Project Notes:

Project Title: Analyzing the Effects of Fluid-Integrated Outsoles on Foot Swelling
Name: Moore, Isaac

Note Well: There are NO SHORT-cuts to reading journal articles and taking notes from them. Comprehension is paramount. You will most likely need to read it several times, so set aside enough time in your schedule.

Contents:

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
Common Variables of Foot Swelling	Addressing and highlighting some of the most common variables that cause foot swelling.	Project Proposal + Grant Proposal	10/11
Illnesses/Symptoms Related to Foot Swelling	Addressing and highlighting some of the common illnesses and symptoms with citations.	Project Proposal + Grant Proposal	10/11
How Foot Swelling Affects Gait		Project Proposal + Grant Proposal	10/16
Average Pressure Distributions in the Foot	Displaying a pressure distribution heat map of a subject's feet and acquiring/displaying data on common high/low pressure areas on the foot.	Project Proposal + Grant Proposal	10/25
Different Parts of the Shoe	Explaining the locations of some of the important parts of the shoe that are relevant to the project.	Project Proposal + Grant Proposal	10/11
Different Types of Fluids and How They Affect Pressure Distributions			

Literature Search Parameters:

These searches were performed between 8/21/25 and 10/4/25
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
WPI Library	Smart Insoles Pressure Sensors	I got a variety of different research and engineering articles on this topic. Many of the articles that came up were very insightful and relevant to my project.
Google Scholar	Causes Foot Swelling	I did not get much of anything useful from this search, all I ended up getting was some past injury reports.
WPI Library	Running Shoe Engineering	I got very similar results to the smart insoles, except there were some additional articles that involved mainstream footwear mechanics which helped a lot.
WPI Library	Fluid Integrated Outsoles	I got one useful article (article 11), but other than that nothing had any relevancy or usefulness.
Google Scholar	Foot Pressure	I got many useful articles that I was able to utilize in my Project Notes.
Google Scholar	Gait	I came across a couple of articles, but the majority of them had no relevancy to my project, so I scrapped the results of this search.

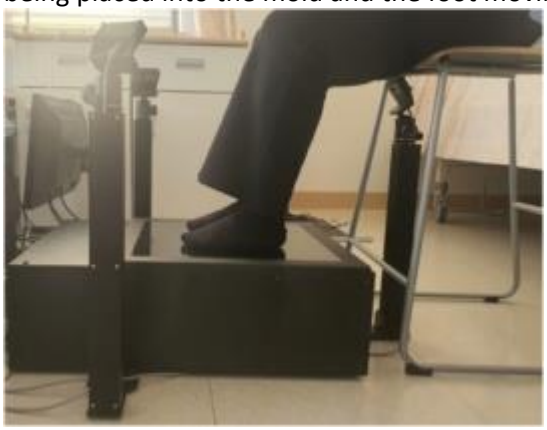
Tags:

Tag Name

#Running	#Insoles
#LiveFeedback	#Injuries
#Shoes	#Swelling
#Fluid	#Outsole
#Non-Newtonian	

Article #1 Notes: Effects of three-dimensional image based insole for healthy volunteers: a pilot clinical trial

Source Title	Effects of three-dimensional image based insole for healthy volunteers: a pilot clinical trial
Source citation (APA Format)	Jeong, B. O., Jeong, S. J., Park, K., Kim, B., Yim, S., & Kim, S. (2023). Effects of three-dimensional image based insole for healthy volunteers: a pilot clinical trial. *Translational and Clinical Pharmacology*, *31*(1), 49. https://doi.org/10.12793/tcp.2023.31.e5
Original URL	https://tcpharm.org/DOIx.php?id=10.12793/tcp.2023.31.e5
Source type	Journal Article
Keywords	Systematic review, Meta-analysis, Low back pain, Insoles, Foot orthoses, Treatment, Prevention, Effectiveness, RCT
#Tags	#Insoles #Running
Summary of key points + notes (include methodology)	In the article, scientists examine whether 3-D image-based insoles or custom-made insoles provide greater comfort and reduce foot fatigue more for the user. Through an experiment of 50 subjects randomly split into two groups, one using 3-D image-based insoles and the other using custom-made insoles, the scientists found that people using the 3-D image-based insoles experienced a statistically significant amount of more comfort and less foot fatigue while wearing the inserts. The findings of the scientists highlight the changes coming to our modern-day insoles, and the potential for 3-D image-based insoles to become the norm.
Research Question/Problem/ Need	Are three-dimensional image-based shoe insoles improving comfort and reducing foot fatigue among healthy individuals more than custom-modeled insoles?
Important Figures	There are two methods to creating personalized insoles and they are as follows:

	 Custom Molding – creates a mold of the foot that can then be used to create an insole. Typically, this method is inaccurate due to many variables such as the foot being placed into the mold and the foot moving while making the mold.  3D Image-Based – Utilizes a 3D scanner to create a 3D rendition of the foot that can then be used to create an insole. This method is usually more accurate due to the device making corrections if the foot moves.
VOCAB: (w/definition)	1. Lumbago – A common, painful condition affecting the lower portion of the spine. 2. Aetiological – causing or contributing to the development of a disease or condition. 3. Sagittal – dividing the body into left and right halves between the head. 4. Obliquity – tilt along an axis 5. Dichotomous – a division or contrast between two things that are or are represented as being opposed or entirely different.
Cited references to follow up on	Nagano, H., & Begg, R. K. (2018). Shoe-Insole technology for injury prevention in walking. *Sensors*, *18*(5), 1468. https://doi.org/10.3390/s18051468
Follow up Questions	1. Could changes to the materials in the insoles affect the performance and lifespan of the insoles?

	2. Would it be possible to make smart insoles give statistics in a similar fashion to a smart watch? (Heart rate monitor, constant pressure sensor, or activity levels, with a smartphone connection) 3. Could the benefits of 3-D image-based insoles change based on people's foot shapes? 4. Do the 3-D image-based insoles provide the same benefits for people of all activity levels?

Article #2 Notes: A wireless, self-powered smart insole for gait monitoring and recognition via nonlinear synergistic pressure sensing

Source Title	A wireless, self-powered smart insole for gait monitoring and recognition via nonlinear synergistic pressure sensing
Source citation (APA Format)	Wang, Q., Guan, H., Wang, C., Lei, P., Sheng, H., Bi, H., Hu, J., Guo, C., Mao, Y., Yuan, J., Shao, M., Jin, Z., Li, J., & Lan, W. (2025). A wireless, self-powered smart insole for gait monitoring and recognition via nonlinear synergistic pressure sensing. *Science Advances*, *11*(16). https://doi.org/10.1126/sciadv.adu1598
Original URL	https://doi.org/10.1126/sciadv.adu1598
Source type	Journal Article
Keywords	Insoles, Gait Monitor, Self-sustaining, Solar cells, Pressure Sensors, Live Feedback
#Tags	#Running #Insoles #LiveFeedback
Summary of key points + notes (include methodology)	- Continuously monitoring the pressure and gait of somebody can provide significant data to prevent, diagnose, and treat various injuries or illnesses, - Currently, foot pressure is measured using pressure plates, but this does not account for the pressure distribution while active - 22 sensors are placed along a layer of the insole which transmit signals via Bluetooth to a smart device - Solar cells are used to convert sunlight into energy and then the energy is stored in a battery found in the arch of the insole - Utilizes the nonlinear synergy strategy to linearize two sets of data that were not linear (Pressure + Current) - The combination of CNT, ACET, and PDMS is needed to create accurate feedback of the insole, with any of them missing, data becomes nonlinearized or inaccurate. - More sensors are placed at the toe and heel as those are the areas where pressure differs by person - Completed many tests of compression and bending to determine the stability of the insoles and energy systems – all resulted in efficiency remaining over 95%

	- R^2 tests were done through the study all with results >.99 (pressure in terms of strain and current in terms of strain) - The insole can self-sustain under medium to strong light but under continuous low-light environments it begins to run out of energy - Jogging/Running tests were done to test the stability of the sensors during active motion and resulted in a success - A Support Vector Machine learning model was used to differenciate between different types of motions including sitting, standing, walking, and running with a 100% success rate in 225 trials - The results of this study could be used in healthcare to assess different foot ailments such as diabetic foot ulcers or even Parkinson's disease
Research Question/Problem/ Need	The goal of this article was to create a self-powered, wireless smart insole system to monitor plantar pressure and visualize gait that could be used to prevent, diagnose, and treat various diseases.
Important Figures	 Figure 1a shows a breakdown of the order of the insole inside the shoe The CNT/ACET/PDMS layer consists of 22 sensors.

Figure 1d shows the physical representation of the modelled insole

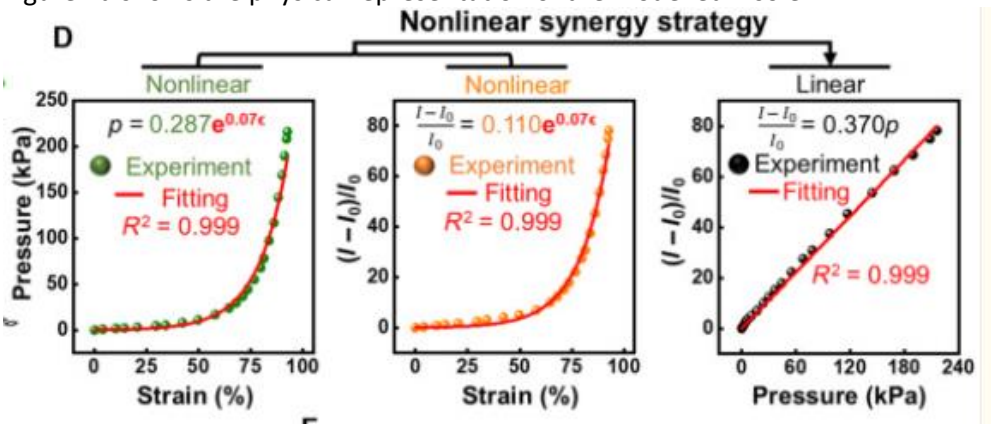


Figure 2d shows a visual representation of the nonlinear synergy strategy

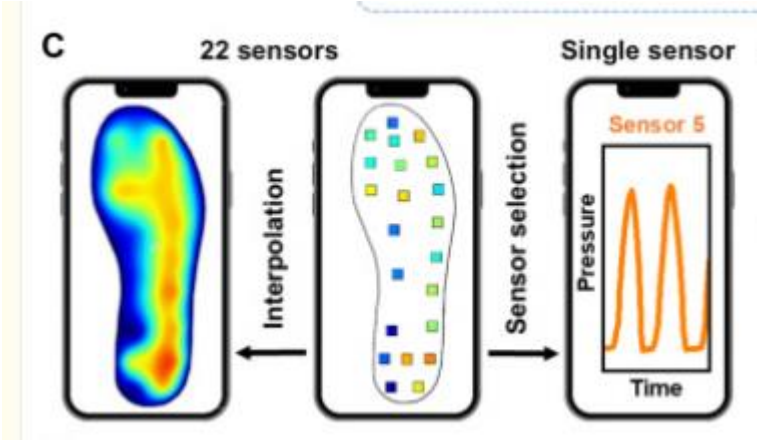
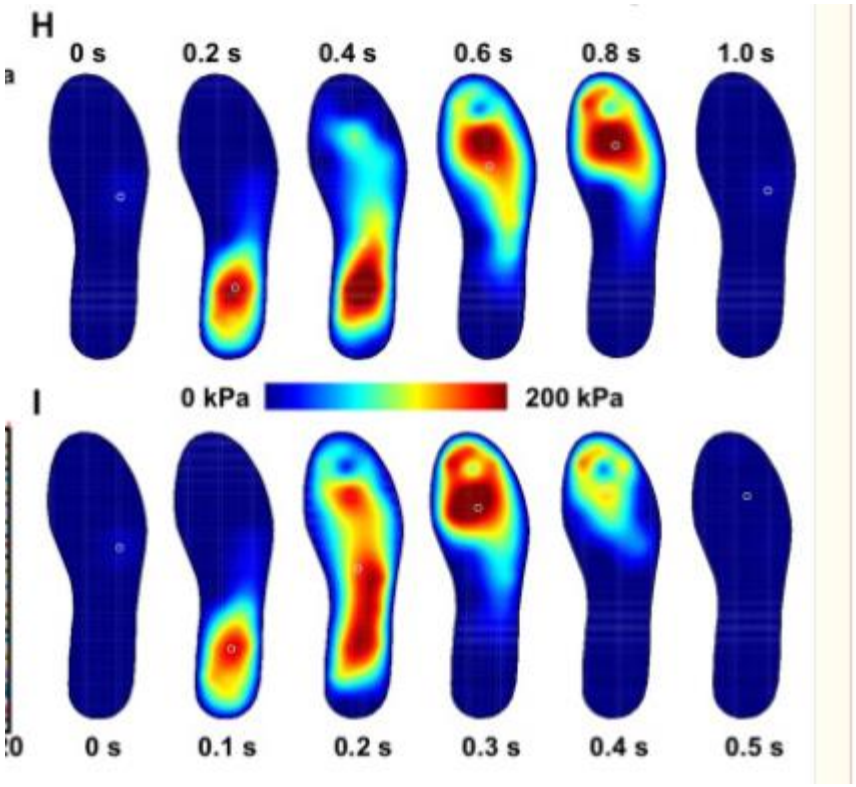


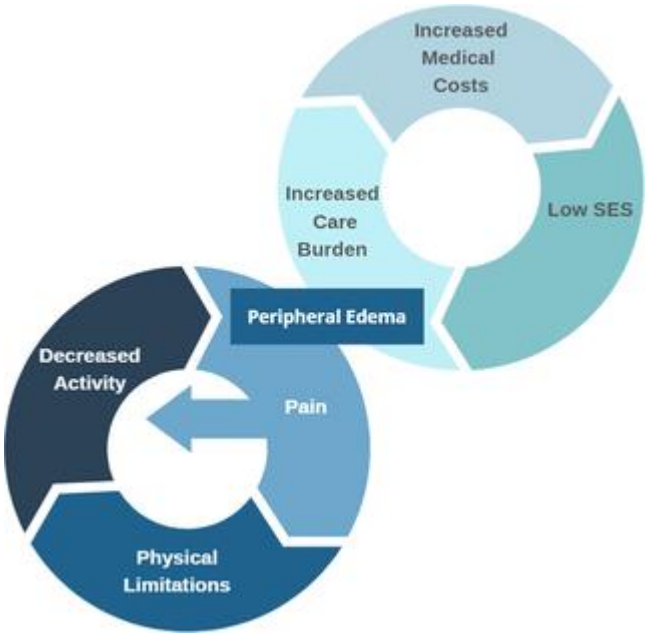
Figure 4c shows what the app displays with the information from the sensors

	 Figures 4I and 4j show the live feedback provided by the sensors of somebody walking and somebody running
VOCAB: (w/definition)	1. Gait – A person's manner of walking 2. Perovskite solar cells – An advanced technology to turn sunlight into energy 3. Polyimide (PI) -- A strong and flexible material that is known for its thermal stability 4. Polydimethylsiloxane (PDMS) – A flexible material that can be found in shoe insoles 5. PCB – Printed Circuit Board 6. CNT – Cabon Nanotube 7. ACET – Acetylene Black 8. Nonlinear Synergy Strategy – Combining elements or strategies with inherently nonlinear (non-straightforward) behaviors in a way that produces an unexpected but beneficial, synergistic outcome
Cited references to follow up on	De León Rodriguez, D., Allet, L., Golay, A., Philippe, J., Assal, J., Hauert, C., & Pataky, Z. (2012). Biofeedback can reduce foot pressure to a safe level and without causing new at-risk zones in patients with diabetes and peripheral neuropathy. *Diabetes/Metabolism Research*

	and Reviews, *29*(2), 139–144. https://doi.org/10.1002/dmrr.2366
Follow up Questions	1. Were there any other ways to be able to acquire the same results? Why was the insole decided specifically? 2. Could the model be expanded to recognize more than 8 types of motion? 3. Would these insoles be unable to be used in areas that receive less solar coverage? 4. Is the data that's given able to be transmitted into results to buy more appropriate shoes? 5. Would the SVM model be capable of perceiving motion types of diverse ability groups?

Article #3 Notes: Peripheral edema: A common and persistent health problem for older Americans

Source Title	Peripheral edema: A common and persistent health problem for older Americans
Source citation (APA Format)	Besharat, S., Grol-Prokopczyk, H., Gao, S., Feng, C., Akwaa, F., & Gewandter, J. S. (2021c). Peripheral edema: A common and persistent health problem for older Americans. *PLoS ONE*, *16*(12), e0260742. https://doi.org/10.1371/journal.pone.0260742
Original URL	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0260742
Source type	Journal Article
Keywords	Edema, Causes & Effects, Reseach Study, 55+, and USA
#Tags	#Injuries #Swelling
Summary of key points + notes (include methodology)	- Chronic edema of the lower limbs can cause pain, heaviness, weakness, discomfort, and negative body image, and limitations in mobility and flexibility - Multiple causes of peripheral edema exist, including deficiencies in the venous or lymphatic systems, heart failure, and certain medications - Considering the high rates of obesity and other risk factors in the U.S., peripheral edema is likely a large public health challenge - The primary outcome was peripheral edema, assessed with the question, “Have you had any of the following persistent or troublesome problems: Persistent swelling in your feet or ankles?” - Demographic variables included in the analyses were age, sex, race, and wealth - Most demographics were assessed with follow-up questions, with some being quantitative answers, but most being qualitative. - There was a total of 19,988 total respondents, representing a population of 109,646,587 (age 51+) - HRS respondents are interviewed by telephone or in-person every two years and followed through multiple survey waves until their non-response or death (in 2000, 2004, 2008, 2012, and 2016) - edema was associated with older age, female sex, minority race, low wealth, overweight/obese status, diabetes, hypertension, pain, low activity, and mobility limitations - The study shows the prevalence of edema is lower than estimates

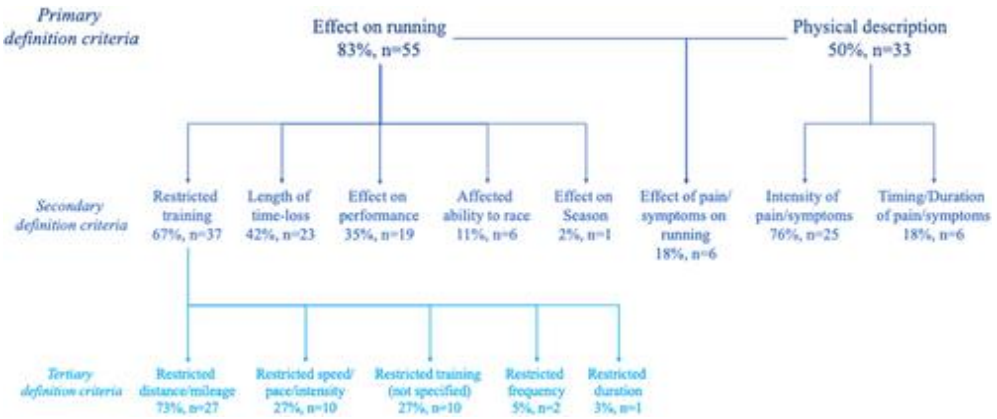
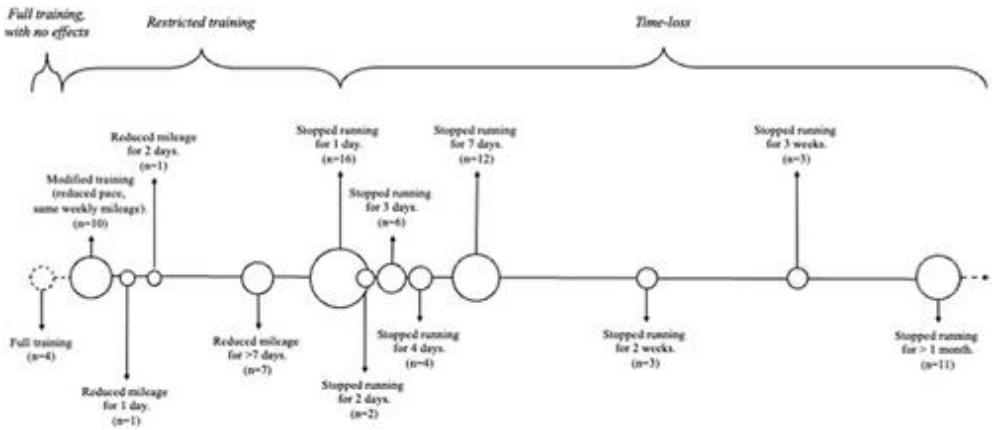
	obtained in the clinic-based studies - There are a couple of limitations to the study such as it is a cross-sectional study, it is limited towards an older demographic, and some data points are self-reported
Research Question/Problem/ Need	Use data from a nationally representative survey to characterize the prevalence of chronic lower limb edema and recent time trends among older Americans, and identify associations between peripheral edema and demographic and clinical features, activity levels, and mobility limitations in the U.S
Important Figures	 This model shows the cycle of peripheral edema. The ailment causes pain, which then leads to physical limitations and decreased activity, leading to more peripheral edema. On top of this peripheral edema also increases medical costs and care burdens, decreasing socioeconomic status which shows a high association to peripheral edema.
VOCAB: (w/definition)	1. Edema – A condition where excess fluid accumulates in the body's tissues, causing swelling 2. Total Wealth – The sum of all wealth components minus all debt 3. BMI – Body Mass Index calculated through self-inputted height and weight 4. Sampling Weights – Values assigned in a sample to adjust the sample size to represent underrepresented and targeted groups better 5. Univariate Statistics – Statistics involving only one variable 6. Cross-Sectional Research – Taking research from a specific point,

	making it impossible to draw conclusions.
Cited references to follow up on	Greene, A., & Meskell, P. (2016). The impact of lower limb chronic oedema on patients' quality of life. *International Wound Journal*, *14*(3), 561–568. https://doi.org/10.1111/iwj.12648 Little, R. C., & Ginsburg, J. M. (1984). The physiologic basis for clinical edema. *Archives of Internal Medicine*, *144*(8), 1661. https://doi.org/10.1001/archinte.144.8.1661
Follow up Questions	1. Why were all of the studies prior chosen to be done in a lab instead of in the real-world? 2. Why does peripheral edema affect populations unproportional/why does it affect different groups of people more than others? 3. Why do the rates of peripheral edema remain relatively the same despite the causes varying over the years (such as obesity rates increasing and physical activity levels dropping)? 4. Could quantitative measures be used to assess the data in the surveys?

Article #4 Notes: An Investigation Into the Measurement of Injury Severity in Running-Related Injury Research: A Scoping Review

Source Title	An Investigation Into the Measurement of Injury Severity in Running-Related Injury Research: A Scoping Review
Source citation (APA Format)	Lacey, A., Whyte, E., Burke, A., O'Connor, S., Dillon, S., & Moran, K. (2024). An Investigation Into the Measurement of Injury Severity in Running-Related Injury Research: A Scoping Review. *Scandinavian Journal of Medicine and Science in Sports*, *34*(8). https://doi.org/10.1111/sms.14704
Original URL	https://onlinelibrary-wiley-com.ezpv7-web-p-u01.wpi.edu/doi/full/10.1111/sms.14704
Source type	Journal Article
Keywords	Running Related Injuries, Scoping Review
#Tags	#Running #Injuries

Summary of key points + notes (include methodology)	- Running Related injuries can cause physical, psychological, and financial troubles
	- Injury prevention requires looking at both the magnitude and frequency of common injuries
	- Current journal articles all categorize running related injuries differently, with some even only considering injured or non-injured.
	  - This is very unhelpful to further research as there's no basis of knowledge
	- Performed a scoping review of journal articles using Boolean search terms to relate the search to running injuries
	  - Screened over 6,000 titles/abstracts
	  - Fully read 180 texts
	  - Kept 66 in the study (the others did not measure injury or running related injuries were not studied)
	- A wide range of definitions and scales were found across studies, highlighting a lack of standardization in measuring RRI severity.
	- Articles were broken into two main definition criteria for injury severity, effect on running and physical description

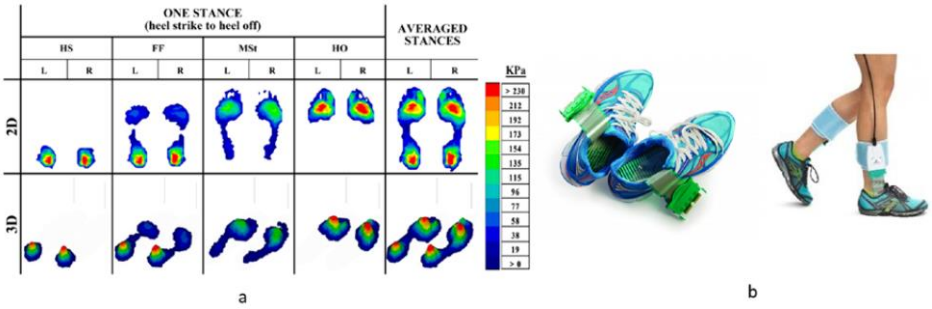
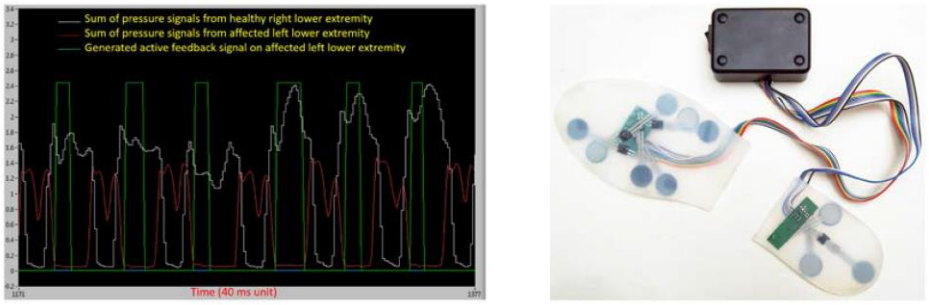
	- Using these, the data from the articles was placed onto two scales of severity, a categorical scale and a continuous number scale - The authors emphasize the need for a standardized definition and scale for injury severity for studies to be increased
Research Question/Problem/ Need	The primary goal of this study is to perform a scoping review to determine how running related injuries are studied in different researches. The secondary aim to this study is to determine if different methods of categorizing running related injuries affects the outcomes of the study.
Important Figures	 Figure 1 shows a breakdown chart of how the 66 articles were categorized based on their definitions of severity in RRIs  Figure 2 shows one of the many scales used to assess the data inside of each article, in this case it is a continuous number scale using time away from training due to RRIs.
VOCAB: (w/definition)	1. Continuous number scale – A scale that represents data that can take any value within a given range including decimals 2. Categorical scale – A scale that quantifies values in categories rather than numerically, in this case it was mild, moderate, and severe

	3. Running related injuries (RRIs) - Any injury caused by running 4. Boolean search terms – Using logical operations to include and exclude certain terms (AND, OR, NOT) 5. Scoping review – A systematic knowledge synthesis of existing text to obtain data
Cited references to follow up on	Hespanhol, L. C., Junior, Van Mechelen, W., & Verhagen, E. (2016). Health and Economic burden of Running-Related Injuries in Dutch trailrunners: A Prospective cohort study. *Sports Medicine*, *47*(2), 367–377. https://doi.org/10.1007/s40279-016-0551-8 Van Der Worp, M. P., Haaf, D. S. M. T., Van Cingel, R., De Wijer, A., Sanden, M. W. G. N. D., & Staal, J. B. (2015). Injuries in runners; A systematic review on risk factors and sex differences. *PLoS ONE*, *10*(2), e0114937. https://doi.org/10.1371/journal.pone.0114937
Follow up Questions	1. How could a universal measurement system of injuries assist in research and prevention? 2. Could a device be used to measure and categorize injuries in real time? 3. What other fields are affected by non-standardized methods of measurement?

Article #5 Notes: A Comparative Review of Footwear-Based Wearable Systems

Source Title	A comparative review of footwear-based Wearable Systems. Electronics
Source citation (APA Format)	Hegde, N., Bries, M., & Sazonov, E. (2016). A Comparative Review of Footwear-Based Wearable Systems. *Electronics*, *5*(3), 48. https://doi.org/10.3390/electronics5030048
Original URL	https://www.mdpi.com/2079-9292/5/3/48
Source type	Journal Article
Keywords	Accelerometry, energy expenditure, energy harvesting, footwear, gait, plantar pressure, and wearable sensors
#Tags	#Shoes

Summary of key points + notes (include methodology)	- Attempts to integrating sensing elements to shoe began in the 1990s
	  - In recent times the production of low power sensors has become an increasingly important topic
	  - Uses range from simple step counting to integral rehabilitation efforts in disabled persons
	- Several vital biomechanical parameters can be estimated using sensors placed in footwear
	- A normal gait means someone is able to easily change directions, go up and down stairs, and can avoid obstacles
	- When placing sensors in footwear, there is a trade-off between data frequency, accuracy, and battery life
	  - High frequencies are preferred
	  - Common battery life for smart footwear is 10 hours
	- Bluetooth is the most common method of data communication
	- The foot and ankle provide the support and flexibility for weight bearing and weight shifting activities such as standing and walking
	- Plantar pressure measurement has been recognized as an important area in the assessment of patients with diabetes
	- Sensors inside of a shoe may be uncomfortable
	- There are many fitness applications that rely on accelerometry, but this study is only focusing on footwear-based solutions
	- Footwear-based systems have yet to become matured in the field of daily energy expenditure estimation
	- Footwear-based systems are beginning to be seen in the field of navigation for visually impaired, first responders, and augmented reality

	applications - The authors then concluded by stating smart footwear has high potential in the upcoming years, with smart insoles and shoe being rapidly developed
Research Question/Problem/ Need	The goal of this journal is to review the advancements made on footwear-based wearable systems based on their target application scenarios.
Important Figures	 a b Figure 1 shows the plantar pressure distribution a health individual has during one heel to toe stride.  a b Figure 2 shows the results of the pressure sensor from a user post stroke
VOCAB: (w/definition)	1. Actuators – A mechanical device that converts an input into 2. Force Sensitive Resistors (FSR) - An electrical device that changes resistance based on the force or pressure provided 3. Temporal Parameters – Measurements that describe the time-related aspects of a process 4. Spatial Parameters – Quantitive measurements that describe aspects of a process such as space, position, and orientation 5. Gyroscope – A device used for measuring and maintaining angular velocity 6. Accelerometry – A technology that uses small sensors to measure the change in an object's velocity 7. Neuroplasticity – The brain's ability to change its structure and function in response to experience
Cited references to follow up on	Crea, S., Donati, M., De Rossi, S., Oddo, C., & Vitiello, N. (2014). A

	Wireless Flexible Sensorized Insole for Gait Analysis. *Sensors*, *14*(1), 1073–1093. https://doi.org/10.3390/s140101073 Hegde, N., & Sazonov, E. (2014). SmartStep: a fully integrated, Low-Power insole monitor. *Electronics*, *3*(2), 381–397. https://doi.org/10.3390/electronics3020381 Leunkeu, A. N., Lelard, T., Shephard, R. J., Doutrellot, P., & Ahmaidi, S. (2014). Gait cycle and plantar pressure distribution in children with cerebral palsy: Clinically useful outcome measures for a management and rehabilitation. *Neurorehabilitation*, *35*(4), 657–663. https://doi.org/10.3233/nre-141163
Follow up Questions	1. What are the main advantages to having sensors in footwear over sensors on the wrist? 2. What are some of the biggest challenges to long-term footwear systems? 3. Are there any ethical concerns with data collection from the footwear?

Article #6 Notes: Experimental Study of Heat Dissipation in Indoor Sports Shoes

Source Title	Experimental Study of Heat Dissipation in Indoor Sports Shoes
Source citation (APA Format)	Dessing, O., Jansen, A. J., Leihitu, C., & Overhage, D. (2014b). Experimental Study of Heat Dissipation in Indoor Sports Shoes. *Procedia Engineering*, *72*, 575–580. https://doi.org/10.1016/j.proeng.2014.06.099
Original URL	https://www.sciencedirect.com/science/article/pii/S1877705814006158
Source type	Journal Article
Keywords	Ventilation, Indoor Sports Shoes, Heat Reduction, Volleyball, Handball, Foot Temperature, Heat Imaging, Heat Sensors
#Tags	#Shoes
Summary of key points + notes (include methodology)	- Due to the constant improvement to durability, grip, traction, stability, and comfort in indoor sport shoes, their ability to dissipate heat has taken a toll - The two sports looked at in the study were handball and volleyball - The use of empirical results was chosen over the use of thermodynamic models - 5 shoe models were used in the study - Each shoe was put through a heat dissipation test 3 times each, being cooled to room temperature before being put through the test again. (described in important figure #2) - Shoes that the water cools the fastest in were determined to dissipate heat the fastest - The research shows clear differences between the shoes and distinguishes which parts of the shoes dissipate heat the fastest (the top of the shoes, especially those that are porous) and the slowest (logos and the soles)
Research Question/Problem/ Need	The objective of this research project is to identify differences in heat dissipation.

Important Figures

Table 1. Overview of shoes used in the experiment.

Shoe Nr.	Brand	Model	Recommended sport by supplier	Recommended retail price	Targeted market segment
1	A	1	Volleyball	€ 150*	Top range
2	A	2	Handball	€ 150*	Top range
3	A	3	Volleyball/Handball	€ 75**	Low range
4	B	1	Volleyball/Handball	€ 130**	Top range
5	C	1	Volleyball	€ 140**	Top range

*Shoes were not yet released onto the market at the time but were released summer 2013 at this recommended retail price according to brand websites.
**Recommended retail price according to brand websites (December 2012).

Figure 1 shows a breakdown of the subjects throughout the study, showing 4 top-end models, one low-end model, and a divide between the two sports.

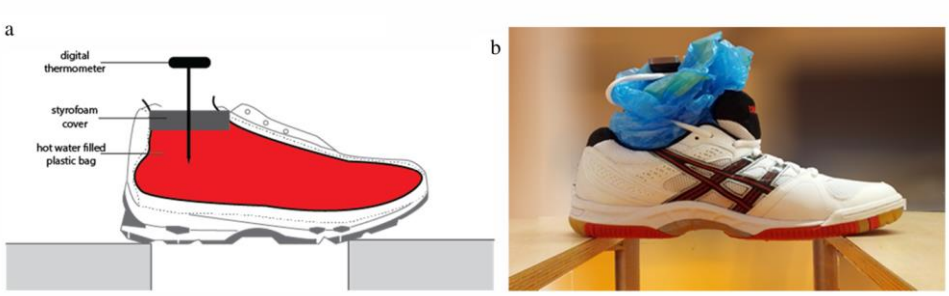


Figure 1. (a) Side view of test set up (b) picture of test set up

Figure 2 shows how the test was conducted, suspending the shoe with contact points on the heel and the forefoot, then filling the shoe with boiling water and measuring the temperature every 5 minutes for 30 minutes total.

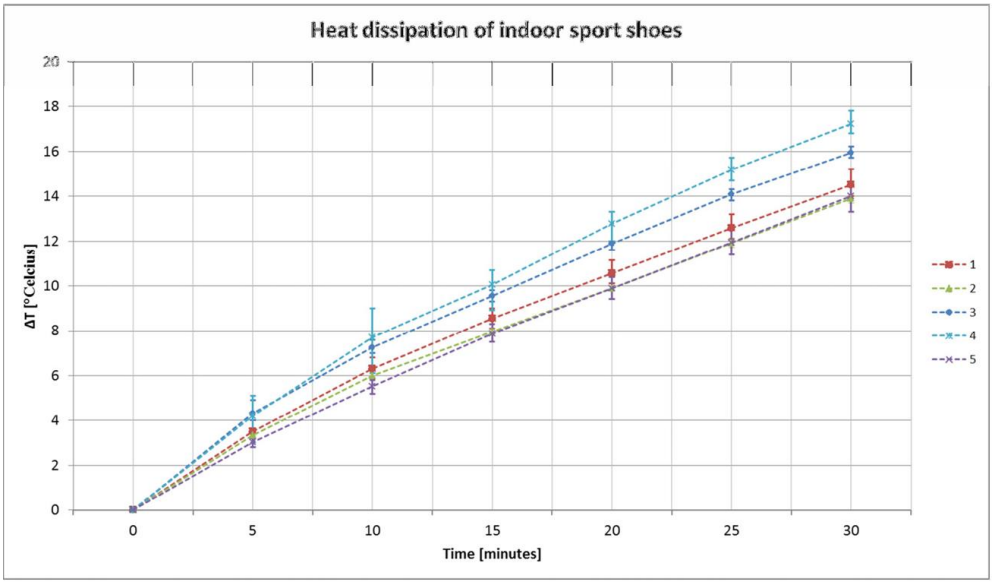


Figure 3 shows the heat dissipation for every shoe over the 30 minute intervals (averaged between three tests).

VOCAB: (w/definition)

1. Empirical Results – Data drawn from observable and measurable data
2. Heat Dissipation – The process of transferring excess thermal energy into the surroundings

	3. Thermoregulation – The process of a biological organism maintaining its internal heat or an object maintaining room temperature 4. Forced Convection – A heat transfer method that uses an external force such as a fan to move fluids around at a higher frequency 5. Thermal Image Contrast – The difference in heat between an object and its background
Cited references to follow up on	Covill, D., Guan, Z. W., Bailey, M., & Raval, H. (2010). Development of thermal models of footwear using finite element analysis. *Proceedings of the Institution of Mechanical Engineers Part H Journal of Engineering in Medicine*, *1*(1), 1–14. https://doi.org/10.1243/09544119jeim860
Follow up Questions	1. Were there any similarities in the materials of the shoes that dissipated heat the fastest? 2. The injuries associated with in-shoe heat are typically caused by sweat and humidity, so could a test be completed to test both the heat dissipation and the sweat dissipation?

Article #7 Notes: Shoe-Insole Technology for Injury Prevention in Walking

Source Title	Shoe-Insole Technology for Injury Prevention in Walking
Source citation (APA Format)	Nagano, H., & Begg, R. K. (2018b). Shoe-Insole Technology for Injury Prevention in Walking. *Sensors*, *18*(5), 1468. https://doi.org/10.3390/s18051468
Original URL	https://www.mdpi.com/1424-8220/18/5/1468
Source type	Journal Article
Keywords	Gait, insole, and Injury Prevention
#Tags	#Injuries #Shoes #Insoles

Summary of key points + notes (include methodology)	- Suboptimal conditions of the gait cycle can leave people prone to injury, especially among the senior population
	- Biomedical interventions for gait should contain some criteria such as a low cost, easy engagement, immediate effects, and little physical effort
	- Current shoes can be broken down into smaller parts that have small effects on gait interference that compound to improve gait
	  o Examples include insoles, outsoles, heel drops, footwear-collars, and midsoles
	- The portability of sensor-based systems will be their essential advantage in future gait assessments and will gradually overcome the limitations of laboratory-based 3D motion capture systems
	- The primary cause of acute injury in locomotion is falls
	- The primary cause of overuse injuries in locomotion are knee injuries and ancle injuries
	- Uneven pressure plantar pressure distribution can lead to many health conditions
	- Inertial sensors along with pressure sensors within an insole can be used to wirelessly monitor a person's gait
	  o Wireless communications such as bluetooth could be used to transmit data
	  o Materials such as EVA foam could be used to maintain comfort
	- Integration of gait monitoring devices could reduce long-term injuries

Research Question/Problem/ Need	What are the current developments of insole technology, how can a wireless gait monitoring insole be developed, and what are the future directions in this field?

Important Figures

Figure 1 shows a current model of a gait monitoring system on a shoe. However, this does not align with the wireless hope of the researcher's desires.

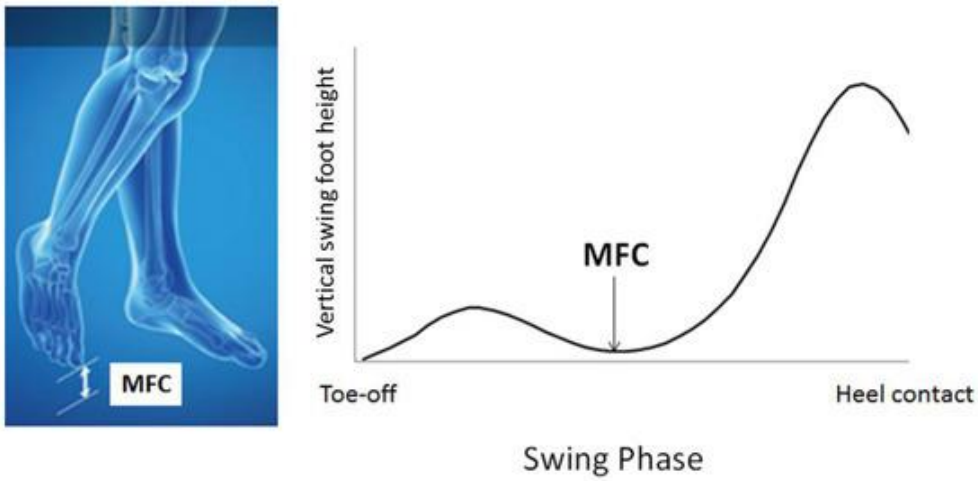


Figure 2 shows a graph of the vertical swing height of a foot during a step. As you can see, during the center of the step the vertical height is relatively low, this is where many elders trip and a fall will occur. The article discusses additional toe lift

	to account for the low MFC, to reduce tripping hazards among elderly people.
VOCAB: (w/definition)	1. Locomotion – The act or ability to move from one place to another 2. Inertial sensors – Determine an object's motion and orientation by measuring changes in acceleration and angular velocity 3. Spatiotemporal – Belonging to both space and time 4. Osteoarthritis – A common joint disease that causes pain 5. Pronated – A natural inward roll of the foot that occurs when weight is placed on it 6. Dorsiflexion – The action of pulling the foot upward so the toes get closer to the shin 7. Anatomical Landmarks – Specific, recognizable parts of the body 8. Center of Mass (CoM) – The point in the body where mass is evenly distributed 9. Base of Support (BoS) – The area beneath the body that includes every point of contact with the ground 10. Extrapolated Center of Mass (XCoM) – A version of the CoM that includes velocity 11. Center of Pressure (CoP) - The point under the foot where total pressure is applied during walking 12. Minimum Foot Clearence (MFC) - The lowest vertical distance between the foot and the ground during the swing phase of walking
Cited references to follow up on	Bálint, G. P., Korda, J., Hangody, L., & Bálint, P. V. (2003). Foot and ankle disorders. *Best Practice & Research Clinical Rheumatology*, *17*(1), 87–111. https://doi.org/10.1016/s1521-6942(02)00103-1 Menant, J. C., Steele, J. R., Menz, H. B., Munro, B. J., & Lord, S. R. (2008). Effects of footwear features on balance and stepping in older people. *Gerontology*, *54*(1), 18–23. https://doi.org/10.1159/000115850 Nyska, M., Liberson, A., McCabe, C., Linge, K., & Klenerman, L. (1998). Plantar foot pressure distribution in patients with Hallux valgus treated by distal soft tissue procedure and proximal metatarsal osteotomy. *Foot and Ankle Surgery*, *4*(1), 35–41. https://doi.org/10.1046/j.1460-9584.1998.00068.x
Follow up Questions	1. Could the model be integrated into rehabilitation programs to provide

	assisted movement that reduces the amount of assistance overtime? 2. What expansions could be made to improve the tripping detection? 3. Could machine learning models be used to assist in tripping detection? 4. Would a similar model be able to be used for different gait types such as flat feet or age differences, and could the model account for terrain differences?

Article #8 Notes: Left foot swelling following a badminton game—more than meets the eye

Source Title	Left foot swelling following a badminton game—more than meets the eye
Source citation (APA Format)	Tay, Z., Kumar, R., & Koh, S. H. (2025). Left foot swelling following a badminton game—more than meets the eye. *Visual Journal of Emergency Medicine*, *40*, 102339. https://doi.org/10.1016/j.visj.2025.102339
Original URL	https://www-sciencedirect-com.ezpv7-web-p-u01.wpi.edu/science/article/pii/S2405469025001529
Source type	Journal Article
Keywords	Foot fracture, Lisfranc injury
#Tags	#Injuries #Swelling

Summary of key points + notes (include methodology)	- Lisfranc injuries can occur from either low-energy or high-energy trauma
	- Due to low-velocity injuries sometimes causing Lisfranc injuries, around 20% of the injuries go undiagnosed and up to 50% go misdiagnosed
	- Researchers believe a diagnosis of the Lisfranc complex should happen for any midfoot injury that remains in pain for over five days
	- Tenderness, swelling over the tarsometatarsal joints, and plantar ecchymosis are some physical signs suggesting a Lisfranc injury
	- X-rays typically only correctly identify around 84% of Lisfranc injuries
	- CT scans and MRIs prove more sensitive to Lisfranc injuries but still do not prove to be perfect
	- Prompt treatment should be started to reduce long-term disability and recover normal function
	- Lisfranc injuries are classified as either stable or unstable
	  ○ Stable meaning it can be treated with time and reducing pressure
	  ○ Unstable meaning surgery is required
	- Lisfranc injuries can also be classified using the Hardcastle and Myerson System which classifies Lisfranc injuries based on direction and degree of displacement
	- The researchers then provided a case study which is about a 36-year-old female with no medical history who had a misdiagnosis of a Lisfranc injury

Research Question/Problem/ Need	Lisfranc injuries are commonly either undiagnosed or misdiagnosed, so the need is for clinics to more accurately diagnose Lisfranc injuries.

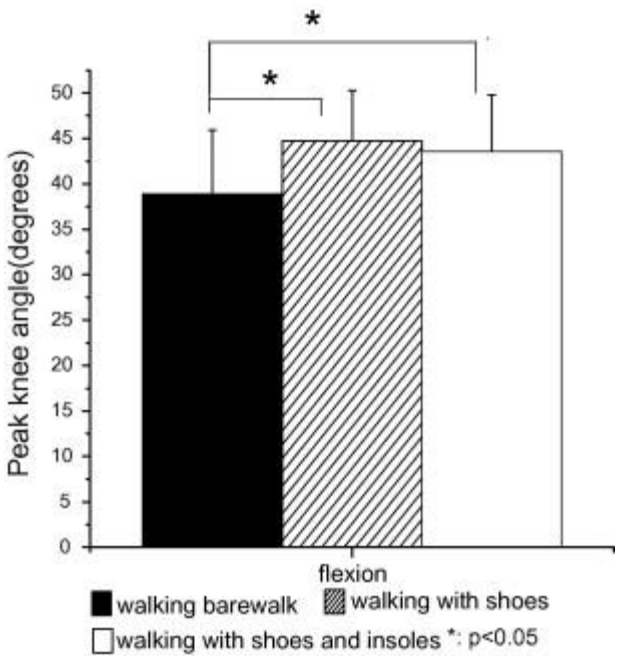
Important Figures	 Figure 1 shows the initial radiograph of the oblique view of the foot, which revealed problems located around the navicular bone, suggesting a navicular bone fracture

	 However, in Figure 2, it is shown there are larger gaps than expected between the medial cuneiform and metatarsals as well as a widening of the Lisfranc joint space through a overhead view, thus, suggesting a Lisfranc injury. After both scans a CT scan was used to take a final decision between the Lisfranc injury and navicular bone fracture, confirming that the injury was a Lisfranc injury. However, this clearly shows the lack of clarity when it comes to diagnosing these injuries. If only one scan was done, the injury would have been treated incorrectly and could have led to further difficulties.
VOCAB: (w/definition)	1. Lisfranc Injuries – A range of injuries involving the Lisfranc complex 2. Lisfranc Complex – Includes the articulation between the metatarsal and tarsal bones 3. Medial Cuneiform – A bone inside of a foot that is attached to the metatarsals 4. Ecchymosis – The discoloration of the skin caused by bleeding underneath 5. Sensitivity – The ability to correctly test whether a person has or does not have a certain injury 6. Non-weight-bearing immobilization – Using a cast or splint to restrict

	movement without applying weight 7. Low-energy trauma – Minor forces such as rolling an ankle or a minor fall 8. High-energy trauma – Significant forces such as a car crash or major sports injuries
Cited references to follow up on	McDermott, A., Repanshek, Z., Koyfman, A., & Long, B. (2024). High risk and low incidence diseases: Lisfranc injury. *The American Journal of Emergency Medicine*, *85*, 172–178. https://doi.org/10.1016/j.ajem.2024.09.019
Follow up Questions	1. Why are Lisfranc injuries often missed during initial X-ray examinations? 2. Does using a different method to detect Lisfranc injuries impact the detection of other injuries? 3. Is there a way to make Lisfranc injuries able to be seen on commonly used detection methods so that health providers do not need to spend the extra time using separate machines? 4. How does the time until treatment affect the overall effects of a Lisfranc injury?

Article #9 Notes: Effects of foot orthoses on gait patterns of flat feet patients

Source Title	Effects of foot orthoses on gait patterns of flat feet patients
Source citation (APA Format)	Chen, Y., Lou, S., Huang, C., & Su, F. (2009). Effects of foot orthoses on gait patterns of flat feet patients. *Clinical Biomechanics*, *25*(3), 265–270. https://doi.org/10.1016/j.clinbiomech.2009.11.007
Original URL	https://www.sciencedirect.com/science/article/pii/S0268003309002630?casa_token=bwJCUCnlv-kAAAAA:IcGHAnps0vot5-OL3YJ7LXd_sHnfqggxcuUml3D3oR2_jmePUYUrplAQK1TfULaXp8HK9-Xr
Source type	Journal Article
Keywords	Flatfoot, Orthoses, Gait, Kinematics, Kinetics
#Tags	#Insoles #Injuries
Summary of key points + notes (include methodology)	- Typical flatfoot symptoms include tenderness of the plantar fascia, laxity of the ligaments, rapid tiring of the foot, pain under stress, and instability of the medial side foot structure - Recent biomechanical studies have shown that insoles improve arch alignment, level walking, and pronation angle of the foot and the tibial internal rotation - 11 adults with flatfoot were each given a custom-molded insole to reduce pronation and were put through three tests to analyze their gait. The three tests were walking barefoot, with shoes, and with shoes and insoles - Using an ANOVA statistic test, they produced a p value of under .05, to determine a significance in the difference of gait measurements. - In other studies, it is shown that the angle of plantarflexion increases when somebody is flatfooted, which can lead to an awkward gait that can lead to further harm - The results of this experiment showed significant results on changes in the ankle joint, but little effect on the knee and hip joints o This is because adding insoles and shoes has a greater effect to the forefoot, which changes how a person's ankle is bent greatly
Research Question/Problem/ Need	This study does an experimental test to investigate the effects of orthoses on the gait patterns of 11 people with flatfoot to determine whether they benefit.

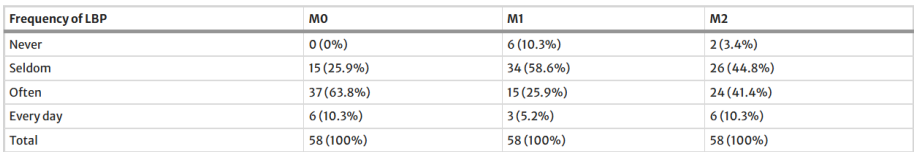
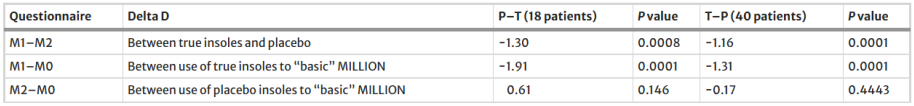
Important Figures	 Figure 1 shoes the difference in the peak knee angle throughout the three tests, showing a significant difference ($p<0.05$) in the angles between barefoot and the other two tests  Figure 2 shows the difference in the peak ankle angle during dorsiflexion and plantarflexion, showing a significant difference in walking barefoot's dorsiflexion and plantarflexion angles compared to the other two tests
VOCAB: (w/definition)	1. Flatfoot – A condition where a person's arch on their foot is lower than usual 2. Laxity – Looseness of a limb or muscle 3. Orthoses – Rigid or semirigid devices worn to assist damage or healing body parts by restricting movement and transferring pressure

	4. Pronation – The natural inward rolling of the foot when in a static position or moving 5. Calcaneal Eversion – The outward rolling of the foot when in a static position or moving 6. Optimum Cutoff – The best threshold for classifying data points into two groups 7. Navicular Height – The vertical distance from the floor to the highest point of the Navicular Bone 8. Navicular Bone – A bone found in between the ankle and the metatarsals 9. Dorsiflexion – The anatomical term for an upward bend in the ankle, where the toes are brought towards the shin 10. Plantarflexion – The anatomical term for a downward bend in the ankle, the toes are brought away from the shin 11. Proprioceptive – Sensory stimuli within the body that give a sense of position and movement
Cited references to follow up on	Branthwaite, H. R., Payton, C. J., & Chockalingam, N. (2004). The effect of simple insoles on three-dimensional foot motion during normal walking. *Clinical Biomechanics*, *19*(9), 972–977. https://doi.org/10.1016/j.clinbiomech.2004.06.009 Eng, J. J., & Pierrynowski, M. R. (1994). The effect of soft foot orthotics on Three-dimensional Lower-Limb Kinematics during walking and running. *Physical Therapy*, *74*(9), 836–844. https://doi.org/10.1093/ptj/74.9.836 Mündermann, A., Nigg, B. M., Humble, R. N., & Stefanyshyn, D. J. (2003). Foot orthotics affect lower extremity kinematics and kinetics during running. *Clinical Biomechanics*, *18*(3), 254–262. https://doi.org/10.1016/s0268-0033(02)00186-9
Follow up Questions	1. What are the differences in a person's gait between a normal person and somebody with flatfoot? 2. Does having flatfoot affect athletic performances? 3. Could the study be limited due to a small sample size? 4. Why was there little difference between "with shoe" and "with shoe and insole"? 5. What are the downsides for somebody having a higher plantarflexion angle?

Article #10 Notes: The effect of insoles on the incidence and severity of low back pain among workers whose job involves long-distance walking

Source Title	The effect of insoles on the incidence and severity of low back pain among workers whose job involves long-distance walking
Source citation (APA Format)	Shabat, S., Gefen, T., Nyska, M., Folman, Y., & Gepstein, R. (2005). The effect of insoles on the incidence and severity of low back pain among workers whose job involves long-distance walking. *European Spine Journal*, *14*(6), 546–550. https://doi.org/10.1007/s00586-004-0824-z
Original URL	https://link.springer.com/article/10.1007/s00586-004-0824-z
Source type	Journal Article
Keywords	Back Pain, Chronic pain, Pain, Pain management, Pain Medicine, Placebo Effect
#Tags	#Injuries #Insoles

Summary of key points + notes (include methodology)	- The prevalence of lower back pain in the general population is estimated to be around 60 to 80 percent
	- One of the common causes for lower back pain is walking long distances
	- Through electromyographic studies, it has been proved that insoles have a direct correlation with reducing lower back pain
	- The researchers performed a double-blind test on 60 post office workers, whose work entailed walking extensively
	  ○ The double-blind test was conducted by giving a real insole and a placebo insole for two separate, 5-week tests.
	- Each subject filled out the MILLION questionnaire survey to determine their lower back pain
	  ○ This survey is considered a valid method of data collection
	- Following the two tests, a statistical test was done to determine the statistical significance, and it determined there was a statistical reduction in lower back pain when wearing real insoles and when wearing placebo insoles
	- Past studies only measured people who stay static most of the day, so the test was important to determine the effects of intensive walking

	jobs
Research Question/Problem/ Need	Past studies have been done based on the belief that insoles improve lower back pain, but prior to this study no research has been done to prove the causation.
Important Figures	 Figure 1 shows a table of the results of the subjects before the experiment (M0), after using the real insoles (M1), and after the placebo insoles (M2). The results are based on their answers to the questionnaire and the results on the left are the results of their back pain  Figure 2 shows a table of the statistical tests done with the data, showing a significant difference in the back pain between people using insoles compared to those before using them or using placebo insoles
VOCAB: (w/definition)	1. Point Pressure – The amount of force applied to a specific, small area 2. Electromyographic – A diagnostic test that measure the electric activity in muscles and nerves 3. Double Blind Test – A clinical research study where neither the subjects or the researchers know which treatment the subject got 4. Lumbar Spine – A part of the spine in the lower back
Cited references to follow up on	Basford, J. R., & Smith, M. A. (1988). Shoe insoles in the workplace. *Orthopedics*, *11*(2), 285–288. https://doi.org/10.3928/0147-7447-19880201-08 Brown, G. P., Donatelli, R., Catlin, P. A., & Wooden, M. J. (1995). The effect of two types of foot orthoses on rearfoot mechanics. *Journal of Orthopaedic and Sports Physical Therapy*, *21*(5), 258–267. https://doi.org/10.2519/jospt.1995.21.5.258 Gross, M. L., Davlin, L. B., & Evanski, P. M. (1991). Effectiveness of orthotic shoe inserts in the long-distance runner. *The American*

Frequency of LBP	M0	M1	M2
Never	0 (0%)	6 (10.3%)	2 (3.4%)
Seldom	15 (25.9%)	34 (58.6%)	26 (44.8%)
Often	37 (63.8%)	15 (25.9%)	24 (41.4%)
Every day	6 (10.3%)	3 (5.2%)	6 (10.3%)
Total	58 (100%)	58 (100%)	58 (100%)

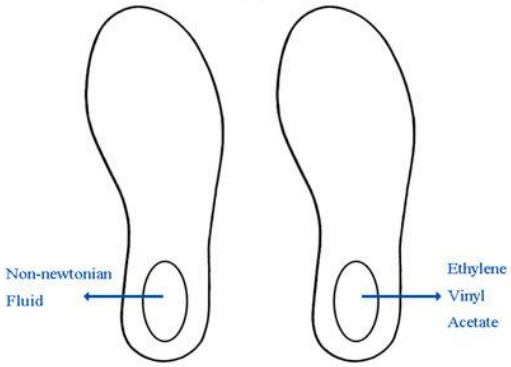
Questionnaire	Delta D	P–T (18 patients)	*P* value	T–P (40 patients)	*P* value
M1–M2	Between true insoles and placebo	−1.30	0.0008	−1.16	0.0001
M1–M0	Between use of true insoles to "basic" MILLION	−1.91	0.0001	−1.31	0.0001
M2–M0	Between use of placebo insoles to "basic" MILLION	0.61	0.146	−0.17	0.4443

	Journal of Sports Medicine, *19*(4), 409–412. https://doi.org/10.1177/036354659101900416
Follow up Questions	1. Does back pain have a strong correlation to foot pain as well? 2. Could similar tests be done for other intensive occupations to assess their correlation between orthoses and lower back pain? 3. Could personalized insoles impact the study even more, reducing lower back pain to an even high extent?

Article #11 Notes: The effects of non-Newtonian fluid material midsole footwear on tibial shock acceleration and attenuation

Source Title	The effects of non-Newtonian fluid material midsole footwear on tibial shock acceleration and attenuation
Source citation (APA Format)	Ye, J., Gao, L., Shao, E., Kovács, B., Li, J., & Gu, Y. (2023). The Effect of Non-Newtonian Fluid Midsole Footwear on Lower Limb Biomechanics after 5 km of Running in High Temperature. *Applied Sciences*, *13*(14), 8024. https://doi.org/10.3390/app13148024
Original URL	https://www.mdpi.com/2076-3417/13/14/8024
Source type	Journal Article
Keywords	non-Newtonian fluid; EVA; high temperature; footwear; biomechanics
#Tags	#Outsole #Fluid #Shoes #Non-Newtonian

Summary of key points + notes (include methodology)	- Thirty-five men utilizing a rearfoot strike ran 5 km at a self-selected tempo at an average summer temperature of 41.7 ± 1.0 °C and relative humidity of 80.7 ± 3.5%.
	- Currently, ethylene vinyl acetate and polyurethane are the most common materials used for shock absorption in running footwear.
	- Participants were split into two groups, wearing either an EVA shoe (control) or a NN shoe to analyze the effects of NN fluids in the midsole.
	- Participants ran 5-kilometer, outdoor tests to assess the shoes
	  o They also participated in 20m sprints indoors onto force plates to assess the ground impact force.
	- A two-way repeated-measures ANOVA was conducted to investigate the main effects of the shoe condition, the temperature, and their interaction on kinematics, kinetics, and muscle activation degree
	- Results included:
	  o Wearing NN increased the range of motion (ROM) of the hip joint by 57–68% of the stance phase after running the 5 km
	  o The first peak ground reaction force and instantaneous

	loading rate increased significantly after 5 km of running at high temperatures in both shoes. o Wearing NN increased the torque in the sagittal plane of the knee by 21–23% and 37–45% of the stance phase after running for 5 km - The temperature increase during the run was greater when wearing the NN shoes (343% > 327%)
Research Question/Problem/ Need	The research question is how changes in the shoe sole material alter its cushioning and shock absorption capacity during prolonged running, especially in a high temperature environment.
Important Figures	 (a)  (b) Figure 1 shows the location of the non-Newtonian fluid when it was integrated into the outsole of the shoe.
VOCAB: (w/definition)	1. Ethylene vinyl acetate – A soft, flexible foam commonly used in running shoe midsoles. 2. Polyurethane – A stronger, more durable type of foam used in some shoes. 3. Non-Newtonian – A material whose thickness or flow changes depending on how much force is applied. 4. Shear thinning behavior – A property where a material becomes thinner and flows easier when force is applied. 5. Maximal voluntary isometric contraction – The strongest force a person can produce with a muscle without moving the joint. 6. Muscle activation degree – How much a muscle is “turned on” or working during a movement. 7. Stance phase – The part of walking or running when your foot is touching the ground. 8. Ground reaction force – The force the ground pushes back on your foot when you land or push off while walking or running.

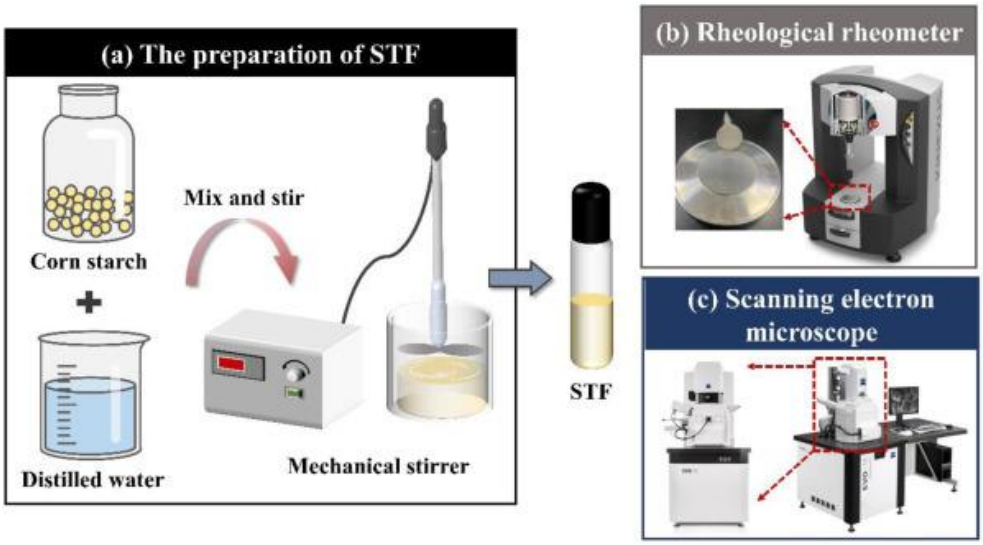
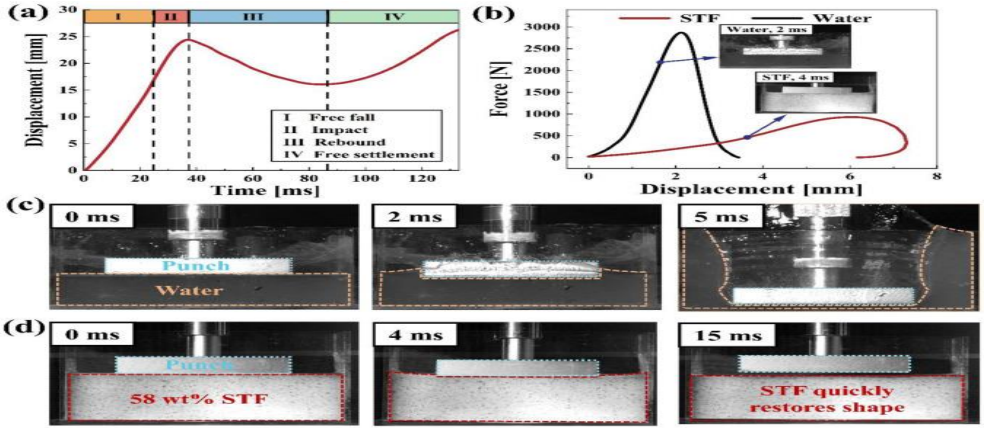
Cited references to follow up on	Dib, M. Y., Smith, J., Bernhardt, K. A., Kaufman, K. R., & Miles, K. A. (2005). Effect of environmental temperature on shock absorption properties of running shoes. *Clinical Journal of Sport Medicine*, *15*(3), 172–176. https://doi.org/10.1097/01.jsm.0000165348.32767.32 Heil, B. (1992). Lower limb biomechanics related to running injuries. *Physiotherapy*, *78*(6), 400–406. https://doi.org/10.1016/s0031-9406(10)61524-6 Kinoshita, H., & Bates, B. T. (1996). The effect of environmental temperature on the properties of running shoes. *Journal of Applied Biomechanics*, *12*(2), 258–268. https://doi.org/10.1123/jab.12.2.258 Lin, S., Song, Y., Cen, X., Bálint, K., Fekete, G., & Sun, D. (2022). The Implications of Sports Biomechanics Studies on the research and Development of running shoes: A Systematic review. *Bioengineering*, *9*(10), 497. https://doi.org/10.3390/bioengineering9100497 Wang, L., Hong, Y., & Li, J. X. (2012). Durability of running shoes with ethylene vinyl acetate or polyurethane midsoles. *Journal of Sports Sciences*, *30*(16), 1787–1792. https://doi.org/10.1080/02640414.2012.723819
Follow up Questions	1. What would have changed if there were more diversity within the subjects (gender, race, age, and physical ability)? 2. Could the results have changed if the environment inside of the lab

	(where the 20m sprints were done) mimicked that of the outdoor track? 3. What would have changed if more non-Newtonian fluid was integrated into the sole of the shoe? 4. How can future studies separate the effects of heat on the materials of shoes to the participants' fatigue?

Article #12 Notes: Jamming behavior and cushioning performance of shear thickening fluids under impact

Source Title	Jamming behavior and cushioning performance of shear thickening fluids under impact
Source citation (APA Format)	Chen, Z., Jing, Y., Wang, H., Zhang, X., Long, S., & Yao, X. (2025). Jamming behavior and cushioning performance of shear thickening fluids under impact. *International Journal of Impact Engineering*, *208*, 105524. https://doi.org/10.1016/j.ijimpeng.2025.105524
Original URL	https://www.sciencedirect.com/science/article/pii/S0734743X25003033
Source type	Journal Article
Keywords	Shear thickening fluid, Impact behavior, Energy absorption, Particle image velocimetry, Jamming state
#Tags	#Fluid #Non-Newtonian

Summary of key points + notes (include methodology)	- STF (Shear thickening fluids) have a unique behavior that makes them highly promising for impact protection applications.
	- When no forces are affecting an STF, they remain in a fluid state. However, once forces are applied, the STF gets a more solid-like state that can resist higher forces.
	- STF was prepared by mixing cornstarch and distilled water at 58% mass fraction and stirred for 15 minutes at 25°C.
	- To test the effects of impact forces on STF, three different punch shapes were tested: flat, conical, and rounded.
	  ○ (flat): highest peak force, best rebound
	  ○ (conical): deepest penetration, caused fractures
	  ○ (rounded): smoother, more distributed response

	- The tests provided the takeaways that STF perform best at 58% mass faction and at ~50mm liquid thickness. - In conclusion, one of the largest takeaways is that both liquid thickness and punch geometry are important factors in the dynamics of STF.
Research Question/Problem/ Need	How do the properties of STF and the impact on it affect the shear-thickening properties of the fluid?
Important Figures	 Figure 1: This shows the process of creating an STF. By adding corn starch, distilled water, and mixing it you can get an STF in a simple way.  Figure 2: This shows the difference in state between and STF and water when pressure is applied. Both fluids are put under a 3 J punch, but as seen in the image, the STF does not react as much as the water due to the solids-state it acquires due to high forces.
VOCAB: (w/definition)	1. Shear thickening fluids – a class of smart materials that transition into a solid-like state under impact. 2. Particle Image Velocimetry – a non-intrusive optical technique that measures a fluid's velocity field.

	3. Continuous shear thickening – A fluid viscosity smoothly and gradually increases as the applied shear rate increases or decreases. 4. Discontinuous shear thickening – A fluid viscosity suddenly skyrockets or plummets when a critical shear stress or rate is exceeded. 5. Rotational rheometer – An instrument used to measure the flow and deformation of materials by rotating a geometry. 6. Peltier plate temperature control unit – Uses thermoelectric modules to provide rapid, precise heating and cooling for samples 7. Rheological – The science of how materials deform and flow under applied forces. 8. Mass fractions – The ratio of a component's mass to the total mass of a mixture. 9. Shear Rate – The measure of how quickly a fluid layer moves past each other.
Cited references to follow up on	Cheng, J., Ye, L., Fu, K., & Wang, H. (2020). Effect of striker shape on impact energy absorption of a shear thickening fluid. *Composites Communications*, *23*, 100560. https://doi.org/10.1016/j.coco.2020.100560 Gürgen, S., & Sofuoğlu, M. A. (2020). Integration of shear thickening fluid into cutting tools for improved turning operations. *Journal of Manufacturing Processes*, *56*, 1146–1154. https://doi.org/10.1016/j.jmapro.2020.06.012 Lyu, H., Sun, P., Miao, J., & Zhang, A. (2022). 3D multi-resolution SPH modeling of the water entry dynamics of free-fall lifeboats. *Ocean Engineering*, *257*, 111648. https://doi.org/10.1016/j.oceaneng.2022.111648 Malkin, A. (2012). Non-Newtonian viscosity in steady-state shear flows. *Journal of Non-Newtonian Fluid Mechanics*, *192*, 48–65. https://doi.org/10.1016/j.jnnfm.2012.09.015

Follow up Questions	1. How could this knowledge be applied to shoes? 2. How does the jamming effect impact the transfer of energy between two objects? 3. How are STF properties affected by continuous sudden forces (such as running/walking)?

Article #13 Notes: High-velocity impact of solid objects on Non-Newtonian Fluids

Source Title	High-velocity impact of solid objects on Non-Newtonian Fluids
Source citation (APA Format)	De Goede, T. C., De Bruin, K. G., & Bonn, D. (2019). High-velocity impact of solid objects on Non-Newtonian Fluids. *Scientific Reports*, *9*(1), 1250. https://doi.org/10.1038/s41598-018-37543-1
Original URL	https://www.nature.com/articles/s41598-018-37543-1
Source type	Journal Article
Keywords	Viscoelasticity, Shear Thickening Fluids, Energy Dissipation
#Tags	#Non-Newtonian #Fluid
Summary of key points + notes (include methodology)	- The researchers measured the velocity decrease when a high-speed spherical object impacted a Newtonian fluid, a shear thickening fluid, and a shear thinning viscoelastic fluid. - Understanding kinetic energy dissipation is key when determining fluid dynamics during an impact. - When going about the model, the researchers expected to find that the object's would slow when hitting the STF due to it hardening; however, when it made impact, it turned into a viscoelastic fluid for a moment to slow down the object. - This observation challenged past beliefs that shear thickening (hardening) was the cause of slowing fast moving objects when it came to STFs. - These insights help provide affirmation that these materials can be used in high-stress environments such as police wear.
Research Question/Problem/ Need	Which property of non-Newtonian fluids determines the deceleration of a high-speed impacting object?

Important Figures

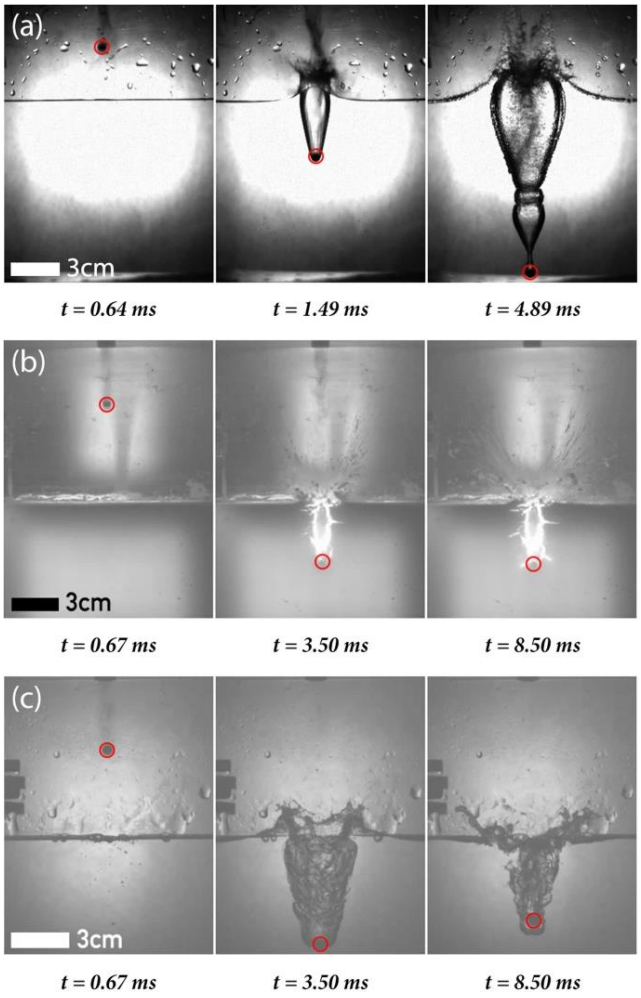


Figure 1 shows the impact of the high-velocity spherical object impacting the water (a), cornstarch (b), and PVA solution (c).

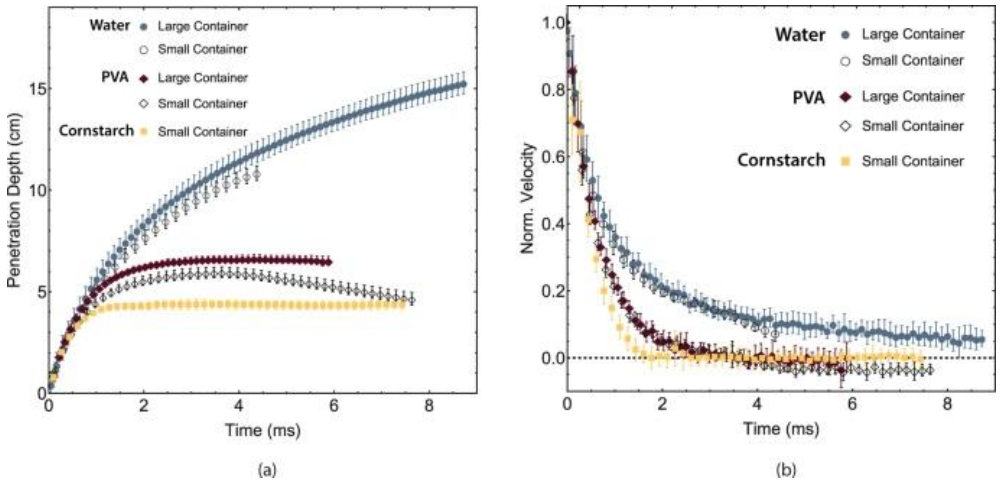


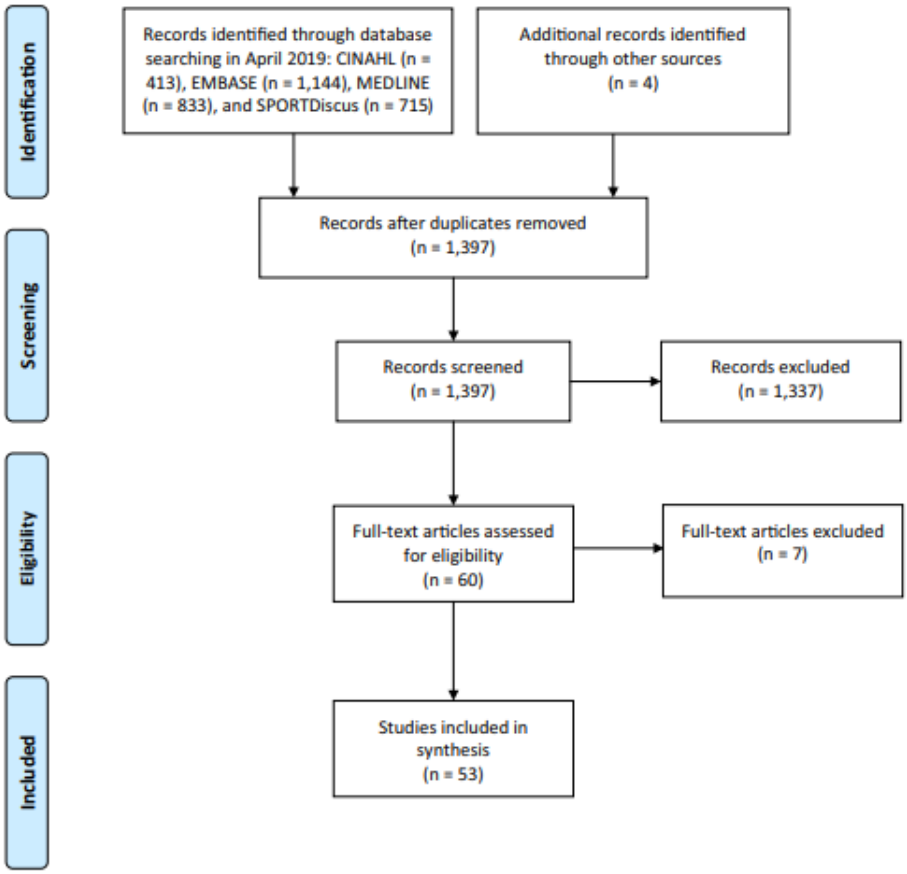
Figure 2 shows two associated graphs to figure 1, showing the position over time and the velocity over time graphs. As you can tell from the graphs, the object impacting the solutions goes deepest and fastest in the water, and goes the

	shallowest and slowest in the cornstarch (Shear Thickening Fluid).
VOCAB: (w/definition)	1. Shear thinning – A property of non-Newtonian fluids where their viscosity decreases as shear stress or shear rate increases. 2. Viscoelastic - Materials that exhibit both viscous (liquid-like, flow) and elastic (solid-like, springy) properties. 3. Liquid body armor designs – Armor designs that use non-Newtonian fluids. 4. Jamming clusters – A process where nanoparticles in the fluid rapidly clump together. 5. Particle sedimentation – The process where solid particles settle out of a liquid. 6. Polyvinyl alcohol (PVA) - A water-soluble synthetic polymer used widely in textiles, adhesives, paper, and packaging.
Cited references to follow up on	Majumdar, A., Butola, B. S., & Srivastava, A. (2012). Optimal designing of soft body armour materials using shear thickening fluid. *Materials & Design (1980-2015)*, *46*, 191–198. https://doi.org/10.1016/j.matdes.2012.10.018 Majumdar, A., Butola, B. S., & Srivastava, A. (2013). An analysis of deformation and energy absorption modes of shear thickening fluid treated Kevlar fabrics as soft body armour materials. *Materials & Design (1980-2015)*, *51*, 148–153. https://doi.org/10.1016/j.matdes.2013.04.016 Majumdar, A., Butola, B. S., & Srivastava, A. (2013b). Development of soft composite materials with improved impact resistance using Kevlar fabric and nano-silica based shear thickening fluid. *Materials & Design (1980-2015)*, *54*, 295–300. https://doi.org/10.1016/j.matdes.2013.07.086
Follow up Questions	1. How would kinetic energy dissipation affect objects with a greater surface area? 2. Is viscoelasticity affected by the depth and mass fraction of the STF? 3. Could this be applied to the biomechanical functions of humans such as

	running or moving a limb? 4. What other neat properties do shear thickening and shear thinning fluids have?

Article #14 Notes: What are the Benefits and Risks Associated with Changing Foot Strike Pattern During Running? A Systematic Review and Meta-analysis of Injury, Running Economy, and Biomechanics

Source Title	What are the Benefits and Risks Associated with Changing Foot Strike Pattern During Running? A Systematic Review and Meta-analysis of Injury, Running Economy, and Biomechanics
Source citation (APA Format)	Anderson, L. M., Bonanno, D. R., Hart, H. F., & Barton, C. J. (2019). What are the Benefits and Risks Associated with Changing Foot Strike Pattern During Running? A Systematic Review and Meta-analysis of Injury, Running Economy, and Biomechanics. *Sports Medicine*, *50*(5), 885–917. https://doi.org/10.1007/s40279-019-01238-y
Original URL	https://link.springer.com/article/10.1007/s40279-019-01238-y
Source type	Journal Article
Keywords	Fitness, Phlebology, Physical Development, Sports Biomechanics, Sport Science, Sports Medicine
#Tags	#Injuries #Running
Summary of key points + notes (include methodology)	- As running becomes more popular, the controversy over the ideal foot strike is increasing just as much. - Researchers analyzed other studies to compare the two main types of foot striking, rearfoot and non-rearfoot striking. - Researched did a systemic review of 53 studies, to acquire data on which of the two foot strike patterns was better. - The researchers had a total of 1397 articles initially, but only 53 of those studies were relevant and contained sufficient evidence to be a part of the review. - In these articles, researchers studied the effects on different running speeds, running efficiency, and most importantly, injury rates. - The researchers found that non-rearfoot striking may be correlated to lower injury rates and is associated more with the calves and ankles. - The researcher's primary discovery was that there seemed to be no apparent difference in running economy between the two types of foot

	striking. ○ Because of this, it is advised that runners currently running one way or the other should not try to switch, as they may injure themselves in the process.
Research Question/Problem/ Need	The aims of this review were to synthesize the evidence comparing NRFS with rearfoot strike running patterns in relation to injury and running economy, and biomechanics.
Important Figures	 Figure 1 shows a flow chart to reflect the process of the systemic review. Of the 1397 initial articles, only 53 remained relevant with sufficient data pertaining to the systemic review. This shows that the systemic review topic may have been too specific.
VOCAB: (w/definition)	1. Non-rearfoot strike – Runners who run with the ball of their foot striking the ground first. 2. Rearfoot strike – Runners who run with the heel of their foot striking the ground first. 3. Running economy – How efficiently your body uses oxygen to run at a given pace. 4. Meta-analysis – A statistical method that quantitatively combines results from multiple studies on the same topic.

	5. Habitual strike pattern – The consistent way a runner's foot strikes the ground.
Cited references to follow up on	Hasegawa, H., Yamauchi, T., & Kraemer, W. J. (2007). Foot strike patterns of runners at the 15-km point during an Elite-Level half marathon. *The Journal of Strength and Conditioning Research*, *21*(3), 888. https://doi.org/10.1519/r-22096.1 Stearne, S. M., Alderson, J. A., Green, B. A., Donnelly, C. J., & Rubenson, J. (2014). Joint Kinetics in Rearfoot versus Forefoot Running. *Medicine & Science in Sports & Exercise*, *46*(8), 1578–1587. https://doi.org/10.1249/mss.0000000000000254 Van Gent, R. N., Siem, D., Van Middelkoop, M., Van Os, A. G., Bierma-Zeinstra, S. M. A., & Koes, B. W. (2007). Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *British Journal of Sports Medicine*, *41*(8), 469–480. https://doi.org/10.1136/bjsm.2006.033548
Follow up Questions	1. How does the difference in foot striking affect plantar pressure? 2. Are some shoes less recommended to people who strike the ground in one way versus the other? 3. Is there a difference in afflicted areas of injuries when the runners of each gait are injured? 4. If more studies were analyzed along with the 53 analyzed, what more data could have been acquired?

Article #15 Notes: Influence of carbon-plated running shoes and fatigue on lower limb biomechanics

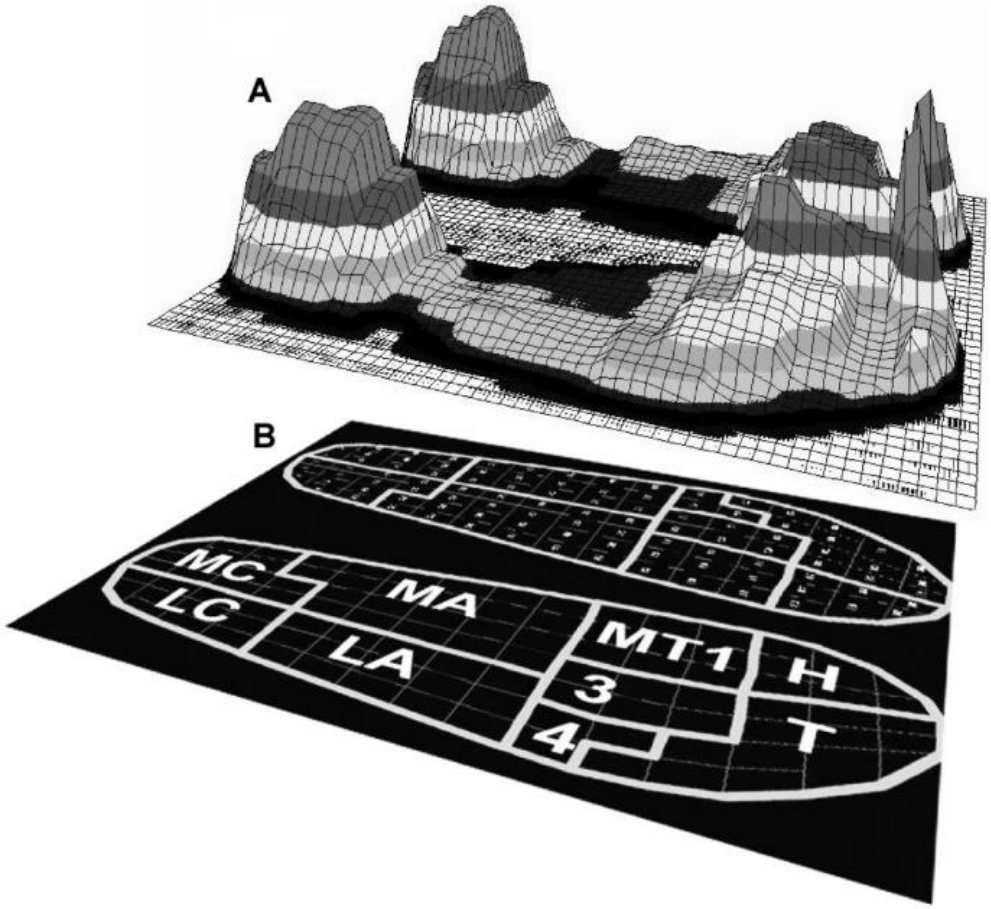
Source Title	Influence of carbon-plated running shoes and fatigue on lower limb biomechanics
Source citation (APA Format)	Luo, X., Liu, R., & Li, B. (2025). Influence of carbon-plated running shoes and fatigue on lower limb biomechanics. *Journal of Biomechanics*, *195*, 113102. https://doi.org/10.1016/j.jbiomech.2025.113102
Original URL	https://www.sciencedirect.com/science/article/pii/S0021929025006141
Source type	Journal Article
Keywords	Carbon-plated running shoes, Fatigue, Lower limb kinematics, Joint stiffness
#Tags	#Shoes #Outsole #Running
Summary of key points + notes (include methodology)	- Carbon-plated shoes have recently gained traction in long-distance running for their high energy return and enhanced propulsion compared to normal running shoes. - Although this design enhances energy return, it increases foot stiffness which can lead to stress along the joints and injury. - In the study comparing a carbon-plated shoe to a non-carbon-plated shoe, 16 male athletes who were active participated in trials wearing both types of shoes. - A 3D motion capture device was used in correlation with 23 markers along the users' lower extremities to collect kinematic data on the hip, knee, and ankle of the participants. - Participants ran down a 20m runway with a ground reaction force sensor placed in the middle of it to collect the data for each trial. ○ Participants participated in two trials for each shoe before and after a 5-minute treadmill run at a self-selected pace to get data for fatigued and not fatigued running. - A two-way ANOVA test was used to determine if the means of joint angles were the same between the shoes and between the presence of fatigue. - The study showed that carbon-plated shoes increase the force put onto the joints, which is even further stressed by the presence of fatigue. - This study shows the need for a compromise between balance stiffness

	and fatigue effect limitations in modern shoes.
Research Question/Problem/ Need	How do longitudinal bending stiffness and fatigue affect lower-limb biomechanics, stiffness regulation, and impact loading during running?
Important Figures	 Figure 1 shows a shoe that has a carbon-plate integrated into the outsole.  (a) (b) (c) Figure 2 shows the locations of the reflexive markers along the participants' lower limbs. There are 23 total distributed across the lower extremities that help gather data.
VOCAB: (w/definition)	1. Longitudinal Bending Stiffness – Resistance of a shoe to bending along its length. 2. Stiffness Regulation – The rigidness of a shoe to bending and twisting. 3. Impact Loading – The magnitude of force transmitted onto the body upon ground contact. 4. Running Economy – Oxygen/energy cost due to running at a certain speed.

	5. Carbon-Plated Running Shoes – Shoes with a carbon plate integrated into the outsole of the shoe to get a greater ground reaction force. 6. Ground-Reaction Force – Force exerted onto the body after the foot contacts the ground. 7. Pronation Moment – Rotational force causing an inward rotation of the ankle.
Cited references to follow up on	Breine, B., Malcolm, P., Van Caekenberghe, I., Fiers, P., Frederick, E. C., & De Clercq, D. (2016). Initial foot contact and related kinematics affect impact loading rate in running. *Journal of Sports Sciences*, *35*(15), 1556–1564. https://doi.org/10.1080/02640414.2016.1225970 Brughelli, M., & Cronin, J. (2008). Influence of running velocity on vertical, leg and joint stiffness. *Sports Medicine*, *38*(8), 647–657. https://doi.org/10.2165/00007256-200838080-00003 Granata, K., Padua, D., & Wilson, S. (2002). Gender differences in active musculoskeletal stiffness. Part II. Quantification of leg stiffness during functional hopping tasks. *Journal of Electromyography and Kinesiology*, *12*(2), 127–135. https://doi.org/10.1016/s1050-6411(02)00003-2
Follow up Questions	1. Do carbon-plated shoes cause any mobility restrictions? 2. Do carbon-plated shoe affect users differently depending on foot type/plantar pressure distributions? 3. How do carbon-plated shoes fare after muscles fatigue? 4. Does a carbon-plated shoe change the gait of the user? 5. What results would have been produced if the participants in the study were more diverse?

Article #16 Notes: Foot pressure distribution during walking in young and old adults

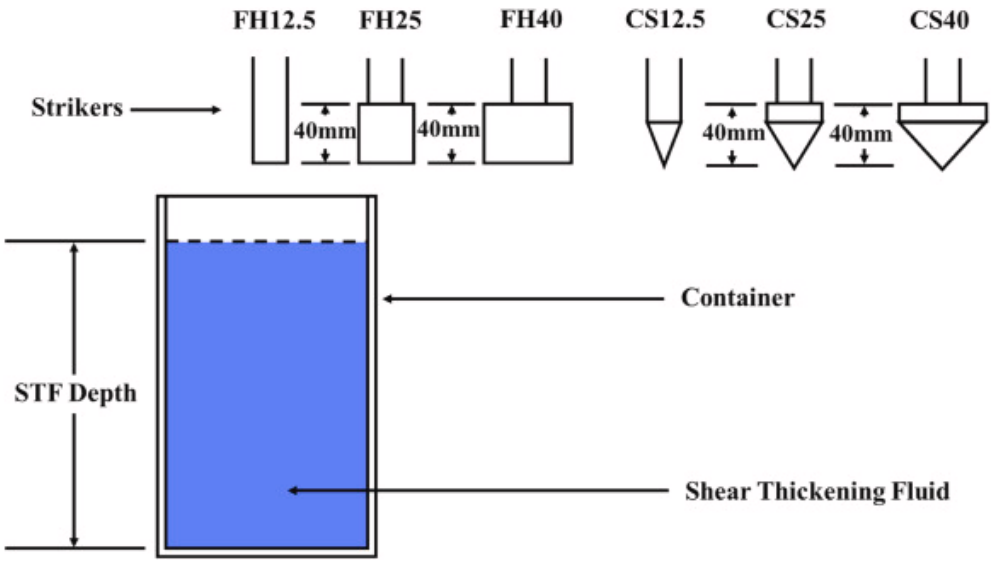
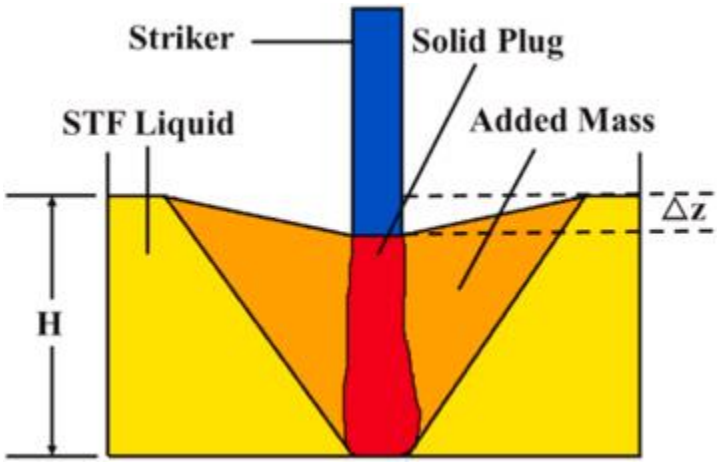
Source Title	Foot pressure distribution during walking in young and old adults
Source citation (APA Format)	Hessert, M. J., Vyas, M., Leach, J., Hu, K., Lipsitz, L. A., & Novak, V. (2005). Foot pressure distribution during walking in young and old adults. *BMC Geriatrics*, *5*(1), 8. https://doi.org/10.1186/1471-2318-5-8
Original URL	https://link.springer.com/article/10.1186/1471-2318-5-8
Source type	Journal Article
Keywords	Plantar Pressure, Normal Walking. Treadmill Walking, Heel Strike, Relative Load
#Tags	#Insole #Livefeedback
Summary of key points + notes (include methodology)	- Analyzing foot pressure distributions is crucial to identifying foot problems, diagnosing gait problems, preventing falls and injuries, and preventing ulcer sores. - People who are older are much more prone to many of these problems because as someone gets older, their bones, ligaments, muscles, and tissues all begin to break down. - This study compared the gait of healthy young people to that of elderly people by utilizing an insole pressure sensor while walking on a treadmill at a constant pace. - Foot pressures were measured around 9 regions of the foot, shown in figure 1. - Older adults were shown to have less pressure around their toes, inner foot, and heel, but they were found to have more pressure around the outer portion of their feet. ○ Results show that these changes are caused by decline in muscle strength, reduced shock absorption, and deteriorating tissues in the body. - During the test, older people were shown to have a higher perceived exhaustion. - The results of this study help people stay aware of the changes older people are going through and why they need the extra care.
Research Question/Problem/ Need	How does healthy aging affect the plantar pressure distribution in different parts of the foot during walking and what are the implications it has on gait and

	stability.
Important Figures	 Figure 1 shows the 9 different regions of the foot where pressure was analyzed at the bottom (B) and the maximum pressure distribution on all sensors from one subject on the top (A).
VOCAB: (w/definition)	1. Calcaneus – Heel bones. 2. Medial – Toward the midline of the body. 3. Lateral – Toward the outside of the body. 4. Toe-off Phase – The phase of walking when the toe first leaves the ground. 5. Stance Phase – The phase of walking where the foot is touching the ground. 6. Swing Phase – The phase of walking where the foot is off the ground moving forward. 7. Capacitive Sensors – Sensors that measure pressure. 8. Nonparametric ANOVA – A statistical test for within-group comparisons. 9. Proprioception – Your bodies innate sense to understand its position/movement
Cited references to follow up on	Morag, E., & Cavanagh, P. (1999). Structural and functional predictors of

	regional peak pressures under the foot during walking. *Journal of Biomechanics*, *32*(4), 359–370. https://doi.org/10.1016/s0021-9290(98)00188-2 Rodgers, M. M. (1995). Dynamic Foot Biomechanics. *Journal of Orthopaedic and Sports Physical Therapy*, *21*(6), 306–316. https://doi.org/10.2519/jospt.1995.21.6.306
Follow up Questions	1. How does foot structure between people affect the FPD differences between youth and the elderly? 2. How could aging affect pressure distribution under different walking conditions such as terrain? 3. How does the difference in foot pressure affect the rest of the joints/limbs of the body? 4. Does staying physically active while aging affect the differences in FPD between youth and elderly?

Article #17 Notes: Effect of striker shape on impact energy absorption of a shear thickening fluid

Source Title	Effect of striker shape on impact energy absorption of a shear thickening fluid
Source citation (APA Format)	Cheng, J., Ye, L., Fu, K., & Wang, H. (2020). Effect of striker shape on impact energy absorption of a shear thickening fluid. Composites Communications, 23, 100560. https://doi.org/10.1016/j.coco.2020.100560
Original URL	https://www.sciencedirect.com/science/article/abs/pii/S0031940610615246?via%3Dihub
Source type	Journal Article
Keywords	Shear thickening fluid, Low-velocity impact, Striker shape, Energy absorption
#Tags	#Non-Newtonian
Summary of key points + notes (include methodology)	- STFs experience rapid solidification during both low and high velocity impacts - During the deformation of solidified STFs, they absorb and abundance of the impact energy - There are three main theories to explain STF behavior, order-disorder theory, hydro-cluster theory, and frictional contact model (explained in vocab) - In this study a scanning electron microscope was used to characterize the microstructure of the STFs under a steady shear pressure - Additionally, low-velocity STF impacts were measured with the same tool to determine the effects of different striker shapes on STF impact absorption attributes - During testing, it was determined that there was a minor peak of impact load at the first contact point between the striker and STF. Following this, there was no further increase. o This indicated that the addition of styrene/acrylate particles greatly strengthens the energy absorption capability as a suspension. - Following all testing, the researchers determined that, at the same impact speed, STF can absorb more impact energy from a striker with a greater diameter and reduce the penetration depth more. - Furthermore, the researchers also determined that conical-shaped strikers had a greater penetration depth than flat-headed strikers. - In conclusion, the greater the surface area, the better the STF performs at absorbing impact energy.
Research Question/Problem	How does a change in striker shape affect the absorption behavior of STFs and how can STF's properties be used to explain this change?

/ Need	
Important Figures	 Figure 1 shows a visual representation of the tests completed. The different objects towards the top of the figure (FH12.5, FH25, FH40, CS12.5, CS25, and CS40) represent the different strikers used, with different widths tested alongside the presence of a flat vs. Pointed tip of the striker.  Figure 2 shows a visual representation of the different properties of the STF when a striker contacts it. The red portion represents the solidified STF, the orange is area where impact was absorbed, and the yellow represents mostly unaffected, liquid STF.
VOCAB: (w/definition)	1. Sandwich Structures - A type of composite design that has two stiff outer layers and a low-density inner layer. 2. Order-Disorder Theory – Particles transition when they go from an ordered to disordered flow state. 3. Hydro-Cluster Theory – Particles form clusters under shear from hydrodynamic forces. 4. Frictional Contact Model – Friction between particles causes a viscosity increase. 5. Striker – The object that contacts the STF.

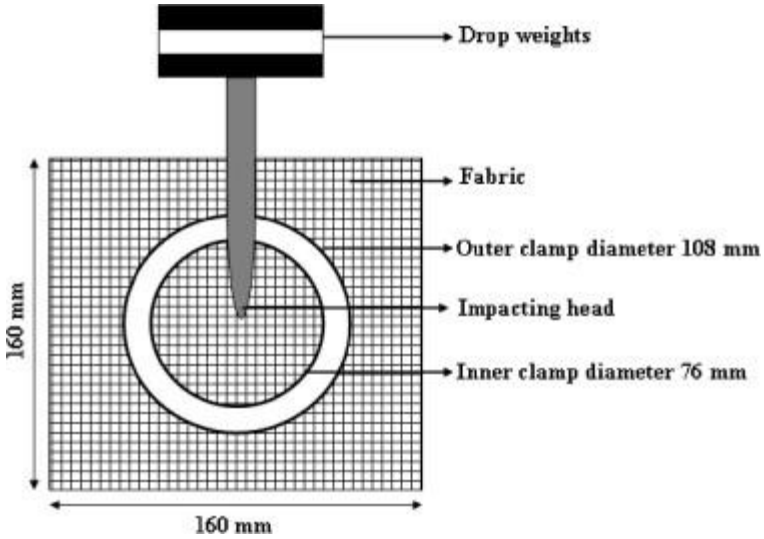
	6. Scanning Electron Microscope - A type of microscope that uses a high-focused electron beam to create high-resolution 3D models.
Cited references to follow up on	Fu, K., Wang, H., Chang, L., Foley, M., Friedrich, K., & Ye, L. (2018). Low-velocity impact behaviour of a shear thickening fluid (STF) and STF-filled sandwich composite panels. *Composites Science and Technology*, *165*, 74–83. https://doi.org/10.1016/j.compscitech.2018.06.013 Gürgen, S., Kuşhan, M. C., & Li, W. (2017). Shear thickening fluids in protective applications: A review. *Progress in Polymer Science*, *75*, 48–72. https://doi.org/10.1016/j.progpolymsci.2017.07.003 Waitukaitis, S. R., & Jaeger, H. M. (2012). Impact-activated solidification of dense suspensions via dynamic jamming fronts. *Nature*, *487*(7406), 205–209. https://doi.org/10.1038/nature11187
Follow up Questions	1. How does striker velocity also affect the absorption behavior of STFs? 2. Do STF properties degrade overtime, due to time taking affect or repeated impacts? 3. Can STFs be optimized for certain impact types (prolonged vs. short, high impacts vs rapid impacts, etc.)?

Article #18 Notes: Optimal designing of soft body armour materials using shear thickening fluid

Source Title	Optimal designing of soft body armour materials using shear thickening fluid
Source citation (APA Format)	Majumdar, A., Butola, B. S., & Srivastava, A. (2012). Optimal designing of soft body armour materials using shear thickening fluid. Materials & Design (1980-2015), 46, 191–198. https://doi.org/10.1016/j.matdes.2012.10.018
Original URL	https://www.sciencedirect.com/science/article/pii/S026130691200708X?via%3Dihub
Source type	Journal Article
Keywords	Kevlar, Shear-thickening Fluid, Body Armor, Impact Absorption
#Tags	#Non-Newtonian #Injuries

Summary of key points + notes (include methodology)	- Kevlar is a prevalent material in current soft body armor applications
	  o Approximately 20-50 layers are used in order to stop a bullet before it penetrates into the body
	  o Due to this extreme number of layers, the body armor is typically heavy and impractical
	- By applying Shear-thickening fluid (STF) to the Kevlar fabric, greater impact resistance can be achieved.
	- The liquid from the STFs transforms into a solid at impact, facilitating the impact energy better than standard Kevlar fabric.
	- Past studies have shown that Kevlar integrated with STFs improves impact, stab, puncture, and ballistic resistance.
	  o Past studies also found that silica-based STFs perform better compared to soft-particle based STFs
	- This study analyzes the differences of STF concentration, padding pressure, and solvent ratio on STF add-on percentage and impact energy absorption.
	- During testing, 15 STF-treated Kevlar samples were used with varying parameters.
	- From many tests, the researchers found that the best impact resistance occurred with high silica concentration, high padding pressure, and low solvent ratio.

Research Question/Problem/ Need	The goal of this study is to develop materials for soft body armor so that it remains lightweight, flexible and bullet-resistant

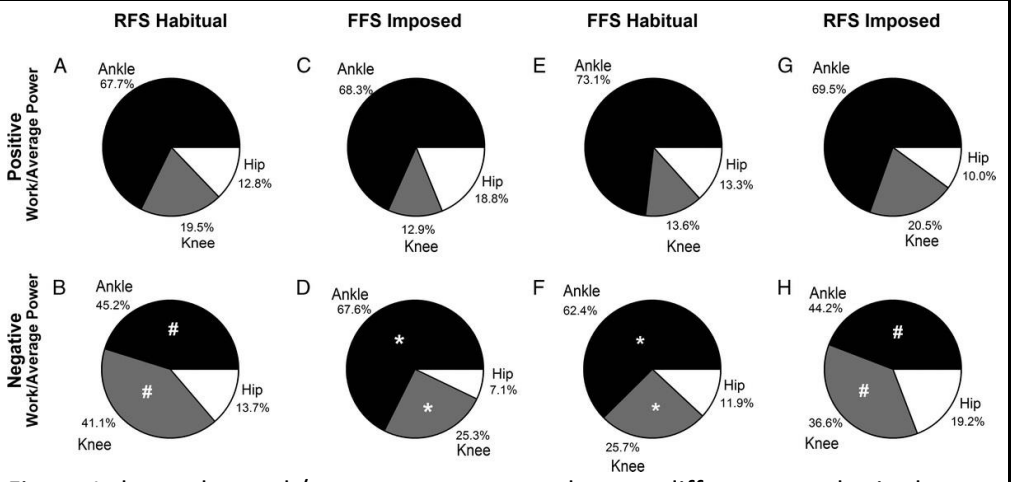
Important Figures	 Figure 1 shows a diagram of how stab/puncture resistance was measured. By dropping a sharp object with weights on top of it onto the desired material, the resistance was found.
VOCAB: (w/definition)	1. Kevlar – A highly strengthened fiber that is used in body armors 2. Nano Particles – Extremely small particles 3. Stab/Puncture Resistance – The object's resistance to sharp objects 4. STF add-on percentage – Amount of STF retained after treatment in the object 5. Pressure Padding - 6. Solvent Ratio - 7. Box–Behnken design
Cited references to follow up on	Decker, M., Halbach, C., Nam, C., Wagner, N., & Wetzel, E. (2006). Stab resistance of shear thickening fluid (STF)-treated fabrics. *Composites Science and Technology*, *67*(3–4), 565–578. https://doi.org/10.1016/j.compscitech.2006.08.007 Hoffman, R. L. (1998). Explanations for the cause of shear thickening in concentrated colloidal suspensions. *Journal of Rheology*, *42*(1), 111–123. https://doi.org/10.1122/1.550884 Srivastava, A., Majumdar, A., & Butola, B. S. (2011). Improving the impact resistance performance of Kevlar fabrics using silica based shear

	thickening fluid. *Materials Science and Engineering A*, *529*, 224–229. https://doi.org/10.1016/j.msea.2011.09.021
Follow up Questions	1. How does STF-treated Kevlar fair under repeated impacts? 2. How do environmental changes affect STFs? 3. What are the comfortability and mobility trade-offs of integrating STFs into Kevlar? 4. Can STF-treated Kevlar be put into other force applications? 5. Are there different STF hybrids that can be used in different applications of repeated pressures?

Article #19 Notes: Joint Kinetics in Rearfoot versus Forefoot Running Implications of Switching Technique

Source Title	Joint Kinetics in Rearfoot versus Forefoot Running Implications of Switching Technique
Source citation (APA Format)	Stearne, S. M., Alderson, J. A., Green, B. A., Donnelly, C. J., & Rubenson, J. (2014). Joint Kinetics in Rearfoot versus Forefoot Running. *Medicine & Science in Sports & Exercise*, *46*(8), 1578–1587. https://doi.org/10.1249/mss.0000000000000254
Original URL	https://journals.lww.com/acsm-msse/fulltext/2014/08000/joint_kinetics_in_rearfoot_versus_forefoot.13.aspx
Source type	Journal Article
Keywords	Foot strike, Joint mechanics, Joint work, Gait, Coaching
#Tags	#Running

Summary of key points + notes (include methodology)	- Runners can be classified into different groups depending on which portion of their foot comes in contact with the ground first.
	  ○ Forefoot strike (FFS)
	  ○ Rearfoot strike (RFS)
	  ○ Midfoot strike (MFS)
	- RFS runners are typically seen more in long-distance, however, as the field becomes more elite, the percentage of MFS and FFS runners increase.
	- 16 male, competitive runners were selected to participate in the study, 8 habitual RFS runners and 8 habitual FFS runners
	  ○ The foot strike pattern was confirmed using high-speed cameras
	- Each participant completed a 5-minute run using both types of foot strikes at a comfortable pace on a pressure sensing treadmill
	- From all of these tests, only stance time was deemed statistically significant between the two strike patterns at a 0.05 alpha level with RFS taking longer
	- The researchers concluded that, overall, there are no mechanically significant factors between RFS runners and FFS runners
	- When comparing the differences between runners switching from their habitual strike pattern to the opposite, they determined that people are more injury prone when they attempt to switch their gait pattern than when the maintain it

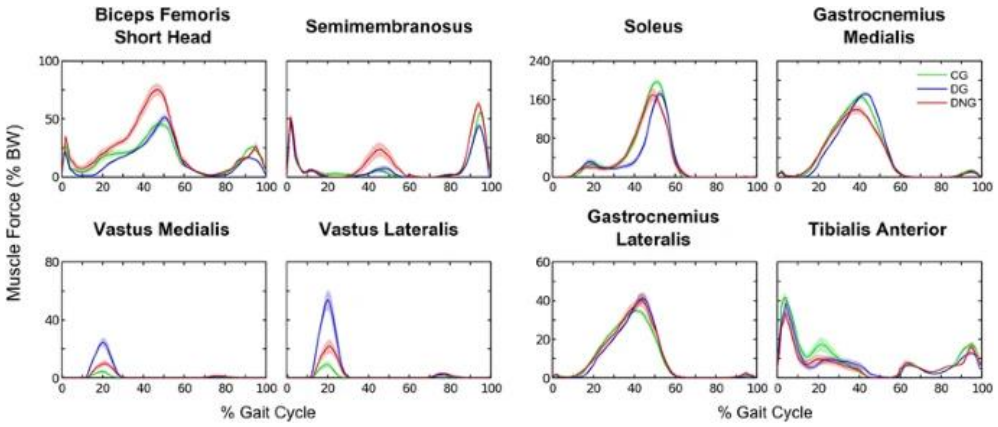
Research Question/Problem/ Need	The goal of this study was to further understand the different mechanical factors between forefoot running and rearfoot running.
Important Figures	 Figure 1 shows the work/average power spread across different muscles in the lower extremities based on the habituality of the runner and which treatment they were going through at the time. When analyzing the graphs, the researchers found no statistically significant difference between the habituality of runners.
VOCAB: (w/definition)	1. Forefoot – When the ball of the foot strikes the ground before the heel. 2. Rearfoot Strike – When the heel of the foot strikes the ground before the ball. 3. Midfoot Strike – When the heel and ball of the foot strike the ground at the same time. 4. Habitual Foot Strike – The type of foot strikes the participant typically engages in 5. Inverse-dynamic – A method used to calculate the forces and torques needed to produce a specific movement. 6. Six-marker Pointer – A motion tracker that tracks X, Y, Z, Pitch, Yaw, and Roll movements.
Cited references to follow up on	Cavanagh, P. R., & Lafortune, M. A. (1980). Ground reaction forces in distance running. *Journal of Biomechanics*, *13*(5), 397–406. https://doi.org/10.1016/0021-9290(80)90033-0 Daoud, A. I., Geissler, G. J., Wang, F., Saretsky, J., Daoud, Y. A., & Lieberman, D. E. (2012). Foot strike and injury rates in endurance runners. *Medicine & Science in Sports & Exercise*, *44*(7), 1325–1334. https://doi.org/10.1249/mss.0b013e3182465115

	Fields, K. B., Sykes, J. C., Walker, K. M., & Jackson, J. C. (2010). Prevention of running injuries. *Current Sports Medicine Reports*, *9*(3), 176–182. https://doi.org/10.1249/jsr.0b013e3181de7ec5 Kulmala, J., Avela, J., Pasanen, K., & Parkkari, J. (2013). Forefoot Strikers Exhibit Lower Running-Induced Knee Loading than Rearfoot Strikers. *Medicine & Science in Sports & Exercise*, *45*(12), 2306–2313. https://doi.org/10.1249/mss.0b013e31829efcf7
Follow up Questions	1. Would the results of the study be different if there was more diversity within the participants' pool (gender and competitiveness)? 2. Would the results for a habitual MFS runner differ from the other two patterns? 3. Is one of these two types of foot strikes better for rehabilitation efforts?

Article #20 Notes: Muscle force distribution of the lower limbs during walking in diabetic individuals with and without polyneuropathy

Source Title	Muscle force distribution of the lower limbs during walking in diabetic individuals with and without polyneuropathy
Source citation (APA Format)	Gomes, A. A., Ackermann, M., Ferreira, J. P., Orselli, M. I. V., & Sacco, I. C. N. (2017). Muscle force distribution of the lower limbs during walking in diabetic individuals with and without polyneuropathy. *Journal of NeuroEngineering and Rehabilitation*, *14*(1), 111. https://doi.org/10.1186/s12984-017-0327-x
Original URL	https://link.springer.com/article/10.1186/s12984-017-0327-x
Source type	Journal Article
Keywords	Biomechanics, Gait, Computer simulation, Diabetic neuropathies
#Tags	#Injuries #LiveFeedback

Summary of key points + notes (include methodology)	- By measuring the muscle force produced by people, especially those in poor health, preserving healthy walking can be maintained.
	- In this study, muscle force from the lower limbs was measured during gait and estimated and compared with diabetic patients with and without polyneuropathy.
	- From previous studies, it has been determined that diabetic individuals use their hip flexor to move their leg more than the typical person who uses their plantarflexor muscles, indicating a change in muscle force distributions.
	- 30 adult participants were split into three experimental groups
	  ○ Healthy individuals (control)
	  ○ Diabetics with polyneuropathy
	  ○ Diabetics without polyneuropathy
	- Participants were asked to walk at a consistent speed (measured by gait cadence) barefoot along a designated area where their foot was measured with cameras and pressure plates.
	  ○ This data was then used to estimate muscle force from selected limbs.

	- Using a MANOVA test, it is determined that the gait speed was the same between all three groups - However, the force distribution was different between the groups ○ Due to this, the researchers recommended rehabilitation efforts to focus on preserving knee and ankle muscle functions.
Research Question/Problem/ Need	How is lower limb muscle force distribution altered between diabetic patients with and without polyneuropathy?
Important Figures	 Figure 1 shows the different muscle force distributions relative to the gait cycle between the three groups. The green line is the control group, the blue line is the group of diabetics with polyneuropathy and the red line is the group of diabetics without polyneuropathy.
VOCAB: (w/definition)	1. Polyneuropathy – A general term for the widespread damage or disease of multiple peripheral nerves. 2. Plantarflexors – A group of muscles on the lower calf that assist in gait. 3. Musculoskeletal Model – A computational model that consists of both the muscular system and the skeletal system. 4. Somatosensory Inputs – Referring to a sense anywhere along the body. 5. Proximal Muscles – Muscles located along the center of an area. 6. Neuromotor – Refers to the connection between the muscular and nervous systems.
Cited references to follow up on	Giacomozzi, C., D'Ambrogi, E., Cesinaro, S., Macellari, V., & Uccioli, L. (2008). Muscle performance and ankle joint mobility in long-term patients with diabetes. *BMC Musculoskeletal Disorders*, *9*(1), 99. https://doi.org/10.1186/1471-2474-9-99 Robinson, A. J. (1994). Invited commentaries. *Physical Therapy*, *74*(3), 213–215. https://doi.org/10.1093/ptj/74.3.213

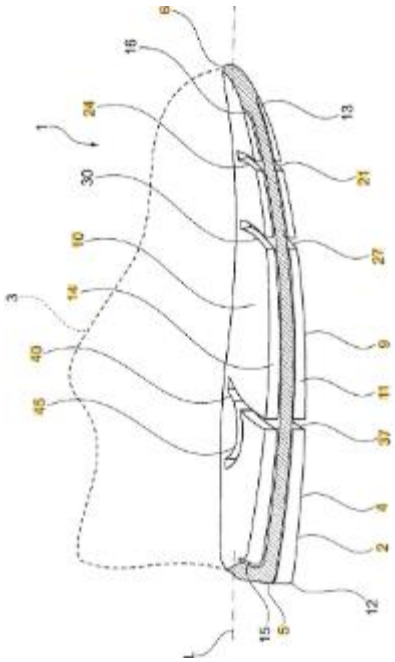
Follow up Questions	1. How would the results of this study change if a greater sample size was used? 2. How would the results change if the activity were different? 3. Could other measurement methods be used in place of these? 4. Why do people with diabetes tend to use their hip more than their plantarflexors when moving their lower extremities?

Patent #1 Notes: Shoe with improved sole

Source Title	Shoe with improved sole
Source citation (APA Format)	M·詹多利尼, R·博雷尔, S·巴托尔德, & Sas, S. (2017, April 13). *CN108720168B - Shoe with improved sole - Google Patents*. https://patents.google.com/patent/CN108720168B/en?q=(shoe)&oq=shoe
Original URL	https://patents.google.com/patent/CN108720168B/en?q=(shoe)&oq=shoe
Source type	Patent
Keywords	Insole, Outsole, Novel Shoe, Fatigue Reduction, Injury Reduction
#Tags	#Insoles #Running #Outsole

Summary of key points + notes (include methodology)	- The primary objectives of this design are to optimize cushioning and flexibility.
	  ○ By optimizing cushioning, fatigue and injury can be reduced and prevented.
	  ○ By optimizing the flexibility of the shoe, some of the user's foot deformation can be accomodated during gait changes.
	- The presented design is intended to improve ground support on both even and uneven terrain and seeks to enable a flexible shoe with an effective cushioning sole.
	- The general structure of the design includes a cushioned sole, an upper portion of the shoe, and a groove-oriented upper sole.
	  ○ The grooves match the natural grooves on the sole of the user's foot.
	  ○ Groove depth is increased towards the heel to increase the flexibility of the shoe.
	- The shoe design encourages natural movements of the foot
	- It reduces the stress on the knees, the hips, the ankles, and the feet

Research Question/Problem/ Need	The shoe presented is intended for practical applications, such as a shoe worn in a city or a sports shoe.

Important Figures	 Figure 1 is a side view of the novel shoe idea proposed by patent owners. Along the outsole of the shoe design, you can view the grooves in the sole of the shoe.
VOCAB: (w/definition)	1. Foot Deformation – Temporary foot structure changes during physical activities 2. Flexible Shoe – Footwear designed to mimic foot deformation during changing gait 3. Cushioning Sole – The midsole portion of the shoe responsible for shock absorption and comfort 4. Sensory Information Transmission – The ability for the foot to percieve ground contact 5. Ambulatory Activities – Walking or running activities
Cited references to follow up on	Gerber, M. L., & Inc, N. (2006, June 22). *USD536517S1 - Portion of a shoe outsole - Google Patents*. https://patents.google.com/patent/USD536517S1/en?q=(shoe)&oq=shoe 丹尼尔·a·约翰逊, & 黄陈玉. (2007, March 21). *CN101557733A - Article of footwear with a sole structure having an articulated midsole and outsole - Google Patents*. https://patents.google.com/patent/CN101557733A/en?q=(shoe)&oq=shoe
Follow up Questions	1. How does the alignment of grooves with joints improve mobility?

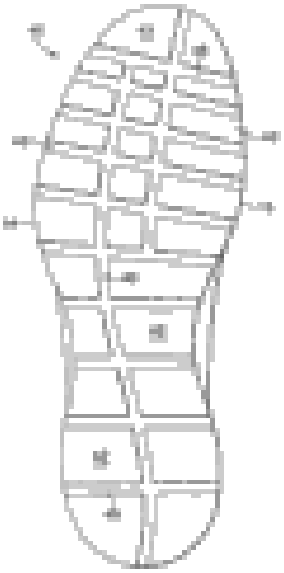
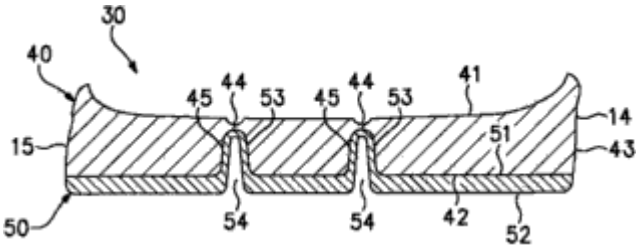
	2. How does this foot compare in terms of balance and stability compared to normal shoes? 3. How does the shoe design affect running economy? 4. Does the shoe perform differently depending on the ground material? 5. Do the grooves on the sole of the shoe affect the likelyhood of ankle rolling?

Patent #2 Notes: Article of footwear with a sole structure having an articulated midsole and outsole

Source Title	Article of footwear with a sole structure having an articulated midsole and outsole
Source citation (APA Format)	丹尼尔·a·约翰逊, & 黄陈玉. (2007, March 21). *CN101557733A - Article of footwear with a sole structure having an articulated midsole and outsole - Google Patents*. https://patents.google.com/patent/CN101557733A/en?q=(shoe)&oq=shoe
Original URL	https://patents.google.com/patent/CN101557733A/en?q=(shoe)&oq=shoe
Source type	Patent
Keywords	Outsole, Articulated Sole, Novel Footwear,
#Tags	#Insoles #Running #Outsole

Summary of key points + notes (include methodology)	- Traditional footwear consists of two primary components, the sole and the vamp
	  ○ Vamp holds the shoe together and covers the foot
	  ○ The sole contacts the ground to apply upward force
	- Aside from polymer foams, the end of a shoe can also be filled with fluids
	  ○ Typically, this fluid-filled chamber is merely a pressurized plastic capsule to trap air.
	- This design is a typical shoe design aside from the sole
	  ○ The end of the sole will contact the vamp on the upper surface
	  ▪ The lower surface will have grooves to fit with the big end
	  ○ The big end will then have matching grooves
	  ▪ It will also have a rigid bottom surface on the big end with ridges for extra traction
	- Due to the hinged structure of the shoe, it is much better for flexibility and elasticity compared to a regular shoe.

Research Question/Problem/ Need	The goal of this patent is to distinguish a sole design that allows for comfort, durability, and natural foot rotation while upholding the cushioning and grip from standard shoes.

Important Figures	 Figure 1 shows the layout of the grooves along the top surface of the big end of the shoe.  Figure 2 shows the bottom surface of the big end of the shoe that will generate the majority of the shoe traction.  Figure 3 shows a visualization of the grooves between the end and the big end that allow the shoe to be more flexible and elastic.
VOCAB: (w/definition)	1. Vamp – Upper portion of the shoe that covers the foot 2. Transverse elasticity – Flexibility of the shoe widthwise 3. Longitudinal elasticity – Flexibility of the shoe lengthwise 4. Hinged structure – Articulated sections along the sole that allow for bending and rolling 5. End – The middle layer of the outsole, this part is typically responsible for poor reaction forces 6. Big end – The bottom layer of the outsole, comes into contact with the ground 7. Interior End – The upper-most portion of the outsole that provides comfort

Cited references to follow up on	De Chaussures De Sport Sarl, A. F. (1976, July 29). *FR2374863A1 - SOLE FOR SPORTS AND LEISURE SHOES - Google Patents*. https://patents.google.com/patent/FR2374863A1/en?q=(shoe)&oq=shoe&peid=64656bd4caad0%3A1cf%3A46623a29 Hunt, H. M., & Individual. (1980, March 27). *US4309832A - Articulated shoe sole - Google Patents*. https://patents.google.com/patent/US4309832A/en?q=(shoe)&oq=shoe&peid=64656bd8206f8%3A1d0%3A9894a009 Jennings, A. L., Brown, J. H. C., & Co, A. C. (1941, August 9). *US2433847A - Sealed insulation block - Google Patents*. https://patents.google.com/patent/US2433847A/en?q=(shoe)&oq=shoe&peid=64656bd17a880%3A1ce%3Adaa4d7aa
Follow up Questions	1. Is there any data to back the claims that the grooves in the outsole improve natural foot rotation? 2. Do the grooves in the sole reduce the durability of the shoes? 3. Is the design solely for athletic usage, or could it benefit those who use it every day? 4. Are the depths, recessions, and depressions all optimized as much as they can be on this outline? 5. How does following the natural rotation of someone's foot affect their injury rate?