ESC European Society of Cardiology
European Heart Journal (2019) **40**, 3440–3441
doi:10.1093/eurheartj/ehz612

DISCUSSION FORUM

Burden of myocardial infarctions attributable to heat and cold

Kai Chen [1,2]*, Annette Peters[1,3,4], and Alexandra Schneider[1]; for the KORA Study Group[†]

[1]Institute of Epidemiology, Helmholtz Zentrum München–German Research Center for Environmental Health, Ingolstädter Landstr. 1, Neuherberg 85764, Germany; [2]Department of Environmental Health Sciences, Yale School of Public Health, 60 College Street, New Haven, CT 06510, USA; [3]Institute for Medical Information Processing, Biometry and Epidemiology, Ludwig-Maximilians-Universität München, Marchioninistr. 15, München 81377, Germany; and [4]German Research Center for Cardiovascular Research (DZHK), Partner-Site Munich, Biedersteiner Straße 29, München 80802, Germany

Online publish-ahead-of-print 17 September 2019

This commentary refers to 'Changing trends and public health relevance of myocardial infarctions attributable to cold and heat' by V. Čulić, 2019;40:3438–3439.

We thank for Dr Čulić's interest in our article,[1] and his comment on the public health relevance of our findings in terms of myocardial infarctions (MIs) attributable to cold and heat.[2] We appreciate Dr Čulić's endeavour of calculating the population attributable risks (PAR) based on the risk estimates of our study. However, it should be noted that the risk estimates for heat or cold effects were only point estimates for temperatures at the 97.5th percentile (heat) or 2.5th percentile (cold) relative to the minimum MI temperature (i.e. optimum temperature). Thus, the PAR for temperatures above the 97.5th percentile or below the 2.5th percentile only account for the MI burden attributable to extreme heat or extreme cold.

Temperature and health generally showed U-shaped associations, with increasing risks for both temperatures above and below the optimum temperature (see Figure 1 in our article[2]). A previous multicountry study showed that mortality risk attributable to extreme temperatures (both extreme heat and extreme cold; 0.86%) was substantially less than that attributable to milder but non-optimum temperatures (6.85%).[3] To gain a complete picture of the attributable burden, we estimated the number and fraction of MI cases attributable to heat (above the optimum temperature), cold (below the optimum temperature), and total temperature (net change, the summed impacts of heat and cold) in Augsburg, Germany using a recently developed approach.[3,4] Briefly, we applied the risk estimates corresponding to each day's temperature in the previously estimated exposure-response function for total MI,[2] and then used the daily series of temperature and MI to calculate the daily attributable number of MI cases. We then calculated the total attributable number by summing the contributions from all the days of the series and calculated the attributable fraction as the ratio of the total attributable number to the total number of MI cases.

During 1987–2014, the total attributable fraction of MI in Augsburg caused by temperature was 11.29% [95% empirical confidence

Table 1 Attributable number and fraction (95% empirical confidence intervals) of total myocardial infarction cases during 1987–2014, 1987–2000, and 2001–14

	Period	All	Heat	Cold
Attributable number of cases	1987–2014	3083 (1123 to 4776)	124 (-98 to 323)	2959 (999 to 4692)
	1987–2000	2072 (640 to 3242)	-75 (-277 to 95)	2147 (807 to 3315)
	2001–14	1066 (-321 to 2258)	145 (-6 to 274)	921 (-530 to 2127)
Attributable fraction of cases (%)	1987–2014	11.29 (4.11 to 17.49)	0.45 (-0.36 to 1.18)	10.83 (3.66 to 17.18)
	1987–2000	15.05 (4.65 to 23.55)	-0.54 (-2.01 to 0.69)	15.59 (5.86 to 24.07)
	2001–14	7.87 (-2.37 to 16.67)	1.07 (-0.04 to 2.02)	6.80 (-3.92 to 15.71)

95% empirical confidence intervals (eCIs) were obtained by using 5000 times of Monte Carlo simulations.[3]

* Corresponding author. Tel: +1 203 787 7004, Email: kai.chen@yale.edu

[†] The KORA-Study Group consists of A. Peters (speaker), H. Schulz, L. Schwettmann, R. Leidl, M. Heier, K. Strauch, and their co-workers, who are responsible for the design and conduct of the KORA studies.

intervals (eCIs) 4.11–17.49%], most of which was due to cold [10.83% (95% eCI 3.66–17.18%)] rather than heat [0.45% (95% eCI -0.46% to 1.18%)] (*Table 1*). However, the cold-attributable MI decreased from 15.59% in 1987–2000 to 6.80% in 2001–14, whereas the heat-attributable MI increased from -0.54% to 1.07%. This means that in the recent period (2001–14), about 7 in 100 MIs can be attributable to cold, 1 in 100 MIs to heat, and a total of 8 in 100 can be attributable to both cold and heat. Our results were similar to the estimated mortality risk attributable to both heat and cold (7.71%) in a previous study.[3] This substantial burden of MI attributable to heat and cold, particularly the rising burden to heat-related MI, calls for attention of healthcare professionals to the growing health threat of climate change.

In conclusion, we appreciate Dr Čulić's comment which provides us the opportunity to present the rising MI burden attributable to heat in Augsburg. We agree that more large and detailed studies are warranted to complement the evidence on temperature-related cardiovascular health trends.

Conflict of interest: none declared.

References

1. Čulić V. Changing trends and public health relevance of myocardial infarctions attributable to cold and heat. *Eur Heart J* 2019;**40**:3438–3439.
2. Chen K, Breitner S, Wolf K, Hampel R, Meisinger C, Heier M, von Scheidt W, Kuch B, Peters A, Schneider A, Peters A, Schulz H, Schwettmann L, Leidl R, Heier M, Strauch K. Temporal variations in the triggering of myocardial infarction by air temperature in Augsburg, Germany, 1987-2014. *Eur Heart J* 2019;**40**:1600–1608.
3. Gasparrini A, Guo YM, Hashizume M, Lavigne E, Zanobetti A, Schwartz J, Tobias A, Tong SL, Rocklov J, Forsberg B, Leone M, De Sario M, Bell ML, Guo YLL, Wu CF, Kan H, Yi SM, Coelho M, Saldiva PHN, Honda Y, Kim H, Armstrong B. Mortality risk attributable to high and low ambient temperature: a multicountry observational study. *Lancet* 2015;**386**:369–375.
4. Gasparrini A, Leone M. Attributable risk from distributed lag models. *BMC Med Res Methodol* 2014;**14**:55.