Author’s response to reviews

Title: Evaluation of different radon guideline values based on characterization of ecological risk and visualization of lung cancer mortality trends in British Columbia, Canada

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Version: 3
Date: 12 October 2015

Author's response to reviews: see over
Response Document: Revision 2
Re: MS: 8702582891761091


October 12 2015

Please find below an outline of the specific revisions taken to improve this manuscript. We again would like to re-iterate our appreciation for the time and effort the reviewers took to provide additional feedback that has allowed us to improve the manuscript.

REVIEWER 1

The authors claim that they visualize lung cancer mortality in several ways in the manuscript – also in the present title: ----“Visualization of lung cancer mortality trends in British Columbia”---- - This is not necessarily an informative description of the content of the manuscript. In the manuscript the authors seem to have proposed something more like a hazard model – with potential limitations regarding validity.

“Visualizations of lung cancer mortality trends” refers to the temporal trends shown in Figures 5 and 6. One of the goals of the manuscript was to assess the differences between different characterizations of ecological risk by simple visualization of the trends in different scenarios. We have not used anything like a hazard model, nor have we proposed one. Based on the last round of reviewer comments we changed the manuscript title to “Evaluation of different radon guideline values based on characterization of ecological risk and visualization of lung cancer mortality trends in British Columbia, Canada” to make the methods used even clearer.

The selection of references may still be limited. The manuscript is based on an assumed consensus regarding the LNT model, reported in different ways by Darby, Krewski and others. Today there are additional scientific literature discussing the LNT model - the references 2-5 given by the authors are not necessarily central with regard to this. These references cannot be considered an undisputed evidence for a scientific consensus regarding the LNT model. There is hardly any discussion on, or references to, updated literature on the LNT model in the present manuscript. To exemplify the concern regarding these references: In the studies published by Darby and Krewski et al, 7148 persons with lung cancer and 14 208 controls were enrolled. The exposure to radon in cases and controls were estimated - some 25 years back in time with 5 years lag - in twelve countries. The estimated exposure ranges to radon - in both cases and controls - were wide both within countries and especially between countries. However, no difference in mean exposure between cases (lung cancer) and controls were found, 3.4 Bq m-3 to be exact - based on retrospective, crude estimates. To what extent the 3.4 Bq m-3 difference is significant, is hardly discussed by Darby et al or Krewski et al. It is not likely that the degree of significance
can be calculated with any method - epidemiological or others. To extend the concerns regarding the present manuscript and the references the scientific work relies on, I would like to address the concern discussed in Science twenty years ago: "One of the dangers of having all these fancy mathematical techniques is people will think they have been able to control for things that are inherently not controllable." a statement from biostatistician Norman Breslow of the University of Washington, Seattle (Epidemiology faces its limits, Science Vol. 269, No. 5221 (1995), pp.164-9). So, please consider the validity and potential limitations of the scientific outcome once more and look at the possibility to extend the list of relevant references.

We acknowledge the assertion that the LNT hypothesis is not undisputed. As a result we have modified the introduction, including the addition of a reference that can direct the reader to literature that does not support the LNT model. While the LNT model is not undisputed, in this manuscript we follow the principle of ALARA as is consistent with Canadian radiation protection policy as set by the Canadian Nuclear Safety Commission. The first paragraph of the introduction now reads, with additional references listed below:

“"The dose-response relationship between radon exposure and lung cancer risk is understood to be linear, with no evidence of a threshold [2–5]. As such, there is no radon concentration at which there is no risk of developing lung cancer, and the probability of developing lung cancer increases with exposures to higher concentrations. Individuals who smoke are at an even greater risk due to the synergistic effects of radon and cigarette smoke [6]. Although the linear no-threshold model has been disputed [7], it is accepted within the Canadian radiation protection policy set by the Canadian Nuclear Safety Commission. These regulations implement the principle of ALARA, which states that public radiation exposures and doses should be kept “as low as reasonably achievable” [8]. This study follows the principle of ALARA, as is consistent with Canadian policy.”


REVIEWER 3

I don't feel the authors must include their full methodology for the verification of spatial independence, but I think that a statement indicating that the authors found no evidence of spatial autocorrelation may aid others who wish to do similar research, and should be included in the manuscript. I think Line 236 is the most appropriate location for this statement.

The manuscript was updated to reflect we tested for spatial dependence as suggested by the reviewer in the Methods section, and now reads:

“An individual balanced random forests model was trained on the subset of 1054 BDAs that had observed vulnerability classes based on the eight selected radon thresholds [8, 9]. Tests for
spatial autocorrelation in both the original radon data (Geary’s $c=0.86$, $p=0.2$) and the 95th percentile aggregated (BDA units) data (Geary’s $c=0.89$, $p=0.186$) indicate no significant spatial autocorrelation and suggest spatial independence of observations.”