1   **Anomalously warm temperatures are associated with increased injury deaths**

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Temperatures which deviate from long-term local norm affect human health, and are projected to become more frequent as the global climate changes.[1] There is limited data on how such anomalies affect deaths from injuries. Here, we used data on mortality and temperature over 38 years (1980-2017) in the contiguous USA and formulated a Bayesian spatio-temporal model to quantify how anomalous temperatures, defined as deviations of monthly temperature from the local average monthly temperature over the entire analysis period, affect deaths from unintentional (transport, falls and drownings) and intentional (assault and suicide) injuries, by age group and sex. We found that a 1.5°C anomalously warm year, as envisioned under the Paris Climate Agreement,[2] would be associated with an estimated 1,601 (95% credible interval 1,430-1,776) additional injury deaths. 84% of these additional deaths would occur in males, mostly in adolescent to middle ages. These deaths would comprise of increases in deaths from drownings, transport, assault and suicide, offset partly by a decline in deaths from falls in older ages. The findings demonstrate the need for targeted interventions against injuries during periods of anomalously high temperatures, especially as these episodes are likely to increase with global climate change.

Anomalously warm and cold weather events are an important public health concern in today's world, and one of the key drivers for seeking adaptation measures against anthropogenic climate change.[3–5] Current assessments of the health effects of weather and climate, and by extension of global climate change, largely focus on parasitic and infectious diseases and cardiorespiratory and other chronic diseases.[3–8] Less research has been conducted on injuries,[9–12] especially in a consistent way across injury types and demographic subgroups of the population. There are two reasons to investigate a potential role for temperature anomalies on injury mortality. First, death rates from injuries vary seasonally and the seasonality varies by

46   age group,[13,14] which motivates investigating whether temperature contributes to their

47   pathogenesis. Second, there are plausible behavioural and physiological pathways for a

48   relationship between temperature and injury – for example changes in alcohol drinking,[15]

49   driving patterns and performance,[12,16–24] and levels of anger[25–27] – which motivates testing

50   whether injury deaths are affected by temperature anomalies. Our aim was to evaluate how

51   deaths from various injuries in the USA might be affected by anomalously warm and

52   temperatures that occur today and are expected to become increasingly common as a result of

53   global climate change.[1]

54

55   We used vital registration data on all injury deaths in the contiguous USA (i.e., excluding

56   Alaska and Hawaii) from 1980 to 2017, with information on sex, age at death, underlying cause

57   of death and county and state of residence. From 1980 to 2017, 4,145,963 boys and men and

58   1,825,817 girls and women died from an injury in the contiguous USA, accounting for 9.3%

59   and 4.2% of all male and female deaths respectively. 95.7% of male injury deaths and 94% of

60   female injury deaths were in those aged 15 years and older, and over half (52.3%) of male

61   injury deaths were in those aged 15-44 years (Figure 1). By contrast with males, there was less

62   of an age gradient in females after 15 years of age.

63

64   Injuries from transport, falls, drownings, assault, and suicide accounted for 78.6% of injury

65   deaths in males and 71.8% in females. The remainder were from a heterogeneous group of

66   "other injuries" (Figure 1), within which the composition of injuries that led to death varied by

67   sex and age group. Transport was the leading injury cause of death in women younger than 75

68   years and in men younger than 35 years. Between 35 and 74 years of age, more men died of

69   suicide than any other injury. Above 75 years of age, falls were the largest cause of injury-

70   related death in both men and women.

71

72   There was a decline in age-standardised death rates of three out of five major injuries (transport,

73   drownings and assault) from 1980 to 2017, although assault deaths have more recently (since

74   2014) increased (Figure 2). By contrast, age-standardised death rates from falls increased over

75   time while those from suicide initially decreased followed by an increase to surpass 1980

76   levels. The largest overall decline over time was for transport deaths in both sexes and for

77   deaths from drownings in men, which declined by more than 50% from 1980 to 2017. Age-

78   standardised death rates for transport injuries and drownings peaked in summer months but

79   deaths from other major injuries did not have clear seasonal patterns.

80

81   We defined a measure of anomalous temperature for each county and month, which represents

82   the deviation from the county's average temperature in that month over the entire analysis

83   period (Extended Data Figure 1). County-level anomalies were aggregated to state level with

84   use of population weights. This generated a number for each state and month that measured

85   deviation from long-term average of the state in that month. Average size of anomaly over the

86   study period (1980-2017), a measure of how variable temperatures are around their state-month

87   long-term average, ranged from 0.4°C for Florida in September, to 3.4°C for North Dakota in

88   February (Extended Data Figure 2). Taken across all states and months, the average size of

89   anomaly had a median value of 1.2°C. Temperature anomalies were largest in January and

90   December and smallest in August and September. Additionally, they were larger in northern

91   and central states than in southern and coastal ones.

92

93   We analysed the association of monthly injury death rates with anomalous temperature using

94   a Bayesian spatio-temporal model, described in detail in Methods. We used the resultant risk

95   estimates and the age-sex-specific death rates from each injury in 2017, to estimate additional

96   deaths if each month in each state were +1.5°C above its long-term average as envisioned under

97   the Paris Climate Agreement.[2] We present additional results, based on a +2°C, which is the

98   upper bound of the Paris Climate Agreement as Extended Data. Based on this analysis, there

99   would be an estimated 1,601 (95% credible interval 1,430-1,776) excess injury deaths,

100 equivalent to 0.75% of all injury deaths in 2017, in a year in which each month in each state

101 was +1.5°C warmer than its long-term average (Figure 3). The number of excess injury deaths

102 would increase to 2,135 (95% credible interval 1,906-2,368), equivalent to 1.0% of all injury

103 deaths in 2017, in each year in which each month in each state was +2°C warmer than its long-

104 term average (Extended Data Figure 3).

105

106 Deaths from drowning, transport, assault and suicide would increase, partly offset by a decline

107 in deaths from falls in middle and older ages and in winter months (Figure 3). Most excess

108 deaths would be from transport injuries (739; 650-814 in the +1.5°C warmer scenario) followed

109 closely by suicide (540; 445-631). 84% of the excess deaths would occur in males and 16% in

110 females. 92% of all male excess deaths would occur in those aged 15-64 years, who have higher

111 rates of deaths from transport and suicide. In those aged 85 years and older, there would be an

112 estimated decline in injury deaths, because deaths from falls are expected to decline in a

113 warmer year.

114

115 Proportionally, deaths from drownings are estimated to increase more than those of other injury

116 types, by as much 13.7% (12.5, 15.2) for a +1.5°C anomaly in men aged 15-24 years (Figure

117 4). The smallest proportional increase was that of assault and suicide (less than 3% in all age

118 and sex groups). There was a larger percent increase in transport deaths for males than for

119 females, especially in young and middle-ages (e.g., 2.0% (1.6, 2.6) for 25-34 year old men

120 versus 0.5% (-0.3, 1.4) for women of the same age) (Figure 4). We present additional results,

121 based on a +2°C, as Extended Data (Extended Data Figure 4).

122

123 That anomalously warm temperature influences deaths from drowning, although not previously

124 quantified, is highly plausible because swimming is likely to be more common when

125 temperature is higher. The higher relative and absolute impacts on men compared with women

126 may reflect differences in their behaviours. For example, over half of swimming deaths for

127 males occur in natural water, compared to about one quarter for females.[28] The former may

128 rise more in warmer weather. Similarly, deaths from falls declined more in older ages because

129 falls in the elderly are more likely to be due to slipping on ice than those in younger people.[29–

130 31]

131

132 The pathways from anomalous temperature to transport injury are more varied. Firstly, driving

133 performance deteriorates at higher temperatures.[20–23] Further, alcohol consumption increases

134 in warm temperatures,[15] which also provides an explanation for why teenagers, who are more

135 likely than other age groups to crash while intoxicated,[32] could experience a larger proportional

136 rise in deaths from transport when temperatures are anomalously warm than older adults.

137 Lastly, warmer temperatures generally increase road traffic in North America;[12,16–19,24] coupled

138 with more people outdoors in warmer weather,[33] this increase could lead to more fatal

139 collisions.

140

141 Pathways linking anomalously high temperatures and deaths from assault and suicide are less

142 established. One hypothesis is that, more time spent outdoors in anomalously warmer

143 temperatures leads to an increased number of face-to-face interactions, and hence arguments,

144 confrontations, and ultimately assaults.[34,35] These effects could be compounded by the greater

145   anger levels linked to higher temperatures.[25–27] However, further research on the association of

146   temperature and assault, and the factors mediating it, is needed.[36] Regarding suicide, it has been

147   hypothesised that higher temperature is associated with higher levels of distress in younger

148   people.[37] Nonetheless, the mechanisms for the links between temperature and mental health

149   requires further investigation, including whether the relationship varies by age and sex, as

150   indicated by our results. Future research should also investigate the extent to which the

151   increased risk of injury death as a result of anomalous temperature depends on community

152   characteristics such as poverty and deprivation, social connectivity and cohesion, quality of

153   roads and housing, public transportation options, emergency response, and social services.

154

155   The major strength of our study is that we have comprehensively modelled the association of

156   temperature anomaly with injury by type of injury, month, age group and sex. Our measure of

157   temperature anomaly internalises long-term historical experience of each state, and is closer to

158   what climate change may bring about than solely examining daily episodes, or average

159   temperature to which people have adapted. To utilise this metric, we integrated two large

160   disparate national datasets on mortality (vital statistics) and meteorology (ERA5), and

161   developed a bespoke Bayesian spatio-temporal model. A limitation of our study is that, like all

162   observation studies, we cannot rule out confounding of results due to other factors. As

163   described above, our statistical model by design adjusts for factors related to month, state and

164   state-month that are either invariant over time or that change linearly. Rather, the confounding

165   factors would be those with anomalies that are similar to those of monthly temperature in each

166   state, such as air pollution. However, to our knowledge, there is currently no evidence of an

167   association between air pollution and injury mortality. We analysed the associations between

168   anomalous temperature and injury mortality at the state level because the small number of

169   events and computational demands made county-level analyses unfeasible. Analyses at finer

170   spatial resolution, such as county or district,[50] would be ideal because the impacts of

171   anomalously warm and cold temperature on deaths from injuries may depend on

172   socioeconomic (e.g., poverty; social connectivity and cohesion; availability of guns),

173   environmental (e.g., availability of swimming pools; distance to bodies of water), infrastructure

174   (e.g., quality and safety of roads; public transportation options), and health and social services

175   (e.g., counselling and mental health services; emergency response). We used categories of

176   injuries that are relevant for public health purposes and for designing and implementing

177   interventions. It may be possible to further split each category. For example, 92% of all

178   transport injuries in males and 96% in females are from road traffic injuries, with the remainder

179   being classified as other transport injuries (Extended Data Figure 5). Similarly, suicides can be

180   classified based on the means of suicide. To the extent that these sub-categories are relevant

181   for interventions, they should be separately analysed in future studies. Finally, as with any

182   Bayesian model, choices of prior distributions and hyper-parameters are necessary. There are

183   alternatives to the priors we used. For example, our weakly informative gamma priors could

184   have been replaced with penalised complexity priors[51] or uniform priors on the standard

185   deviation scale.[52] We tested a limited number of alternatives and found that our results were

186   robust to such specifications.

187

188

189   Our work highlights how deaths from injuries are currently susceptible to temperature

190   anomalies and could also be modified by rising temperatures resulting from climate change,

191   unless countered by social infrastructure and health system interventions that mitigate these

192   impacts. Though absolute impacts on mortality are modest, some groups, especially men in

193   young to middle-ages, experience larger impacts. Therefore, a combination of public health

194   interventions that broadly target injuries in these groups – for example targeted messaging for

195 younger males on the risks of transport injury and drowning – and those that trigger in relation

196 to forecasted high temperature periods – for example additional targeted blood alcohol level

197 checks – should be a public health priority.

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Methods

Data sources

We used data on deaths by sex, age, underlying cause of death and state of residence in the contiguous USA from 1980 to 2017 through the National Center for Health Statistics (NCHS) (https://www.cdc.gov/nchs/nvss/dvs_data_release.htm) and on population from the NCHS bridged-race dataset for 1990 to 2017 (https://www.cdc.gov/nchs/nvss/bridged_race.htm) and from the US Census Bureau prior to 1990 (https://www.census.gov/data/tables/time-series/demo/popest/1980s-county.html). We did not include Alaska and Hawaii, (which together made up 0.5% of the US population in 2017) because their climates and environment are distinct from other states due to their substantial physical distance. We calculated monthly population counts through linear interpolation, assigning each yearly count to July.

The underlying cause of death was coded according to the international classification of diseases (ICD) system (9th revision from 1980 to 1998 and 10th revision thereafter). The 6 million injury deaths fell into six categories: transport, falls, drownings, assault, suicide and an aggregate set of other injuries (Extended Data Table 1). We report the results of all of these categories except other injuries (1,402,941 deaths or 23% of total injury deaths during 1980-2017), because the composition of this aggregate group varies by sex, age group, state and time.

We obtained data on temperature from ERA5, which uses data from global in-situ and satellite measurements to generate a worldwide meteorological dataset, with full space and time coverage over our analysis period.[38] We used gridded four-times-daily estimates at a resolution of 30 km to generate monthly temperatures by county.

Anomalous temperature metric

319   With few exceptions,[9,39] current climate change risk assessments extrapolate from associations

320   of daily mortality with daily temperature.[7,8,40–42] Climate change, however, will fundamentally

321   modify weather, including seasonal weather patterns, compared to long-term averages, and

322   hence can disrupt existing forms of adaptation. To mimic the conditions that may arise with

323   global climate change, we developed methodology to examine how deviations from long-term

324   average temperature may impact injury death rates.

325

326   We first defined a measure of anomalous temperature for each county and month, which

327   represents the deviation from the average temperature of the county in that month over the

328   entire analysis period. To calculate the magnitude of temperature anomaly, we first calculated

329   average temperatures for each month in each county over the entire 38 years of analysis. We

330   subtracted these long-term average temperatures from respective monthly temperature values

331   to generate a temperature anomaly time series for each month and year in each county

332   (Extended Data Figure 1). The temperature anomaly metric measures the extent that

333   temperature experienced in a specific month, year and county is warmer or cooler than the

334   long-term average to which the population has acclimatised. These values can be different for

335   different months in the same county, and different counties in the same month. Further, a

336   county with higher, but more stable, temperature in a specific month has smaller anomalies

337   than one with lower but more inter-annually variable temperature. County-level anomalies

338   were aggregated to state level with use of population weights for analysing their associations

339   with mortality.

340

341   *Statistical methods*

342   We analysed the association of monthly injury death rates with anomalous temperature using

343   a Bayesian spatio-temporal model, which leveraged variations over space and time to infer

344 associations. We modelled the number of deaths in each month in each year as following a

345 Poisson distribution:

346 $$deaths_{state-time} \sim Poisson(death\ rate_{state-time} \cdot population_{state-time})$$

347 with log-transformed death rates modelled as a sum of components that depend on location

348 (state) of death, month of year, overall time (in months) and temperature anomaly:

$$
\begin{aligned}
\log(death\ rate_{state-time}) = \\
\alpha_0 \ + \ \beta_0 \cdot time + \\
\alpha_{state} \ + \ \beta_{state} \cdot time + \\
\alpha_{month} \ + \ \beta_{month} \cdot time + \\
\zeta_{state-month} + \\
\psi_{state-month} \cdot time + \\
\nu_{time} \ + \\
\gamma_{month} \cdot Anomaly_{state-time} + \\
\varepsilon_{state-time}
\end{aligned}
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359 The model contained terms that represent the national level and trend in mortality, with α_0 as

360 the common intercept and β_0 the common slope with overall time. Death rates also vary by

361 month, which may be partly related to temperature and partly due to other monthly factors;

362 monthly variations tend to be smooth across adjacent months.[13] Therefore, we allowed each

363 month of the year to systematically have a different mortality level and trend, with α_{month} the

364 month-specific intercept and β_{month} the month-specific slope with overall time. We used a

365 first-order random walk prior for the monthly random intercepts and slopes, widely used to

366 characterise smoothly varying trends.[43] The random walk had a cyclic structure, so that

367 December was adjacent to January.

368

369 We also included state random intercepts and slopes for death rates, with α_{state} as the state-

370 specific intercept and β_{state} the state-specific slope with overall time. These terms measure

371 deviations of each state from national values, and allow variation in level and trend in mortality

372 by state. We modelled the state-level random intercepts and slopes using the Besag, York, and

373 Mollie (BYM) spatial model,[44] which includes both spatially-structured random effects with

374 an intrinsic Conditional Autoregressive (ICAR) prior and spatially-unstructured independent

375 and identically distributed (IID) Gaussian random effects. The extent to which information is

376 shared between neighbouring states depends on the uncertainty of death rates in a state and the

377 empirical similarity of death rates in neighbouring states. We also included state-month

378 interactions for intercepts and slopes ($\zeta_{state-month}$ and $\psi_{state-month}$), to allow variation in

379 mortality levels and trends in a particular state for different months and vice-versa. These state-

380 month interactions were modelled as IID and therefore were of Type I space-time

381 interactions.[45] Non-linear change over overall time (in months) was captured by a first-order

382 random walk, ν_{time}.[43] In order to ensure identifiability each set of random walk terms or state

383 random effects was constrained to sum to zero.

384

385 Finally, we included a term that relates log-transformed death rate to the above-defined state-

386 month temperature anomaly, $\gamma_{month} \cdot Anomaly_{state-time}$. The coefficients of γ_{month} represent

387 the logarithm of the monthly death rate ratio per 1°C increase in anomaly. There was a separate

388 coefficient for each month which means that an anomaly of the same magnitude could have

389 different associations with injury mortality in different months. As with the month-specific

390 intercepts and trends, we used a cyclic first-order random walk to smooth the coefficient of the

391 temperature anomaly across months. An over-dispersion term ($\varepsilon_{state-time}$) captured the

392 variation unaccounted for by other terms in the model, modelled as $N(0,\sigma_\epsilon^2)$. We used weakly

393 informative priors so that parameter estimation was driven by the data. As in previous

394 analyses,[46,47] hyper-priors were defined on the logarithm of the precisions of the random

395 effects, in other words on $\log(1/\sigma^2)$. These were modelled as logGamma(θ, $\boldsymbol{\delta}$) distributions

396 with shape $\theta = 1$ and rate $\boldsymbol{\delta} = 0.001$. The same hyper-priors were used for all precision

397 parameters of the random effects in the model. For the common slope, we used $N(0, 1000)$ and

398 for the common intercept a flat prior.

399

400   In addition to representing the spatial (across states) and temporal (across months and years)

401   patterns of mortality, the intercept terms (α_{month}, α_{state}, $\zeta_{state-month}$) in our statistical model

402   implicitly adjust for unobserved factors that influence mortality at the state, month and state-

403   month level; the slope terms (β_{month}, β_{state}, $\psi_{state-month}$) do so for changes in these factors

404   over time.[46] This means that the only confounding factors would be those that have the same

405   state-month anomaly as temperature.

406

407   We fitted the models using integrated nested Laplace approximation (INLA), using the R-

408   INLA software, which is computationally more efficient than traditional MCMC for Bayesian

409   inference[48] The uncertainty in our results were obtained from 5000 draws from the posterior

410   marginal of each month's excess relative risk. The reported 95% credible intervals are the 2.5th

411   to 97.5th percentiles of the sampled values.

412

413   Analyses were done separately by injury type, because different injuries can have differing

414   associations with anomalously warm and cold temperature. Analyses were also done separately

415   by sex and age group (0-4 years, 10-year age groups from 5 to 84 years, and 85+ years) because

416   injury death rates vary by age group and sex (Figure 1 and Extended Data Table 2), as might

417   their associations with temperature. We used the resultant risk estimates and the age-sex-

418   specific death rates from each injury in 2017, to calculate additional deaths if each month in

419   each state were +1.5°C above its long-term average, not only realistic in our lifetimes under

420   current projections of global climate change but an agreed upper bound chosen under the Paris

421   Climate Agreement.[2,49] +1.5°C is also within the range of anomaly size experienced by some

422   states (Extended Data Figure 2). We did similar calculations for +2°C, which is the upper

423   bound of the Paris Climate Agreement, and present these as Extended Data. For these

424   calculations, we multiplied the actual death counts for each month, sex, state and age group in

425   2017 by the corresponding excess relative risk, which was calculated as the exponential of the

426   coefficient of the temperature anomaly term from the above analysis.

427

428   *Sensitivity analyses*

429   We conducted sensitivity analyses to assess how much our results might depend on the

430   temperature metric used to generate anomalous temperature. First, instead of building our

431   monthly temperature anomalies based on daily mean temperatures, we used daily maxima and

432   minima. These measures were strongly correlated to those generated from daily means

433   (Extended Data Table 3), and therefore we did not run models using these alternatives.

434

435   Second, together with temperature anomaly based on daily mean temperatures, we also

436   included a second measure of anomaly in the model. We tested three different measures for

437   this sensitivity analysis: (i) temperature anomaly calculated based on 90th percentile (°C) of

438   daily mean temperatures within a month, compared to the average of 90th percentiles for each

439   state and month; (ii) number of days in a month above the long-term 90th percentile of average

440   temperature for each state and month (adjusted for length of month); and (iii) number of 3+

441   day episodes above the long-term 90th percentile of average temperature for each state and

442   month (adjusted for length of month). These additional measures were related to more extreme

443   anomalous situations which may be relevant if the impacts on injuries are related to more

444   extreme temperatures and how frequent they are in each month.

445

446   The correlations among these variables and anomaly based on mean were between 0.60 and

447   0.89 (Extended Data Table 4). The estimated rate ratios of temperature anomaly based on daily

448   means (i.e., the anomaly measure used in the main analysis) were robust to the addition of

449   alternative measures of anomaly, while the coefficients of the additional measures were

450   generally not significant and with large credible intervals. Therefore, we did not include the

451   alternative additional measures of extreme anomalous temperature in the main analysis.

452

453   *Comparison with previous studies*

454   While there are no previous studies of how deviations of monthly temperature from long-term

455   average are associated with injury mortality, our results are broadly in agreement with those

456   that have analysed associations with absolute temperature and for specific injury types. A study

457   of suicide in US counties over 37 years (1968-2004) estimated that 1°C higher monthly

458   temperature would lead to a 0.7% rise in suicides,[9] compared to our findings of 0.7-1.5% in

459   males and 0.5-2.9% in females in different ages for a +1.5°C anomaly. A cross-sectional

460   analysis in 100 US counties found that a 1°C higher temperature would lead to a 1.3% increase

461   in death rates from road traffic injuries,[24] compared to our finding of 0.6-3.1% in males and

462   0.5-2.0% in females for a +1.5°C anomaly. In a study of six French heatwaves during 1971-

463   2003, mortality from unintentional injuries rose by up to 4% during a heatwave period

464   compared to a non-heatwave baseline.[10] A study of daily mortality from all injuries from

465   Estonia found a 1.24% increase in mortality when daily maximum temperature went from the

466   75th to 99th percentile of long-term distribution.[11]

467

468

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Data availability

ERA5 temperature data are downloadable from https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5. Vital statistics files with geographical information can be requested through submission of a proposal to NCHS (https://www.cdc.gov/nchs/nvss/nvss-restricted-data.htm).

Code availability

The computer code for the Bayesian model used in this work is available at www.globalenvhealth.org/code-data-download.

Author contributions

529 All authors contributed to study concept and interpretation of results. RP, GD and ME collated

530 and organised temperature and mortality files. RP, JEB, VK and ME developed statistical

531 model, which was implemented by RP, JEB and VK. RP performed the analysis, with input

532 from other authors. RP and ME wrote the first draft of the paper; other authors contributed to

533 revising and finalizing the paper.

534

535 **Competing interests statement**

536 ME reports a charitable grant from AstraZeneca Young Health Programme, and personal fees

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538 declare no competing interests.

539   **Figure 1.** Number of injury deaths, by type of unintentional (transport, falls, drownings, and

540   other) and intentional (assault and suicide) injury, by sex and age group in the contiguous USA

541   for 1980-2017.

542   **Figure 2.** National age-standardised death rates from 1980 to 2017, by type of injury, sex and

543   month.

544   **Figure 3.** Additional annual injury deaths for the 2017 US population in year in which each

545   month was +1.5°C warmer compared with 1980-2017 average temperatures. The top row

546   shows breakdown by type of injury, sex and age group. The bottom row shows the break down

547   by type of injury, sex and month. Black dots represent net changes in deaths for each set of

548   bars. See Extended Data Figure 3 for results for scenario of 2°C warmer.

549 **Figure 4.** Percent change in death rates in year in which each month was +1.5°C compared

550 with 1980-2017 average temperatures by type of injury, sex and (A) age group or (B) month.

551 Coloured dots show the posterior means and error bars represent 95% credible intervals, both

552 obtained at the posterior draw level. See Extended Data Figure 4 for scenario of 2°C warmer.