T. Kunz-Plapp, J. Hackenbruch, J.W. Schipper

Responses to interactive comments of Anonymous Referee #1
C1965–C1967

on the discussion paper:

“Factors of subjective heat stress of urban citizens in contexts of everyday life” by T. Kunz-Plapp et al.

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Dear Reviewer,
Thank you very much for your time and your helpful questions and comments. We appreciate them very much. In the following, we respond to all of them and outline how we address them in a restructured and revised manuscript.

Dear authors,

Thank you very much for this scientifically and societally highly relevant paper on subjective heat stress of urban citizens in daily life. I very much enjoyed reading it. For further improvement of the paper I have some major suggestions:

1) I would suggest better specifying your definition of heat stress in the introduction and clarifying how far your empirical study is related to heat stress or heat waves. I understand that you did your survey immediately after a heat wave. It would be interesting to include a discussion on how do you see your findings in terms of transferability to other heat stress events or heat stress in general?

> A: Thank you very much for this suggestion. We agree that this would improve the clarity of the paper.
>
> In the revised manuscript, we therefore include the definition of subjective heat stress, and the aim to investigate subjective heat stress immediately after heat waves in the introduction of the revised paper.
>
> We also include a short discussion on transferability of our findings (please see our response to the specific comments).

2) Moreover, I would suggest including a definition of the frequently and very differently used terms of risk, vulnerability, coping, adaptation to avoid confusion in the manuscript and to go inline with the recent concepts and theories.

> A.: The literature cited in the research overview and the empirical studies used to inform the concept for our empirical study itself is based more or less explicitly on different approaches with different conceptualizations and definitions of risk, vulnerability and adaptation. Although a more intense discussion on definitions would be interesting, it would go beyond the scope and objective of this paper to include a discussion on all of them.
>
> In the revised manuscript, we reduce ambiguity in the text and we define the terms that are relevant for our study, in particular subjective heat stress and coping.

3) The paper would improve from precise research questions, objectives or hypotheses. In the present version the aim is described twice in a rather general way (4621, ll 25; 4627, ll 7). You have collected a lot of interesting material with your survey. Precise research questions would help to guide the reader and to structure the discussion of your findings in the light of other studies.

A.: Thank you very much for this advice.

We address this in the revised manuscript as follows:

"To contribute to the further understanding of SHS of urban citizens, the general aim of our study is to identify what individual, social and factors of the urban built environment determine the SHS in different contexts of daily life during a heat wave. Our first main research question therefore is to explore to what extent urban citizens experienced heat in various typical daily situations as stress, how their health was affected by the heat and what measures they implement to cope with it. Urban citizens experience heat at home or at work outdoors or in buildings surrounded by urban structures with small-scale variability of temperatures. Our second main research question therefore is how health, coping attitude and behavior during the heat wave, age and other sociodemographic variables on the one side and spatial structures and elements of the urban built environment on the other side are associated with SHS. Our final aim is to derive the major determinants for the self-reported heat stress in general, at home, and at work in a multivariate perspective."

We restructure the discussion section accordingly and take into account the specific comments below.

4) Chapter 3 (Methods) and subchapters are very extensive and not easy to follow at the moment, restructuring with another subchapter (e.g. Study area, Concept, Data collection and sample, Data analysis) would probably help to make it easier to read: You start with a description of the study area at the beginning of chapter "3.1 Concept of the study". I would suggest better changing the title to "Study area". In l 24 on 4628 I could imagine to insert the subheading "concept", before you are mainly describing the study area.).

A: Thank you very much for this suggestion, we agree.

In the revised manuscript we restructure the section "methods" with the subsections "study concept", "study area", "data collection" and "data analysis" and we shorten the text. We have furthermore prepared a table with all variables and scores used in the data analysis as suggested below (and by the second reviewer).

Some more specific comments in detail:

- How you define heat waves in you study area should be explained earlier than on p4628 (l 14).

A: In the revised version of the manuscript, we provide a clarification of heat waves in the context of our study in the introduction. In the revised subsection "study concept", we address the heat wave definition as follows:

"As there is no standard definition of heat waves (Fischer and Schär, 2010; Lissner et al., 2012; Robinson, 2001; Tinz et al., 2008), we use the term heat wave in our study if heat warnings by the DWD were issued during three or more consecutive days. The DWD heat warnings are based on the perceived temperature (PT, Staiger et al. 2010), with warnings of great heat stress with $+32 \leq PT < 38$ °C and of extreme heat stress with PT > 38°C."

- It would be interesting to include the question you asked for the outcome variable in the text as well besides presenting it in the figure.

A: We include the question to measure subjective heat stress in the revised study concept and in the new table 1 with all variables.

- Was the survey distributed in German language only? Is there a bias because of language barriers/cultural barriers? It's relevant in other cities I am not sure about Karlsruhe though.

A: The survey was distributed in German language only, which implies a barrier for non-German speaking residents in Karlsruhe. Even if cultural differences in subjective heat stress and coping behavior would be interesting and relevant, this was not part of our study. Regarding particular social groups to reach with the random sample of the survey, the priority of our survey immediately after the heat waves was to reach elderly people with the paper version of the questionnaire.

We will include this in the discussion section of our revised manuscript.

- In 3.3 you introduce the different scores that you use. Could you perhaps explain in more detail or refer to other studies how you approached the scores? In general I would find it easier to have a table with all variables you use in the statistical analysis.

A: We include this explanation in the revised manuscript as below. In addition, the new table 1 lists all variables used in the data analysis.

"The health impairments score was developed after Wittenberg et al. (2012) as a measure for the overall health impact during heat. We further refined their calculation and related the summated frequency of reported health impairments to the total number of health impairments with valid answers. Doing so, we were able to include also respondents with missing answers in one of the nine health impairments.

The scores for the heat protection elements, outdoor recreation elements, and the number of known insulation elements were simple summated scores that each counted the number of available elements. The variables used for the scores had been included in previous studies as single elements (Großmann et al., 2012; Pfaffenbach and Siuda, 2010; Wittenberg et al., 2012). They were summated based on the finding from studies with indoor temperature measurments that is it difficult to isolate effects of single elements of buildings (Franck et al., 2013; Langner et al., 2014)."

- At the moment it is not exactly clear how you use the meteorological data that you explain in 3.1.

A: We used the meteorological data to introduce the study area and its suitability for a study on subjective heat stress, and to introduce the meteorological conditions prior to the survey. As we do not use them further in the data analysis, we will reduce and shorten the meteorological information to what's necessary for the purpose of the paper.

In response to the other reviewer, we provide a Figure with temperatures (min, max, average) in the 4 weeks before the survey.

- "The mean of 2.40 on the health impairments score (SD = 0.60, score range 1 to 4) indicates that the number and frequency of health symptoms suffered during the heat resulted on average in a modest health impairment rate." => Can you explain this in more detail?

A: We mentioned the score and its values or mean and SD as it is the input for the multiple regression. Mean and SD indicate that the score values are normal distributed and that the average of 2.4 is close to the expected mean on a scale from 1 to 4. The summarized score shows that majority of respondents reported a modest overall rate of health impairments, and that only a minority of respondents had no health problems and only a minority was affected from all health symptoms in the questionnaire.

Taking into account the suggestion of the other reviewer to shorten the text in the results section, we include this only briefly in the revised manuscript when explaining the results shown in Figure 4 (p. 4633, line 17).

"The number and frequency of health symptoms suffered during the heat as summarized in the health impairments score indicates that the majority of respondents reported a modest overall rate of health impairments (score mean = 2.40, SD = .60, score range 1 to 4)."

- In the results section you present the multiple regression analysis but in the methods chapter there is hardly any information on e.g. measures of goodness, how you deal with multicollinearity. Please explain in more detail.

A: The three regression models for subjective heat stress in general, at home, and at work showed a good model fit with Durbin Watson values of 1.99, 2.03, and 1.99, respectively. All independent variables entered into the regressions presented in the paper were tested for collinearity and accepted only if they fulfilled the criteria of a tolerance measure >0.25 and a Variance Inflation Factor VIF <5. With observed tolerance values of >0.5 and VIF <2, all independent variables had tolerance measures > 05, and VIF < than 2.

This information will be included in the revised version of the paper.

In the discussion I would be interested in your critical reflection of your findings *in the light of other studies on*:

- are there possible differences between the online survey and printed survey?

A.: We had chrosschecked this, and the answer is "yes" and "no".
In the revised manuscript, we address this briefly in the revised discussion in a paragraph that summarizes potential limitations of the study due to the research design (survey in German, online and printed version of the questionnaire) as follows:

"Regarding particular social groups to reach with the random sample of the survey, the priority of our survey immediately after the heat event was to reach elderly people with the additional paper version of the questionnaire. Hereby, the differences in subjective heat stress of elderly citizens as presented in the paper cannot be related to the form of the questionnaire. Non-parametric statistic tests showed no differences for the online/printed version of the questionnaire among the survey participants older than 65 years."

- do you see a difference in your findings for heat stress or heat events?

A.: We here respond to this specific comment and to the general suggestion No. 1 regarding the transferability of results. We address the transferability of our findings in the light of other studies to other heat events in the revised discussion as follows:

"As a case study from Karlsruhe the generalizability to subjective heat stress in other heat wave events is limited. However, while in the other surveys in Germany the level of heat stress surveyed differs with or without immediate experience of a heat wave, the factors that make a difference for the self-reported heat stress are very similar. In future studies that transfer our study concept to other cities and heat waves, we therefore would expect similar results on the major or minor factors determining subjective heat stress during a heat wave."

- how you estimate the self-reported heat stress (impairment) and what this may mean for the results that “the health impairments from the heat and the feeling of being helplessly exposed“ explain a lot? Could this be due to the respondent’s behaviour?

  - A.: In the revised discussion section we discuss the coping attitude in the light of actual coping behavior and its meaning as a determinant for subjective heat stress as follows:

  “The feeling of being helplessly exposed to the heat is reflected also in the coping behavior. Many respondents did not have the possibility to implement the measures they would actually have liked to implement. With air condition, seeking cooler places, shift activities to other times of the day, slow down and avoid exertion these all represent ways to either escape from the heat or to change or reduce activities to better sustain the heat.”

- how do you think about the studies that combine individual measurements and assessments throughout the day to assess perceived heat and measured heat?

  A.: We had already included this briefly in the first version of the manuscript (p. 4640, lines 11-17): “The elements making a difference for subjective heat stress confirm results of previous surveys in German cities by Großmann et al. (2012) and Pfaffenbach and Siuda (2010). Moreover, they are in line with results obtained in temperature-related indoor and outdoor heat discomfort studies regarding the location of the level within the building (Langner et al., 2014; White-Newsome et al. 2012).”

  We add a more detailed discussion in the revised manuscript.

- In the conclusion you refer to the “expressed-preferences approach” in your study. Since the readers of NHESSD come from very different fields I would suggest to explain this already in the concept section of your study.

  A: We include this in the new version of the manuscript in the revised and shortened methods section in the study concept.

- The figures are very good and support the text. Is there any reason why you present figure 3 in colours and 4 in black and white?

  A: In the revised manuscript we use a color code in figure 3 and 4 that is still readable when printed in black and white.

Thank you very much again for your time and your comments.

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