



# Running Shoes: What we do and don't know

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# Running Shoes: What we do and don't know

Presented by: Andrea Rector, DPT and Zachary Sanchez, ATC

**The purpose of this talk is to educate you on the history of the modern running shoe, describe the different types of shoes on the market, describe the typical shoe anatomy and look at what research tells us about commonly held beliefs.**

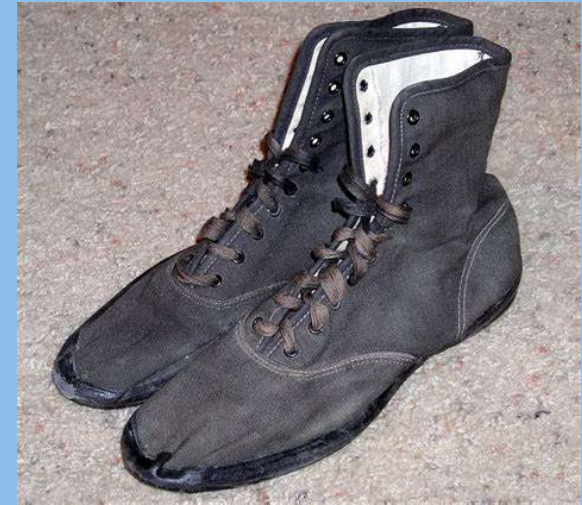
# Introductions

Andrea Rector & Zack Sanchez-O'Neill



# History of the Modern Running Shoe

- 99.9975% of history humans were barefoot or work primitive shoes
- Earliest footwear-sagebrush sandals found in caves dated back to 10,000 years (SF Stewart, 1972)
  - Smooth foot surface held on by straps over the instep
  - Function was protection of the sole
- Early 1800's athletic shoes emerged
- 1926 Adolf Dassler introduced the first customized running shoe



# History of the Modern Running Shoe



- 60 years ago saw the rise of cushioned running shoes
- 1970's saw a running boom with more inexperienced runners
  - 1972 the first Nike running shoes were introduced
- 1980's Nike consulted with three DPM to help them design their new shoes
  - Rather than conditioning the runner, they conditioned the shoe to support the unconditioned runner



# Functions of a Shoe

- **Protection**
- **Shock attenuation**
- **Traction**
- **Energy return**
- **Rear foot control**



# Shoe Anatomy



# Types of Running Shoes

# Types of Running Shoes



- Minimalist
- Traditional
  - Neutral
  - Stability
  - Motion Control
- Maximalist



# Minimalist



# 'Pseudo' Minimalist



# Traditional - Neutral



# Traditional - Stability



# Traditional – Motion Control



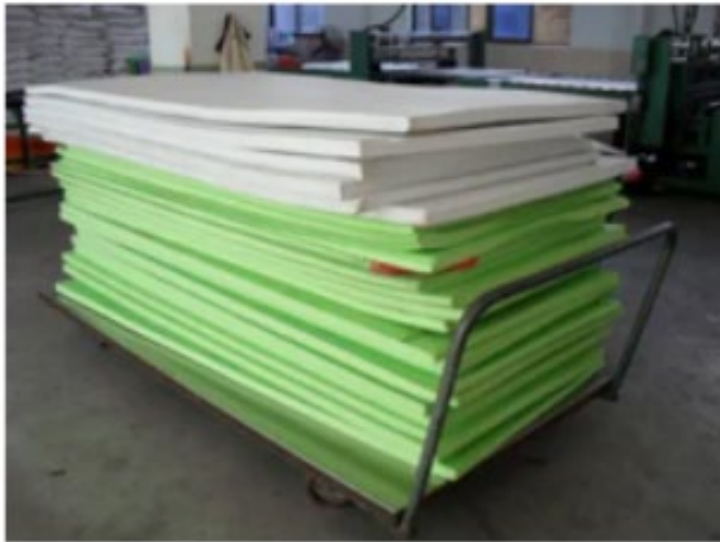
# Maximalist



# Midsole

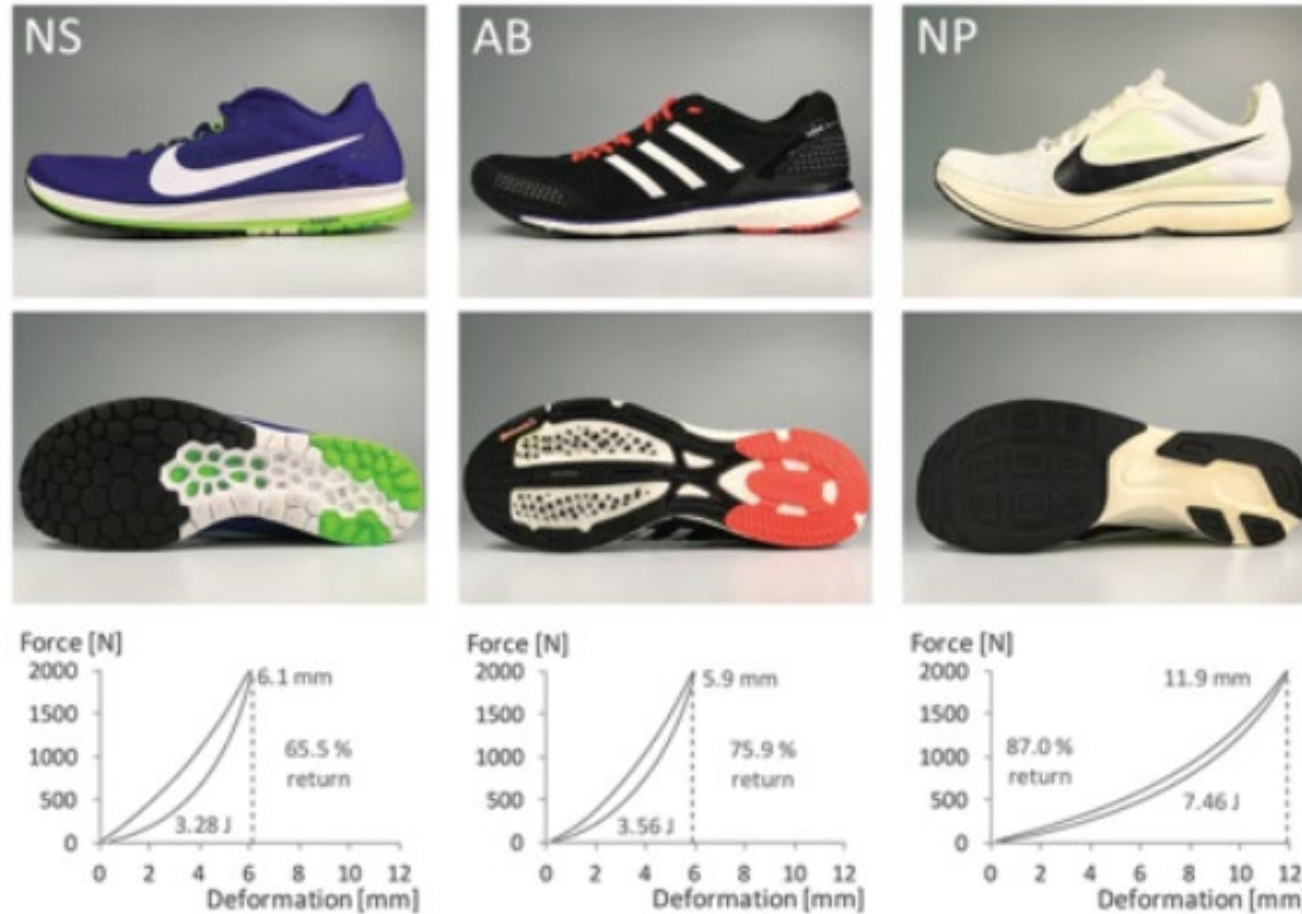
Where the biggest differences are

- PU (POLYURETHANE)
- EVA (ETHYLENE-VINYL ACETATE)
- TPU (THERMOPLASTIC POLYURETHANE)
- E-TPU (EXPANDED THERMOPLASTIC POLYURETHANE)
- PEBA (POLYETHER BLOCK AMIDE)



# Midsole

Where the biggest differences are



# Commonly Held Beliefs

Runners get injured due to impact and therefore need protection from impact

Runners get injured due to excessive pronation

Running shoes can correct excessive pronation and decrease amount of impact

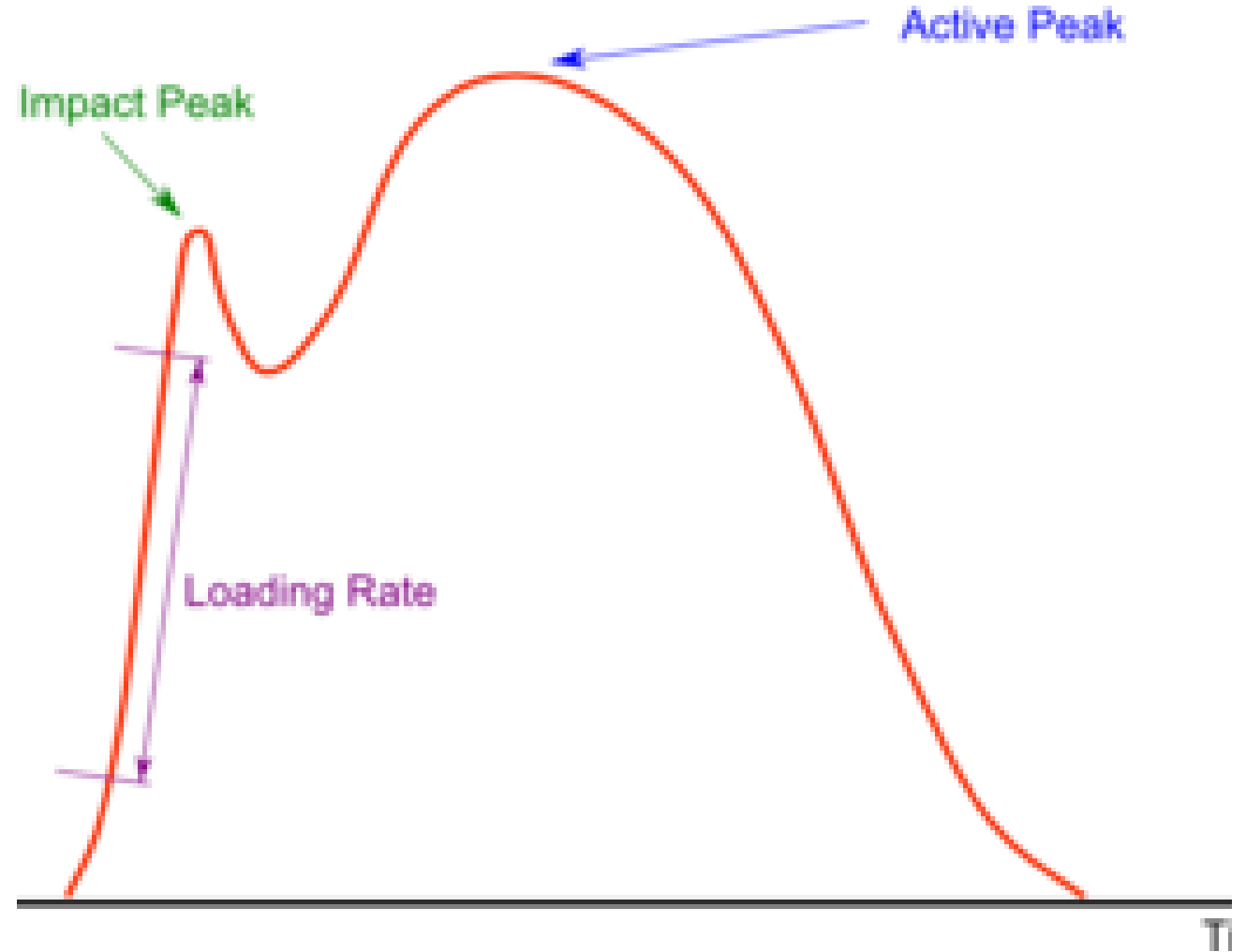
Running shoes can reduce injury

Running shoes should be prescribed based on foot type

Raised heels and increased arch support can better support the foot

# Ground Reaction Forces aka Impact

- Impact Peak- greatest force seen at initial landing
- Active Peak-greatest force detected during foot strike
- Loading Rate-how rapidly the forces build up



# Impact and Injury

- Epidemiological studies show the relationship is unclear (Nigg, Benno) (Messier, et al)
- A review of available research in 2007 found no relationship between impact peak and injury rates. (RN. Van gent)
- S.W. Bredeweg evaluated the symmetry of the impact peak in 210 novice runners and their subsequent injury rates
  - No difference in impact forces comparing injured limb to non-injured side



# Landing Pattern and Impact Peak

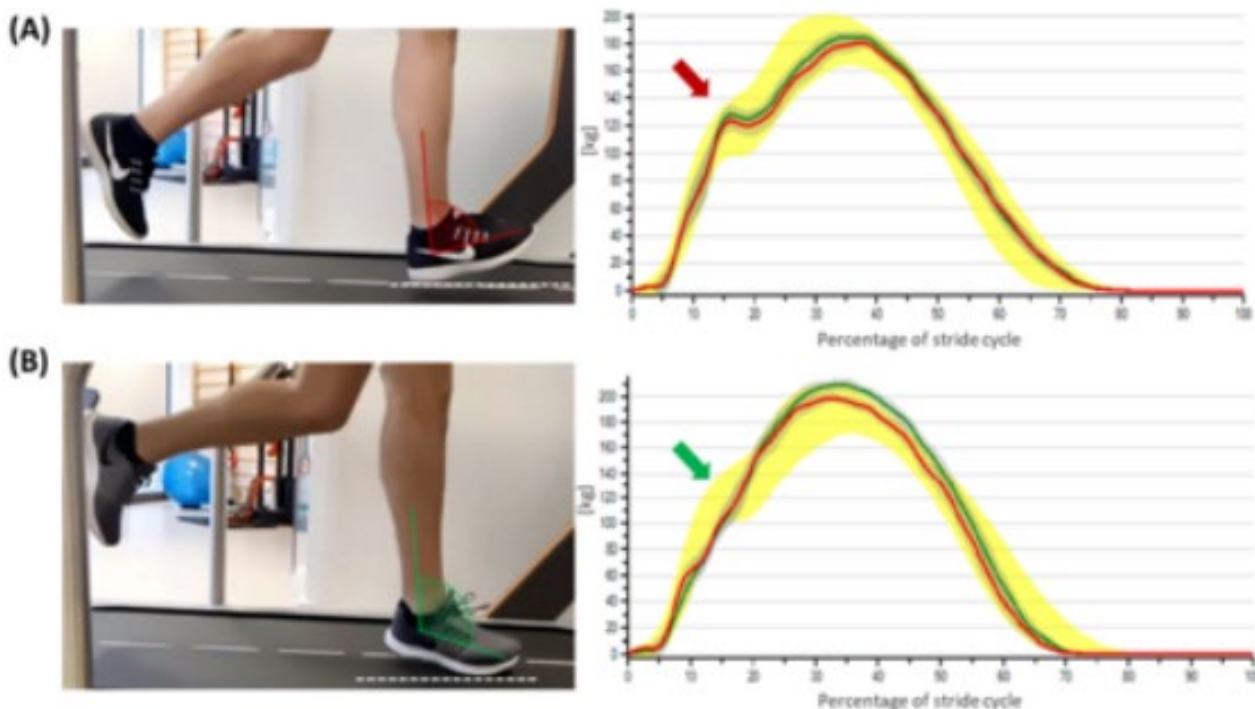


Figure 2. The impact peak force graphs showing impact peak presence (A), the red arrow specifies the impact peak occurrence; and impact peak absence (B), the green arrow specifies the impact peak absence. The red line represents the left side of the body, the green line represents the right side, the yellow band represents normal values.

- Rearfoot strike
  - Higher biomechanical load to patellofemoral joint and over the ground
  - Appears to produce a higher magnitude and an earlier impact peak
- Forefoot strike
  - Lieberman et al (2010) found that forefoot running did not generate the double impact peaks associated with heel strike running.
  - Boyer found that while forefoot strikers had a lower impact peak and a lower vertical loading rate, they demonstrated many GRF and LR similar to or greater than rear foot strikers (Boyer 2014)
- Strike pattern and relation to shoe type
  - Studies have shown that those who prefer a forefoot strike pattern tend to choose a shoe with a lower heel to toe drop and rear foot strikers tend to prefer shoes with a higher heel to toe drop (Roggio, et al)

# Impact and Injury



- Evidence to support a relationship between higher impact peaks and stress fractures
  - Peak impact rates were higher in those that had a previous injury (A. Hreljac, RN)
  - Meta-analysis of 13 studies showed a relationship between stress fractures and rate of loading (AA Zadpoor)
  - Meta-analysis of 18 studies in 2016 showed that the loading rate is higher in respondents with a history of stress fracture than in respondents without running injuries. (Henk van der Worp, 2016)
  - A comparison study of female runners with previous tibial stress fractures found that the injured runners had greater braking and impact forces than the controls (Zifchock, R 2006)

# Running Shoes and Impact

- Current evidence suggests that increased cushioning does not reduce impact
  - A study in the Journal of Biomechanics showed that midsole hardness did not influence external impact force peaks in heel-toe runners (B.M. Nigg 1987)
  - When comparing shoes with the same midsole hardness but different heel to toe ratios, there were no impact changes (Hamill, Joseph 2011)
  - No difference in impact forces between two shod conditions in which one type of shoe provided 50% more cushioning (TE Clarke, 2008)
  - Midsole hardness of modern cushioned running shoes does not seem to influence risk of running related injuries (RRI) (Theisen et al 2014)
  - A study of 93 runners that compared three different shoe hardnesses found that running in softer shoes had a greater impact peak due to runners increasing their joint stiffness in the softer shoes ( Aznar et al, 2015)



# Running Shoes and Pronation Control



Pronation is a necessary component of normal running biomechanics, facilitating shock absorption and stabilization.

Biomechanically, it can be shown that abnormal eversion could be related to injury, however, no cause-effect relationship has been directly established in the literature to date (Dierks, 2011)

Current evidence suggests that even a motion control shoe can only reduce pronation by around 1.5%

Foot pronation not associated with increase injury in novice runners wearing a neutral shoe (Nielsen et al , 2014)







# Typical Footwear Recommendations

Historically based on arch height and plantar shape:

- High/normal arch-neutral shoe
- Moderate arch drop-stability shoe
- Severe arch drop-motion control shoe

Thought to reduce injury risk by providing support

## The myth of arches and shoe types

Foot Type	Alignment	Shoe Type
 High Arch	 Supination	Cushioning Shoe
 Normal Arch	 Neutral	Stability Shoe
 Flat Foot	 Pronation	Motion Control Shoe

# Arches and Shoe Type

Matching footwear to foot type had no influence on injury (Knapik and Colleagues 2010)

- Three randomized control studies involving three branches of the military in which subjects were assigned shoe type based on their foot shape
  - Little to no difference was found in injury risk between those who were assigned a shoe based on their foot type versus those who were given a general “stability” shoe.

Ryan et al (2011) Br J Sport Med

- Examined injury status of 81 female runners assigned either neutral, stability or motion control shoe
  - Found most missed training days in those that were assigned motion control shoe
  - Regardless of foot type, those assigned the motion control shoe reported the most pain on a VAS
  - Concluded that the current approach to prescribing in-shoe pronation control systems on the basis of foot type is overly simplistic and potentially injurious.

Nielsen et al (2014) Br J Sports Med

- Foot pronation not associated with increased injury in novice runners wearing a neutral shoe

# Raised Heels and Arch Supports

Shoes with raised heels have not been shown to reduce Achilles tendon or calf injuries (van Gent, 2007)

Ankle range of motion does not change during running regardless of levels of shoe drop and heel height did not change the stress to the Achilles tendon (Reinschmidt, 1995)



As the level of drop decreases, the tendency for runners is to adopt more of a Midfoot to forefoot strike pattern (Chambon, 2013)

Achilles tendon stress may increase in minimalist shoes (Sinclair, 2015)

# Minimalist Shoes/Barefoot Running

A study comparing 107 barefoot with 94 shod runners found similar injury rates though barefoot runners had fewer injuries per runner (Altman, 2016)

Barefoot runners had more foot injuries but fewer injuries elsewhere

A systematic review in 2019 (Anderson, 2019) of 53 studies found that minimalist shoes reduced impact forces through the lower leg but no concurrent relationship between strike pattern and injury risk.

Authors concluded that assuming a runner is injury free, they should avoid changing their footwear

A 2017 systematic review in 2017 (Warne, 2017) showed runners who transitioned to minimalist shoes shows no difference in RRI compared to those who wore traditional shoes.



# Summary

There is no best algorithm for prescribing running shoes

Choose a shoe that is comfortable with the least amount of cushioning needed

Forefoot strikers should choose a shoe with less heel to toe drop

Transitioning to a minimalist shoe will most likely lead to a forefoot strike pattern



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