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Economic theory teaches us that competition typically results in increased efficiency and reduced costs in an effort to stay competitive. But although this phenomenon may hold true in more saturated healthcare systems with market-based principles such as the United States, this does not necessarily translate to similar advantages in growing health systems. Various countries across the globe still lack sufficient (or even any) pediatric cardiac surgical capacity whereby early competition between the public and private sector can cause (1) low per-center volume because of still having to scale, (2) resulting poorer outcomes as a result of volume–outcome relationships, (3) higher costs from a lack of economies of scale and higher rates of complications, (4) potential scrutiny of and reduced investment in public centers as a result of poorer infrastructure and outcomes, and (5) financial barriers to receive care in private centers in the event of monopoly or oligopoly (ie, no or limited competition).

In other words, public–private partnerships cannot be dismissed and should be leveraged as countries work toward universal health coverage and leaving no (cardiac) patient behind. Although rarely recognized, governments themselves have great incentives to invest in local cardiac surgical services, with the ability to save up to millions of dollars annually compared to relying on sending patients abroad and only having visiting teams in country.² Building cardiac capacity has health systems–wide effects that benefit all levels and services of a health system. Strategic public–private partnerships can accelerate this and provide greater purchasing power, shared learning, improved efficiency, and cost-sharing, all of which are necessary to better manage more patients. Data-driven efforts, such as the International Quality Improvement Collaborative,³ can further emphasize continuous quality improvement along with comprehensive monitoring and evaluation of surgical volume, patient populations, outcomes, and even financial metrics. Examples from centers in India (eg, Narayana Health) and China (eg, Shanghai Children’s Medical Center), which provide some of the highest annual per-center cardiac surgery volumes at some of the lowest costs anywhere in the world,⁵ are ones to follow, illustrating the power of bridging the public–private divide.

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STATISTICAL CONSIDERATIONS FOR THE DISAPPEARED SIGNIFICANCE IN REGRESSION MODELS

To the Editor:

We read with great interest the valuable study by Tjoeng and colleagues¹ reporting that compared with white children, African-American children had a greater mortality risk after cardiac surgery. This study is well designed. However, one limitation should be mentioned.

Multivariable logistic regression is widely used to adjust for potential confounders. In the current study, the authors concluded that the association between ethnicity and mortality was mediated by disease severity, as this result became nonsignificant after adjusting for severity scores. This speculation is possible; however, it is not rigorous enough. Therefore, we briefly summarize other possible statistical conditions in 4 schematic diagrams (Figure 1) that may lead to the nonsignificant result.

First, the multicollinearity² should be evaluated when the association between the independent variable (ethnicity) and dependent variable (mortality) is significantly affected by a confounding variable. For instance, in the case of Figure 1, A, ethnicity has a strong relationship with disease severity, and the intersection of ethnicity and mortality is basically covered by disease severity. Under this circumstance, the association between ethnicity and mortality could be overwhelmed after adding disease severity as a confounder. Tolerance and variance inflation factors are commonly used for multicollinearity detection and should be reported in the current study.

Second, the modulating or interacting effect between ethnicity and disease severity may also lead to a similar

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condition. For instance, in Figure 1, B, ethnicity has an impact on mortality; however, the effect size varies at different disease severity levels, suggesting that this association is modulated by disease severity. When this modulating effect between ethnicity and disease severity is bidirectional, we call it an interaction (Figure 1, C). The presence of an interacting/modulating effect should also be tested in the current study, and subgroup analysis may help to interpret these findings when a significant interacting/modulating effect was detected.

Third, the mediation effect^{3,4} also should be considered under this condition, using mediation analysis (Figure 1, D). The coefficient between ethnicity and mortality (γ), ethnicity and disease severity (α), disease severity and mortality (β) should be tested to determine the existence of a

mediating effect. The percentage and significance of the direct and indirect effects also should be reported.

Finally, Tjoeng and colleagues raised an important issue for patients undergoing cardiac surgery, and we suggest these statistical issues should be considered to reach a stable result.

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FIGURE 1. A-D, Four statistical conditions that may lead to a nonsignificant result.