Geographical disparities in the impacts of heat on diabetes mortality and the protective role of greenness in Thailand: a nationwide case-crossover analysis

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Abstract

Diabetes is a major public health problem in Thailand, and heat exposure is a potential risk factor for death among diabetes. This study examines the association between heat and diabetes mortality in different regions of Thailand and investigates whether heat effects are modified by regional greenness. Daily temperature and daily diabetes deaths data were obtained for 60 provinces of Thailand during 2000-2008. A case-crossover analysis was conducted to quantify the odds of heat-related death among diabetes. Meta-regression was then used to examine potential modification effects of regional greenness (as represented by the Normalized Difference Vegetation Index) on heat-related mortality. A strong association between heat and diabetes mortality was found in Thailand, with important regional variations. Nationally, the pooled odds ratio of diabetes mortality was 1.10 (95% confidence interval (CI): 1.06-1.14) for heat (90th percentile of temperature) and 1.20 (95% CI: 1.10-1.30) for extreme heat (99th percentile of temperature) compared with the minimum mortality temperature, across lags 0-1 days. Central and northeast Thailand were the most vulnerable regions. Regional greenness modified the effects of heat, with lower mortality impacts in areas of higher levels of greenness. In conclusion, heat exposure increases mortality risk in diabetics, with large geographical variations in risk suggesting the need for region-specific public health strategies. . Increasing greenness levels may help to reduce the burden of heat on diabetes in Thailand against the backdrop of a warming climate.

Keywords: Heat; Greenness; Diabetes; Mortality; Thailand

1. Introduction

Diabetes mellitus (hereafter called diabetes) is a major public health problem worldwide (GBD 2017 Causes of Death Collaborators, 2018). According to the 2017 report from International Diabetes Federation (IDF, 2017), globally 425 million people suffer from diabetes and over one third of these reside in the Western Pacific regions. Thailand is one of those countries in the Western Pacific regions with a high diabetes burden. In Thailand, the prevalence of diabetes has been increasing in recent decades, ranging from 2.3% in 1991 to 4.6% in 1997, 6.8% in 2004, and 6.9% in 2009 (Deerochanawong and Ferrario, 2013). Diabetes is responsible for substantial medical, public health, and economic impacts in Thailand (Deerochanawong and Ferrario, 2013).

To reduce the disease burden from diabetes, it is crucial to identify modifiable risk factors. Risk factors are known to be associated with an increased risk of developing diabetes include long-term unhealthy diets, smoking, alcohol use, obesity, physical inactivity, low income, and low education attainment (GBD 2017 Risk Factor Collaborators 2018, 2018). Furthermore, short-term exposure to environmental risk factors may trigger death in diabetic people, but the potential relationships between such exposures and diabetes mortality have to date never studied in Thailand.

One such environmental risk factor that may be culpable is ambient temperature since it is an important determinant of human health (Watts et al., 2018). Heat exposure is considered to adversely affect diabetics in multiple ways, including disturbing normal regulation of the cardiovascular system and glycaemic control (Al-Qaissi et al., 2019; Kenny et al., 2016). Although the adverse effects of heat on mortality have been well documented in previous literature, most of these report on deaths from all-cause, cardiovascular or respiratory diseases (Chen et al., 2018; Gasparrini et al., 2015; Sera et al., 2019). To date, only a few studies have looked at extreme temperature and diabetes mortality and few have considered important spatial variations in risk (Seposo et al., 2017; Yang et al., 2016). In addition, previous investigations focussed only on one or a few settings and employed differing methodologies, thus limiting comparisons and extrapolation of current evidence to other regions or countries with different climatic, demographic, and socioeconomic profiles.

Previous studies have shown that the temperature-mortality association can be modified by various contextual characteristics, including greenness which was shown to alleviate heat stress and lessen heat-related disease burdens in various populations (Dang et al., 2018; Sera et al., 2019). However, the potential modifying effects of greenness on temperature-diabetes mortality associations have been investigated in limited studies (Xu et al., 2019). To address these knowledge gaps, this study examines the association between ambient heat and diabetes mortality in a total of 60 provinces across Thailand using a standard analytical protocol.

2. Materials and methods

2.1 Data collection

This study was conducted in Thailand, a developing country with a tropical climate. Thailand consists of 76 provinces across six regions: east, west, south, north, northeast, and central. Sixty provinces were included in this study, with the remainder omitted due to unavailability of data The included provinces located in all regions of Thailand and account for more than 87% of the national population in 2010 (figure 1).

Data on individual diabetes deaths for each province from 2000 to 2008 were provided by the Ministry of Public Health, Thailand. The diagnosis of diabetes was based on the

10th Revision of International Classification of Diseases (ICD-10: E10-E14). Daily temperature (maximum, mean, and minimum) and relative humidity for each province during the same study period were obtained from the Meteorological Department, Ministry of Digital Economy and Society, Thailand. This weather data have been described in detail elsewhere (Huang et al., 2018).

Monthly greenness data with a 0.1° * 0.1° spatial resolution were obtained from the National Aeronautics and Space Administration website (https://neo.sci.gsfc.nasa.gov/view.php?datasetId=MOD_NDVI_M). Green space is measured as the Normalized Difference Vegetation Index (NDVI), reflecting the amount of live green vegetation within a given area. NDVI ranges between -1 and 1, with higher values associated with higher vegetative density (Ji et al., 2019). Since NDVI values in the 76 regions of Thailand remained relatively stable throughout a typical year (Supplementary Fig. S1), the average NDVI value across months for each province during the study period was calculated and then used to examine the relation between greenness and heat-related mortality risk.

Because other regional characteristics may confound the modifiying effects of greenness on heat-related risk, province-specific data on education (average years of educational attainment of the population aged 15 years and over), gross provincial product per capita (GPPPC), and the proportion of people aged ≥ 65 years from used in previous work (Huang et al., 2018) were also collected. Average values of mean temperature and relative humidity in each province were also considered as potential confounders.

2.2 Data analysis

In this study, a two-stage analysis was conducted to quantify the effects of temperature on daily diabetes mortality and then to examine the modifying effects of greenness. In the first stage, a time-stratified case-crossover analysis was used to model the association between temperature and mortality (Bhaskaran et al., 2012; Chen et al., 2019; Xu et al., 2019). This analysis was performed for all months of the year and not limited to just the summer months since Thailand is a tropical country and people in most regions of Thailand experience daily maximum temperatures of above 30 °C throughout a typical year (Supplementary Fig. S2). A case-crossover study is a type of self-matched case-control study. For each person, the temperature exposure value on the day of the diabetes death (case day) was compared with corresponding values on days of the same day of the week and within the same calendar month as when the death occurred (control day) (Bhaskaran et al., 2012). Then, conditional logistic regression was applied to compare exposure data between case and control days. This study design thus has the advantage of automatically controlling for time-invariant confounders at the individual level, because comparisons between case and control days are made within each individual.

To quantify heat effects, a distributed lag model up to six days following daily mean temperature exposure was used, with a focus of results on lags 0-1 days since adverse heat effects are known to be acute and largely persist for only a few days (Yang et al., 2016). To allow for a potential non-linear association between temperature and diabetes mortality, mean temperature was included in the model with a nature cubic spline with 5 degrees of freedom (Yang et al., 2016). Potential time-varying confounders were adjusted for: daily relative humidity and diurnal temperature variation calculated from the difference between daily maximum temperature and daily minimum temperature were included in the model using natural cubic splines with 3 degrees of freedom in each case. In most regions, there was low correlation of mean temperature with temperature variation and relative humidity (Supplementary Figs. S3-S4), meaning that multi-collinearity was unlikely to be an issue in the regression model.

This analysis was repeated for each province, the six regions, and nationally. Since the value of temperature at which adverse effects become apparent are unique to each location, we employed two common used approaches to determine threshold placement. First, we chose the minimum mortality temperature associated with the lowest mortality risk as the temperature threshold (Gasparrini et al., 2015; Sera et al., 2019). If a minimum mortality temperature could not be identified (i.e. the exposure-response curve was not U- or J-shaped), the median temperature was used as the temperature threshold instead (Lam et al., 2018). Secondly, as sensitivity analysis, the 75th percentile of the temperature distribution in each province was selected as the threshold (Chen et al., 2013; Yang et al., 2016). Odds ratios (OR) of diabetes mortality were calculated separately for heat (the 90th percentile of the temperature distribution) and extreme heat (the 99th percentile), both compared with the temperature threshold. The heat effects were reported as the OR and 95% confidence intervals (CIs).

In the second stage, the province-specific effect estimates were pooled for the five regions and the whole of Thailand using random-effects meta-analysis through maximum likelihood (Cheng et al., 2017; Huang et al., 2018; W, 2010). To check whether regional greenness modified heat effects, random-effects meta-regression model was used to fit the relation between province-specific effect estimates and province-specific NDVI values. Residual heterogeneity was tested and then reported by the Cochran Q test and I^2 statistic, respectively.

All analyses were conducted using R software (version 3.4.0). The “dlnm” and "survival" packages were used to fit conditional logistic regression for the time-stratified case-crossover design. *P* values < 0.05 (two-sided) were regarded as statistically significant.

3. Results

A total of 59,836 diabetes deaths were recorded during the study period 2000-2008 (Table 1). The average mean temperature ranged between 25.1 °C and 29.3 °C across the 60 provinces (Fig. 1), and between 26.5 °C and 29.3 °C across the six regions (Table 1). The average NDVI values were between 0.5 and 0.8, with the highest values mainly in southern regions and the lowest values mainly in eastern regions (Fig. 1). Further descriptive data on diabetes deaths, mean temperature, relative humidity, and temperature variation in 60 provinces are shown in Supplementary Table S1.

Fig. 2 shows the effects of heat on diabetes mortality over lags 0-1 days for each region as well as nationally. The temperature-mortality relationships differed across the different regions. Generally, there was a flat U-shaped curve for the whole of Thailand, northeast, and central regions, with a higher risk of mortality at higher temperatures.

Fig. 3 shows the estimated province-specific ORs over lags 0-1 days. The ORs varied across provinces for heat ($p<0.01$ for Cochran Q test) and extreme heat ($p<0.01$ for Cochran Q test), compared with the temperature threshold (i.e., minimum mortality temperature or median temperature). Similar results were found when selecting the 75th percentile of temperature as the temperature threshold (Supplementary Fig. S5).

Table 2 reports the pooled ORs for the regions and nationally. For the whole of Thailand, heat effects were acute and limited to the first week (Table 2). The pooled national ORs over lags 0-1days were 1.1 (95% CI: 1.06-1.14) for heat and 1.2 (95% CI: 1.10-1.30) for extreme heat. The central and northeast regions seemed to be the most vulnerable. Heat effects were also strongly evident in the capital city Bangkok.

Associations between greenness and heat-related mortality risk are reported in Fig. 4. Results are expressed as the change in OR for each one-unit increase in NDVI. For both heat and extreme heat effects, NDVI was negatively associated with ORs before and after adjusting for other confounders, with the exception of adjustment for relative humidity which rendered results non-significant.

4. Discussion

Using data from 60 of the 76 provinces in Thailand, positive associations were found between heat and the risk of diabetes mortality. Heat effects varied across the provinces and regions, with the northeast and central regions being most at risk. In general, the adverse heat effects were acute and short-term (limited to the first few days). Furthermore, this study demonstrated an inverse relationship between NDVI and heat-related effects, indicating lower heat-related mortality risk in areas with higher levels of greenness. This protective effect of greenness seemed independent of economic indicators such as GDP.

Our findings are consistent with previous epidemiological studies. Yang et al. (Yang et al., 2016) reported that higher temperature was associated with increased risk of diabetes mortality in 9 Chinese cities. Similar findings have also been reported for the UK, South Korea (Seoul), and the Philippines (four cities) (Gasparrini et al., 2012; Kim et al., 2015; Seposo et al., 2017). Nevertheless, there is heterogeneity in the size of effects observed, some of which may be explained by variations in statistical modelling choices. For example, both linear and non-linear regression models have been used previously (Gasparrini et al., 2012; Kim et al., 2015; Seposo et al., 2017). However, a non-linear association between temperature and diabetes mortality was clearly demonstrated here (Fig. 2) and in two previous studies (Seposo et al., 2017; Yang et al., 2016). Therefore, a linear modelling assumption may underestimate the temperature effect, especially at extreme temperatures. In the light of increasing prevalence of diabetes worldwide and also global climate change which is leading to more hot days (IDF, 2017; IPCC, 2014), additional efforts are needed to characterise the associations between temperature and diabetes mortality in other settings.

Aside from mortality impacts, there is evidence that medical practitioner consultations among diabetic patients and emergency room visits for diabetes increase dramatically during hot days (Basu et al., 2012; Hajat et al., 2017). However, mechanisms that link exposure to heat and diabetes risk has not been fully elucidated, with some plausible explanations proposed by researchers. Diabetes was reported to cause impairment in eccrine sweating that leads to a marked reduction in the capacity to dissipate heat (Al-Qaissi et al., 2019). During heat exposure, individuals with diabetes have lower skin blood flow and sweating responses, as well as greater insulin absorption and peaking effect, which can have important consequences for cardiovascular regulation and glycemic control (Al-Qaissi et al., 2019; Kenny et al., 2016). Furthermore, diabetes is often accompanied by one or more other health conditions such as cardiovascular disease and hypertension. These comorbidities could further affect an individual’s ability to dissipate heat during heat stress, making diabetic patients even more vulnerable to heat effects (Al-Qaissi et al., 2019).

The present study found spatial variations in heat effects, in line with findings from previous studies (Seposo et al., 2017; Yang et al., 2016). This indicates that heat could disproportionately affect diabetics in certain parts of the country, and identifying the high-risk regions is the priority for targeted interventions. Previous studies merely examined one or a few cities or focused on the average effects of heat (Gasparrini et al., 2012; Huang et al., 2018; Kim et al., 2015; Seposo et al., 2017; Yang et al., 2016), providing no information on important spatial variations in heat effects in the country under study. In this contribution, a higher vulnerability to heat effects was observed in the northeast and central regions. Public health measures targeting the high-risk regions identified here could help reduce the burden of temperature on diabetic patients in Thailand.

Regarding possible factors that may contribute to heterogeneous heat effects across regions and countries, a number of indications pertinent to demographic and socioeconomic characteristics, meteorological variables, and health systems, for instance population density, education level, and gross domestic product, have been examined previously, but with inconsistent findings (Dang et al., 2018; Ma et al., 2014; Sera et al., 2019). By contrast, greenness, an indicator which has been little studied to date, was found to reduce heat effects (Dang et al., 2018; Ma et al., 2014; Sera et al., 2019). In previous work, it was estimated that in Vietnam (Ho Chi Minh) every 1-square kilometre increase in green space per 1000 people can prevent 7.4 deaths caused by heat (Dang et al., 2018). However, the role of greenness in specifically modifying diabetic patients' vulnerability to heat effects remains an unanswered question. This study indicates that higher greenness levels are associated with lower heat-related diabetes mortality risk. The protective effects of greenness may be related to increased opportunities for physical activity, increased social interactions, lower exposure to air pollution, and decreased exposure to extreme temperatures (Brown et al., 2016). If this finding is confirmed in other countries, arguments to promote policies that retain green spaces can be made on the grounds of reducing health risks among diabetic patients, as well as other benefits. It is likely that different types of greenness such as grass, forests, and parks have differential effects on reducing heat stress. Future studies are thus warranted to determine which types of residential greenness provide maximum protection against adverse heat effects, especially among high-risk individuals.

This study has several strengths. A total of 60 provinces that make up over 87% of the national population and covered all geographical regions in Thailand were included in the analysis (Fig. 1 and Table 1), allowing us to evaluate both national and regional effects of heat-related mortality in diabetics. The acute and short-term effects of heat on diabetes mortality presented here suggest the importance of avoidance of exposure when hot weather is forecast and other rapid prevention and treatment responses in relation to temperature rises. To the best of our knowledge, this is the first study to examine the relationship between greenness and heat vulnerability among diabetic patients. Thus, our findings have important public health implications for identifying the at-risk regions and preventing the detrimental impacts of heat in such a vulnerable group.

Several limitations should also be acknowledged. First, this study was inherently an ecologic analysis and thus exposure misclassification could not be fully excluded. Second, because of the issue of data availability, this present study did not conduct analysis by age, gender, and category of diabetes, which may be of particular interest to policy makers, clinicians, and diabetic patients and their carers. Third, this study was conducted only in one country, and caution is needed when generalising our findings to our countries with different socio-economic and climate characteristics. Fourth, we did not collect data on air pollution which in particular may explain some of the protective effects of greenness observed here since green areas are also likely to have better air quality.

5. Conclusions

This nationwide study provides strong evidence that heat is associated with elevated risk of mortality among diabetics in Thailand. Heat effects on diabetes mortality varied spatially across Thailand, with the northeast and central regions being most vulnerable. Areas of increased greenness were associated with lower heat effects on diabetes mortality.

Acknowledgments

Author contributions

C.H. conceived the study. Y.H., L.C. and J.B. conducted the study, performed the statistical analysis and drafted the manuscript. S.D., W.L., and L.C. researched data and contributed to the discussion. B.T. assisted with data acquisition. Q.W and S.H contributed to discussion and reviewed/edited manuscript. C.H. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conflicts of interest

No potential conflicts of interest related to this article.

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Table legends

Table 1: Descriptive data on diabetes deaths and mean temperature in Thailand, 2000-2008.

Table 2: Pooled odds ratios and their 95% confidence interval of heat and extreme heat effects on diabetes mortality over different lag days in Thailand, 2000-2008.

Bold figures represented the significant estimates;

[a] The 90th percentile of temperature compared with minimum mortality temperature;

[b] The 99th percentile of temperature compared with minimum mortality temperature;

Lag 0-1, Lag 0-2, ... Lag 0-6 indicated the moving average temperatures of current day and one to six days prior to the death of diabetics.

Table 1: Descriptive data on diabetes deaths and mean temperature in Thailand, 2000-2008.

Region	Number of provinces	No. of deaths	Mean temperature (°C)					
			Mean	SD	Min	p25	p75	Max
East	7	4 158	28.2	1.7	20.0	27.3	29.3	34.1
West	3	1 637	27.2	2.3	15.9	25.9	28.8	33.5
South	12	6 648	27.8	1.3	22.4	27.0	28.7	34.9
North	9	7 561	26.5	3.0	14.6	24.8	28.4	35.6
Northeast	15	25 319	27.2	2.9	14.5	25.8	29.1	35.7
Central	14	14 513	28.3	2.2	18.4	27.2	29.7	34.5
Capital city (Bangkok)	1	5 120	29.3	1.7	21.5	28.5	30.4	33.7
National (Total)	60	59 836	27.6	2.4	14.5	26.5	29.1	35.7

Table 2: Pooled odds ratios and their 95% confidence intervals of heat and extreme heat effects on diabetes mortality over different lag days in Thailand, 2000-2008.

Lag days	National	East	West	South	North	Northeast	Central	Capital city (Bangkok)
Heat [a]								
0	**1.10 (1.06-1.15)**	1.02 (0.77-1.34)	1.28 (0.93-1.77)	1.07 (0.96-1.20)	1.07 (0.98-1.17)	**1.13 (1.06-1.21)**	**1.10 (1.01-1.20)**	**1.15 (1.01-1.31)**
0-1	**1.10 (1.06-1.14)**	1.01 (0.97-1.05)	1.00 (0.97-1.04)	1.02 (0.97-1.07)	**1.17 (1.02-1.33)**	**1.12 (1.05-1.19)**	**1.16 (1.04-1.29)**	**1.24 (1.09-1.41)**
0-2	**1.06 (1.03-1.10)**	1.02 (0.93-1.12)	1.01 (0.87-1.17)	1.02 (0.88-1.18)	**1.17 (1.04-1.31)**	**1.05 (1.00-1.10)**	**1.13 (1.02-1.26)**	**1.19 (1.05-1.36)**
0-3	**1.05 (1.01-1.09)**	1.04 (0.93-1.16)	1.13 (0.75-1.71)	1.01 (0.84-1.22)	1.01 (0.92-1.10)	1.04 (1.00-1.09)	**1.13 (1.02-1.26)**	**1.22 (1.07-1.39)**
0-4	1.00 (1.00-1.01)	1.00 (0.90-1.11)	1.17 (0.80-1.72)	1.00 (0.96-1.05)	0.96 (0.88-1.04)	1.01 (0.99-1.03)	**1.14 (1.04-1.25)**	**1.22 (1.07-1.39)**
0-5	1.01 (1.00-1.02)	1.01 (0.91-1.11)	1.19 (0.84-1.69)	1.02 (0.96-1.09)	0.94 (0.87-1.03)	1.01 (0.99-1.02)	**1.14 (1.04-1.24)**	**1.21 (1.06-1.38)**
0-6	1.00 (1.00-1.00)	1.01 (0.92-1.10)	1.19 (0.86-1.63)	1.09 (0.92-1.29)	0.94 (0.86-1.02)	1.00 (1.00-1.00)	**1.10 (1.02-1.19)**	**1.19 (1.04-1.36)**
Extreme heat [b]								
0	**1.21 (1.11-1.32)**	0.83 (0.45-1.54)	1.45 (0.87-2.41)	1.12 (0.92-1.37)	1.17 (0.89-1.55)	**1.25 (1.12-1.39)**	**1.27 (1.05-1.54)**	**1.35 (1.08-1.70)**
0-1	**1.20 (1.10-1.30)**	0.92 (0.52-1.63)	1.17 (0.83-1.64)	0.98 (0.79-1.22)	**1.30 (1.04-1.62)**	**1.24 (1.11-1.39)**	**1.30 (1.06-1.61)**	**1.44 (1.15-1.80)**
0-2	**1.16 (1.06-1.26)**	0.81 (0.44-1.48)	1.13 (0.75-1.71)	0.94 (0.73-1.21)	**1.28 (1.03-1.59)**	**1.21 (1.08-1.35)**	**1.30 (1.05-1.62)**	**1.34 (1.06-1.68)**
0-3	**1.14 (1.04-1.24)**	0.80 (0.41-1.55)	1.42 (0.70-2.86)	0.87 (0.70-1.09)	1.17 (0.95-1.44)	**1.20 (1.08-1.34)**	**1.27 (1.00-1.61)**	**1.31 (1.04-1.64)**
0-4	**1.12 (1.03-1.21)**	0.74 (0.41-1.33)	1.68 (0.85-3.32)	0.92 (0.74-1.15)	1.10 (0.90-1.34)	**1.15 (1.04-1.28)**	**1.27 (1.02-1.59)**	**1.30 (1.03-1.65)**
0-5	**1.11 (1.02-1.20)**	0.77 (0.41-1.45)	1.67 (0.95-2.92)	0.97 (0.78-1.21)	1.04 (0.85-1.26)	**1.13 (1.02-1.26)**	**1.25 (1.01-1.55)**	**1.31 (1.03-1.66)**
0-6	1.09 (1.00-1.18)	0.76 (0.44-1.31)	**1.66 (1.02-2.72)**	0.93 (0.76-1.15)	1.03 (0.85-1.26)	1.10 (0.99-1.22)	**1.28 (1.01-1.62)**	1.27 (0.99-1.64)

Bold figures represented that heat or extreme heat could increase the risk of diabetes mortality risk;;

[a] The 90th percentile of temperature compared with minimum mortality temperature;

[b] The 99th percentile of temperature compared with minimum mortality temperature;

Lag 0-1, Lag 0-2, ..., Lag 0-6 indicated the moving average temperatures of current day and one to six days prior to the death of diabetics.

Figure legends

Fig. 1: The geographical distribution of annual average temperature and NDVI in Thailand, 2000-2008.

The grey areas on the left panel indicate the missing values; NDVI is the Normalized Difference Vegetation Index.

Fig. 2: The nonlinear relationships between ambient temperature and diabetes mortality in different regions of Thailand, 2000-2008.

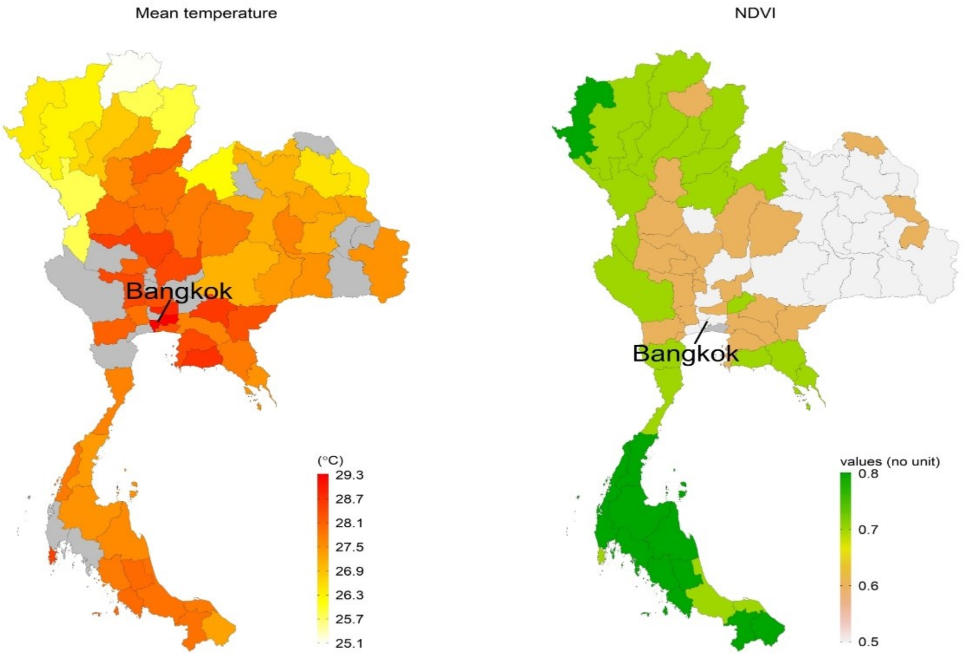
The relationships are presented as odds ratio of the full range of temperature with lags of 0-1 days compared to the temperature thresholds (minimum-mortality temperature, otherwise median temperature). The blue lines are the effect estimates and the dotted red lines are the 95% confidence intervals.

Fig. 3: Province-specific odds ratio of diabetes mortality for heat and extreme heat over lags of 0-1 days.

The rectangles represent the effect estimates and the horizontal lines represent the 95% confidence intervals. Heat is defined as the 90th percentiles of temperature and extreme heat as the 99th percentiles of temperature, both compared with the temperature thresholds (minimum-mortality temperature, otherwise median temperature).

Fig. 4: Estimated relationships between NDVI and effects of heat and extreme heat on diabetes mortality, before and after the adjustment of confounders.

Results are presented with changes in odds ratio of diabetes mortality associated with each one-unit increase in NDVI values.



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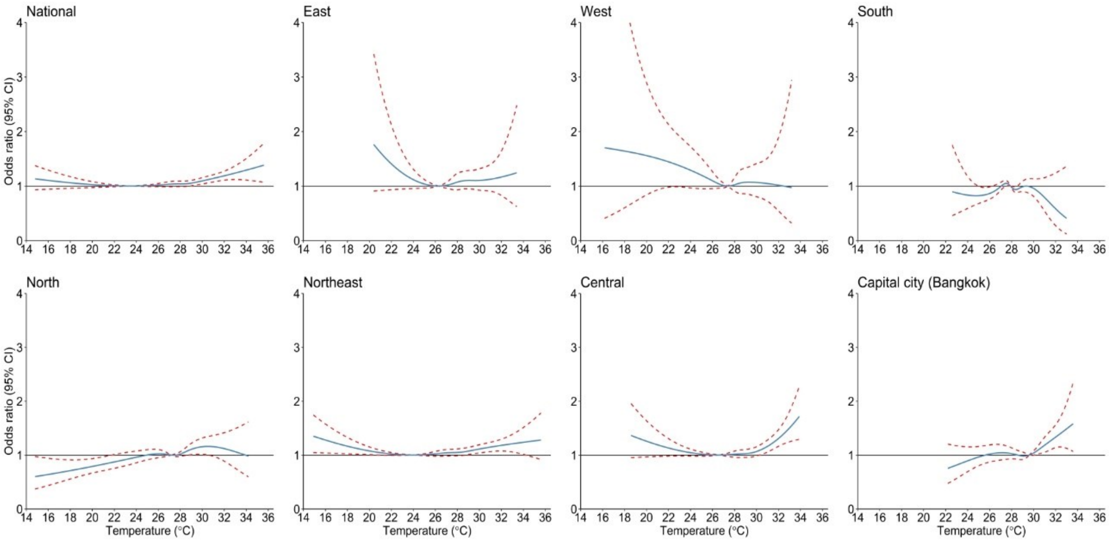

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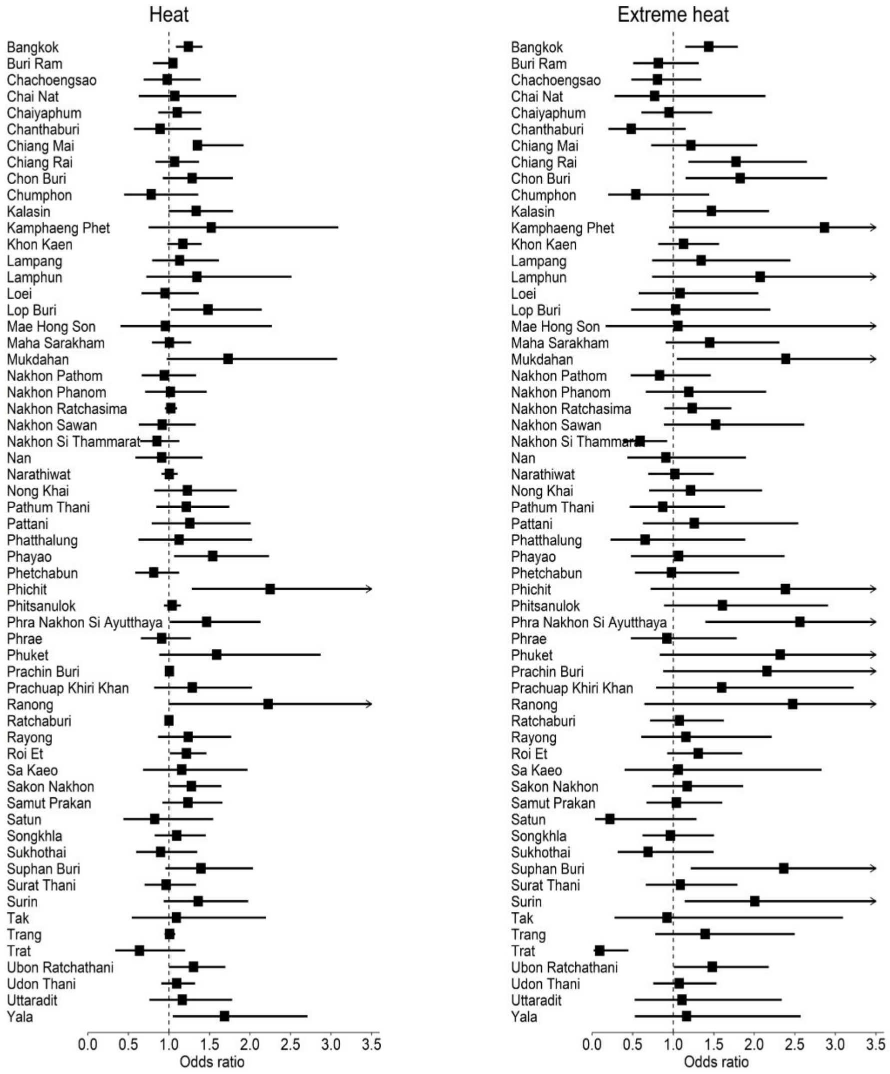

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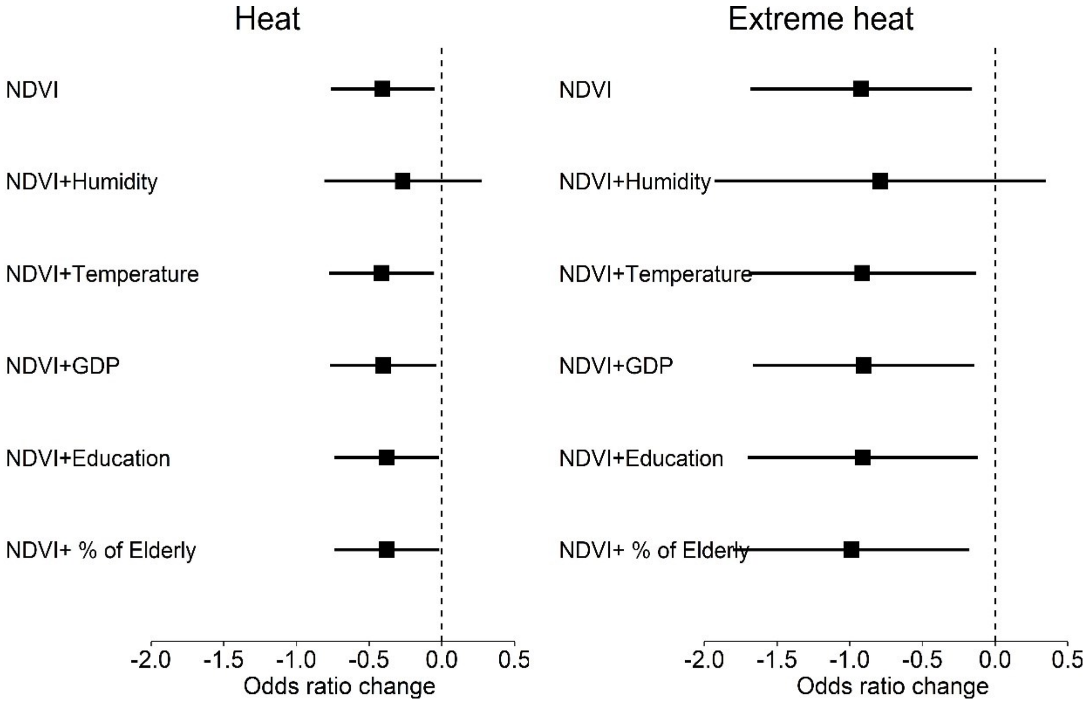

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