Author’s response to reviews

Title: Petroleum Contaminated Water and Health Outcomes in a Rural Nigerian Community: A Cross-Sectional Pilot Study

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Author’s response to reviews: see over
October 12, 2015

Dear Dr. Grandjean,

Thank you very much for considering our manuscript and for your helpful feedback and encouragement to resubmit. As recommended, we have highlighted the international aspect of this paper by changing the title to "Petroleum Contaminated Water and Health Symptoms: A Cross-Sectional Pilot Study in a Rural Nigerian Community". We have strengthened the paper by thoroughly addressing all reviewer comments, and including additional, more detailed statistical analyses. While budget and significant security constraints precluded the conduct of a more detailed health assessment at this time, we agree that such studies are needed and have added more on this topic to the Discussion section.

Sincerely,

Wendy Heiger-Bernays

Wendy Heiger-Bernays, PhD
Associate Professor of Environmental Health (whb@bu.edu)
Journal: Environmental Health  
Manuscript ID: 1861680044175828  
Title: "Petroleum Contaminated Water and Health Symptoms: A Cross-Sectional Pilot Study in a Rural Nigerian Community"  
Author(s): Kalé Z Kponee, Andrea Chiger, Iyenemi I Kakulu, Donna Vorhees and Wendy Heiger-Bernays  

Dear Reviewers,

Thank you very much for your thoughtful feedback on this manuscript. We have strengthened the paper by fully addressing reviewer comments and adding new and more detailed analyses. While budget and significant security constraints precluded the conduct of a more detailed health assessment at this time, we agree that such studies are needed and have added more on this topic to the Discussion section.

Our responses to individual reviewer comments are detailed below.

Sincerely,

Wendy Heiger-Bernays, PhD  
Associate Professor of Environmental Health (whb@bu.edu)
Reviewer Comments to Author:

Referee: 1

Comments:

Thank you for the excellent and very helpful suggestions for improving this manuscript. We have addressed each comment with an addition or edit as detailed below.

1. No soil ingestion?
   - Changes in bold were made to reflect that exposure to hydrocarbons can also occur via soil ingestion. “Exposure can occur via inhalation of hydrocarbons in ambient air and via consumption of and dermal contact with hydrocarbons in water, soil, and sediment [1],[3].” [Page 3, line 65]

2. Mention alkylated PAHs? Abundant, mostly unknown effects.
   - Change made, as suggested. The following text was added to the Background section: “Alkylated PAHs comprise the majority of PAHs detected in petroleum products and are particularly persistent. Although the health effects of alkylated PAHs have not been well studied, limited evidence suggests that they may be more toxic and carcinogenic than their parent PAH compounds [17].” [Page 5, line 95-97]

3. Emergency water not commonly used for drinking?
   - Changes in bold were made to reflect that emergency water is also used for drinking by participants. “Emergency water was most commonly used for drinking, cooking, brushing teeth, and washing food”. [Page 10, line 209]

4. Could sachet water be contaminated?
   - Sachet water is not subject to standardized quality testing; therefore, it could contain biological and chemical forms of contamination at levels of potential concern for human health. The following text has been added to the discussion section of the paper: “Sachet water might also be contaminated. Prior studies on sachet water quality in Nigeria have found numerous chemical and bacterial contaminants, as well as widespread improper storage and handling practices.” [Page 14, line 301-304]

5. Does each household have a well or are they community wells?
   - This has been clarified in the manuscript. “Approximately 97% of individuals in Eteo reported using their individual household borehole drinking water wells for all specified household activities”. [Page 10, line 219-221]

6. Do years of exposure to borehole well correspond to years living in house or to when wells are drilled?
   - Participants were asked how long they have been using their primary water source; the number of years of exposure to borehole well water is equal to the number of years reported.

7. Did you ask if anemia was helped by iron supplements?
   - We did not ask participants about any medications they were using. We have amended the Conclusion section of the paper to recommend that future studies include more detailed methods, “Future studies should define the full extent of contaminated household
water and incorporate more detailed methods of exposure and outcome assessment for exposed populations” [Pages 15-16, line 336-338].

8. Any chance of comparing Ogale residents who use emergency water with Ogale residents who don’t for health effects? Maybe even a rough dose estimate of n=12 all needs met, n=12 partial needs met, n=76 no emergency water.

• Changes made, as suggested. A new table is added to the manuscript that compares health symptoms in participants with sufficient, insufficient or no emergency water supplies (Table 5). The following text was added to the Results section: “Chi-square analyses were used to examine differences in health symptoms among participants in Ogale who reported receiving sufficient, insufficient or no emergency water supplies (Table 5). The frequency of irritation and gastrointestinal symptoms were significantly different between the three groups. Participants in Ogale who received sufficient emergency water supplies were less likely to report having irritation (8.3%) than those receiving insufficient or no emergency water (66.7% and 50% respectively). Overall, participants who received sufficient emergency water supplies reported the lowest proportions of health symptoms across the three groups.” [Page 11-12, line 246-252].

9. Also with repeated exposure to VOCs (see MSDS for gasoline), and I would argue, dermal exposure to PAHs.

• Change made, as suggested. The following text in bold has been added to the sentence. “Participants in Ogale were more likely to report throat irritation, skin irritation, and rashes; these symptoms are consistent with exposure to high concentrations of PAHs and VOCs found in oil [5],[6], [12].” [Page 14, line 302].

10. Inhalation and dermal exposures may also occur through use of contaminated water for activities such as bathing.

• Changes made, as suggested. The following text in bold has been added to the sentence. “Even if the emergency supply is adequate for drinking and cooking, residents of Ogale might be exposed to petroleum hydrocarbons via inhalation and dermal routes. Inhalation and dermal exposures may occur through use of contaminated water for household activities such as bathing and cleaning.” [Page 14, line 297-300].

11. Further studies should also include a more detailed health evaluation, including blood testing for immunological and genetic effects of exposure as conducted for Prestige Cohort”.

• Point well taken. Future studies will include detailed health evaluation including blood testing for immunological and genetic effects of exposure as conducted for Prestige Cohort.

12. Table 3. Are these the folks drinking from contaminated borehole or are all residents exposed?

• This table pertained to individuals in Ogale who report receiving emergency drinking water, but the table has been removed in response to another reviewer’s comments. To answer your question: although their primary source of water for drinking is the emergency water, a majority of these 24 individuals might still exposed to their borehole well water through other non-drinking activities. This is clarified in the Discussion section of the paper: “Ogale participants who receive inadequate emergency water supplies may still be exposed to contaminated borehole water. Even if the emergency supply is adequate for drinking and cooking, residents of Ogale might be exposed to petroleum hydrocarbons via inhalation and dermal routes. Inhalation and dermal
exposures may occur through use of contaminated water for household activities such as bathing and cleaning.” [Page 14, line 295-300].

13. Table 4. I find this table misleading because the odors are associated with a particular water source, yet this table combines them. I think the comparison of odor vs. water source is at least as important as the Ogale vs. Eteo here.

- We agree that the original table was misleading. Table 4 is now Table 3, and has been revised to specify both the water location and source for each odor reported. The corresponding Results section is as follows: “Participants in Ogale were significantly more likely to perceive their primary water source as having an odor (39% vs. 8%) The main sources of water with a reported odor in Ogale were borehole well and emergency water (Table 3). The majority of participants in Ogale who reported a borehole well odor (69%) stated that it smelled like petroleum fuel. Among Ogale participants reporting an emergency water odor, the most common description was chlorine (10%). In Eteo, one participant described the borehole well water as having a fuel odor (1%). [Page 10, line 227]
Referee: 2
Comments:
General Comments:
The paper by Kponee et al describes the results of a survey that compared the prevalence of declared symptoms among inhabitants from two cities in the region of Ogoniland, Nigeria, a region highly impacted by petroleum extraction. In one of the cities, Ogale, the drinking water wells have been found by a UNEP study as contaminated with petroleum hydrocarbons, including benzene at concentrations reaching up to 1,800 times the US-EPA drinking water standard. The “control” city, Eteo, 10 miles away, was not reported with petroleum contamination in the UNEP assessment but was similar to Ogale with respect to race, language, culture, and behavioral practices.
The paper presents the results of a pilot study whose design and analysis is rather simple: 100 participants from each community were selected following a random sampling approach through door-to-door recruitment in three areas of both Ogale and Eteo. In both communities, a 98% response rate was obtained and data were collected by trained interviewers who administered standardized questionnaires in all respondents’ homes. Information was collected on the primary source of water (borehole well, sachet water or emergency government-supplied water) and its use for a variety of household activities including bathing, cooking, washing, drinking, and washing dishes and food; and on current health symptoms and medical history.
The self-declared symptoms prevalence was compared with simple Khi-square tests, followed by multivariate logistic regression models adjusting on gender, age, smoking status, occupation, and education level.
Despite important limitations in the quality of data that cannot be overcome at this late stage, this paper is of interest because it is one among the very rare that documents the health consequences of the activity of petroleum extraction by large international companies, activity that has been managed during decades in complete ignorance of the living environment and health conditions of local communities. These pilot study results will serve as a basis for further investigations, including quantitative assessment of exposure, and for the implementation of a long-term prospective cohort study, as recommended by UNEP. As it stands, the paper does not meet the quality requirements for publication in the Journal but it can be improved.
- Thank you for the detailed suggestions for improving this manuscript. We have addressed each comment with an addition or edit as detailed below.
Specific Comments:

1. My main recommendations bear on the tables; they are too many and their information can be transferred in the main text. Data from table 3 is not necessary; it should be presented in the appropriate paragraph of the Results section. Same comment for table 4A.
   - Changes made, as suggested. Table 3 and Table 4a have been deleted. Information on both tables has been retained in the results section.
   - Table 3: “Only 24% of participants in Ogale reported receiving emergency water supplies. Although over 80% of these individuals stated that water delivery occurs at least once per week, half of them found the volume of water delivered to be insufficient for daily needs.” [Page 10, line 213-214].
   - Table 4a: “Participants in Ogale were significantly more likely to perceive their primary water source as having an odor (39% vs. 8%)” [Page 10, line 226-227].

2. Not sure that table 5 is really necessary. The hypothesis is that the main exposure is associated with borehole water. Now, individuals who receive emergency water or sachet water may consume also raw water because of instability in emergency water delivery, as this is stated in the discussion, so that their exposure to borehole water is not null. This might explain why there is no difference in symptoms reporting according to the declared primary water source, a result that drove the authors to lump together all subjects in the following tables, irrespective of primary water source.
   - Point well taken. We retain Table 5 (which is now table 4) to highlight the importance of adequate emergency water supplies.

3. Data from table 6 should be included in table 7 as a ‘grand category effect measure’, and the comments restructured accordingly in the text p 11-12.
   - Changes have been made as suggested. Tables 6 and 7 have been combined, and the Results section has been restructured accordingly. The following sentences in bold have been added. “**Table 6 displays general and specific self-reported health symptoms for all participants.** After controlling for age, sex, smoking status, occupation, and education level, Ogale residents were significantly more likely to self-report any irritation (OR=2.7; 95% CI, 1.5-5.1), any neurological effects (OR=2.8; 95% CI, 1.5-5.5), and any hematologic effects (OR=3.3; 95% CI, 1.5-7.0) [page 12, line 254-258].

4. Given that there is probably a low access to medical services in the study area, that 14 persons reported a medical diagnosis of anemia in Ogale is quite surprising. So are the 4 cases reported in Eteo. Please comment. In the same paragraph, the sentence "although residents did not report their specific anemia diagnosis" is unclear. What does this mean?
   - Data on primary health care locations in both communities were added to Table 1. The following text was added to the Results section: “Participants in both communities had consistent access to medical services. The majority of participants reported visiting a health centre, general hospital or private clinic for their medical care and health services (72% and 76% in Ogale and Eteo respectively). In addition, 19% of participants in Ogale sought medical care from a local chemist compared to 15% in Eteo.” [Page 9, line 202].
   - Residents in both communities reported whether or not they currently had an anemia diagnosis. Data were unavailable on the specific type of anemia they had been diagnosed with (aplastic anemia, sickle cell anemia, etc.).
5. Add a map of the study region with the location of the cities of Ogale and Eteo and, if possible of the main petroleum extraction wells.
   • Point well taken. Unfortunately, we were unable to secure or create a map of Ogale and Eteo.
6. -Edit GREE (Egree) in the References section (item 25)
   • Changes have been made, as suggested: “Ana G, Sridhar MK, Bamgboye EA. Environmental risk factors and health outcomes in selected communities of the Niger delta area, Nigeria. Perspect Public Health. 2009;129(4):183-191.” [page 20, line 537].
Referee: 3
Comments:
The topic in the manuscript is adequate and understands for public, further it is original research for environmental contamination and consequences over public health. With the reading of researcher, the public has some possibilities.

• Thank you for your comments. We have addressed each one and made additions as necessary.

1. The data are adequate with objectives due specific the judgments about to evaluate the ills over population affected by petroleum contamination, but there some questions with children. They are susceptible to develop many ills about environmental contamination.

• Point well taken. We discuss the adverse reproductive and developmental effects of PAHs in the Introduction section. Since this is a pilot study, we first needed to establish a relationship between exposure and outcome. Subsequent work will address susceptible populations and more specific outcomes. The final sentence of the manuscript has been modified to reinforce this point: “Future studies should define the full extent of contaminated household water and incorporate more detailed methods of exposure and outcome assessment for exposed populations, including its most susceptible members.” [page 16, line 336].

2. The manuscript lacks of references that support their reasoning.

• We respectfully acknowledge the general concern of Reviewer 3, but we have reviewed the literature and conclude that our references are adequate. If we have missed something, this is inadvertent.

3. With suppositions are fit to reproducible again although there some questions about susceptibility among women and men for this study. If possible to make correlation analyses with the results with intention of possible associations with the evaluated variable.

• We took differences between men and women into account by controlling for sex in our multivariate logistic regression model.

4. Need some explanations in discussion and conclusions of results further the possible analysis in other groups of population for this pollution area.

• Changes made, as suggested. Information has been included in the Discussion and Conclusion sections about subsequent research. Please refer to Comment #1.

5. Be clear in support with UNEP report

• We agree and have strengthened our conclusion: “These results reinforce UNEP’s recommendations for establishment of a health registry, medical surveillance, and a prospective cohort study for the Ogale community [3]. 15, line 334].

6. The English in general is correct but the organization of sections did not clear among discussion, conclusion and references for better consistency and clarity.

• The text has been carefully reviewed and clarified to address this comment.