Letters

COMMENT & RESPONSE

Correct Data and Meta-analytic Approaches Show the Reduced Risk of Concussion for Athletes Playing at Higher Altitudes

To the Editor We read with interest "Risk of Concussion for Athletes in Contact Sports at Higher Altitude vs at Sea Level: A Meta-analysis."[1] Unfortunately, Zavorsky and Smogila[1] made errors that invalidate their meta-analysis. The authors mistakenly used altitude (in feet) as the number of adverse events.[2] Detailed in Table 1[1] were 842 concussions used for the low altitude group and 52 concussions used for the high altitude group (which were actually median altitudes in feet, not incident concussions) taken from the original report that only had 284 total concussions.[2] The authors also excluded relevant concussion data from Lynall et al,[3] ignoring the incident concussions between 178 m and 284 m, thus inaccurately increasing the relative effect size[3] compared with the 2 larger studies included in their analysis.[2,4]

The authors used a random-effects model; however, using the fixed- or random-effects model is dependent on the inference that the researcher is trying to obtain. Because the authors suggested that the line of research should end based on the results of their meta-analysis, we assume that they aimed to make generalizable inferences.[1] As such, the inclusion of all populations would be most appropriate to test this hypothesis using their random-effects model. The random-effects meta-analysis that addresses the aforementioned errors and includes the remaining nonfootball population as a study group[4] showed a significantly decreased relative risk of concussion at increased altitudes (relative risk, 0.83, 95% CI = 0.71-0.98; $P = .03$).

Random-effects analyses should be considered approximate when the number of included studies is very small because of the poor precision of "between-studies" variance.[5] To overcome the shortcomings of the random-effects approach, a fixed-effects analysis was also evaluated to support a more specific descriptive analysis of existing studies that examined concussion incidence and altitude in American football. While this more conservative approach does not allow us to make inferences about a wider population,[5] in contrast to their claims,[1] the fixed-effects model with correct data from 3 studies demonstrates a statistically significant reduced relative risk for concussion (relative risk, 0.81, 95% CI = 0.75-0.86; $P < .001$) at higher altitudes in American football.

The current aggregate analysis (random- and fixed-effects meta-analyses), using correct data, consistently indicates a reduced risk of concussion at increased altitudes; however, the data still may not be robust enough to make strong inferences regarding wider populations. Importantly, based on the emergent preclinical and early-phase clinical trial data on jugular compression devices that directly support the safety and efficacy of the "tighter fit" hypothesis, the relative value of extrapolating indirect altitude data to further this question may have limited value.[6]

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