

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

- | | |
|-------------------------------------|--|
| n/a | Confirmed |
| ☐ | ☒ The exact sample size (<i>n</i>) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☒ | ☐ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☐ | ☒ The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ A description of all covariates tested |
| ☐ | ☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☐ | ☒ For null hypothesis testing, the test statistic (e.g. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☐ | ☒ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☒ | ☐ Estimates of effect sizes (e.g. Cohen's <i>d</i> , Pearson's <i>r</i>), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	We used Google Earth Engine to obtain daily temperature data from the ERA5-Land reanalysis dataset. (Instead of traditional version numbers, Google Earth Engine updates its platform continuously with new features, improvements, and bug fixes.)
Data analysis	All statistical analyses were performed using R software (version 4.3.1, R Foundation for Statistical Computing, Vienna, Austria). Key packages included lme4, lmerTest, dlnm, dplyr, ggplot2, ipw and emmeans. Map production and visualisation were conducted using ArcGIS Pro software (version 3.0.3, Esri Inc., Redlands, CA, USA).

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Daily temperature data are available from the ERA5-land reanalysis dataset (<https://cds.climate.copernicus.eu/datasets/reanalysis-era5-land?tab=overview>). The

cohort data were obtained from the MJ Health Management Institution and are not publicly available due to legal and ethical regulations. However, access may be granted to qualified researchers upon reasonable request to the institution and the corresponding author.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender

We conducted sex-based analysis.

Population characteristics

Since 1994, MJ Health Management Institution has offered a comprehensive medical screening program to residents of Taiwan. Participants are encouraged to undergo periodic physical examinations and complete self-administered questionnaires. By the end of 2022, this cohort included over 0.6 million participants with more than 1.5 million observations. Regarding the cohort based on initial examination visits, there were over 24,000 participants aged 0–19 years, more than 585,000 aged 20–64 years, and over 36,000 aged 65 years or older. Participation in interviews, basic health exams, and biomarker sample collection is voluntary, with all participants providing written informed consent.

Recruitment

Participants were enrolled through a paid membership and had relatively high levels of education and economic status. Therefore, generalizing results to other populations and regions should be done with caution. We have acknowledged this limitation in the discussion.

Ethics oversight

The Human Research Ethics Committee of the University of Hong Kong approved this research (EA240157).

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences

☒ Behavioural & social sciences

☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description

Our analysis employs a longitudinal cohort design to analyze the impacts of heatwaves on the acceleration of ageing. We used linear mixed models, accounting for intra-participant correlation.

Research sample

In this study, 29,110 adult Taiwanese aged between 25 and 80, with 40,721 observations with data for the acceleration of ageing, were initially included from 2008 to 2022. We further excluded 1,011 observations without information on the residential address and 6,009 observations due to missing data on covariates. Finally, a total of 24,922 adults aged 25 to 80 years, with 33,701 observations between 2008 and 2022, were included in the main analysis. At baseline, the mean age of participants was 45.25 years, and 50.2% were male. The participants included in the study are representative of the whole cohort.

Sampling strategy

This study encompassed adult individuals from the Taiwan MJ cohort, aged between 25 and 80, with data on ageing acceleration collected from 2008 to 2022. The primary exclusion criterion was related to data completeness. A total of 24,922 adults comprising 33,701 observations were included in the main analysis. The selected sample size is considered adequate for the study's objectives. Furthermore, the substantial sample size provides a robust dataset for statistical analysis, thereby enhancing the study's ability to identify associations between heatwave exposure and accelerated ageing.

Data collection

All personally identifiable information was removed from the raw data and replaced with a unique identification code. This information was then stored on a dedicated server, accessible only to authorized personnel.

During each examination visit, behavioral and lifestyle information was collected via health questionnaires, while anthropometric and biological data were gathered through physical examinations. Data from the questionnaires have been stored electronically since 1996. Blood samples are stored long-term in -80°C freezers.

Blood analyzers used include ABBOTT Cell-Dyn 3000/3700/Ruby. Biochemical analyzers used include HITACHI 7150 and TOSHIBA C8000. Immunoassay analyzers used include ABBOTT IMX/AxSYM/i2000. Urine analyzers used include AMES E1000 and ROCHE Miditron/Cobas U411. Blood pressure monitors used include SANKEN SM-100, YAMASU 600, KENLU K300, HICO, GE Dinamap Procare 100, DINAMAP Procare NIBP V100, and OMRON HEM-7201. Spirometers used include FUKUDA MICROSPIRO HI-501, FUKUDA HI-501, FUKUDA CHESTGRAPH HI-701, and CHEST HI-801.

Timing

The data covers the period from January 1, 2008, to December 31, 2022.

Data exclusions

We excluded 1,011 observations that lacked information on residential addresses and 6,009 observations due to missing data on

Data exclusions	covariates, which included education (3,331), smoking (122), drinking (73), exercise (527), vegetable/fruit intake (114), BMI (10), and occupation (1,832).
Non-participation	Among the 24,922 participants finally enrolled in this study, 14,706 participants provided only baseline data and did not attend any subsequent visits by 2022.
Randomization	This observational study did not involve randomization.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems		Methods	
n/a	Involved in the study	n/a	Involved in the study
☒	☐ Antibodies	☒	☐ ChIP-seq
☒	☐ Eukaryotic cell lines	☒	☐ Flow cytometry
☒	☐ Palaeontology and archaeology	☒	☐ MRI-based neuroimaging
☒	☐ Animals and other organisms		
☒	☐ Clinical data		
☒	☐ Dual use research of concern		