Author's response to reviews

Title: Childhood lead exposure in France: benefit estimation and partial cost-benefit analysis of lead hazard control

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Author's response to reviews: see over
Letter with answers for two reviewers and additional editorial requests

Abstract
1. “respectively” in the first sentence can be deleted.
Answer: we deleted.

Background
2. The sentence on lines 3-4 implies that lead exposure that could be attributed to its use as a petrol additive was organic lead, which is incorrect. Tetraethyl lead was the form added to petrol, but after combustion, it was emitted as inorganic lead from the tailpipe.
Answer: See p 5. The text has been changed accordingly. Further to this comment, we deleted the part of the sentence “since its ban as petrol additive”, which was already said line 13.
3. lines 5-6: A reference should be provided for the statement that food is “the major source” of lead exposure. The reference that is provided at the end of the sentence seems to refer to the statement that cereals and vegetables are responsible for most food borne lead exposure. This statement that food is the major source is inconsistent with the information on the correlates of blood lead levels presented in Methods, where contaminated dust and soils are identified as being of major importance as predictors of blood lead levels greater than 100 µg/L. Perhaps the issue is that the relative importance of different sources/pathways depends on the portion of the blood lead range under consideration.
Answer: See p 5: we changed the text accordingly and added the reference of Glorennec et al regarding food as “the major source” of lead exposure for BLL lower than100 µg/L. We also altered the next sentence “Tap water can also, in some cases, be an important contributor”.

Methods
4. line 91: replace “… degraded paintings …” by “… degraded paint …”
Answer: See p 8: we replaced “… degraded paintings …” by “… degraded paint …”
5. line 99+: I found this sentence difficult to understand, specifically the phrase, “...distribution per media for weekly lead exposure of children selected at the 75th percentile...” Perhaps it could be revised to make it clearer.
Answer: See p 9, the text has been changed accordingly.
6. line 119: The double negative (“... absence of no threshold level currently established...” is a bit confusing. I would suggest simplifying this sentence, to something such as, “Given that no threshold for lead toxicity has been established...”
Answer: The text has been changed accordingly, p 10
7. line 121: It is internally inconsistent to state that no threshold has been established and then to assume several values for the blood lead level at which IQ loss starts (15, 24, and 100 µg/L). On line 194, it is stated that a 1 point IQ loss is associated with an increase in blood lead level from 15 to 24 µg/L. If a slope of -0.51 points per 10 µg/L
is assumed, along with the absence of a threshold, a loss of approximately 0.75 point should be assumed for the range of 0-15 µg/L.

**Answer:** We do not think choosing the hypothetical levels of 15, 24 and 100 µg/L to compute health impacts and associated costs is inconsistent with the statement that there is no currently accepted threshold toxicity level. We state these values as “what if?” levels (see p 10), not as true established thresholds. Should the literature show some day evidence of lower values, then the health cost figures would of course be substantially increased. We added this in the discussion section, p 22.

8. line 125: The assumption of a 1.9 point IQ loss at blood lead levels above 100 µg/L does not accurately reflect the findings of the Lanphear et al (2005) analysis. A loss of 1.9 points was associated with an increase from 100 to 200 µg/L, so that not all children with a blood lead level greater than 100 would be expected to incur such a loss.

**Answer:** See p 10: We changed the sentence in order to reflect accurately the findings of Lanphear et al

9. I find the notation with the number subscripts of B difficult to follow, have to look up the definition again and again. It would be much easier for the reader to have mnemonic subscripts, e.g. Bmed instead of B1 for the medical costs (screening and treatment), Bearn instead of B2 for lost earnings, Bspec.ed instead of B3 for special education, Bcrime instead of B4 for delinquency, and Bother instead of B4 for what the authors call “intangible costs” (I don’t see a clear distinction of tangibility between these costs and most of the others). I would replace the second subscript by “15-24”, “24-100” and “>100”.

Likewise use Cpaint, Cwater and Cind instead of C1, C2 and C3.

**Answer:** As recommended, we followed the mnemonic subscripts see modification in red from p 11 until at the end of the article and in the tables (and footnotes)

10. The time t in line 145, Eq. 1, is not explained.

**Answer:** we completed the sentence and write the formula, p11

The discounting in lines 333-335 and for the relation between the last two columns of Table 2 needs to be made more explicit: show the formula.

**Answer:** we wrote and applied the formula p18.

11. Since the $2006 17,815 of Gould is already the present value and the authors adjust it for inflation, no further correction for discounting is needed.

**Answer:** yes, we adjusted the present value for inflation. Gould applied a calculation to the total IQ point loss based on the relationship between IQ and lifetime earnings provided by Nevin et al. (2008) that find that each IQ point loss represents a loss of $17,815 in 2006 US Dollars but they did not discount. We applied a 3% discounting with a time horizon of 30 years.
12. line 168: The cost associated with a blood lead level >100 ug/L (1,819 to 4,851) is not just the cost of screening but also includes other interventions that might be undertaken.
Answer: This is correct. But we do not have the details of these costs, despite requests to the Aubervilliers local authorities (see the French 2008 report of InVS "Expertise opérationnelle sur le Saturnisme, quelle stratégie de dépistage chez l'enfant ? p217").

13. I find the text in lines 165-180 very confusing. Since the groups 15-24 and 24-100 receive only screening without treatment I would replace the sentence of lines 165-167 by “Since treatment is used only for children above 100 µg/L, the groups 15-24 µg/L and 24-100 µg/L incur only a screening cost which amounts to 120 € per child” – at least that’s how I interpret the text.
Answer: See lines 173-176: we revised the sentence.

14. The high costs on line 169 ("the screening cost per child was estimated from €1,819 to €4,851 for children with B-Pb concentrations up to 300 µg/L") seem to include treatment, despite of what the text says (the meaning of “screening” is diagnostic, not treatment). There is no explanation how the cost B12 = 2,932 € on line 177 and in Table 1 is obtained from the numbers 1,819 and 4,851 (line 169) and 2,365 and 1,126 (line175).
Answer: See p12: we revised these sentences.
And what is the meaning of the Unit cost 3,172 in the last line of Table 1?
Answer: We deleted the last line with the Unit cost 3,172.

15. line 174+: It is assumed that a child with a blood lead level >300 ug/L would undergo chelation. Most centers currently would not use chelation under such circumstances, reserving it for children with a level greater than 450 µg/L.
Answer: According to the French Recommendations for monitoring of children blood lead levels, chelation can be considered and applied above 250µg/L. This is the reason why we assumed a child with a blood lead level >300 ug/L would undergo chelation.

16. line 183: there is no point in mentioning the human capital approach which is discredited and no longer used for this kind of analysis. The ground rule nowadays is to use the willingness-to-pay of individuals to avoid a loss. I would therefore replace lines 182-189 by a much shorter “The indirect costs include the loss of lifetime earnings, the costs of special education, and the costs of juvenile delinquency.”
Answer: See p12: we deleted reference 34 and used the sentence suggested.

17. line 203+: The sentence, “For the 2008 cohort...” is not clear to me. Can it be rephrased?
Answer: See p13. The sentence was rephrased and we added: “We therefore assumed these IQ losses could be applied to the selected 1-6 years children”.

18. line 205: add [7] after “Gould’s method” and modify line 206 to read “her 2006 estimate of $2006 17,815 for the present value of incremental lifetime earnings per IQ point.”
Answer: see p13 the sentence was rephrased.
19. Since this number is highly dependent on the assumptions for discount rate, % change per IQ point and future growth of income, it would be desirable to state what Gould assumed.

Answer: see p13: the sources used by Gould are referenced + answer to the question 11, above.

20. There is no explanation how the costs for special education in Table 5 were derived from the text in lines 214-229.

Answer: See footnotes table 5

21. line 217: The costs estimated for special education are based on the expenditures at two French institutions that care for children with “severe cognitive and behavioral impairment.” Are these costs reasonable to assume in this analysis insofar as the IQ losses being assumed to result from lead exposure would not be expected to result in “severe” cognitive and behavioral impairments.

Can the argument supporting the use of these estimated costs be strengthened?

Answer: see p13: we deleted “severe”.

22. line 222: I would suggest that a paper other than Nevin (2006) be used to support any statements about blood lead levels at which increased service needs become evident. Nevin’s analyses, while provocative, provide only weak support for inferences about critical dose.

Answer: see p 14: We added the Wang et al, 2009 reference: the authors studied health effects of environmental lead exposure in children: their results: “Children with B-Pb≥100μg/L showed lower intelligence and behavior changes”

23. lines 242-244: the authors should explain how they estimate the shares of the crime categories.

Answer: see p14: We added the following sentence: “we used the data from the French national observatory of Delinquency”

24. The costs assumed in Table 3 for rape and murder are absurdly low. The value for murder should include at the very least the so-called value of statistical life for which something around 1.5 million € is often used in the EU. But that’s for accidents, not for something as horrifying as a murder. I don’t have any reference, but I would use at least 3 million €, so the cost of murders would be about 100 times higher. The cost of assaults and rapes should also be much higher.

Answer: We do not have any references to calculate the VSL for murder, so we suggest that we add the following sentences in the discussion part, p 22: “the costs of crime and rape are probably underestimated, because they did not include the value of statistical life, which may be greater than that of accidents (between €0.5 to 1.5 million in Europe and French estimations were the lowest bracket estimate)”.

25. line 277: I would suggest that the use of “threshold values” here (and throughout the manuscript) be eliminated. As the authors note, recent risk assessments have not identified threshold values for the critical health effects of lead.

Answer: As said above and made now clearer in the text, we used these values as “what if?” levels, not to suggest they represent true toxicity threshold. We understand this remark and
decided to add the term “hypothetical threshold values”, see several changes in each part of the article.

26. Lines 279 and 361: the titles should be “Abatement costs” rather than “Annual costs”. The word “cost” is general and vague, whereas here you need the standard technical term “abatement” to be precise. “Annual” is all the more misleading in this context because the remediation of houses and water pipes is a one-time expense.

Answer: we changed the title p 19.

27. lines 298-305: this needs more explanation. Above all, how much Pb control, down to what emission levels, is included? I presume it is just to implement current regulations. But here you are addressing the cost of further reductions, and those costs would be much higher. Could you provide more detail, for instance a table with the main industrial sectors (and one “all others”), showing their emissions, production volumes and abatement costs?

Answer: we understand but unfortunately, we don’t have all data to perform this suggested table: we do not have the recent production volumes, the year of a part of the data is 2001 (air and water emissions of industries). Changes in lead industry between 2001 and until nowadays don’t allow us to calculate these estimates, the number of industry is reduced and the volume has changed. However, last data show that major French industrial sources of lead are metals and non metallic minerals (66% in 2006). Three quarters of the emissions take place through water and two waste treatment facilities are alone 60% of total emissions of the ten most –emitting facilities see p 22.

28. line 311: The units should be changed from ug/dL to ug/L.

Answer: the text has been changed, see p 17

29. additional editorial requests

Answer: we added the sentence p 18 in order to introduce the used references to calculate costs to eliminate water lead pipes.

30. line 322+: Would it be possible to place confidence intervals around the estimates of benefits and costs? While the sensitivity analyses conducted provide the reader with some sense of the precision of the estimates, providing 95% CIs would provide even more information.

Answer: Unfortunately, this is not possible with the current state of the information we had to use to translate epidemiological data into economic valuation. Most impact estimates do not convey statistical distributions. We added p 24 and appreciation of the degree of uncertainty attached to these figures (from Rabl et al).

31. line 401: “for the blood lead ranges of 15, 24, and 100 ug/L” should be added before “respectively” at the end of this sentence

Answer: see p 21

32. Finally it would be good to emphasize that the authors have only considered a subset of benefits. In particular, the analysis of NHANES data by Menke et al [2006] finds a very large impact of premature mortality due to lead which according to my preliminary estimate implies a far higher social cost than the IQ decrement.

Answer: See p 21 and in the bibliography.

below 0.48 mmol/L (10 mg/dL) and mortality among US adults”. Circulation. 2006;114:1388 –1394.

33. line 422: with regard to contaminated sites, the authors should point out the need for a site-specific analysis.
Answer: See in the discussion p23

34. Showing an uncertainty range only for abatement costs is very misleading since the uncertainties of the benefits are even larger. They should be mentioned at least. I have done quite a few assessments of uncertainties for cost-benefit analysis and suggest a factor two uncertainty, each, for dose-response function and for monetary valuation;
Answer: See p 23

35. line 500 “low” blood lead levels should be clarified as pertaining to levels below 100 ug/L.
Answer: See p24

36. line 504: It is not clear what is meant by, “...the now low prevalence of unacceptably high B-Pb concentrations.” My interpretation of the analyses presented is that levels less than 100 ug/L should be considered “unacceptably high” insofar as most of the social costs are attributable to children with levels in that range.
Answer: we understand but we did not change the text.

37. Tables: It would be helpful if the authors could lead the reader through the tables, clarifying how the various calculations were carried out. This could be done in a footnote. In their present form, it is somewhat difficult to see how the numbers in the different columns were combined to produce estimates.
Answer: we made the changes, see table and footnotes

38. For the social discount rate I recommend 5% as a more reasonable choice than the 3% of the authors – however, it is quite uncertain and anything between 3 and 8 % could be justified.
Answer: Yes, it is quite uncertain, and in most of sources consulted, a 3% discount rate was often used e.g. (Pearce et al, 2006) and (Treich, 2006), French Economist Association, CES), we decided to keep 3%

39. Since the abatement for remediation of houses is a one-time cost, it should really be expressed as an equivalent annual cost. The capital recovery factor of standard engineering economics (and interest calculations for loans) is the appropriate conversion factor, but in this case it is not clear what the appropriate time horizon should be. In principle, unlimited. If the discount rate is high, the difference between infinite horizon and finite horizon can become sufficiently small. For instance with social discount rate 5%, the annual cost is 5.8% of the one-time cost for a 40 yr horizon, compared to 5% for infinite time horizon. Such a difference is negligible compared to the uncertainties. In any case, the authors should discuss this point. In view of the uncertainties of time horizon and social discount rate, I would use 0.05 as a conversion factor between one-time cost and annual cost, as a compromise these values: 0.057 for discount rate 3% and 25 yr, 0.071 for discount rate 5% and 25 yr, and 0.03 and 0.05 for infinite horizon.
Answer: for a one-shot cost, we chose a time horizon of 30 years and a discount rate of 3%. As explained A. Rabl, we could express an equivalent annual cost by using the capital recovery factor of standard engineering economics and interest calculations for loans which is the appropriate conversion factor. But, we have uncertainties regarding the following figures: the time horizon and social discount rate to use, which is reduced or increased. So, a 0.05 conversion factor between one-time cost and annual cost could be a compromise, and we could use a social discount rate of 5%, we could obtain the annual cost of 5.8% of the one-time cost for a 40 years horizon.” See p 23.

40. The entry for direct costs per crime in the last line of Table 3 makes no sense (like in the last line of Table 1).
Answer: We deleted the last line of tables 1 and 3.

41. In Table 4 the meaning of the 3 cost columns needs to be explained: the text in the footnote is almost incomprehensible. What are the “classic works”? etc. etc.
Answer: See footnotes table 4.

42. Table 4: The footnote is hard to understand (e.g., “rate max 20% applied to €13000 of classic works
Answer: See footnotes, table 4, we made the changes.

43. The presentation in Table 5 is very confusing. Numbers are presented for totals without indication how they were obtained from the numbers in the text or in the preceding tables. The meaning of the 3 columns should be explained in the caption. For example, the third row says “Health costs = B10 + B11 + B12”, but the entry for “from 24” includes only B11 + B12 and for “from 100” only B12. And those column headings should be replaced by “15-24 µg/L”, “24-100 µg/L” and “>100 µg/L”, in both Tables 5 and 6.
Answer: Further to these comments, please see new Table 5 and Table 6.

44. Table 6 is not clear at all. I have the impression that the authors consider only remediation of houses (another standard technical term) to remove leaded paint. It is indeed necessary to consider costs and benefits separately for each abatement option, rather than lumping all options together. If my interpretation is correct, that is what they do for the removal of leaded paint. But that should be stated explicitly in the caption, and the text needs to explain clearly what percentages are applied to which of the benefits in Table 5. It would also be desirable to compare costs and benefits for remediation of water pipes and for the abatement of atmospheric emissions by industry, if the authors can estimate the percentage of the benefits attributable to those options. That would make the paper far more useful, by providing targeted guidance for policy makers, rather than just a vague plea to do something.
Answer: See changes in the text, from p 16 and in the abstract (changes in results) and table 6.
45. For the presentation in Table 6 I would show either only the central estimates, with comments on the uncertainty in footnotes, or else show the uncertainty range in parentheses and smaller print.

Answer: See table 6, we made changes.