

## Letter to the Editor

# Response to Dobie *et al.* Letter, 'Exchange Rate and Risk of Noise-induced Hearing Loss in Construction Workers'

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We thank Dobie *et al.* for their letter and the additional discussion around this important issue. However, we believe that Dobie *et al.* have mischaracterized or misrepresented multiple aspects of our study. We hope this response will help clarify these issues for Dobie *et al.* and other readers.

As Dobie *et al.* note, the exposure metrics we compared were the equivalent continuous sound level ( $L_{EQ}$ ) with a 3-dB exchange rate (ER) and no threshold and the average sound level ( $L_{AVG}$ ) with a 5-dB ER and 80-dBA threshold. We have previously demonstrated that the threshold has a very minor impact on noise levels measured during construction work, even among workers with exposure levels around the threshold (Seixas *et al.*, 2001).

Dobie *et al.* correctly point out that for our models comparing the two metrics we compared model fit using the Akaike information criterion (AIC). We specifically noted that 'Models with lower AIC values were deemed to better fit the data'. We chose to use an information-theoretic (I-T) approach because it provides a framework for a quantifiable comparison of *a priori* set of hypotheses (Burnham *et al.*, 2011). This is preferable to comparing the degree of statistical significance (*i.e.*, the *P* value) of the  $L_{EQ}$  and the  $L_{AVG}$  coefficients of each

model (Gelman, 2013). Despite the comments by Dobie *et al.*, we did not state that one set of models was more predictive or significantly better than the others. We are unsure why Dobie *et al.* fail to make this distinction, as they are certainly aware of the work of Burnham *et al.* on using an I-T approach, even going so far as to cite an additional paper by Burnham *et al.* (2011) in their letter. Dobie *et al.* correctly cite information in Figure 2 of Burnham *et al.* (2011) when they say an AIC difference of 4–7 indicates plausible models, but neglect to mention that Table 1 in the same article shows that an AIC difference of 4 (*i.e.* the approximate difference between the baseline  $L_{EQ}$  and  $L_{AVG}$  4-kHz models in our study) indicates that one model is 7.4 times more likely than the competing model (Burnham *et al.*, 2011).

We take issue with the assertion by Dobie *et al.* that the use of the word 'consistently' supposedly 'hints at another route to statistical significance'. The word 'consistently' appears exactly twice in our article: once in the conclusion section of the abstract describing the general trend observed in the  $L_{EQ}$  and  $L_{AVG}$  models, and again in the final paragraph of our article in an unrelated context. In all but one case, the  $L_{EQ}$  models had a smaller AIC when compared to the corresponding  $L_{AVG}$  models.

We do not claim that this trend is indicative of a statistically significant difference, as we did not assess statistical significance; such an approach would go against the I-T approach as outlined by Burnham *et al.* (2011). In fact, we chose to use the I-T approach precisely because comparing the degree of statistical significance between the two sets of models is inappropriate (Gelman and Stern, 2006). However, the largest differences in AICs were seen at 3 and 4 kHz, the frequencies most vulnerable to noise-induced hearing loss (Royster *et al.*, 2003).

Dobie *et al.* cite a personal correspondence with one of the authors (R.N.) as evidence that neither the  $L_{EQ}$  nor  $L_{AVG}$  noise metrics improve prediction of hearing threshold levels (HTLs) compared to the ‘null’ model (*i.e.* the model without the noise exposure metric). This is a mischaracterization of the personal communication. In fact, the personal communication stated that ‘The AIC difference between the  $L_{EQ}$  and “null” model ... was not significant based on the AIC cutoffs we used in the paper. However, when comparing the  $L_{AVG}$  AIC to the null model the difference was significantly worse (again using our pre-defined criteria) ...’ (R.N.).

In our article, we justify our decision to exclude the baseline HTLs from our models and instead used them as an additional repeated measure (Glymour *et al.*, 2005). Dobie *et al.* are correct that the inclusion of our measure of peakiness improved the AIC of both models regardless of the exposure metric used, and we agree that this is an important consideration for future research. However, even after adjusting for peakiness, our models still favor the  $L_{EQ}$  over the  $L_{AVG}$  exposure metric. These results are in line with the recommendations of Suter (2016), which represent the most comprehensive review of the issue to date.

Dobie *et al.* assert that the estimated  $L_{EQ}$  and  $L_{AVG}$  values may not represent the workers’ actual exposures. As they are no doubt aware, for any longitudinal study of this duration, it is not feasible to measure each participant’s daily exposure to all sources of noise; in fact, this limitation applies to the two studies regarding impact noise that Dobie *et al.* cite in their letter (Taylor *et al.*, 1984; Thiery and Meyer-Bisch, 1988). Nevertheless, we stand behind our exposure estimation methods. In response to Dobie *et al.*’s specific concerns about these methods:

1. Dobie *et al.* are correct that we calculated  $L_{EQ}$  and  $L_{AVG}$  task-based noise levels in this analysis, but their characterization of the underlying data is grossly inaccurate. As demonstrated in the paper cited by Dobie *et al.* (Neitzel *et al.*, 2011a), task-based exposure estimates showed better agreement with measured exposures than the traditional trade-mean and subjective approaches to exposure estimation.

In addition, it is important to note the uncertainty in the measured exposures themselves, which were based on only three measurements per individual (Neitzel *et al.*, 2011a). We do not argue that task-based exposure estimation is infallible, but the evidence indicates that this is the best currently available approach for estimating noise exposures among construction workers. Dobie *et al.* assert that our analysis lacked dosimetry data. This is simply not true, as was clearly stated in our original manuscript: ‘The task-based noise levels were calculated from 1310 full-shift noise measurements (with noise levels data logged at 1-min intervals and simultaneous recording of task involvement and timing by subjects) collected between 1997 and 2008 on commercial construction sites’ (Seixas *et al.*, 2012).

This substantial dataset of dosimetry measurements represents more measurement data than were available in many historical epidemiological assessments of noise-induced hearing loss.

2. Dobie *et al.* note that we did not consider nonoccupational noise in our analysis. This is correct; our prior analyses that indicated that nonoccupational noise exposure never entered any of our models as a significant predictor of noise-induced hearing loss, and we chose to exclude consideration of this exposure in the current paper based on these previous results (Neitzel *et al.*, 2004; Seixas *et al.*, 2012).
3. We chose not to consider any effects of hearing protection because, as we noted in our original manuscript, ‘This inception cohort was chosen because of reported infrequent use of hearing protection ...’ (Neitzel *et al.*, 2011b; Seixas *et al.*, 2012). This decision is supported by a number of our prior studies that have documented the very low usage rates of hearing protection device use among construction workers (Neitzel *et al.*, 1999; Seixas *et al.*, 2001, 2011; Edelson *et al.*, 2009; Griffin *et al.*, 2009).

With regard to the choice of databases for comparison of rates of noise-induced hearing loss, ISO 1999:2013 leaves the choice of which database to use up to the discretion of the user. We chose to use the highly screened population in Annex A of the standard because the workers who participated in the study were screened for otological irregularities upon their entrance into the study, and because we assessed nonoccupational noise exposures and found them to be insignificant with regard to risk of noise-induced hearing loss (Seixas *et al.*, 2005, 2012). On the basis of these circumstances, we believe it was appropriate to use the highly screened population in ISO 1999:2013 as our basis of comparison.

We hope that this response clarifies our conclusion that the I-T approach indicates that the  $L_{EQ}$  is the recommended metric for the evaluating noise exposures among construction workers and other populations with similar exposure characteristics.

## Declaration

The authors have no conflict of interest to disclose. However, in the spirit of full disclosure, the authors would like to make the editor aware that one of the authors (B.R.) is currently employed at Cardno ChemRisk, a scientific consulting firm involved with litigation. The research for this article was completed when the author was a doctoral student at the University of Michigan, and his current employment had no impact on this article.

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