LETTER TO THE EDITOR

Inappropriate use of covariate analysis renders meaningless results

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In this journal, Anstey et al. (2006) reported the results of a potentially important clinical study on the effect of cataract removal on the cognitive performance of older adults. Unfortunately, because of inappropriate data analyses, some reported results are meaningless. Consequently, the conclusions drawn by the authors regarding the impact of the cataract surgery cannot be considered valid.

Two groups were compared in the study. All participants were identified as having bilateral cataracts. The intervention group had cataract surgery while the comparison group did not have surgery at the time of the evaluation. The authors were concerned, appropriately, that visual acuity and age differences between the clinical comparison groups may make interpretation of the intervention difficult. This is particularly true because it was the intervention group that was younger and had significantly better acuity at the presurgery evaluation. The authors' treated acuity as a proxy variable for cataract severity.

To address the group differences in age and acuity, the authors used a series of covariate analyses. Such analyses are appropriate to determine the impact of the covariates on the main group effect. That is, the portion of variance attributable to the covariate can be partialled out of the main effect and the remaining variance can be evaluated to determine whether there is a difference between groups. However, the covariate cannot be used to adjust interaction terms with variables that are repeated measures or within subjects. "Only the between-subject comparisons are adjusted for the effect of the covariate, the within-subject (split-plot) comparisons will all have adjustments which are numerically equal to zero (Winer, 1971)." The fundamental flaw of the study is that the authors used the covariates in interaction terms involving the pre- and postmeasures of performance.

In fairness to the authors, they were misled by their statistical package. SPSS outputs interaction terms in mixed designs with covariates. SPSS has addressed this problem by issuing a technical response, Resolution No. 22133 (SPSS Knowledgebase, 2001). SPSS advises conducting the analysis of covariance (ANCOVA) to only determine whether the covariate has a significant impact on the main effect associated with the covariate. The interaction terms should be ignored in the output of the ANCOVA. To evaluate the interaction terms, a separate ANOVA should be done with no covariate.

The adjusted means reported in Tables 2 and 3 and interactions involving the covariates are incorrect. The authors need to redo all of their analyses without the covariates to determine whether or not there are significant interaction terms. Also, the covariate adjusted means should only be used for the main effect of group and not for the means in the interactions.

Until the authors report the appropriate unadjusted means and analyses, the conclusions of the study must be considered invalid.

AUTHOR NOTE

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