

The Effects of Improper Pointe Shoe Health and Practices: A Literature Synthesis

Submitted by
Kathryn Rose Calleja

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Mentor: Elizabeth Kattner, Ph.D., Associate Professor of Dance
Department of Dance
Oakland University

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Abstract

This research aims to examine the consequences of improper alignment and poor pointe shoe health and fit, to analyze extant research on what are recommended healthy pointe shoe practices, as well as to discuss the implications of allowing pre-pubescent students to dance in pointe shoes. In the form of a literature synthesis, various sources are presented to address conflicts, discrepancies, or similarities in order to compile and communicate the current knowledge of ballet injuries related to pointe work.

This research found that taking extreme measures to break in pointe shoes causes decreased ability for the shoe to support the dancer, compromising stability in the foot and ankle. Wearing pointe shoes that are too worn-down or ‘dead’ can result in extreme stretching of the metatarsal ligaments, which proves dangerous to dancers. It is vital that dancers employ healthy practices with their pointe shoes in order to avoid injury. Additionally, teachers must establish their practices, while keeping health and safety in mind, to ensure that young dancers may continue to pursue dance for years to come. Teaching correct alignment and technique and monitoring and evaluating students properly is imperative for the safety of dancers. To provide a baseline on evaluating students, this study also explores a five-point objective test as a guide for teachers to determine a dancer’s readiness for pointe shoes.

The expected results of this paper will allow dancers and educators to have a greater understanding of the physical damage and effects of pointe training and technique on a dancer’s body – in both the scientific and performing arts world.

Methodology

Although ballet is a strict and technical art form that does not differ much universally, there are many ideologies and methods of pointe shoe training currently being used; some of which can be extremely detrimental to the body. The main topics that will be analyzed in this paper are the physical effects of ‘breaking in’ and dancing in heavily worn or ‘dead’ pointe shoes, and the potential physical consequences of allowing young dancers to dance in pointe shoes.

Because there are various methods of training pointe dancers that center around different studio cultures, as well as an undersupply of scientific studies analyzing these practices, it was deemed more advantageous to compile various current research on pointe shoe practices and injuries in the form of a literature synthesis. Compiling and analyzing information from journals will allow for the development of a broad foundation of scientific knowledge. This paper chiefly focuses on investigating scientific sources; specifically, those that examine the harmful effects on the body that excessively worn (dead) pointe shoes can have, and the evaluation of dancers’ physical readiness for pointe.

For comparison, this study also examines similar information from various informal sources, which are not expected to be as in-depth as the scientific sources. These sources consist of periodicals (e.g. *Dance Spirit* or *Dance Magazine*), discussion boards, or studio blogs. Though they are informal in nature – and may be secondary sources, or perhaps consist of opinions – they will highlight what is currently being discussed and practiced in the discipline, even though it may not be factual or safe for dancers’ health. Dance teachers and students read these resources often and look to them as guides for how to navigate various situations in the field. It is

important that these sources are included in this study in order to gain a more realistic and comprehensive evaluation of current practices.

Analyzing both types of sources addresses conflicts, discrepancies, and similarities between these two types of sources, and poses questions and suggestions for additional research. Practical, healthy, and technically-sound advice that will not sacrifice technique and training is important for dancers. Currently, there is discrepancy between what is being practiced by dance studios around the world and what is considered to be safe dance practices. There are many practices that are ‘comfortable,’ or ‘tradition’ (i.e. breaking in shoes), or aesthetically pleasing to audiences, yet are extremely unsafe for the dancer, with scientific studies as evidence. Somehow, the risks of these practices are not being taken seriously. Many studios, and even large dance companies continue to sacrifice the health of dancers for traditions and aesthetics. This research serves as a platform to discuss the differences between the worlds of science and dance and bridge the gap between them to prioritize the health and safety of dancers globally without losing the essence and beauty of pointe work.

A note on gender in scientific studies of dance: this paper analyzes pointe shoe health and practices from a variety of sources. Although ballet has become more inclusive and diverse in recent decades, it must be acknowledged that pointe dancers are almost exclusively female, and these biases need to be considered when drawing conclusions. Due to this, the paper may at times refer to ballet dancers using female pronouns; however, this is not meant to ostracize any personal or group identities, nor should it be considered indicative of the ballet/pointe dancer population as a whole, but rather, it is a reference to and reflection of the current research and practices.

Literature

The sources in this paper address the body on pointe, breaking in pointe shoes, ‘dead’ pointe shoes, and determining pointe readiness in students, and how each of these components may affect the health and performance of ballet dancers. The body on pointe is an extraordinary feat, detailed physiologically by Prisk et al. (2008), Sarah Wakes and Joanne Caudwell (2010), and Bickle et al. (2018), and requires much strength, flexibility, and balance from the dancer. In addition to the physical requirements, it is also imperative that the pointe shoe is well-fitted to the foot. Many dancers are known to engage in a shoe modifying process called ‘breaking in.’ Excessively breaking in pointe shoes can put a dancer at greater risk of injury. The process of breaking in pointe shoes and its potential effects on the body is discussed in the articles, “How to Properly Break in Pointe Shoes” (2017), “The Dangers of Dancing on Dead Pointe Shoes” (Meier, 2020), and “3 Pointe Shoe Safety Tips” (Marks, 2017), and studied by Dinika Singh (2019), Bickle et al. (2018), and Wakes and Caudwell (2010).

When a pair of pointe shoes ages and is no longer hard enough to support the body, it is considered to be dead. Dead pointe shoes are an area of great concern, and many connections between dancing in deteriorating pointe shoes and the potential for injury are explored through research by Bickle et al. (2018), Aquino and Amasay (2019), Dinika Singh (2019), and discussed in the article “The Dangers of Dancing on Dead Pointe Shoes” (Meier, 2020). One goal of this paper is to attempt to clarify appropriate criteria for a young dancer to begin dancing in pointe shoes. Although a highly debated topic, this research compares the differing information surrounding the topic from both a scientific perspective, by Dinika Singh (2019), Selina Shah (2009), as well as what is currently being discussed in the dance world by Emma Sandall (2018), and Katherine Beard (2018).

Introduction

Pointe shoes are perhaps the most universally recognizable aspect of a ballet dancer, giving a ballerina the appearance of loftiness, flight, and grace, while allowing her to dance on the tips of her toes. Ballet has existed for centuries – and much of the technology of the art has evolved since its days in Louis XIV’s court. Floors have been created with better shock absorption for the body’s joints, stage lights have been developed with the safety of performers and audiences in mind and are no longer lit with gas lighting, and costuming has become more flexible and breathable for the dancer (Singh, 2019). Ballet itself has become less elitist and more inclusive of different races, genders, and body types, constantly broadening its horizons and challenging the norm aesthetics established long ago (Singh, 2019). One aspect of ballet though, has remained constant – the pointe shoe.

Dancers spend many hours in pointe shoes through warm-up classes, rehearsals, and performances. Ballet and other forms of dance are extremely demanding on the body, with a lifetime injury incidence of up to 90% (Prisk et al., 2008). Dancing in pointe shoes requires immense amounts of strength, flexibility, and proper technique and alignment. In fact, dancing in pointe shoes increases the forces placed on the foot by 12 times the dancers’ body weight (Shah, 2009). Foot and ankle injuries are commonplace in professional and pre-professional ballerinas, with fractures to the tibia and metatarsals as the leading pathologies (Singh, 2019). Throughout long hours of rehearsals, many dancers, despite having injuries, will continue to dance. Unfortunately, in the dance world, there is an ongoing expectation of pain, and stoicism through this pain, that has led teachers to encourage their students to “dance through the pain” in order to succeed, or that experiencing pain is indicative of ‘working hard’ (Molnar & Karin, 2017). This

idea, however, is an extremely detrimental mindset, as injuries can result in serious and harmful long-term effects, if not corrected quickly or treated properly.

In addition to the injuries that may arise in even the most experienced dancers, there is also a chance that injuries can occur in young, inexperienced dancers who receive their pointe shoes too early. Though many dance students do not wish to continue on to a professional career, it is often a dream of young dancers to receive their first pair of pointe shoes. Currently, there are conflicting opinions as to what age a young dance student should receive her pointe shoes, and there is a scarcity of studies that directly address the question of when a dancer is ready to dance on pointe (Shah, 2009). Although the dance world is becoming increasingly more alert and aware of dancers' health, there are still many studios, teachers, and dancers that would rather sacrifice long-term health for short-term aesthetics and the gratification of allowing students to obtain their pointe shoes.

The Body on Pointe

Dancing on pointe requires a dancer to rise onto the tips of her toes while wearing a pointe shoe. Though a difficult concept to comprehend for non-dancers, and a major scientific and physical feat, it is actually not a difficult act if the dancer is experienced and strong. Dancing on pointe is much easier if the dancer has maximal plantar flexion throughout the entire foot, as well as flexibility and strength in the ankle, and correct alignment within the pointe shoe (Prisk et al., 2008). If the pointe shoe structure is correctly fitting, and the dancer is trained correctly, the shoe actually aids the dancer with movement, and acts as a major stabilizer to the foot (Bickle et al., 2018). The shoe is designed to support the dancer's full body weight on a small base of support – sometimes distributing the weight between two feet – while most other times, just one foot supports this extreme load. In addition to foot and ankle flexibility and strength, the

dancer must also have impeccable core balance, calf, and leg strength (Wakes & Caudwell, 2010).

The foot is designed to move on the sagittal plane – which is not the way that a pointe shoe requires the foot to be. This changes the distribution of load on the foot and eliminates many shock-bearing tools that the foot has naturally (Wakes & Caudwell, 2010). When the foot is in a pointe shoe, the body's center of gravity and much pressure is centralized between the first two toes. The Achilles tendon and gastrocnemius and soleus muscles are also put under stress – continually contracted while the foot is in this upright position (Wakes & Caudwell, 2010). It has been found that many ballet injuries are influenced by the ballet shoe and inadequate fit.

Breaking in Pointe Shoes

As mentioned above, the fit of a pointe shoe is an extremely important factor to consider. In order to support the body, it must mold perfectly to the dancer's foot. Sometimes, dancers must even purchase differently sized shoes for each foot. According to *Dance Teacher* magazine, author Andrea Marks, who has been training dancers for twenty years in Connecticut at the School of Hartford Ballet, shoes that are well-fitted and properly laced are vital to achieving the correct technique and preventing injury on pointe. Any shoe that is too short, narrow, long, or wide, can alter the dancer's ability to be properly aligned in pointe shoes. It can also lead to injuries – from blisters and tendonitis to a sprain or stress fracture (Marks, 2017). There is little room for compromise on fit and feel with pointe shoes – even the smallest change in fit can cause a variety of injuries.

There are only around 20 shoe companies that create pointe shoes; they are hand-made and require many steps including layers upon layers of glue and fabric to create the hard toe box that is used to solidify the shoe. There is a large variety of styles, sizes, fabrics, and fits from

which to choose. Because of this, no two pairs, even from the same manufacturer, and in the same style, are alike. In order to achieve the most ideal fit for a dancer, all sources throughout this research have recommended that dancers be fitted for pointe shoes by a professional.

Although each pointe shoe is unique and hand-crafted, they are standardized with no arch, and an almost brick-like hardness when purchased new. They must be modified in a process called ‘breaking in.’ Breaking in shoes allows them to be more comfortable, molding them to the shape of the dancer’s foot (“How to Properly Break in Pointe Shoes,” 2017).

Many professional dancers have been known to spend hours modifying their shoes – cutting the shanks (inner sole) with scissors, scraping the suede bottom on gravel or with a steel brush for traction, slamming the toe box in a door or onto the ground to soften it, and often cutting the satin from the tip of the toe box to increase friction while dancing on pointe (Singh, 2019). These extreme measures are often done by professional dancers who only need the shoe to last one performance, as the usual cost of a pair of pointe shoes is around \$150 (Singh, 2019).

Students who break in their shoes too heavily run the risk of injury and ruining their shoes. In a 2018 study conducted by Celeste Bickle, Martine Deighan, and Nicola Theis published in *Human Movement Science*, variances in foot and ankle kinetics between new and worn pointe shoes were examined on 15 professional dancers from the United Kingdom (Bickle et al., 2018). The study found that in worn-down pointe shoes, midfoot flexion and plantar flexion (pointing the feet) were much greater than in new shoes. This increased midfoot flexion results from the metatarsals curling underneath the foot, which may cause extreme stretching of the metatarsal ligaments. Although this study presents the dangers of breaking in pointe shoes, it does not provide any suggestions on how to maximize a dancer’s comfort safely. Current

scientific research on the topic does not allow for any alternate or safer practices to breaking in shoes – or any suggestions to modify the design of the shoes.

On the contrary, though, a study performed by Sarah Wakes and Joanne Caudwell of University of Otago's Department of Design Studies in New Zealand examined the potential of a user-centered approach to ballet shoes. A case study assessed nine female ballet students over the age of 18 with varying ability levels. The dancers responded to a questionnaire regarding breaking in shoes, different shoe attributes and injury, personal modifications made to shoes, and the relationship between experience level and shoe attribute preference (Wakes & Caudwell, 2010). Interestingly, the researchers found it was more likely for an inexperienced dancer to take more extreme measures in breaking in a shoe. One subject with nine years of pointe experience recalled that once the correct shoe was found and fitted, she no longer needed to break in her shoes. This suggests that less experienced dancers may be purchasing shoes that are too hard or are not fitted correctly, thus requiring more forceful and destructive procedures to maximize comfort (Wakes & Caudwell, 2010). Another interesting point was that most injuries and discomfort were found to be unrelated to the amount of pointe shoe experience. Six out of the nine dancers reported that they modified their shoes after injury, and wrapped their toes, or added extra padding to reduce injury. Additionally, no relationship was found between injuries and each dancer's individual method of breaking in shoes. This suggests that the design of the shoe itself is lacking, as modifications to shoes are common.

Harlequin Dance Store recommends that non-professional dancers should simply start the breaking-in process by dancing in the shoes, with only a few moderate adjustments. A recommended way to soften the toe box is to step on it lightly, or to crunch the box with one's hands ("How to Properly Break in Pointe Shoes," 2017). This will make the toe box less square,

and more flexible to the shape of the toes. After the box is broken in, the dancer should put the pointe shoe on, and mold the shank of the shoe to the arch and ball of the foot (“How to Properly Break in Pointe Shoes,” 2017). Bending the shoe to the arch of the foot allows for the heel to “rest” onto the shank, while bending it at the ball of the foot assists the dancer in rolling up to pointe more fluidly. The dancer must be careful not to snap the shank. Breaking a pointe shoe, rather than molding it to the dancer’s foot, can significantly shorten the life of the shoe, while also greatly risking the safety of the dancer, as a broken shoe no longer supports the body and compromises the structure of the shoe (Meier, 2020).

Dead Pointe Shoes

A pointe shoe is considered “dead” when the shoe is no longer hard enough to support the foot and ankle (Singh, 2019). Approximately 12 hours of wear on a pair of pointe shoes is considered a normal lifespan, or a fatigued shoe, while 20 hours is a worn or dead shoe (Bickle et al., 2018 as cited in Singh, 2019). While pointe shoes cost upwards of \$150 per pair, it is unlikely that a non-professional dancer will be purchasing a new pair of pointe shoes after only 20 hours of wear. For example, a typical intermediate or advanced dancer at a recreational studio spends 3 hours per week in pointe class (i.e. each class is 1.5 hours in length and meets twice weekly). If a typical studio season follows a 40-week/180-day school schedule, and a student begins the dance season with new pointe shoes, after week 4 the pointe shoes will reach their lifespan of 12 hours. After week 7, the shoes will be past their worn status at 21 hours, thus dead for the rest of the dance season. This is not considering any extra performances, competitions, or rehearsals. Though this is hazardous to a dancer’s physical health, most recreational dancers only replace their pointe shoes once or twice per dance season. Due to the high cost of shoes, many

young dancers, or their parents, are unlikely to purchase new pointe shoes every 7 weeks, totaling 6 pairs, or \$900, yearly.

Not only can dancing weaken shoes, but alignment, the strength of the dancer, choreography, and simply even foot sweat can wear down pointe shoes. Similar to a “cardboard box left in the rain,” foot sweat dampens the glues in the shoe, leading to a softer, more malleable piece of footwear (Meier, 2020). A worn pointe shoe with decreased structural integrity reduces the ability of a dancer to correct postural sway, which could cause increased rates of muscle fatigue, ankle sprains, and falls (Bickle et al., 2018). The center of gravity changes with a softened shoe – instead of an equally distributed force throughout the foot, forces are concentrated at the top of the foot – putting structures, such as the ankle at increased risk for stress fractures (Meier, 2020). Increased flexibility of a pointe shoe, which will occur with a softened shoe, increases plantar and midfoot flexion significantly, which also places excessive loads on the body’s joints (Bickle et al., 2018). Less support of the foot and ankle in the upright, pointed position can be extremely detrimental to the body, especially in dancers who are weak in those areas.

Compression of soft tissue structures is also of great concern – as a dead pointe shoe has lost much of its structure, strength, and the rigidity needed in order to support the foot. Figure 2 shows the compression of the joints through an X-ray of the feet in new shoes (left) and old shoes (right). The compression and reduced space between the bones of the feet can be clearly seen, as well as the changes in alignment due to the lack of support (Meier, 2020). The joints and ligaments of the feet are already not designed to work in the plane that pointe shoes require – and they certainly are not designed for excessive loads in these positions, as well (Bickle et al., 2018). This overload of joints can cause bunions, cartilage damage, arthritis, bone spurs, or even

hallux rigidus, which is a loss of motion in the joint of the big toe (Meier, 2020). Not only are these issues detrimental to a dancer's immediate future but can impact her for the rest of her life. Even if a dancer is fortunate to not be seriously injured from dancing in dead shoes, they may experience muscle strains, tendinitis, tendon tears, or bursitis due to other muscle groups working harder, compensating for the increased load on the ankle.

A study conducted in the United Kingdom published in *Human Movement Science* in 2018 by Celeste Bickle, Martine Dieghan, and Nicola Theis directly examined the effects of pointe shoe deterioration on foot and ankle kinematics and kinetics in professional ballet dancers. Fifteen female ballet dancers from leading companies in the United Kingdom with at least three years of professional pointe experience and 25 hours of ballet training per week were evaluated. The experimenters measured changes in midfoot flexion and ankle plantar flexion through visual study using anatomical markers with each subject, as well as vertical and ground reaction forces using a force platform (Bickle et al., 2018). Figure 1 illustrates the definition of plantar flexion and midfoot flexion in a pointe shoe. The angle that is formed between the lateral epicondyle of the knee, the lateral malleolus (ankle bone), and the fifth metatarsal, is the angle of plantar flexion. The midfoot flexion angle was measured between the navicular bone, the calcaneus (heel bone), and the fifth metatarsal (Bickle et al., 2018). The dancers all warmed up the same way and were then instructed to match three to four steps to a piece of music from *Swan Lake*. Each dancer was evaluated with a new pair of pointe shoes, and a pair of shoes that were worn for approximately 20 hours (Bickle et al., 2018).

This study found that wearing old shoes significantly increased midfoot flexion and plantar flexion, as compared to wearing new shoes. It was also found that plantar flexion was greater in worn shoes (Bickle et al., 2018). Figures 3 and 4 show the results of this study,

demonstrating the significant increase in both midfoot flexion and plantar flexion, respectively. Worn pointe shoes added, on average, about 7° more for midfoot flexion and 3° more for plantar flexion, as compared to new shoes (Bickle et al., 2018). Although these small angles may seem insignificant, altering the angles just slightly can certainly impact the forces acting on the foot. It is speculated that a greater angle of midfoot flexion is due to the metatarsals curling underneath the foot in the pointe position, which is not favorable (Bickle et al., 2018). The anterior talofibular ligament, which is not equipped to bear high loads, becomes the main stabilizer of the ankle. This unnatural loading on the ligament may lead to lateral ankle sprains, or displacement or fractures of bones in the foot (Bickle et al., 2018).

Another study, through Barry University in Florida, conducted by Jessica Aquino, MS, and Tal Amasay, Ph.D., aimed to analyze the biomechanical differences between new and dead pointe shoes in professional dancers. The researchers asked 13 female professional dancers with ten or more years of experience to perform three trials of *relevé*, *sous-sous*, and *pirouettes*, in both types of shoes. The center of pressure sway area and ground reaction forces were recorded through the use of a force plate (Aquino & Amasay, 2019). Pointe shoes were deemed ‘new’ if they had been worn between 5 and 50 training hours, or ‘dead’ if worn between 51 and 500 training hours. The study showed a statistically significant difference for all three movements between new and dead shoes. The mean area of sway in dead pointe shoes compared to new shoes were 53 mm², 146 mm², and 101 mm², for *relevé*, *sous-sous*, and *pirouette*, respectively (Aquino & Amasay, 2019). This data suggests that wearing a dead pointe shoe decreases the footwear’s stability, and in turn, the dancer’s ankle and foot stability, as well. In a more difficult move, such as a *pirouette*, which requires significant stability to perform, greater amounts of sway could be harmful. A swaying axis of rotation could prove hazardous for a dancer executing

multiple turns. The researchers also proposed that this instability may require greater compensation from the body (Aquino & Amasay, 2019). Compensation may lead to overuse injuries, and if the dancer cannot compensate enough, she may fall out of a position, which could also lead to injury (Aquino & Amasay, 2019).

Due to the insufficient number of studies investigating the effects of dead pointe shoes, both studies by Aquino and Amasay (2019) and Bickle et al. (2018) serve as foundations for future endeavors and shed light on the various negative consequences and health risks of dancing in worn shoes. While it is difficult to determine the exact definition of a dead shoe, clearly seen by each study's differing definitions, these studies are paving the way for those discoveries. There is a definite need for more research to understand the full impact of dead pointe shoes. Both experiments suggest that the state of a pointe shoe may contribute to injuries, both by increased flexibility and decreased stability in the foot and ankle. This seems logical, as increased flexibility in joints of the body correlates with decreased stability.

Megan Meier, MD, recommends in the *Dance Magazine* article, "The Dangers of Dancing on Dead Pointe Shoes – And 5 Ways to Prevent Injury," that students trying to extend the lifespan of their shoes should take steps to prevent injury. Although shoes deteriorate naturally, students can be mindful of their pointe shoe habits in order to keep the health of themselves and their shoes well-maintained. It is suggested that new pointe students should not break in their shoes unless directed to by a dance instructor, and not destroy them to break them in. Dancers should be sure that their shoes fit well and are allowed to dry completely after dancing; dancing on damp shoes only exacerbates the issue of soft shoes in accordance with decreased stability of the shoe. Additionally, shoes should be monitored for any soft, asymmetrical, or excessively worn spots before and after dancing (Meier, 2020). Extreme wear

on a certain portion of the shoe can indicate a number of issues, such as poor ankle alignment, or decreased flexibility or strength in the foot. Therefore, it is imperative that if dancers are physically ready to wear pointe shoes, they must be prepared to take on the responsibility of caring for their shoes as well.

Determining Pointe Readiness

A dancer receiving her first pair of pointe shoes and beginning to dance on pointe is perhaps one of the most exciting moments in a young dancer's career. Many students spend much of their early dance careers infatuated with ballerinas dancing on their toes, eagerly awaiting the day they will be fitted for their first pair of pink satin shoes. However, if the dancer is not well-trained, or receives the shoes too early in her training, the beautiful shoes that she longed to dance in will eventually cause much more harm than good. One of the main issues revolving around young dancers, though, is that there is no consensus, in either the scientific nor the dance world, on exactly when dancers should receive their first pair of shoes. Currently, there are no studies specifically addressing the eligibility of a dancer to begin pointe work. This complex issue revolves around many factors (e.g. age, technique, anatomy, strength, flexibility, and alignment). Which factors are to be considered with more weight is an area of much debate. Compiling extant information surrounding this topic will hopefully allow for further understanding of the significance of each of these factors. To reiterate, one of the goals of this paper is to attempt to clarify appropriate criteria for a young dancer to begin dancing in pointe shoes.

Most ballet students receive their first pair of pointe shoes around the age of 11 or 12, after years of training (Lai & Kruse, 2016). Despite no universal consensus on when a dancer is ready, a reasonable determination can be made by examining certain anatomic, training, and

performance requirements that would indicate a student's readiness for pointe work. Wearing pointe shoes requires immense amounts of strength, flexibility, and proper technique and alignment. As formerly mentioned, dancing in pointe shoes increases the forces placed on the foot by 12 times the dancer's body weight (Shah, 2009). Receiving pointe shoes is certainly an achievement in a dancer's career; however, dance teachers and dancers alike must be conscious of the amount of technique required of a dancer in order to safely dance on pointe.

Evaluating whether or not a student is ready for pointe can be difficult and many factors must be considered. The proper age for a student to receive their pointe shoes continues to be highly contested. Perhaps the most significant concern is the physical maturity of the dancer. There is hesitation regarding whether or not teachers should wait until a student has gone through puberty - when most of the body matures (Shah, 2009). Although a student may be technically proficient and seem ready, her body may still be developing. Specifically, the growth plates of the bones have not yet ossified. Many health care professionals have concerns about allowing students to dance on pointe during childhood and early adolescence. Because the growth plates have not ossified, specifically those of the feet, they are more susceptible to injury. Growth plates in children are constantly being remodeled, meaning they cannot withstand a large load of shear and tensile forces (Shah, 2009). This potential negative effect, which is an under-researched topic, is perhaps the main reason why there is much doubt surrounding the subject of the proper age to go on pointe. Placing students on pointe could put them at risk for premature closing of the growth plates (Sandall, 2018). One issue arising with coinciding puberty with pointe shoes, however, is that it can be very difficult to determine when each student reaches puberty. It may be physically noticeable in some young girls with the development of body hair, acne, and breasts, among other things; yet, in other girls, these physical changes may be harder to

visually detect. Additionally, there is no specific age that all girls begin puberty. There is a wide range for American girls; initial onset of puberty may occur as early as age eight, while others may not begin puberty until the age of fifteen (Lee, 1980).

In addition to the difficulty in detecting puberty in a student, physical maturation should not be the only indicator of a student's preparedness to receive pointe shoes. *Dance Spirit* argues that age is not the key to determining eligibility for pointe shoes, and that most teachers know when a student is ready to do pointe work when "bodily awareness" is developed (Beard, 2018). This can be easier to determine in a student, but there is much more to consider. A student who has great proprioceptive skills may not have sufficient flexibility within the foot, alignment, balance, or control in order to dance on pointe.

In *Dance Magazine*, the article "How Young is Too Young for Pointe Work?" mentions that in 2018, the Youth American Grand Prix (YAGP), a large international student ballet competition, prohibited dancers under age 11 to dance in pointe shoes. The policy on pointe shoes was changed after many jurors and teachers were becoming increasingly concerned about the very young age of some dancers who were doing pointe work. Apparently, students are now progressing so quickly technically that some teachers are allowing these children to receive pointe shoes much earlier than in years' past (Sandall, 2018). Consistent with YAGP's standard, many schools in the United States will not allow dancers to get pointe shoes until they are at least 11 or 12 years old, but this is based on tradition, not scientific fact (Shah, 2009). While it seems to be the consensus of opinion in both primary and secondary literature reviewed, debate continues on whether it is truly safe for all students to start pointe work at this age. Interestingly, there have been no studies to date that show dancing on pointe before growth plates have ossified

to be harmful (Shah, 2009). Yet, many dance teachers are still hesitant to risk harm regarding students' bone health.

Currently, it seems that most teachers' assessments are far more subjective, rather than objective, when determining pointe readiness. However, if a dance teacher is inexperienced or does not have a careful eye to spot a student's weaknesses or gaps in training, then it can become difficult to rely on subjective evaluations. In order to be more objective in assessment, some teachers look to clear, black-and-white standards to test students. For example, Dr. Selina Shah, a sports medicine physician who treats dancers in California, recommends in her research to evaluate students on strength, alignment, postural control, proprioception, and placement with a series of objective tests. Shah (2009) asserts, if dancers are able to perform these movements, there is a good chance that they are technically ready for pointe work. These tests include:

1. Balancing in *passé relevé* without shaking or excessive adjustments. The dancer should not have excess lumbar lordosis, and the standing foot should be in proper alignment. Ideally, the dancer will achieve this with no balance support. This evaluates alignment, balance, and ankle strength.
2. Performing a *grand plié* in *first*, *second*, and *fifth positions* to observe proper alignment and technique. The weight should be correctly distributed, and the student should not be 'sitting' in the *plié* but maintaining resistance and leg muscle activation.
3. Executing a single *pirouette* on each leg from *fourth position*. The turn should be performed without falling to observe the balance of the student.

4. The Airplane test (Figure 5). The student will stand on one leg with the arms and trunk stretched towards the ground and the opposite leg extended back, parallel to the floor.

The dancer must perform 4 out of 5 controlled *pliés* in this position in order to pass. This test observes alignment, and leg/ankle strength.

5. The *Sauté* test. At least 8 out of 16 properly executed *sauté* jumps on each leg is required to pass the test. The dancer should be able to keep a neutral pelvis, a quiet and stable trunk, proper toe-ball-heel landing, a fully extended knee, and a pointed toe. The jumps are executed in parallel *first position* on the standing leg, while the non-working leg should be lifted posteriorly.

Shah recommends other important factors to evaluate a student, which are: past and current injuries, difficulties in dance class, number of years of dance training, hours per week of ballet training, hours per week of other forms of exercise, age of first dance class, turn-out of the student, and measure of plantar flexion (Shah, 2009). Using these criteria as a guide, along with the five-objective test, can make a teacher's determination for a student much easier and less subjective. Furthermore, if a student knows that they must reach these certain benchmarks in order to receive their pointe shoes, they have clear goals toward which to work. Not all students know how much hard work and technique is required to dance in pointe shoes. Rather than face rejection from a seemingly arbitrary or subjective decision from their instructor, these tests create something for the student to reflect on – either one passes or fails. It would be interesting to study the impact of using these benchmarks to assess potential pointe students universally.

Parents, too, must understand that pointe shoes should only be given to those who are ready. A common practice today is for parents to take their child to a different studio if their current teacher/studio decides the child is not ready to wear pointe shoes. Parents must be educated about the factors that play into pointe work. If taught how pointe shoes can detrimentally affect a child's body who is not yet ready for pointe shoes, parents may be more likely to understand and be willing to agree with the decision of the teacher.

There is also a component of mental readiness. A child must be responsible enough to know how to take care of her shoes and her feet properly and follow the direction of her instructors. Students must be able to listen to their instructor and be mature enough to handle corrections appropriately. Even minor injuries can result from pointe work, such as ingrown toenails, hallux valgus (bunions), bursitis, and tendinitis (Prisk et al., 2008). A young dancer must be able to recognize when she is injured, and how to properly take care of herself; or, take steps to help prevent these injuries from happening.

Conclusion

The body on pointe is an extraordinary feat. While defying gravity can be beautiful, improperly fitted pointe shoes can make the body susceptible to many injuries. Shoes that are well-fitted are vital to achieving the correct technique. Any shoe that is ill-fitting can completely alter the dancer's ability to be properly aligned in pointe shoes (Marks, 2017). Even though pointe shoes are unique and hand-crafted, many dancers try to achieve the perfect fit by breaking in their shoes with extreme measures, such as slamming them into doors or cutting the soles in half. Current scientific studies found that in worn-down pointe shoes, midfoot and plantar flexion were significantly greater than in new shoes (Bickle et al., 2018). These results are seen in Figures 3 and 4. Consequences of this increased flexion suggest extreme stretching of the

metatarsal ligaments, which could prove dangerous to a dancer. In a 2010 case study of professional dancers, it was found that less experienced pointe dancers may be more prone to forcefully and destructively breaking in their shoes, which lessens the shoes' ability to support the dancer (Wakes & Caudwell, 2010). Complementing these findings, it was found that many informal sources recommended that inexperienced dancers should not attempt to break in their shoes; simply dancing in them is sufficient to begin the process of molding them to the feet.

Excessively worn, or 'dead' pointe shoes, were found to be extremely dangerous to dancers. Compression of soft tissue structures is of great concern, as a dead pointe shoe has lost much of its structure, strength, and the rigidity needed to support the foot; ergo, a dancer's full body weight. Figure 2 shows the compression of the joints through an X-ray of the feet in new shoes (left) and old shoes (right). The compression and reduced space between the bones of the feet can be clearly seen, as well as the changes in alignment due to the lack of support. This overload of joints can cause bunions, cartilage damage, arthritis, bone spurs, or even hallux rigidus (Meier, 2020). Additionally, one study found the mean area of sway in worn pointe shoes compared to new shoes to be 53 mm², 146 mm², and 101 mm², for *relevé*, *sous-sous*, and *pirouette*, respectively (Aquino & Amasay, 2019). These data suggest that wearing worn-out pointe shoes decreases the footwear's stability, and, therefore, compromises a dancer's ankle and foot stability.

Due to the scarcity of studies on the effects of pointe shoes on the body, the findings included here serve as foundations for future research to shed light on the potential health impacts of dancing in pointe shoes and subsequent risks corresponding to the shoes' level of wear. While it is difficult to determine the exact definition of a dead shoe, the studies presented are paving the way for establishing specifically defined parameters. The state of a pointe shoe

does contribute to injuries through increased flexibility and decreased stability in the foot and ankle. Current literature suggests the design of the shoe itself is lacking, as personal shoe modification is common practice amongst dancers. Additionally, this research suggests it is possible that a new shoe design could reduce injuries; however, more studies are necessary to test this hypothesis. Since a redesign of the pointe shoe is not planned presently, this paper provides scientific, evidence-based advice to dancers on proper pointe shoe care to maximize safety and shoe lifespan.

Not only should students be mindful of their own pointe shoe practices, but dance teachers must be knowledgeable about how quickly the shoes deteriorate, and how dead shoes can negatively affect a dancer's physical health. Dance teachers should teach and model mindful shoe wear by tracking students' time spent in pointe shoes and/or reducing the time allotted for pointe work; dancing for merely three hours a week during a typical recreational dance season in pointe shoes will cause rapid deterioration, which is not only very costly, but detrimental to the students' health. There are many expenses associated with dancing; add the price of pointe shoes to costume costs, tuition, and competition fees, and not-so-serious dance students (or their families) may consider purchasing new pointe shoes as unnecessary. There are many cost, energy, and time-consuming aspects associated with purchasing new pointe shoes that could understandably make buying a new pair of shoes a low-priority to a dancer, especially if the teacher or student is not knowledgeable about the health risks of dancing in dead pointe shoes.

If many dancers are attempting to use their pointe shoes for an entire 40-week span (i.e., one full season), it is imperative for teachers to limit the amount of time dancers spend in the shoe. For technique and learning reasons, this could be difficult, as a dancer must train, master steps, develop endurance, and strengthen key muscles for pointe, which is only possible while in

pointe shoes. One way to remedy this could be to limit wearing the shoes while learning choreography; if a dancer could reduce the number of hours spent on pointe by half, it would slow the deterioration of shoes immensely over a full season, thus minimizing risk of injury.

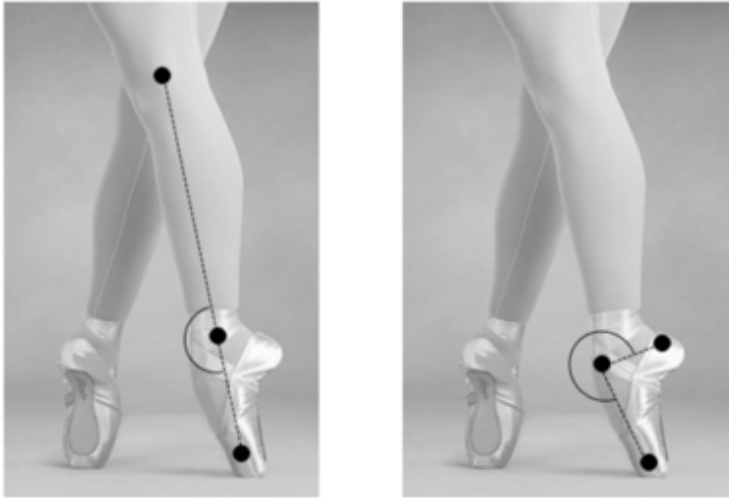
It is vital that dancers and teachers know the implications of their training methods. The lifetime injury incidence of 90% indicates just how demanding ballet and other forms of dance can be on the body (Prisk et al., 2008). Pointe is stressful, particularly on a dancer's forefoot, and requires maximal plantar flexion through the forefoot, midfoot, and hindfoot. Tremendous flexibility and strength are required, which can only be attained safely through many years of training.

Many factors determine a dancer's readiness for pointe. Not only must a dancer be physically and technically ready, but mentally prepared for the responsibility and maturity that is required for pointe work. Students of the same age and class level may not be ready for pointe work at the same time, or even in the same year, which can lead to feelings of discouragement and disappointment; however, this may be minimized by using Shah's assessment (2009). With an objective test, teachers can provide clear explanations and reasoning to all students ahead of time, in addition to providing clear goals toward which students can work. Students should transition to pointe only when they are ready, which must not be based solely on age or an arbitrary number of years of training, but rather, their technical ability and maturity as a dancer. Waiting until the dancer is ready for pointe may decrease the risk of injury attributed to starting too early. Future research could be directed to study the impact on the number of injuries incurred while using these various benchmarks to assess potential pointe students universally.

Figures

Figure 1

Definition of plantar flexion angle (left) and midfoot flexion angle (right) on pointe.



Note: Reprinted from Bickle et al., 2018.

Figure 2

An X-ray of feet in a new pointe shoe (left) and a worn pointe shoe (right), showing the change in alignment and collapse of the joint spaces caused by the lack of support.

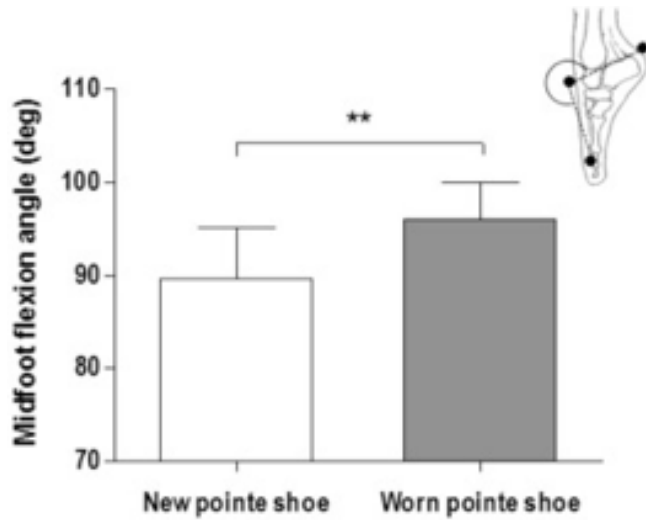


Note: Reprinted from Meier, 2020.

Figure 3

Midfoot flexion in the new and worn shoe conditions. Values are means ± standard deviation.

****** $p < 0.01$

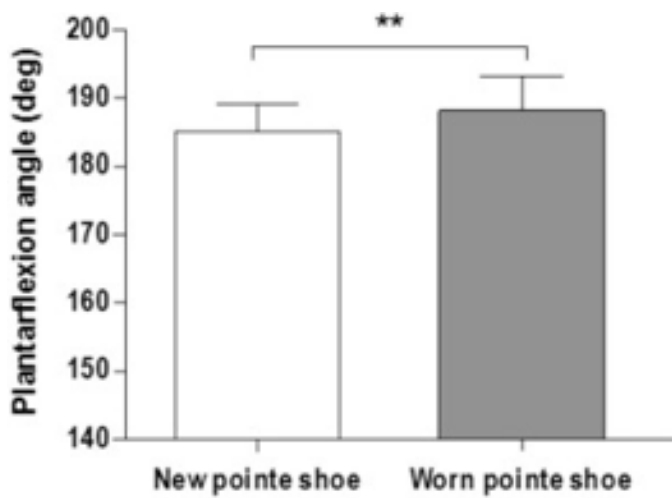


Note: Reprinted from Bickle et al., 2018.

Figure 4

Plantar flexion in the new and worn shoe conditions. Values are means ± standard deviation.

****** $p < 0.01$



Note: Reprinted from Bickle et al., 2018.

Figure 5

Airplane Test.



Note: Reprinted from Shah, 2009.

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