BOISE STATE UNIVERSITY

Biomechanical Analysis of Knee Motion to Prevent and Treat Progression of Knee Osteoarthritis

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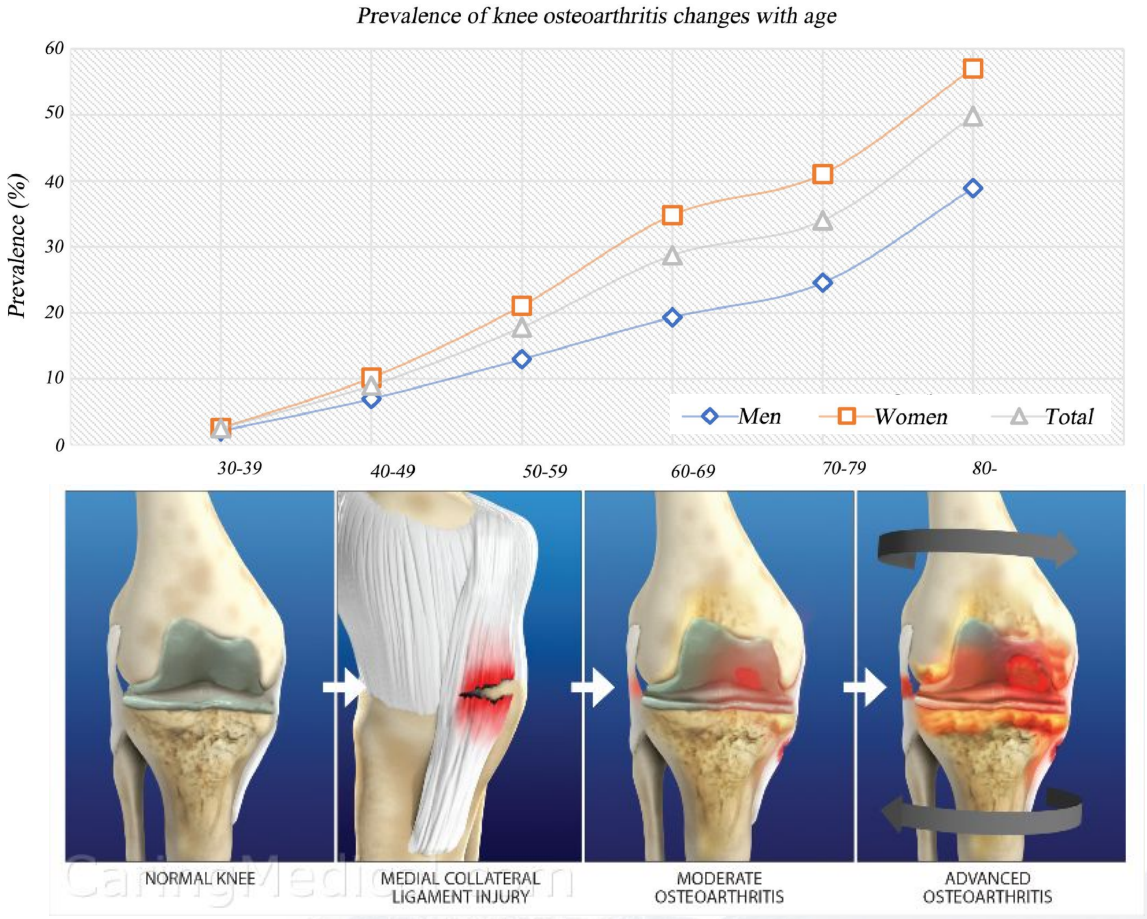
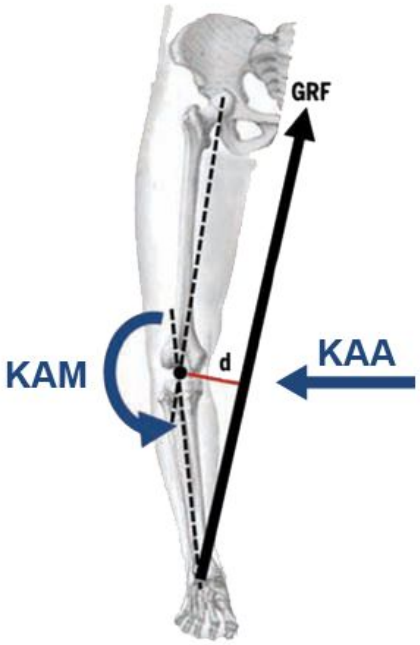
Knee OA is a degenerative joint disease affecting over 30% of individuals 65 years and older.

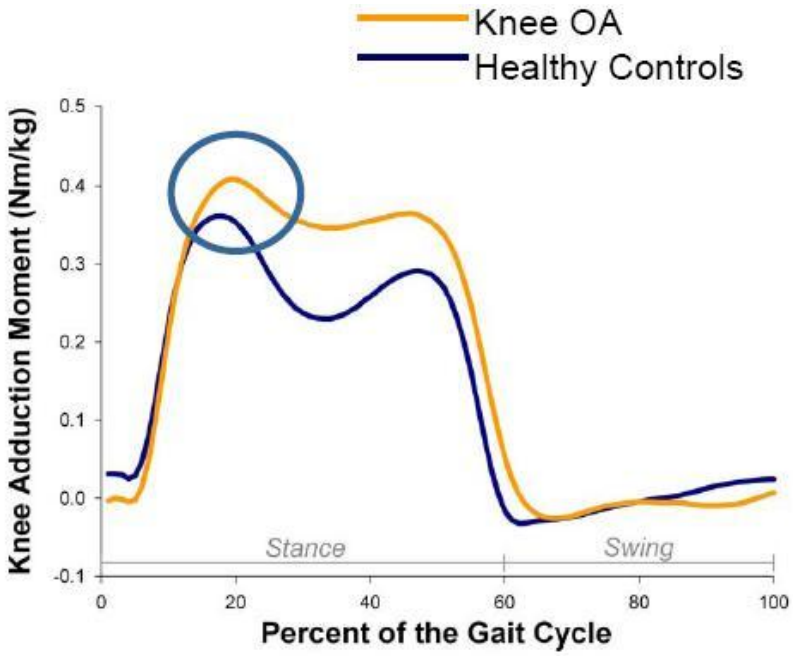


adapted from Cui et. Al., 2020

Current **knee OA treatment** is expensive, often toxic, and only marginally effective, as individuals still develop chronic pain and long-term disability.

Joint instability is major knee OA pathogenic factor, self-reported by 80% of OA individuals.



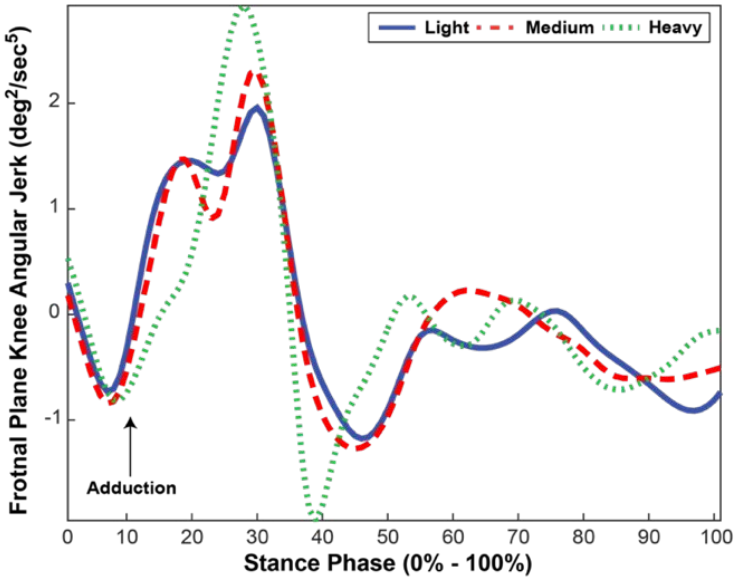


Knee adduction angle (KAA) and **moment** (KAM) are related to presence, progression and severity of knee OA (Chang et al., 2013; Foroughi et al., 2009).

No effective, modifiable measure of knee instability currently exists.

Hypothesis: individuals with musculoskeletal injury and disease will exhibit “jerkier” knee adduction motion.

Jerk - estimates “*smoothness*” of kinematic parameter (Flash & Hogan., 1985)

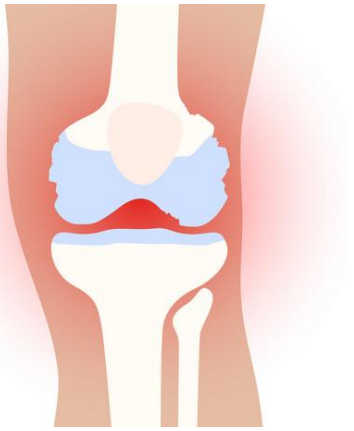


$$J_C = \frac{1}{2}\int_0^T \left|\frac{d^3\theta}{dt^3}\right|^2 dt$$

Aim: Quantify *smoothness of knee adduction* for individuals MSK injury and disease walking over flat and uneven surfaces.

Participants: To date, 18 adults have completed testing.

Cohort 1.



Radiographically confirmed knee MSK injury (ACL-R) .

Cohort 2.

Radiographically confirmed knee MSK disease (OA) .

Cohort 3.

Healthy sex-matched adults.

Walk Task: 10 m at self-selected speed and 1.3 ± 5% m/s.

Normal.

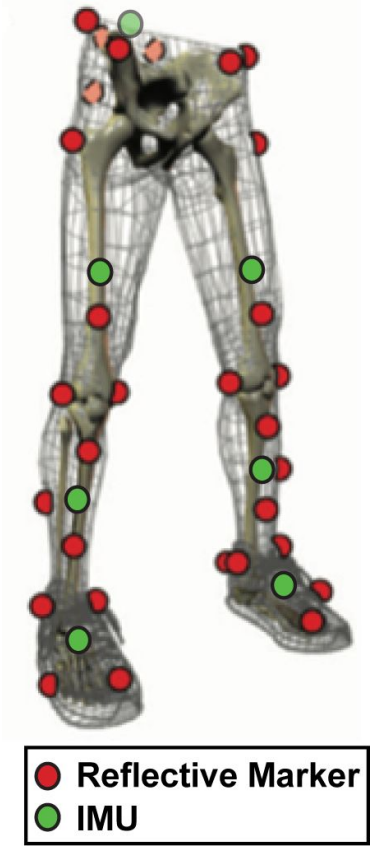
flat, painted wood panel

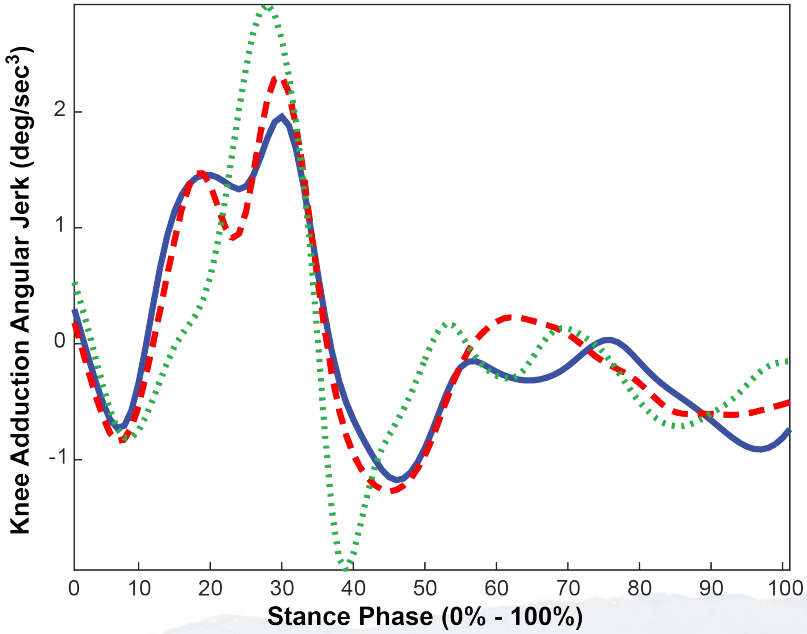
Uneven.

9 wood blocks of differing heights

Biomechanical Data: collected 3 trials at each speed, over each surface.

Biomechanical Analysis: quantified stance phase knee joint biomechanics.

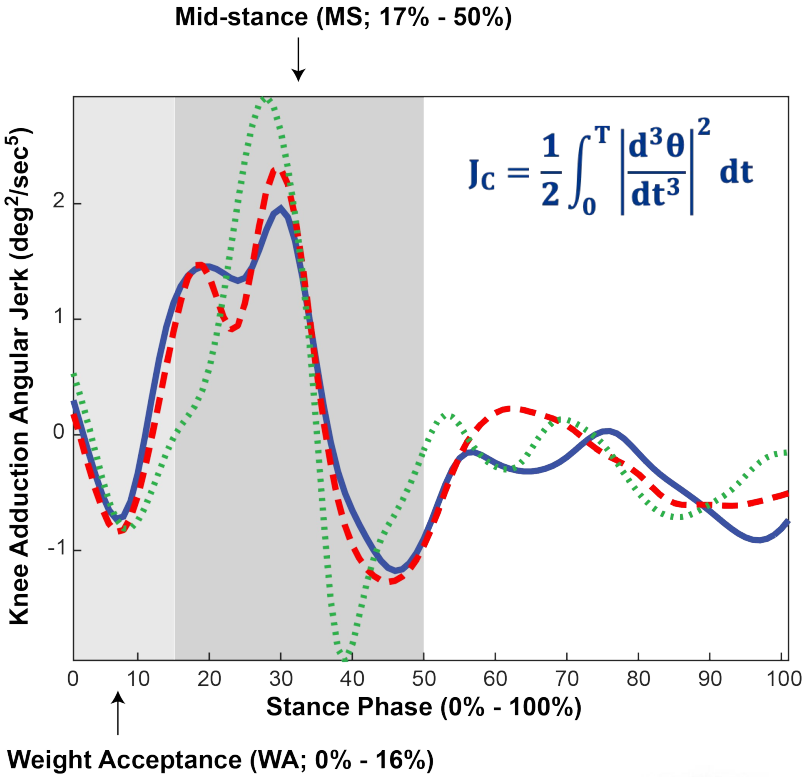


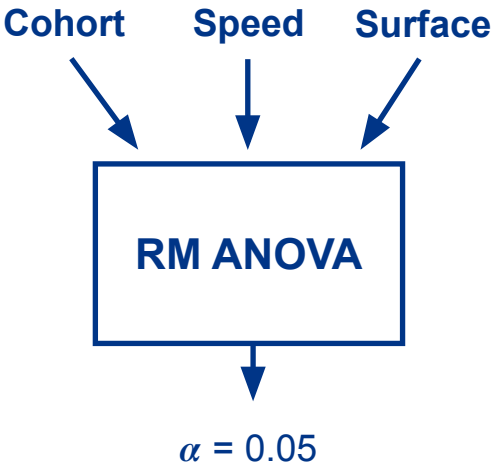


Video-based Data: 32 reflective markers

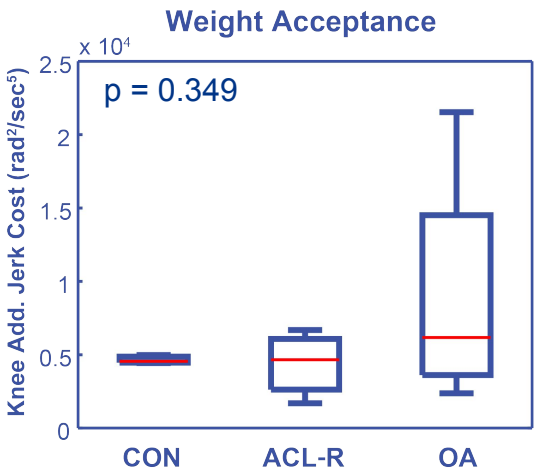
Where: θ = knee angle (rad); t = time (sec)

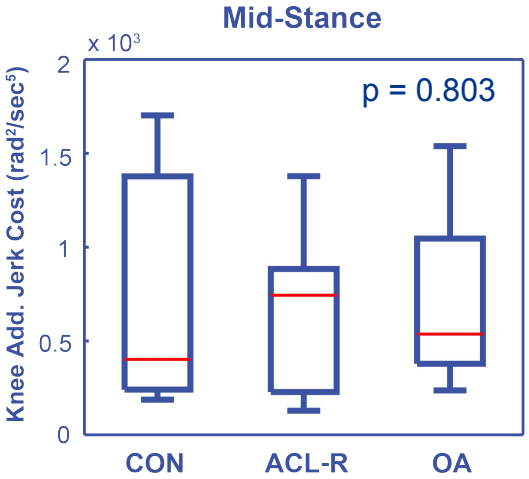
Jerk cost for knee adduction motion for the affected (or dominant) limb was submitted to analysis.

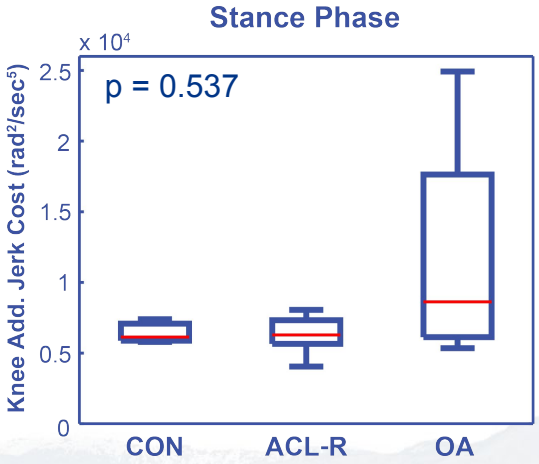




No significant main effect of cohort (p>0.349).

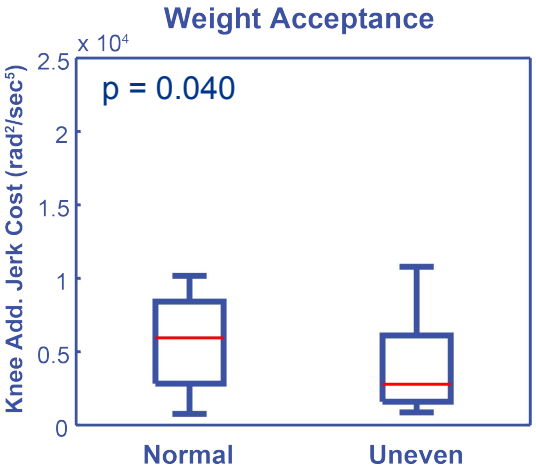


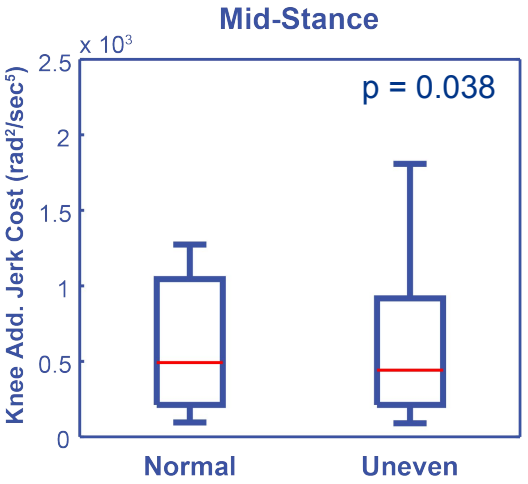


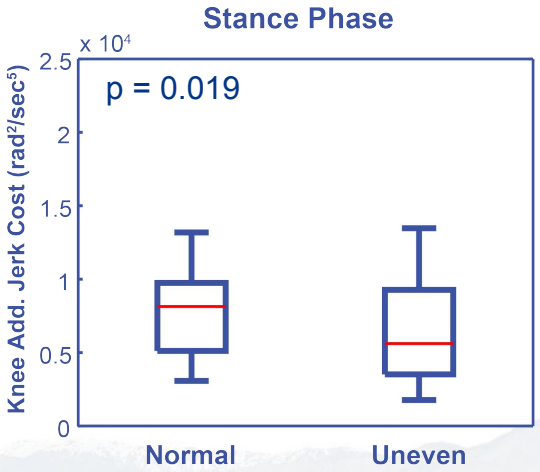


OA participants exhibited up to **95% and 96% greater jerk** cost than Con and ACL-R

Surface impacted “jerky” knee motion (p<0.040).

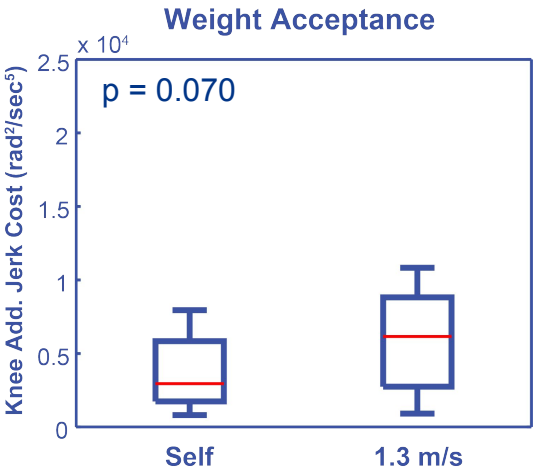


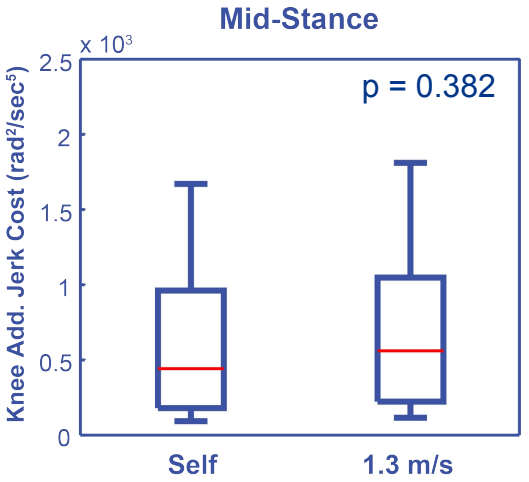


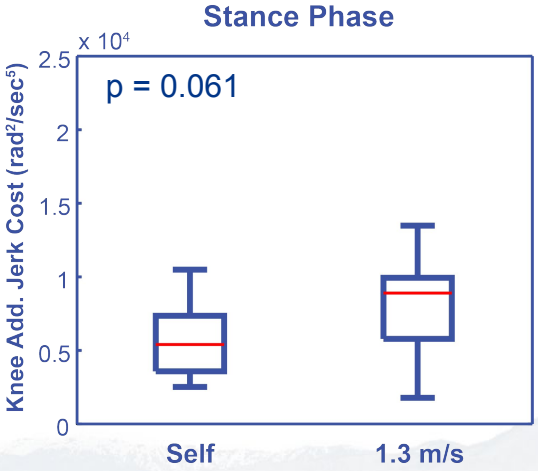


Contrary to our hypothesis, participants exhibited **greater jerk on the normal compared to uneven**.

Walk speed did not impact "jerky" knee motion (p>0.061).







Participants **exhibited a 20% to 50% reduction** in jerk cost with self-selected speed.

Preliminary Findings. OA participants exhibited a large, albeit statistically insignificant, increase in “jerky” knee motion.

Grant Submissions.

R01 - NIAMS

Aim 1. Determine whether “jerky” knee motion is an indicator of joint disease and function.

Aim 2. Evaluate whether “jerky” frontal plane knee motion is modifiable.

Aim 3. Develop statistical model of cartilage loading from “jerky” knee motion.

Applied Research Award - CDMRP (DoD)

Aim 1. Quantify knee joint instability with accelerometer-based sensors during operational and training-related tasks.

Aim 2. Identify service members at high-risk of developing premature knee OA.

Aim 3. Determine effective neuromuscular training strategies to prevent symptomatic knee instability.

Questions?

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