Nat. Hazards Earth Syst. Sci. Discuss.,
doi:10.5194/nhess-2016-154-RC1, 2016

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Influence of heat index on regional mortality in Europe" *by* D. Lee and T. Brenner

Anonymous Referee #1

Received and published: 15 June 2016

The manuscript presents a statistical approach for a European-wide, regional investigation on NUTS3 level how the annual heat exposure derived from Heat Index is influencing annual mortality. The topic of heat related mortality is relevant and is suitable for the scope of NHESS. I have questions in particular regarding the approach developed and tested in the manuscript, and I have further suggestions for revisions to substantially improve the manuscript.

Section 2, Hypotheses:

1. While the tested hypotheses are stated clearly, it is not exactly clear to me how you derived or developed them including the assumed underlying mechanisms. The paragraphs introducing the hypotheses (P3, line 5-8) and the four hypotheses would benefit if the concepts and literature used to derive the hypotheses are included in the

manuscript.

2. Hypothesis 4: P3, line 16: you mention adaptation in architecture and behavior as potential mechanisms to assume that HI effect on mortality is lower in high HI average countries. In the light of the room you give to physiological problems of heat and heat loads on the body in the subsection on the influence of heat on health, I wonder if the potential role of physiological acclimatization to hot weather and climate in addition to behavioral and architectural measures should also be considered in the assumed mechanisms underlying Hypothesis 4.

Section 3, Methods and Material 3. P5, line 1-15: I understand that you used 4 thresholds of HI and 3 criteria to obtain categories that account for the different frequency, intensity, and duration of heat waves, and that you used one annual value for each category as a measure for heat exposure to compare with one annual value for mortality. I have two questions:

Question 1: Your heat wave definition is "at least five consecutive days on which the HI exceeded the chosen threshold" (p5, line 4), and to avoid co-correlation you use the difference to adjacent categories in the further analysis. I am not sure if I understand this correctly. How would, for example, a persistent heat situation with a total duration of 12 days with 5 days threshold "danger", 2 days "extreme danger", and again 5 days "danger" be classified/represented in the measures of annual heat exposure? Would it be two heat waves of 5 days with danger or one heat wave? How would either affect the results of your regressions? An additional example exercise for all categories would be helpful. On p. 5, lines 11-15, you explain the combination of danger level with "nrun", but not with "cross". This would be in particular helpful as "cross" turns out to be important in the results of the regressions.

Question 2: physiological acclimatization to heat varies across Europe due to climate conditions. This is reflected in relative heat wave definitions, and, for example different thresholds are applied in heat warning systems in European countries. Did you

consider this differences in acclimatization/thresholds in your HI thresholds?

4. P 5, line 17 and following: I understand that you combine 13 years mortality data (2000-2012) with 25 years meteorological data (1979-2013). How have this different time periods of data been considered in the investigation of influence of HI on mortality? It is not clear to me whether the HI data of the years 1979 to 1999 are included in the statistical analysis at all.

5. Page 6, line 3-6: I understand that you used normalized annual mortality data (all causes) per NUTS3 region to study the relation between HI and mortality. How did you check that also other causes than heat waves could be related to additional mortality in the years of 2000-2012, and that therefore other causes than heat could have influenced the mortality? Did you use any additional criteria in your approach to define "heat-related mortality" and to attribute annual mortality to heat?

6. Same place: As you use Eurostat mortality data from 2000-2012, I wonder if regional mortality patterns of the European heat waves 2003 statistically dominate the results and conclusions on your hypotheses. Have you considered the potential effects of this particular extreme event in your analysis of HI influence on annual mortality?

7. Page 6, line 3-5: I understand that you used the GDP and related it with mortality in your HI categories. Have you checked before how the GDP is distributed over the NUTS3 regions relative to the HI? Given the European scale of analysis, I wonder if regions with lower GDP are more often located in geographical regions exposed to higher HI than regions with higher GPD. Additionally, other studies show effects of the temperature on the GDP/economic production (as an additional example: Burke et al. 2015), so that that determining cause and effects in the relation of GDP on heat mortality is a rather complex issue. I wonder if your results later in the paper regarding GDP and heat mortality rather show the effect the regional HI distribution of HI than the effect of GDP on heat mortality.

8. P6, lines 8-15: GGM regression approach: you explain in detail how you performed

the regression. Could you provide information on the goodness of fit of the regression models?

Results and Discussion:

9. Results and discussion are presented in one section, and the discussion parts are rather short and structured according to the individual four hypotheses. I miss in particular a section that critically reflects the presented approach and that discusses the results against the background of all four hypotheses. Please consider restructuring and expanding the discussion.

10. The discussion of the results on potential underlying mechanisms and interactions that might explain the results of the regressions and the varying influences of the heat exposure measures would benefit from literature that supports the argumentation and assumptions made (see examples below).

11. P7, Table 4 (and also Tables 5-7): Precise column heads are missing. What is shown? GGM Regression coefficients, p-values?

12. P7, lines 14 to p8, line 2) "This is in line with health literature suggesting that there is a behavioral risk component involved. . .. that if a heat wave lasts a substantial amount of time, vulnerable individuals can adapt, mostly likely due to their awareness of the danger of sensitivity to the discomfort causes by the weather. . . . this awareness decreases, causing individuals to engage in less cautious behavior and thus increase their vulnerability to HI-based mortality": please include example references from the health literature supporting these different assumptions and explanations (see general comment on discussion above).

13. P9, line 6-7: ". . . indicating that as this point, the population takes countermeasures against heat load. This most likely does not take place when the less dangerous thresholds are crossed". How can you conclude this? Additional literature, for example on behavior during heat waves, would support this assumption on underlying mecha-

nisms.

14. P9, line 9-10: “Hubris in the face of nature is not an unfamiliar characteristic of regions with high economic productivity”. This is a very strong final statement that needs a good and substantial argumentation in the lines before (see above).

15. P. 9, line 6-14: Your results show that mortality in regions with higher GDP is significantly related to the “lower” HI thresholds and in regions with lower GDP to the “higher” HI thresholds and you explain this result by resources for better adaptation to heat waves in richer regions. Again, I am wondering in how far this result reflects the European regional pattern of GDP distribution and the pattern of heat wave deaths in 2003 (see for example Robine et al., 2008).

16. P 10, line 10: “it is probable that due to the low frequency of HI events, the population is more acutely aware of their dangers and reacts especially strongly accordingly. It might also be that in regions that are usually very cold, mortality is more driven by cold than by hot periods and that a higher number of heat events. . ..” Also this argumentation would benefit substantially from examples / references from the literature.

17. In the discussion section, I would highly welcome further critical reflections on

o How do your results agree or disagree with other studies on heat mortality from the scholarly literature that you have mentioned in the introduction and the theoretical background sections?

o What are the advantages and also limitations of your approach, what further research questions do evolve from your results (suggestions see next two bullets)?

o How could further relevant questions in heat related mortality be included in the approach? You have, for example, mentioned the urban island as a factor for heat impact (P2, line 15-16), but you did not include any proxy for urban structures or settlement in your analysis. Do you have ideas how additional proxies from EU Data could be used?

o Small-scaled variability of temperature distribution in particular in urban areas and

complex relationship of indoor/outdoor temperature on the one side and a high aggregation level of a regional approach with one observed value per Nuts3 level?

Additional references mentioned:

Burke, M.; Hsiang, S. M. & Miguel, E., 2015: Global non-linear effect of temperature on economic production Nature, Nature, 527, 235–239.

Robine, J.-M.; Cheung, S. L. K.; Roya, S. L.; van Oyen, H.; Griffiths, C.; Michel, J.-P. & Herrmann, F. R., 2008: Death toll exceeded 70,000 in Europe during the summer of 2003, C. R. Biologies, 331, 171-178.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., doi:10.5194/nhess-2016-154, 2016.