

Dear Dr Parks,

Your manuscript entitled "Trends and disparities of hazardous heat exposure among incarcerated people in the United States" has now been seen by 3 referees, whose comments are attached. You will see from their comments below that while they find your work of interest, some important points are raised.

While Reviewers 1 and 3 were favorable to your manuscript, Reviewer 2 still had some remaining concerns regarding the interpretation of the results, among others. The rest of the referees' reports are clear and the remaining points should be straightforward to address. We are very interested in the possibility of publishing your study in Nature Sustainability, but would like to consider your response to these concerns in the form of a revised manuscript before we make a final decision on publication.

We thank the Editors and Reviewers for their thoughtful and constructive suggestions. We have revised the manuscript in response to the Editors' and Reviewers' comments, as detailed below.

We have tried our utmost to respond to the suggestions below, particularly from Reviewer 2. We are mindful, however, that this is a Brief Communication with a strict word limit of 1,700 words, and we have therefore attempted to balance the two priorities.

All page/line/reference numbers refer to the tracked revised manuscript.

We are committed to providing a fair and constructive peer-review process. Do not hesitate to contact us if there are specific requests from the reviewers that you believe are technically impossible or unlikely to yield a meaningful outcome.

If you have not done so already please begin to revise your manuscript so that it conforms to our Brief Communication format instructions at <http://www.nature.com/natsustain/info/final-submission/>

Nature Sustainability Brief Communications have a word limit of 1,500 words (including abstract, references and figure legends, and contains no headings) with 2 small display items (figures or tables). We have some flexibility, and can allow a revised manuscript at 1,700 words, but please consider this a firm upper limit.

We have maintained a total word limit of 1700 words) with 2 figures in the revised manuscript.

After the main text, a Brief Communications carries a Methods section of about 500 words and does not count towards the main text length. For additional details, please use a Supplementary Information file.

The Methods section is 289 words in the revised manuscript.

Nature Sustainability titles should give a sense of the main new findings of a manuscript,

and should not contain punctuation. Please keep in mind that we strongly discourage active verbs in titles, and that they should ideally fit within 90 characters each (including spaces).

The proposal title of the paper, 'Trends and disparities of hazardous heat exposure among incarcerated people in the United States', contains no active verbs in titles, and is 96 characters including spaces.

To improve the accessibility of your paper to readers from other research areas, please pay particular attention to the wording of the paper's opening bold paragraph, which serves both as an introduction and as a brief, non-technical summary in no more than 70 words. If, however, you require one or two extra sentences to explain your work clearly, please include them even if the paragraph is over-length as a result. The opening paragraph should be unreferenced. Because scientists from other sub-disciplines will be interested in your results and their implications, it is important to explain essential but specialised terms concisely. We suggest you show your summary paragraph to colleagues in other fields to uncover any problematic concepts.

We have edited the paper's opening bold paragraph. We have incorporated the Editors' instructions of a word limit of 70 words with one or two extra sentences, currently at a word count of 92 words, as below in the revised manuscript (P. 2, Lines 19-26):

~~*Incarcerated*~~*The ~2 million incarcerated people in the US are at high risk for United States face growing heat-related illness and death. However, a comprehensive assessment of heat conditions at US carceral facilities is required. Here, we**health risks. We evaluated recent exposure trends to potentially hazardous heat —defined as number of days annually the maximum wet bulb globe temperature (WBGT_{max}) exceeded 28°C— during 1982-2020 at for 4,078 continental US carceral facilities holding ~2 million incarcerated people. On average, during 2016-2020. We found that state-run carceral facilities in Texas and Florida accounted for 52% of total exposure, despite holding 12% of all incarcerated people. Further, the number of hot days per year increased during 1982-2020 for 1,739 carceral facilities experienced 41.25 million person-days of exposure annually, with state prisons contributing 61%, and encountered 5.5 more potentially hazardous heat days annually compared to the remainder of the US population. An estimated 915,627 people (45% of total) were incarcerated in 1,739 facilities with an increasing number of days per year WBGT_{max} exceeded 28°C; southern facilities experienced the most rapid changes. Our findings, primarily located in the Southern US. We highlight the urgent need urgency for enhanced infrastructure, health system interventions, and reform in the treatment of incarcerated people, especially as under climate change intensifies hazardous heat exposure.*

Please include a separate "Data availability" subsection at the end of your Methods. This section should inform our readers about the availability of the data used to support the conclusions of your study. This information includes references to source data published as supplementary items (Excel sheet) alongside the paper, accession codes to public repositories, unique identifiers such as URLs to data repository entries, or dataset DOIs, and any other statement about data availability. At a minimum, you should include the following statement: "The data that support the findings of this study are available from the corresponding author upon request", mentioning any restrictions on availability. If DOIs

are provided, we also strongly encourage including these in the Reference list (authors, title, publisher (repository name), identifier, year). For more guidance on how to write this section please see: <http://www.nature.com/authors/policies/data/data-availability-statements-data-citations.pdf>

We have done this, as below in the revised manuscript (P. 12, Lines 556-562):

Data availability

Daily 4-km PRISM data ~~from~~during 1982–~~to~~–2020 and HIFLD data are freely available at <https://prism.oregonstate.edu/recent/> and <https://hifld-geoplatform.opendata.arcgis.com>, respectively. National Center for Health Statistics (NCHS) bridged-race dataset (Vintage 2020) is available ~~from~~during 1990–~~to~~–2020 https://www.cdc.gov/nchs/nvss/bridged_race.htm and from the US Census Bureau before 1990 <https://www.census.gov/data/tables/time-series/demo/popest/1980s-county.html>.

If your paper is accepted for publication, we will edit your display items electronically so they conform to our house style and will reproduce clearly in print. If necessary, we will re-size figures to fit single or double column width. If your figures contain several parts, the parts should form a neat rectangle when assembled. Choosing the right electronic format at this stage will speed up the processing of your paper and give the best possible results in print. We would like the figures to be supplied as vector files - EPS, PDF, AI or postscript (PS) file formats (not raster or bitmap files), preferably generated with vector-graphics software (Adobe Illustrator for example). Please try to ensure that all figures are non-flattened and fully editable. All images should be at least 300 dpi resolution (when figures are scaled to approximately the size that they are to be printed at) and in RGB colour format. Please do not submit Jpeg or flattened TIFF files. Please see also 'Guidelines for Electronic Submission of Figures' at the end of this letter for further detail.

We have provided figures as separate pdf files.

Figure legends must provide a brief description of the figure and the symbols used, within 350 words, including definitions of any error bars employed in the figures.

We provide two figure legends for, both fewer than 350 words in the revised manuscript (PP. 14-15, Lines 596-609):

Figure 1. Mean annual exposure during 2016–~~to~~–2020 to potentially hazardous heat in carceral facilities within the continental United States (N=4,078), measured by: (a) the number of person-days WBGT_{max} exceeded 28°C for incarcerated people by state and carceral facility type; and (b) the number of days WBGT_{max} exceeded 28°C for each carceral facility.

Figure 2. (a) Population-weighted difference between the annual number of days $WBGT_{max}$ exceeded 28°C at the location of carceral facilities versus all other locations in the continental United States during 1982—2020, overall and stratified by state, ordered by average population-weighted difference, (b) the total change in the number of number of days $WBGT_{max}$ exceeded 28°C per year for each carceral facility in the continental United States during 1982—2020, and (c) the total change in disparity in number of number of days $WBGT_{max}$ exceeded 28°C per year for each carceral facility in the continental United States, compared with the rest of the state the carceral facility is located, during 1982—2020.

Please limit the number of references to no more than 20, and then include any additional references for the Methods in this list as well. Article titles are omitted from the reference list. Any citations in the Supplemental Information will need inclusion in a separate SI reference list.

There are 20 references in the revised manuscript.

Please include a statement before the acknowledgements naming the author to whom correspondence and requests for materials should be addressed.

We have done this in the revised manuscript (P. 12, Lines 569-571):

Correspondence

Correspondence should be addressed to Robbie M. Parks (robbie.parks@columbia.edu) and Cascade Tuholske (cascade.tuholske1@montana.edu)

Finally, we require authors to include a statement of their individual contributions to the paper -- such as experimental work, project planning, data analysis, etc. -- immediately after the acknowledgements. The statement should be short, and refer to authors by their initials. For details please see the Authorship section of our joint Editorial policies at http://www.nature.com/authors/editorial_policies/authorship.html

We have done this in the revised manuscript (P. 13, Lines 589-592):

Author contributions

C.T. and R.M.P. designed research; C.T., V.D.L., and R.M.P. performed research; C.T. and R.M.P. contributed analytic tools; C.T., V.D.L., Y.A., C.R., and R.M.P analyzed data; and C.T., V.D.L., R.S., A.E.N. and R.M.P wrote the paper with assistance from Y.A. and C.R.

When revising your paper:

*** include a point-by-point response to any editorial suggestions and to our referees. Please include your response to the editorial suggestions in your cover letter, and please upload your response to the referees as a separate document.**

We have done this below.

*** ensure it complies with our format requirements for Letters as set out in our guide to authors at www.nature.com/natsustain/info/gta/**

We have done this.

*** state in a cover note the length of the text, methods and legends; the number of references; number and estimated final size of figures and tables**

We have done this.

Please ensure that all correspondence is marked with your Nature Sustainability reference number in the subject line.

We have done this.

We hope to receive your revised paper within four weeks. If you cannot send it within this time, please let us know.

We have submitted our revised manuscript within four weeks of receipt of the reviews.

Nature Sustainability is committed to improving transparency in authorship. As part of our efforts in this direction, we are now requesting that all authors identified as ‘corresponding author’ on published papers create and link their Open Researcher and Contributor Identifier (ORCID) with their account on the Manuscript Tracking System (MTS), prior to acceptance. This applies to primary research papers only. ORCID helps the scientific community achieve unambiguous attribution of all scholarly contributions. You can create and link your ORCID from the home page of the MTS by clicking on ‘Modify my Springer Nature account’. For more information please visit www.springernature.com/orcid.

We look forward to hearing from you soon.

Yours sincerely,

**Yamini Kashimshetty, PhD
Associate Editor
Nature Sustainability**

Reviewers Comments:

Reviewer #1 (Remarks to the Author):

All my comments have been correctly addressed. I acknowledge the large amount of work done by the original and new authors. No additional changes are needed. I congratulate the authors for this interesting article.

We thank the Reviewer for the thoughtful and constructive comments.

Reviewer #2 (Remarks to the Author):

The authors' response to the original inquiry about the importance of location-specific factors in shaping heat-related outcomes in prisons is satisfactory. They have acknowledged the significance of geographic location, especially focusing on the Southern United States, where the risk of dangerous heat conditions in carceral facilities is particularly high.

In the expanded discussion, the authors highlight that the majority of these facilities have seen a rapid increase in hot and humid days since the 1980s. This increase is attributed not only to anthropogenic climate change but also to land-cover and land-use changes, including the urban heat island effect exacerbated by the materials used in constructing these facilities. This point effectively underscores the multifaceted nature of the problem, where environmental factors are compounded by infrastructure choices.

Moreover, the authors draw attention to the interplay between geographic disparities and state-level criminal justice policies. They note that Southern states, which have some of the highest incarceration rates, often do not have mandatory indoor temperature requirements, thereby increasing the risk of heat-related issues. This adds depth to the understanding of how different states' approaches to prison management can affect inmate welfare, particularly in relation to climate conditions. The mention of specific states like Texas, Florida, Arizona, and Louisiana as the most exposed to hazardous heat days provides concrete examples that reinforce the argument.

We thank the Reviewer for the thoughtful and constructive suggestions. We have responded point-by-point to the Reviewer's questions and comments below.

The lack of universal air conditioning in these states' prisons highlights a critical area of concern and vulnerability, especially given the increasing frequency and intensity of heatwaves - but is this true and validated?

We agree with the Reviewer that it is a challenge to understand whether each prison and jail has air conditioning. Further direct research needed, ideally with each prison in our study (for example, by making a Freedom of Information Act (FOIA) request for every jail and prison). However, it is likely that there are many prisons and jails without air conditioning if they are not required to install air conditioning units, particularly given that 44 states do not universally provide air conditioning in carceral facilities, as well some prisons and jails which lack maintenance and upkeep of existing cooling infrastructure, as stated in the revised manuscript (P. 7, Lines 322-326):

Further work is critical to ~~both~~ comprehensively characterize the vulnerability of the United States incarcerated population to heat, as well as how heat impacts ~~their health, health, to build reliable and validated datasets of cooling mechanisms in prisons and jails, to directly measure indoor temperatures in prisons and jails, and~~ to deploy adaptation measures to mitigate the worst impacts of climate-related stressors.

We also agree that our paper highlights a critical area of concern and vulnerability for the incarcerated population, and we propose that the overall message of the manuscript is

successful in providing a firm foundation establishing a strong area of concern (as is the scope of a Brief Communication) to perform more detailed analyses in the near future.

The concern and the elephant in the room is the lack of information on indoor environments and personal exposures in the study. To be, this is a crucial limitation in interpreting the findings. Despite the use of advanced exposure assessment techniques, the absence of specific data on indoor temperatures, particularly in prisons, casts uncertainty on the conclusions drawn about the actual conditions experienced by inmates.

While data measuring indoor temperatures, particularly in prisons and jails, in the United States is scarce, a study from Denmark found temperatures in prison cells to be 4-5°C above those outdoors in summer, while another study of indoor heat in Harlem found similar results. We have added this information and references to the revised Supplementary Information due to space constraints of the Brief Commentary:

While data measuring indoor temperatures in prisons and jails in the United States is scarce, a study from Denmark found temperatures in prison cells to be 4-5°C above those outdoors in summer.⁵ This is approximately what was also found in the Harlem Heat Project in New York City, a study of indoor domestic temperatures in domestic settings in Harlem, which is an area of New York with many residents who suffer cooling hardship.⁶

Related to the above point by the Reviewer, we have added that more research is needed to directly measure indoor temperatures in prisons and jails in the United States in the revised manuscript (P. 7, Lines 322-326):

Further work is critical to ~~both~~ comprehensively characterize the vulnerability of the United States incarcerated population to heat, as well as how heat impacts ~~their health, health, to build reliable and validated datasets of cooling mechanisms in prisons and jails, to directly measure indoor temperatures in prisons and jails, and~~ to deploy adaptation measures to mitigate the worst impacts of climate-related stressors.

Indoor environments, especially in settings like prisons, can significantly differ from outdoor ambient conditions. Factors such as building materials, ventilation, and the presence or absence of air conditioning or shades play a critical role in determining the indoor climate. Without data on these aspects, any conclusions about temperature exposure are primarily based on external environmental conditions, which may not accurately reflect the actual exposure experienced by individuals indoors.

We recognise that temperatures which incarcerated people experience indoors is determined by many factors. Nevertheless, there are many emerging stories of incarcerated people dying in prisons and jails (e.g., <https://www.nytimes.com/2023/06/29/us/texas-prisons-heat.html>), which no doubt highlights how this is a major issue and will continue to be under climate change. The advantage of our analysis is it takes a top-down approach to lay foundation for further research, which we state clearly as needing to be done in the revised manuscript (PP. 6-7, Lines 304-327):

Our work highlights how incarcerated populations in the ~~United States~~US are systematically exposed to potentially hazardous heat with the greatest exposure and rates of increase concentrated in state-run institutions. Federal, state, and local laws mandating safe temperature ranges, enhanced social and physical infrastructure, and health system interventions could mitigate the effect of ~~heat exposure on this underserved and overburdened group.~~hazardous heat. Underlying this is the need for a fundamental overhaul to the perception and treatment of incarcerated people in environmental public health policy and regulatory action. Further work is critical to ~~both~~ comprehensively characterize the vulnerability of the United States incarcerated population to heat, as well as how heat impacts ~~their health,~~health, to build reliable and validated datasets of cooling mechanisms in prisons and jails, to directly measure indoor temperatures in prisons and jails, and to deploy adaptation measures to mitigate the worst impacts of climate-related stressors. Doing so is critical to environmental justice, particularly for incarcerated people with limited social and political agency.

This limitation is important in understanding the health risks associated with heat exposure in prisons. Suppose the indoor conditions are markedly different from the outdoor temperatures (either cooler due to air conditioning or hotter due to poor ventilation and overcrowding). In that case, the study's findings might not fully capture the true extent of the risk or lack thereof. Surely, there are adaptation or acclimation measures for inmates and staff? The availability and quality of outdoor spaces for inmates can vary, and in some high-security settings, access to outdoor areas is highly restricted -- how does this factor?

As we have stated above, while data measuring indoor temperatures in prisons and jails in the United States is scarce, a study from Denmark found temperatures in prison cells to be 4-5°C above those outdoors in summer. In general, this is approximately what was found in the Harlem Heat Project in New York City, a study of indoor domestic temperatures in Harlem. We have added this information and references to the revised Supplementary Information due to space constraints of the Brief Commentary:

While data measuring indoor temperatures in prisons and jails in the United States is scarce, a study from Denmark found temperatures in prison cells to be 4-5°C above those outdoors in summer.⁵ This is approximately what was also found in the Harlem Heat Project in New York City, a study of indoor domestic temperatures in domestic settings in Harlem, which is an area of New York with many residents who suffer cooling hardship.⁶

The Reviewer is correct that many incarcerated people get very limited outdoor time. This will likely factor in increasing their vulnerability if indoor environments are not adequately cooled.

The format of the submission is Brief Communication and therefore we are very restricted in words. Nevertheless, we have substantially added where possible that more research is needed in the revised manuscript (P. 7, Lines 322-326):

Further work is critical to ~~both~~ comprehensively characterize the vulnerability of the United States incarcerated population to heat, as well as how heat impacts ~~their health,~~health, to build reliable and validated datasets of cooling mechanisms in prisons and jails, to directly

measure indoor temperatures in prisons and jails, and to deploy adaptation measures to mitigate the worst impacts of climate-related stressors.

Lastly, we need a comparison group. Clarifying the characteristics of non-prison or non-institutionalized comparison groups would provide a clearer context for understanding the relative risk faced by the incarcerated population compared to non incarcerated population.

We have added statistics in the revised Supplementary Information regarding comparisons between incarcerated and non-incarcerated groups in the United States as Supplementary Tables 1 and 2, copied below for convenience (next page and page after):

We refer to Supplementary Tables 1 and 2 in the revised manuscript (P. 4, Lines 214-216):

Statistics comparing the characteristics of incarcerated and non-incarcerated people are found in Supplementary Tables 1 and 2.

Supplementary Table 1. Race, sex, and some SES variables for state incarcerated populations compared to U.S. general population.

Variable	State incarcerated population	U.S. general population (18+)	Source
Race			<p>Beyond the count: A deep dive into state prison populations from the Prison Policy Initiative, 2022. https://nicic.gov/weblink/beyond-count-deep-dive-state-prison-populations-2022</p> <p>-data are from Bureau of Justice Statistics' 2016 Survey of Prison Inmates</p> <p>-data are not regularly collected; most recent year available</p>
White	32%	62%	
Black	34%	12%	
Hispanic	21%	17%	
Sex			
Men	93%	49%	
Women	7%	51%	
Unemployment rate (pre-incarceration)	14.8%	4.7%	
Percent homeless (pre-incarceration)	4.9%	0.2%	
Percent with less than high school education	White: 52% Black: 68% Hispanic: 69%	Overall: 12%	<p>Prisons of poverty: Uncovering the pre-incarceration incomes of the imprisoned, 2015 https://www.prisonpolicy.org/reports/income.html</p>
Percent with annual income of < \$22,500 (pre-incarceration)	57%	23%	

Note: the Prison Policy Initiative Reports are all based on Bureau of Justice Statistics

Supplementary Table 2. Race of incarcerated population compared to state population for CA, TX, AZ.

State	State incarcerated population	State general population	Source	Year
California			California's Prison Population Fact Sheet from Public Policy Institute of California, 2017 https://www.ppic.org/publication/californias-prison-population/	2017
Black men	28.5%	5.6%		
Black women	25.9%	5.7%		
Incarceration rate for black men	4,236 / 100,000			
Incarceration rate for white men	422 / 100,000			
Texas			Texas state profile from Prison Policy Initiative, 2023 https://www.prisonpolicy.org/profiles/TX.html	2021
Black	33% prisons, 28% jails	12%		
White	34% prisons, 40% jails	41%		
Hispanic	33% prisons, 31% jails	40%		
Arizona			Incarceration trends in Arizona from Prison Policy Initiative, 2023 https://www.prisonpolicy.org/profiles/AZ.html	2021
Black	15% prisons, 16% jails	4%		
White	38% prisons, 55% jails	53%		
Hispanic	39% prisons, 20% jails	32%		
NA/AN	6% prisons, 8% jails	4%		

Reviewer #3 (Remarks to the Author):

The authors have greatly improved their already strong manuscript in response to Reviewer comments, with several additional sensitivity analyses and important clarifications to the text. I recommend this manuscript for publication and believe it will have a meaningful impact on epidemiologic research on the health of incarcerated populations as well as informing actions to address extreme heat exposure.

We thank the Reviewer for the thoughtful and constructive comments.