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Professional Football Participation and Mortality

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In Reply We agree with Drs Smith and Siddiqi that the estimated mortality hazard may be clinically meaningful, but because it is based on a small number of deaths, further follow-up is necessary. We would encourage this interpretation even if the *P* value had fallen below .05.

Both letters question our choice of comparison group, but this choice should be viewed in the context of the prior literature, which used general population controls. Professional football players have higher levels of physical fitness and tend to abstain from unhealthy behaviors compared with individuals in the general population.^{1,2} The skill and ability to succeed in professional football are likely negatively correlated with baseline mortality risk. We believed that this healthy worker bias³ was substantial,⁴ likely explaining why prior studies demonstrated substantially lower mortality risks of NFL players relative to general population controls.⁵ We focused on replacement players because we believed these athletes—by virtue of being on the margin of making an NFL roster—had baseline risk factors that were more similar to NFL players than general population controls. We could not test this assumption because this was a historical case study and collecting baseline health data was infeasible. Nevertheless, our findings were consistent with this contention. We found higher estimated mortality risk among career NFL players, opposite to the conclusion of prior studies.

In response to this correspondence, we examined replacement and NFL players who ostensibly were matched more closely in terms of baseline mortality risk, specifically, replacement players who were skilled enough to play as starters in a replacement game vs career NFL players. If our idea about the directionality of bias was correct, the estimates should be larger. This is what we found: adjusted mortality HR, 1.86 (95% CI, 1.1–3.1); *P* = .02, although we urge caution because this analysis was not prespecified.

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Furthermore, we agree that our design focused on differences in mortality from regular participation in professional football vs individuals who may have had substantial exposure to the sport short of professional participation. However, the fact that even this comparison among more experienced athletes yielded substantively meaningful estimates is striking. Moreover, the differences found in this study may implicate other mechanisms by which NFL exposure may influence health beyond head trauma, including lifestyle factors or difficulty adjusting to retirement. Our design does not allow estimation of the relationship between duration of play and mortality. However, this relationship is hard to credibly estimate. Among NFL players, those with longer careers had relatively lower mortality risk, suggesting that healthy worker bias is material even within professional athletes.⁴

In addition, with regard to sample size determination, our ex ante method was premised on the fact that the number of replacement players was fixed. Therefore, we used a log-rank test-based method to ascertain the number of cases needed to detect an elevated mortality hazard among NFL players consistent with prior literature. Also, we agree with Dr Fernandes and colleagues that survivorship bias is possible because NFL players were older at retirement. We believe, though, that the resulting bias was not large, especially as we adjusted for left truncation, so that individuals were considered at risk starting at last football activity. Mortality selection prior to retirement may also bias estimates, but only 4 deaths (all NFL players) occurred among active players in our cohort.

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