that at an 80% of a max repetition, minimalist weightlifting was found to be “associated with the lowest peak and average power performance in comparison to the shod and barefoot conditions” (Sinclair et al., 2014). While, this is only one study; further research is needed to further examine the benefits of barefoot or minimalist training, as there is no biomechanical evidence to support the advertised benefits (Sinclair et al., 2014).



## Chapter Three: Methodology

After reviewing the literature behind the development of minimalist shoes, it is also important to understand how this research was found. In pursuit of an explanation as to why the minimalist movement came about, only peer-reviewed research was used in this investigation. Also, to ensure that this investigation is free of bias, research both in-favor and against the minimalist movement were under review.

### Data Sources

For the purpose of this study, databases were searched throughout the months of May through October in 2015 to find viable articles and sources of supporting studies. The databases that were included in the search are Google Scholar and EBSCOhost databases accessed through the University of Central Florida's library catalog. The EBSCOhost databases used were SPORTDiscus, PubMed or MEDLINE, and Physical Education Index or ProQuest. Using these databases, the keywords that were searched are as followed: *minimalist shoes, minimalist running, barefoot, injury, biomechanics, Vibram, FiveFinger, and Nike Free*. Because of the selected databases used, the only research articles that are included in this study are those that are peer-reviewed and published through academic journals and newspapers. All studies were published in the English language and can be found publicly. In the studies of research involving subjects, only human subjects were used.

## **Study Selection**

With the restrictions of the given databases and keywords used, 33 research studies were chosen to support this thesis. Of those 33 sources of research, 12 were considered scientific studies involving subjects. An analysis of data collected for results of each of those studies, see Table 2 in Chapter Four: Results. The criteria by which these studies were chosen included the relevance of the research, the validity of the results, and the date of publication. Only valid research articles relevant to the thesis published in 2000 and later fit this criteria and were chosen.

## Chapter Four: Results

To understand the initial popularity of minimalist shoes, an evaluation of the footwear that existed before the minimalist shoe is necessary. In the 1970s, the traditional running shoe was introduced (Bowles et al., 2012). From the 1970s to present day, the traditional running shoe has always catered to the rearfoot-striking runner, characterized by a dense heel cushioning (McCartan, 2013). Because most runners have a heel-striking running pattern, common injuries developed among shod runners (Bowles et al., 2012; Lieberman et al., 2015). This prevalence of injury led to a search for alternative solutions such as barefoot running and minimalist footwear (Bowles et al., 2012; Tucker et al., 2014). This inevitably led to the invention of minimalist footwear and the research behind its design. The following research traces the growth and waning popularity of the minimalist movement as we know it.

To understand the effects that minimalist shoes have on running biomechanics, some of the research findings are provided. In one study, runners were instructed to shorten stride length and increase stride frequency (Hollander et al., 2015; Smith et al., 2015). The results included a footstrike pattern similar to forefoot striking, seen in both barefoot and minimalist running (Hollander et al., 2015; Smith et al., 2015). It has been demonstrated that this change in gait characteristics forced the foot to make contact closer to the center of mass, reducing the ground reaction forces (Bowles et al., 2012; Hollander et al., 2015; Tucker et al., 2014). Because ground reaction forces are

decreased, it was suggested that an athlete's running economy would improve with the use of minimalist shoes (Ridge et al., 2015). This hypothesis was supported in a research study at Brigham Young University (Ridge et al., 2015). Subjects showed improved running economy after a ten week training period in Vibram Five-Fingers minimalist shoes (Ridge et al., 2015). When analyzing running balance, subjects wearing Vibram Five-Fingers showed a better anterior-posterior balance and overall stability level than the barefoot counterparts (Smith et al., 2015). When observing running performance, it has been reported that "heart rate and relative perceived exertion have been found to be significantly lower in barefoot" runners as compared to shod runners (Rothschild, 2012). These are some of the research findings that helped mold the minimalist movement and the development of the popular minimalist shoe.

Although there are several reasons for the decline in popularity for minimalist shoes, much of the research has cited the prevalence of injury as a major cause. Approximately "30 to 70% of distance runners" suffer from musculoskeletal injuries every year (Bowles et al., 2012). It has been suggested that "minimalist runners appear to be more susceptible to injuries associated with forefoot impact" because of the change in running mechanics (Bowles et al., 2012). Conversely, traditional shod runners have a tendency to suffer from "injuries related to heel impact" (Bowles et al., 2012). However, although these gait characteristics indicate a trend of different injuries, it does link the injuries directly to the footwear (Bowles et al., 2012; Hollander et al., 2015). In a research study conducted by the University of Hamburg, Germany,

regardless of a participant's footwear, a rear-foot strike pattern was seen in 50% of study subjects, even those assigned to wear minimalist shoes (Hollander et al., 2015). Similar results were found in a research study involving participants in a two-week training program (Willson et al., 2014). Although subjects were wearing minimalist footwear, they still display a rearfoot striking pattern, both before and after the two-week period (Willson et al., 2014). These studies support the contention that the type of footwear is not enough to predict a footstrike pattern (Tucker et al., 2014). To suggest that barefoot or minimalist running is "synonymous with forefoot striking" is incorrect and "may obscure the real kinematic differences and their effects on injury risk" (Tucker et al., 2014). Therefore, a runner's predisposition for injury is not determined by the footwear alone, but rather by the foot strike pattern and injury history of the runner (Bowles et al., 2012; Tucker et al., 2014).

With the evidence behind injury prevalence, questions still remain. Will the use of minimalist shoes decrease the risk of injury and/or improve running performance? Although some studies in this review claim to have come to a conclusion about an aspect of minimalist footwear, there are others studies to challenge the findings. (See Table 1 for individual results for each of the twelve research studies noted and the resulting conclusions; also, Figure 9 illustrates the breakdown of the results found by Perkins, Hanney, and Rothschild's systematic review study in 2014.) With all of the research collected in this review of literature, the conclusion, common to all studies, suggests that there is not enough evidence to support or reject this statement (Cortese,

2009; Johnston, 2011; Nigg, 2009; Perkins et al., 2014; Rothschild, 2012; Sinclair et al., 2014; Willson et al., 2014). With more factors than footwear alone affecting the prevalence of injury, further research on the subject is needed to conclude a clear consensus (Nigg, 2009; Perkins et al., 2014; Rothschild, 2012).

In close, after reviewing all of the mentioned research studies, the results do not seem to come to unanimous deduction. The majority of the studies resulted that further research is needed in order to conclude any risks or benefits for the use of minimalist shoes. According to Table 1 illustrating the conclusions from each study taken into account, results were contradictory. This can only suggest further research is needed. Furthermore, because research is inconclusive, this leads the explanation for the minimalist movement up for discussion, which this thesis elaborates in the next chapter.

Study Title	Year	Results & Conclusions
Biomechanical Consideration on Barefoot Movement and Barefoot Shoe Concepts	2009	Footwear does not mimic barefoot movement
Footwear for Distance Runners: The Minimalist Trend	2012	Recommend proper shoe transition, or remain using shoe runner is accustomed to
Running Barefoot or in Minimalist Shoes: Evidence or Conjecture?	2012	No evidence to support risk of injuries or improvement of performance
Barefoot Running: An Evaluation of Current Hypothesis, Future Research, and Clinical Applications	2013	No evidence to support risk of injuries or improvement of performance; adaptation is necessary for transition
The Risk and Benefits of Running Barefoot or in Minimalist Shoes: A Systematic Review	2014	See Table 3
Short-Term Changes in Running Mechanics and Foot Strike Pattern After Introduction to Minimalistic Footwear	2014	After 2 week training period, footwear does not determine footstrike pattern
The Influence of Different Footwear on 3-D Kinematics and Muscle Activation during the Barbell Back Squat in Males	2014	Footwear does not determine better squat muscle activation
Effects of Wearing Athletic Shoes, Five-Toed Shoes, and Standing Barefoot on Balance Performance in Young Adults	2015	Minimalist footwear result better balance than barefoot; Vibram Five-Fingers test highly similar to barefoot
Lower Extremity Biomechanical Relationships with Different Speeds in Traditional, Minimalist, and Barefoot Footwear	2015	Footwear is a key factor in foot strike pattern; Speed does not determine foot strike
Variation of Foot Strike Patterns among Habitually Barefoot and Shod Runners in Kenya	2015	Footstrike pattern is not directly correlated to footwear type; footstrike is habitual
Comparison of Minimalist Footwear Strategies for Simulating Barefoot Running: A Randomized Crossover Study	2015	No concluding evidence for risk of injury; foot strike is due to speed and footwear
The Effect of Training in Minimalist Running Shoes on Running Economy	2015	Minimalist training does not directly improve running economy

*Table 1 Twelve Study Results and Conclusions by Publication Date*

	Studies Included	Conclusion/Level of Evidence
<b>Kinetics</b>		
Ground reaction forces	5,6,8,9,17,20,23	Moderate evidence suggestive of lowered maximum vertical GRF when barefoot
	8,17	Limited evidence suggestive of lowered max vertical GRF only during barefoot FFS
	20	Very limited evidence suggesting decreased medial-lateral and increased anterior-posterior GRF when barefoot
Impulse	9,27	Very limited evidence suggesting greater braking and pushing impulses of plantar flexors during FFS Very limited evidence suggestive of differences in peak vertical or medial-lateral impulses while barefoot
Rate of loading	1,6,40,41	Very limited evidence suggestive of differences in loading rates when running barefoot, in minimalist shoe, or shod
Joint moments and power	3-5,20,39	Limited evidence suggesting less extension moment and power absorption at the knee when barefoot
	3,39	Limited evidence suggesting increased power generation and absorption at the ankle when barefoot
<b>Kinematics</b>		
Foot-strike pattern	8,17,26,27,39,41	Limited evidence suggesting FFS is associated with barefoot running
Stride	3-6,10,13,20,24,26,38,41	Moderate evidence suggesting barefoot running is associated with increased stride frequency, shorter stride length, and less ground contact time
Joint range of motion	3,18,39,41	Moderate evidence suggestive of decreased foot and ankle dorsiflexion at initial contact when barefoot
	41	Very limited evidence suggesting decreased ankle eversion at ground contact
	5,6,18,28	Moderate evidence suggesting increased knee flexion at ground contact and less knee flexion during stance when barefoot or in minimalist shoes
Running economy	10,13,16,27,35,38	Very limited evidence suggestive of significant difference in running economy between barefoot, shod, and minimalist shoes
EMG	1,26,39	Limited evidence suggests decreased peak tibialis anterior activity when barefoot FFS

EMG, electromyography; FFS, forefoot strike; GRF, ground reaction force.

Figure 9 “Level of Evidence for Outcome Categories” (Perkins, Hanney, & Rothschild, 2014)



## Chapter Five: Synthesis and Discussion

After researching minimalist shoes, the question of why the minimalist running movement came and went so rapidly could be addressed. It seemed that minimalist shoes were introduced with the demand for them immediately skyrocketing. But within a few years, popularity seemed to decline as quickly as it rose. Using research from both enthusiasts and detractors to find the true reasons for the trend, some common reasons were found. These reasons helped explain the sudden decline of the minimalist movement thereby changing the way that runners view footwear.

Researching the history of minimalist shoes and how they were first designed revealed much about the intentions. While designed to mimic barefoot running, the purpose was to improve running performance by changing the runner's footstrike pattern. It has been demonstrated that different footfall patterns are associated with running-related injuries. One of the intentions of the minimalist shoe was to decrease the prevalence of those injuries. Footwear companies, such as Vibram, had marketed and advertised that the use of their minimalist shoes would decrease injuries and improve performance (McCartan, 2013). However, those statements were revealed to not be true. Furthermore, transitioning to a minimalist style shoe did not demonstrate any enhancements to athletic performance. This has been identified as one of the reasons why the minimalist movement had marked decline in sales and popularity (Germano, 2014a, 2014b; Ryan, 2012). After consumers tried minimalist shoes and did not experience the results that were promised, many reverted back to conventional

shod running shoes (Bowles et al., 2012). This trend seemed to have been reflected in the sales trends over the course of the minimalist movement -- the peak in popularity when minimalist shoes first made the market and research was released proving its possible benefits and, finally, its pitfall in popularity when the alleged benefits were not seen fit for runners not accustomed to the barefoot imitator.

Continually, with so many of the consumers that attempted to try minimalist style shoes, many of the injuries that those runners experienced were the result of the transition to the minimalist shoes. Perhaps the most important factor when analyzing the injury prevalence in minimalist shoes is the transition from different footwear styles. As discussed earlier, transitioning from one form of footwear to another is not a process to be taken lightly. Although there is not one correct and proper way to transition, there are some guidelines to ensure a safe and injury-free changeover. Time being the most important factor of the transition, it is crucial to ensure enough time during the transition for the runner's body to adapt to the changes. Even with recommended transitioning training periods by the leading footwear companies, injury was still prevalent and may have led to the downturn of the minimalist movement.

Ultimately, although the minimalist movement was not long-lasting, it reformed the athletic footwear industry for the better; there is now a footwear category known as minimalist or barefoot-inspired shoes, a category that did not exist before the minimalist movement took place. Also, it effected how even athletic shoes in general are designed. Even some of the most popular shod running shoes are designed with a more

minimalistic-inspired padding compared to its predecessors. While further research is needed to prove the risks and benefits of minimalist shoes and their minimal padding designs, it has left its mark on the history of the footwear industry and have paved the way for future footwear production.

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