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Category: Physics and Astronomy

Title: Impact of the shock absorption properties of basketball shoe cushioning systems on the likelihood of lower extremity overuse injuries

1. All projects must have a Research Plan/Project Summary

- a. **Written prior to experimentation following the instructions below to detail the rationale, research question(s), methodology, and risk assessment of the proposed research.**
- b. **If changes are made during the research, such changes can be added to the original research plan as an addendum, recognizing that some changes may require returning to the IRB or SRC for appropriate review and approvals. If no additional approvals are required, this addendum serves as a project summary to explain research that was conducted.**
- c. **If no changes are made from the original research plan, no project summary is required.**

2. Some studies, such as an engineering design or mathematics projects, will be less detailed in the initial project plan and will change through the course of research. If such changes occur, a project summary that explains what was done is required and can be appended to the original research plan.

3. The Research Plan/Project Summary should include the following:

a. RATIONALE: Include a brief synopsis of the background that supports your research problem and explain why this research is important and if applicable, explain any societal impact of your research. (include studies that I read that helped me arrive at my research)

Over 1 billion people in the world play sports. With this high level of participation, many injuries occur. While some are more severe than others, injuries prevent an athlete from playing his/her sport. The majority of sports injuries involve the lower body (lower extremity injuries). In almost all sports, participants wear sneakers, which can help protect from injuries. Several studies have been completed that have examined the relationship between athletic sneakers and injuries and performance. In one study, the height, weight and flexibility of shoes were tested to measure athletic performance (Blache, Beguin, & Monteil, 2011). In a second study, different heights of shoes (high-top vs low-top) were tested against each other to determine injury rates. It was determined that high-top shoes reduce the prospect of ankle injuries compared to low-top shoes (Ricard, Schulties & Saret 2000). As a high school basketball player with first hand experience with the impact on the body of daily activity, I understand that overuse injuries are common. In an attempt to address this issue, I decided to focus my study specifically on the cushioning systems of basketball shoes to determine the impact of the shock absorption properties of basketball shoe cushioning systems on the likelihood of lower extremity overuse injuries.

b. RESEARCH QUESTION(S), HYPOTHESIS(ES), ENGINEERING GOAL(S), EXPECTED OUTCOMES: How is this based on the rationale described above?

Research Question(s):

- What is the impact of the shock absorption properties of basketball shoe cushioning systems on the likelihood of lower extremity overuse injuries?

Goal(s):

- Determine the shock absorption of specific cushioning systems.
- Hypothesize/determine a correlation between shock absorption and injury rates.

Hypotheses:

- The cushion that absorbs shock the best (in bench study) will minimize the force impact on the foot during the lab simulation.
- It is most favorable for overuse injury prevention to have a cushioning system with increased shock absorption because it will minimize the force put on the foot.

c. Describe the following in detail: • Procedures: Detail all procedures and experimental design including methods for data collection. Describe only your project. Do not include work done by mentor or others. • Risk and Safety: Identify any potential risks and safety precautions needed. • Data Analysis: Describe the procedures you will use to analyze the data/results.

I plan to perform two different phases as part of my overall study. In my bench study (Phase 1), I will find the shock absorption of four specific basketball cushioning systems by completing a drop test:

- Drop Test
 - Evaluating cushioning systems for energy return and shock absorption.
 - I will drop a ball from a specific height and record the height that the ball bounces off of the cushion.
 - A higher bounce correlates to more energy return and less shock absorption. Conversely, a lower bounce correlates to less energy return and a greater amount of shock absorption.
 - This will establish the relative level of shock absorption in each of the four shoes tested.

For the second phase of my study (Jump landings), I use advanced insole technology (Loadsol) from a lab to measure the normal/reaction force on the foot while wearing each shoe.

- Jump Landings (Phase 2)
 - Purpose
 - To determine the correlation between shock absorption levels measured in Phase 1 and the likelihood of overuse lower extremity injuries
 - Will determine if the shock absorption levels (determined in phase 1) correlate to the likelihood of overuse lower extremity injuries
 - Materials
 - The four basketball shoes
 - LeBron, Zoom Shift, Attack, Tai Chi

- Loadsol® insole <http://www.novel.de/novelcontent/loadsol>
- Monitors the normal force between the plantar side of the foot and the shoe.
- Loadsol® measures the total force on the foot
- Platform for jump landing - 2 ft
- Loadsol® app
- Procedure
 - Put the loadsol® insole inside the Lebron shoes
 - Perform 25 (or another number) jump landings
 - Track the total force on the foot in the loadsol app
 - Repeat this procedure on each of the three other basketball shoes
- Analysis
 - Find the mean force on the foot wearing each of the 4 shoes
 - Analyze the slope of peak loading to see the rate of landing
 - Immediate force on the foot or more spread out landing
- Statistical Analysis
 - Perform a One-Way ANOVA test to determine if my data is significant - if there is a statistically significant difference in my data
 - Perform the Tukey Method (if necessary)
- Limitations
 - Fatigue
 - Consistency of jump landing force

d. BIBLIOGRAPHY: List major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.

Blache, Y., Beguin, A., & Monteil, K. (2011). Effects of various parameters of basketball shoes on vertical jumping performance: A case study. *Science & Sports*, 26(1), 48-50.
doi:10.1016/j.scispo.2010.08.007

Ricard, M. D., Schulties, S. S., & Saret, J. J. (2000). Effects of High-Top and Low-Top Shoes on Ankle Inversion. *Journal of Athletic Training*, 38-43.

Chen, Chia-Hsiang, et al. "Effects of Forefoot Bending Elasticity of Running Shoes on Gait and Running Performance." *Human Movement Science*, vol. 38, 2014, pp. 163–172., doi:10.1016/j.humov.2014.10.002.

Da Silva, R. M., & Rodrigues, J. L. (2009). Evaluation of shock absorption properties of rubber materials regarding footwear applications. *Polymer Testing*, 28(6)

Items 1–4 below are subject-specific guidelines for additional items to be included in your research plan/project summary as applicable.

1. Human participants research:

a. Participants: Describe age range, gender, racial/ethnic composition of participants. Identify vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).

- In Phase 2 of the study, there will be 5 participants in the study
 - All between 15-18 years old, male, white, no vulnerable populations.

b. Recruitment: Where will you find your participants? How will they be invited to participate?

- Harrison High School students who have a size 8 foot and are willing to be in the study

c. Methods: What will participants be asked to do? Will you use any surveys, questionnaires or tests? If yes and not your own, how did you obtain? Did it require permissions? If so, explain. What is the frequency and length of time involved for each subject?

- The 4 participants will be asked to perform 5 jump landings in each of the 4 basketball shoes (so 20 total jump landings). This may take 30-45 minutes per participant

d. Risk Assessment: What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants? How will you minimize risks? List any benefits to society or participants.

- A very small amount of risk is involved. Participants will land from jumps in four basketball shoes that all provide ample support. The jump landings will be normal landings that athletes perform in normal movements.
- The tests will utilize standard equipment and will be supervised.

e. Protection of Privacy: Will identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected? Will data be confidential/anonymous? If anonymous, describe how the data will be collected. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will data be stored? Who will have access to the data? What will you do with the data after the study?

- No personal data/information will be collected.

f. Informed Consent Process: Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.

- I will explain my study to each participant, along with giving them a simple, easy to follow summary of the study and what they will be asked to do.