

LETTER TO THE EDITOR

Letter to the Editor about the article “Prediction equation of hip external rotators maximum torque in healthy adults and older adults using the measure of hip extensors maximum torque”



In 2021, Martins et al.¹ published a study with the aim to establish a prediction equation of hip external rotators (HER) maximum torque as a function of hip extensors (HEX) maximum torque in healthy and older adults. They included 83 healthy individuals in the original group and performed a simple linear regression resulting in the following equation: $HER_{torque} = -0.02 + 0.58 \times HEX_{torque}$ ($R^2 = 0.64$). The authors concluded that the prediction equation was valid and accurate, and could be used to estimate HER muscle strength in healthy and older adults. This is an interesting study that could help clinicians evaluate their patients more effectively.

The torque values were calculated multiplying the maximum isometric force measured with a hand-held dynamometer (Microfet 2[®] Draper, USA) by the distance between the dynamometer position and the greater trochanter, and then normalizing that measure by the individual's body mass (Nm/kg).¹ Thus, both HER and HEX torque values in Nm were divided by the individual's body mass, which can lead to a spurious association between hip extensors and external rotators strength.

Several authors have previously advised against the use of ratios for normalizing, because it can lead to a decrease in statistical power and the appearance of spurious associations.^{2,3} There could be a spurious correlation between ratios with a common divisor even when the two variables itself are uncorrelated.^{2,3}

As early as 1897, Karl Pearson realized this problem and proposed an approximate formula for the correlation between ratios with a common divisor.⁴ Many years later, Ji-Hyun Kim provided an exact formula for the correlation between ratio variables when all three variables are independent.³ If X , Y , and Z are uncorrelated, the relationship between X/Z and Y/Z , according to the approximation by Pearson is (note: V is the coefficient of variation):⁴

$$r_{(X/Z)(Y/Z)} \cong \frac{V_Z^2}{\sqrt{(V_X^2 + V_Z^2)(V_Y^2 + V_Z^2)}}$$

And the exact formula proposed by Kim when both $E(X)$ and $E(Y)$ take the same sign is:³

$$r_{(X/Z)(Y/Z)} = \frac{V_{1/Z}^2}{\sqrt{[V_X^2(1 + V_{1/Z}^2) + V_{1/Z}^2][V_Y^2(1 + V_{1/Z}^2) + V_{1/Z}^2]}}$$

From these formulas it can be calculated that the correlation between X/Z and Y/Z , when all the variables have equal coefficient of variation is approximately 0.51. Furthermore, when V_Z increases, the correlation between X/Z and Y/Z will increase, and when V_X or V_Y increase, then the correlation between X/Z and Y/Z will decrease. This kind of spurious association is called mathematical coupling.⁵

In their study, Martins et al.¹ divided both X (Nm of HEX) and Y (Nm of HER) by the individual's body mass (Z). This procedure could have led to a spurious association between X and Y , thus overestimating the relationship between them, and the predictive performance of their prediction equation. There are no data regarding mean and variance of X , Y , and Z within the manuscript, so we cannot know to what extent their results are due to mathematical coupling.

The correct mathematical notation for this kind of linear model, to prevent this issue when normalizing for a third variable, is as follows:

$$HER_{Nm} = \text{Intercept} + \beta_1 * HEX_{Nm} + \beta_2 * \text{Weight}$$

For these reasons, I would suggest Martins et al.¹ to correct their initial prediction model, and instead report the results according to the correct linear model presented above, in aim to avoid the issue of mathematical coupling, that could have overestimated their ability to predict HER torque based on HEX torque.

Conflicts of interest

The author declares no conflicts of interest.

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