Using culpability analysis to infer crash risk requires unrealistic assumptions

Author’s response to: Culpability Analysis is Still a Valuable Technique

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In a commentary in the February 2013 issue of IJE, I noted serious concerns about inferring the relationship between cellphone use and crash risk from the association between cellphone use and culpability. I also noted a range of possible biases and measurement errors that challenge the internal validity of the study by Asbridge et al. Despite the technical nature of these arguments, the authors have responded by appealing to tradition and noting the consistency of their findings with other studies on cell phone use. Since the fundamental inference issues remain unaddressed, I highlight the central arguments from my original commentary here. As before, my interest is limited to causal inference methodology.

In their response, Brubacher et al. do not address the potential sources of bias and measurement error in their analysis. For example, it is possible that police reporting of cellphone use was nonrandom and correlated with the culpability assessment, especially given the small proportion of identified cellphone users, relative to what might be expected. In particular, unsafe driving actions, which come with heavy penalties on the culpability tool, may be more likely to be reported when cellphone use is reported. Also, cellphone use may be more likely to be reported when other explanations are not identified. In fact, the differences in the culpability assignments between cellphone users and non-users that are provided by Brubacher et al. in their response could easily be overwhelmed by these considerations.

Furthermore, the inference by Asbridge et al. that cellphone use increases crash risk, based on a positive association between cellphone use and culpability, in part assumes its conclusion. Culpable and non-culpable conditions are a set of parameters, ranging from the weather to the attending police officer, under which drivers are more and less likely to be found culpable, respectively. Among drivers who crashed, Asbridge et al. observe a greater proportion of cellphone users under culpable conditions than under non-culpable conditions. In terms of crash risk, there are at least two possible explanations for this. Perhaps cellphone use increases crash risk, and does so more under culpable conditions. Alternatively, cellphone use decreases crash risk, and does so more under non-culpable conditions. However, Asbridge et al. ignore the second scenario by assuming that under non-culpable conditions, cellphone users and non-users share the same crash risk.

Finally, Asbridge et al. assume that cellphone use is independent of driving conditions, which is unrealistic even if culpability and cellphone use at the time of the crash are ascertained independently by objective standards. More plausibly, occasional cellphone users are most likely to use phones under apparently safe road or traffic conditions, and least likely to use them under the hazardous conditions that disproportionately generate non-culpable crashes. Hence, the rate of cellphone use observed in non-culpable crashes might not be representative of cellphone use under the full range of non-culpable conditions or of use under culpable (safer) conditions. Indeed, a higher rate of cellphone use in culpable than non-culpable crashes would follow even in the absence of a causal effect of cellphone use on crash risk. Thus, culpability analysis should not be used to infer crash risk.

Funding

P.S. is supported by a National Science Foundation Graduate Research Fellowship.
Benson et al. recently published in this journal analyses of the Million Women Study to study tumour incidence in relation to the use of mobile phones. Based on their analyses of this exceptionally large and valuable cohort, the authors concluded that their study did not show any increased incidence of glioma, meningioma or non-CNS cancers. However, it is surprising that the important positive finding of their study showing a statistically significant increased risk of acoustic neuroma (relative risk (RR) 2.46, 95% confidence interval (CI) 1.07–5.64) with long-term (10+) use of mobile phones was not included in the conclusion section of the abstract and was only discussed after pooling with the Danish prospective cohort in the conclusion section of the paper.

This is surprising given that the finding provides further support for the Working Group of the IARC monograph programme to classify radio frequency electromagnetic fields as ‘possibly carcinogenic to humans’ (Group 2B) based on limited evidence from epidemiological studies for acoustic neuroma (and glioma, but not meningioma). The finding itself is further strengthened by an observed clear dose-response association; with RR = 1.00 (0.54–1.82) for <5 years of use, RR = 1.80 (1.08–3.03) for 5–9 years of use and finally RR = 2.46 for 10+ years of use.

The main argument for not interpreting these results as indicative of a causal association between long-term mobile phone use and increased risk of acoustic neuroma, even in the presence of a clear dose-response associations, is that after pooling the data from this study with those of the Danish prospective study, the pooled risk estimate is non-statistically significant with a RR of 1.16 [95% CI 0.75–1.81] for mobile phones use for at least 10 years. As outlined by the authors, the rationale for post hoc pooling of two studies from different populations was that both were prospective cohort studies that did not suffer from the recall bias in case-control studies: most notably the INTERPHONE study and work published by Hardell et al. However, the Danish prospective cohort study is also not free from bias, most notably because of problems with correct identification of mobile phone subscribers between 1987 and 1995 (with all non-participants (42%), including business users, classified as ‘non-exposed’). These problems in the design of the Danish study will have biased any risk estimates towards the null and pooling therefore has inevitably led to a reduction in the effect size; despite the strengths of the Million Women Study in itself. A common and more transparent approach would have been to conduct a meta-analysis of all available scientific papers (incorporating each study with its own strengths and weaknesses), instead of post hoc and selective pooling of data as done by Benson et al.

The epidemiological evidence on long-term (10+ years) use of mobile phones and risk of acoustic neuroma is summarized in Table 1, with the results of the random-effects meta-analysis also shown graphically in Figure 1. As shown, the accumulated scientific evidence remains inconclusive, but does indicate a 14–43% summary increased risk of acoustic neuroma because of long-term (10+ years) use of mobile phones, although without reaching statistical significance (95% CI 0.76–2.67).

In conclusion, in contrast to conclusions on acoustic neuroma by Benson et al., a meta-analytic approach indicates, in agreement with the conclusions from the IARC monograph programme, that long-term (10+ years) mobile phone use may lead to increased risk but, not surprisingly, that the evidence is not yet conclusive. Future prospective studies with improved exposure assessment using records of mobile phone