Exercise and Sports Biomechanics (EXS2ESB) - Force-acceleration principles

Problem Title	Determining influence of landing technique on ground reaction forces

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Learning Outcome(s)	
1	Determine the effects of landing technique on ground reaction forces
2	Calculate ground reaction force from body worn accelerometer data
3	Discuss the relationship between force and time when the change in momentum is controlled
4	Analyse and apply the data obtained to design a training program

Concepts / Competencies expected to engage with	• Force-acceleration principles (2nd Newton's mechanics law)

Course Level	Second year (introduction to biomechanics)

This problem involves data analysis	**Yes**	No	Maybe

Approximate Length	2 hrs

Class/ Group Size	25 students

Useful References	Tran, J., Netto, K., Aisbett, B. and Gastin, P. 2010, Validation of accelerometer data for measuring impacts during jumping and landing tasks, in Proceedings of the 28th International Conference on Biomechanics in Sports (2010), International Society of Biomechanics in Sports, Konstanz, Germany, pp. 1-4. Simons, C., & Bradshaw, E. J. (2016). Do accelerometers mounted on the back provide a good estimate of impact loads in jumping and landing tasks? Sports Biomechanics, 15(1), 76-88.

Mode of Instruction	Online or Face to face

The Scenario:

The indoor sports stadium observed a high number of shin splints in athletes involved recreationally in basketball. The stadium management group considered that the cost to replace the surface of their multiple courts would be too high and opted to engage an exercise scientist to explore the effectiveness of an assessment and retraining program to attempt reducing these injuries. You started your work and observed that, because of the nature of basketball involving jumps and landing, your best strategy would be to assess and improve the landing technique. During landing in Figure 1, the targeted muscles groups must be activated before landing to reduce the acceleration after ground contact. This is an important strategy to minimize bone stress, which could help reduce the risk of non-traumatic injuries such as stress fractures. Reducing peak acceleration and increasing time during landing are logical strategies to improve muscle engagement (via eccentric contractions) and better dissipate forces.

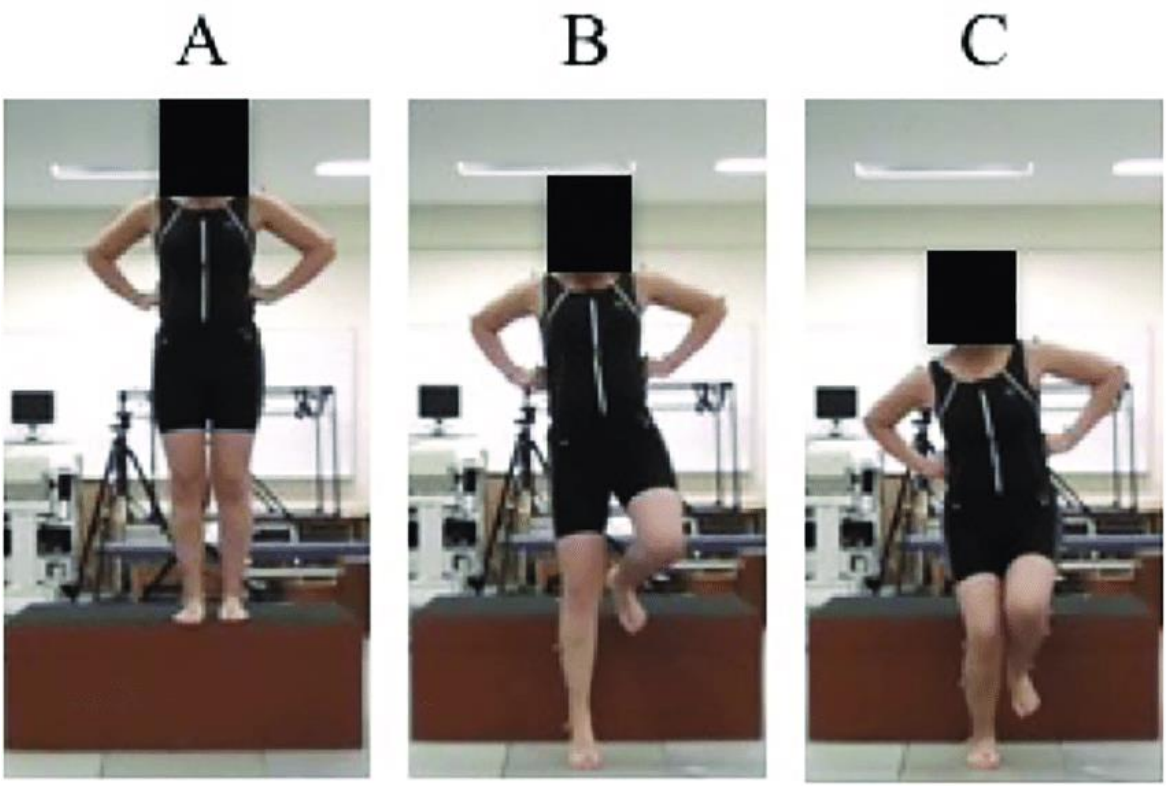

Figure 1. Example of a single leg drop landing task. Reference: https://www.researchgate.net/figure/Each-landing-phase-of-single-leg-drop-landing-A-Single-leg-drop-landing-Start_fig1_330644176

In order to do undertake your assessments and plan your retraining program at a lower possible cost, you will use accelerometers to calculate the force during drop landing using different techniques.

The Question:

1. You are in charge to explore different landing techniques that could reduce the peak landing force. Please discuss with your peer(s) regarding your approach and design to find the best landing technique.

2. Based on the data you have collected, how would you prescribe retraining exercises that would allow your athletes to reduce peak force during landing?

Guided Questions

The questions below may help you to explore the process.

1. After performing your normal landing with the accelerometer, please creatively design three different landing techniques that may reduce the peak GRF when landing from the same height. Qualitatively describe how the landing should be performed in correct anatomical and mechanical terminologies.
2. Perform the designed landing techniques and collect accelerometer data. Make sure the landing performance is executed as the techniques designed. Provide the GRF plots that represent all different landing techniques.

3. Calculate, rank, identify, and discuss the peak GRFs resulting from all attempts. Further discuss how and why the technique designed resulted in the lowest peak GRF with correct anatomical and mechanical language.
4. Provide examples of three exercises that you would utilize in your retraining program to help athletes reduce peak forces during landing. Provide a clear rationale for each of the exercises.

Expected Outcome:

1. The first three learning outcomes can be assessed through Question 1 specifically through the guided questions 1, 2, and 3. Students are required to provide the following work for assessment:
    a. qualitative description of three different landing techniques designed
    b. GRF plots that represent normal landing (baseline) and three different landing techniques
    c. worksheet that shows the steps to obtain the peak GRF via accelerometer data
    d. analysis and discussion of the technique that results in the lowest peak GRF from the perspective of the impulse-momentum relationship and other biomechanical concepts
2. The last learning outcome can be assessed through Question 2 and guided question 4. Students need to provide the design of retraining exercises that could reduce the peak landing force. The rationale and justification for the connection between the exercise designed and the data obtained need to be included.