**Worksheet: stress fractures in young runners**

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| Reference  Adam S. Tenforde et al. (2013), “Identifying sex-specific risk factors for stress fractures in adolescent runners,” *Medicine & Science in Sports & Exercise* **45**(10): 1843-51.  Pics: gostanford.com, stanford.edu |  |

Abstract (truncated)

**PURPOSE:** Adolescent females and males participating in running represent a population at high risk of stress fracture. Few investigators have evaluated risk factors for prospective stress fracture in this population.

**METHODS:** To better characterize risk factors for and incidence of stress fractures in this population, we collected baseline risk factor data on 748 competitive high school runners (442 girls and 306 boys) using an online survey. We then followed them prospectively for the development of stress fractures for a mean ± SD of 2.3 ± 1.2 total seasons of cross-country and track and field; follow-up data were available for 428 girls and 273 boys.

**RESULTS:** We identified prospective stress fractures in 5.4% of girls (n = 23) and 4.0% of boys (n = 11). Tibial stress fractures were most common in girls, and the metatarsus was most frequently fractured in boys. Multivariate regression\* identified four independent risk factors….

\*Multivariate regression:

* A regression is an analysis of how one variable (say, y) can be predicted from another variable (say, x).
* The usual form of a linear regression is *y = mx + b*, where m is the slope and b is the y-intercept.
* Multivariate regression uses multiple variables (which could be shown as multiple x’s) to predict another variable. It could take a form like *y = m1x1 + m2x2 + m3x3 + b*. This type of analysis is appropriate for variables like the likelihood of developing a stress fracture, which may depends on several other variables.

1. List at least 2 possible risk factors that might make an adolescent runner more likely to get a stress fracture.

2. What does “mean ± SD” mean?

3. Where did most stress fractures occur? Point out where these bones are in the body. Do these seem like expected or surprising locations for runners to have stress fractures? Briefly explain.

Table 1: Baseline characteristics and percent risk factors in male and female adolescent runners with or without prospective stress fracture injury.



4. What is the meaning of the P values (0.00 to 1.00)?

5. Did the researchers consider the risk factors you listed in question #1?

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| Table 2: Unadjusted and adjusted hazard ratios and 95% confidence intervals for various predictors and stress fracture risk in female runners. “Fracture history” refers to whether each person has previously had a stress fracture.  6. What are *late menarche* and *amenorrhea*? |  |

7. What is a hazard ratio? What is the range of possible values?

8. How do the univariate models differ from the multivariate model? (Hint: *uni* = 1; *multi* = more than 1.) Why do some of the possible risk factors become non-significant in the multivariate model?

9. Why might there be a hazard ratio above 1 for calcium supplementation?

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| Table 4: Unadjusted and adjusted hazard ratios and 95% confidence intervals for prospective stress fracture risk in male runners. |  |

Analysis

10. Why might participation in dance or gymnastics be associated with increased risk for girls, while participation in basketball is associated with decreased risk for boys?

11. Based on this study and your knowledge of anatomy and physiology, what 3-4 pieces of advice would you give to a female high school runner who wants to avoid stress fractures?