Making inferences about racial disparities in police violence

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This manuscript was compiled on November 6, 2019

policing | racial bias | police violence

A recent PNAS study, Johnson et al. (1), analyzes fatal officer-involved shootings to investigate the role of race in police violence. Unlike several previous studies which focused on victim race alone, the paper features original data about the race of *officers* involved in deadly force incidents. The analysis also offers a rare accounting of other shooting attributes, such as rates of attempted "suicide by cop" by civilians, that illuminate the context of these fatal encounters. The study discusses possible "discrimination by white officers," but concludes that racial diversity in police agencies brings limited benefits. These claims were quickly repeated in numerous major news outlets and cited in U.S. Congressional testimony, inflaming an already contentious policy debate.

But despite the value of this much-needed research, the analyses presented are mathematically incapable of supporting the study's central claims and the strong policy recommendations that follow. In this letter, we clarify the gap between what the paper claims to estimate and what it actually estimated, as well as the substantive implications of that difference for policymakers and future scholarship on race and policing.

The paper begins with the promise to address "the degree to which Black civilians are more likely to be fatally shot than White civilians," and its statement of significance prominently asserts that "White officers are not more likely to shoot minority civilians than non-White officers." This assertion forms the basis for the study's chief policy conclusion, "that increasing diversity among officers by itself is unlikely to reduce racial disparity in police shootings." In the language of probability, the paper states:

$$\begin{aligned}&\Pr(\text{shot}|\text{minority civilian}, \text{white officer}, X) \\ &\quad - \Pr(\text{shot}|\text{minority civilian}, \text{minority officer}, X) \;\leq\; 0\end{aligned} \qquad [1]$$

where X is a set of encounter attributes.

The paper's analysis cannot recover the shooting rates in Equation 1 because *all* observations in the data involve shootings. Instead, it estimates another quantity, "whether a person fatally shot was more likely to be Black (or Hispanic) than White," that does not correspond to the stated assertions. Specifically, the study estimated $\Pr(\text{minority civilian}|\text{shot}, \text{officer race}, X)$. The paper then infers "no evidence of anti-Black or anti-Hispanic disparity," because most fatally shot civilians are white (a pattern we would expect, given the white population's majority status).*

In a preprint response to our concerns, Johnson and Cesario (2) acknowledge that the original paper did not estimate the necessary quantities for the assertions we highlight here.

The analysis cannot inform the original claims—the left-hand side of Equation 2—without taking into account Bayes' rule, which states:

$$\begin{aligned}&\Pr(\text{shot}|\text{minority civilian}, \text{white officer}, X) \\ &\quad - \Pr(\text{shot}|\text{minority civilian}, \text{minority officer}, X) \\ &\quad = \frac{\Pr(\text{min. civ.}|\text{shot}, \text{white off.}, X)\Pr(\text{shot}|\text{white off.}, X)}{\Pr(\text{minority civilian}|\text{white officer}, X)} \\ &\qquad - \frac{\Pr(\text{min. civ.}|\text{shot}, \text{min. off.}, X)\Pr(\text{shot}|\text{min. off.}, X)}{\Pr(\text{minority civilian}|\text{minority officer}, X)}.\end{aligned} \qquad [2]$$

The study only examines part of the numerators in Equation 2, the terms dealing with $\Pr(\text{minority civilian}|\text{shot}, \ldots)$. Because it does not consider how many minority or white civilians are encountered, $\Pr(\text{minority civilian}|\ldots)$—the denominators in Equation 2—the study's analyses provide no evidence about whether "Black civilians are more likely to be fatally shot than White civilians" in the same circumstances, i.e., if $\Pr(\text{shot}|\text{black civilian}, X) > \Pr(\text{shot}|\text{white civilian}, X)$. For the same reason, the evidence also does not support the assertion that "White officers are not more likely to shoot minority civilians than non-White officers," i.e. $\Pr(\text{shot}|\text{minority civilian}, \text{white officer}, X) \leq \Pr(\text{shot}|\text{minority civilian}, \text{non-white officer}, X)$. The omission of $\Pr(\text{shot}|\text{officer race}, X)$—the second part of the numerators—is yet another point of divergence between the stated claim and the quantity estimated.

Johnson et al. provides new facts about the racial composition of civilians shot by white and nonwhite officers. While a contribution, these facts on their own cannot inform the relative likelihood of white and nonwhite officers shooting civilians of various groups. Interested readers and policymakers should keep this important limitation in mind when considering this work.

1. Johnson DJ, Tress T, Burkel N, Taylor C, Cesario J (2019) Officer characteristics and racial disparities in fatal officer-involved shootings. *Proceedings of the National Academy of Sciences*. Published online ahead of print July 22, 2019. https://www.pnas.org/content/early/2019/07/16/1903856116.
2. Johnson DJ, Cesario J (2019) Reply to knox and mummolo: Critique of johnson et al. (2019). 53. https://doi.org/10.31234/osf.io/dmhp.

*The paper tests regression intercepts, holding race-specific homicide rates equal (SI p. 5, ln. 208–215), and concludes, "Controlling for predictors at the civilian, officer, and county levels, a person fatally shot by police was 6.67 times less likely (OR = 0.15 [0.09, 0.27]) to be Black than White and 3.33 times less likely (OR = 0.30 [0.21, 0.47]) to be Hispanic than White. Thus, in the typical shooting, we did not find evidence of anti-Black or anti-Hispanic disparity... and, if anything, found anti-White disparities," (p. 15880).

D.K. and J.M. declare no conflicts of interest.

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