Long-term impact of temperature changes on cardiovascular seasonal mortality in Taiwan between 1977 and 2016

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Highlights

- There was a significant trend of decreasing cardiovascular mortality rates in summer and in winter across years in all age groups.
- Cardiovascular mortality rates in winter decreased more than that in summer.
- The relative risk of cardiovascular mortality in winter, compared to cardiovascular mortality in summer, was negatively associated with mean winter temperature in the age groups above 30 y/o.

Introduction

- There are 10 stations in Taiwan that have recorded weather information for more than 100 years.
- These recordings show that ambient temperature has increased in the 100 years, especially during winter and nights.
- Previous studies using Taiwan's mortality database still show a typical U-shape correlation between cardiovascular mortality and ambient temperature (Lin et al., 2011; Pan et al., 1995).
- Most previous studies adopt distributed lag models to account for the lag effects, but these models can only identify lag effects within 2-3 weeks.
- If we want to consider a delay of mortality caused by certain weather factors beyond this period, we need to use annual or seasonal mortality rates instead of daily mortality rates.

Methods

Data Collection

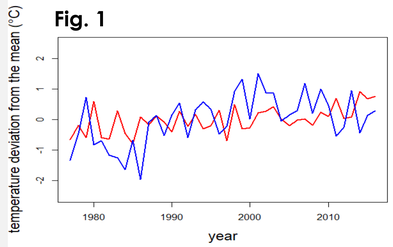
- Mortality numbers: vital statistics and census data from 1977 to 2016 provided by the Executive Yuan Department of Health and the Ministry of Interior.
- Data for deaths from circulatory diseases (ICD-9 390-459) and cancer (ICD-9 140-239).
- Temperature data: daily average temperature from the Taichung station to represent the daily average temperature across Taiwan.

Data Analysis

- Summer season: June, July, and August
- Winter season: December, January, and February as winter season.
- Multivariate linear regression models were used to evaluate whether mean summer and winter temperatures affected the ratios between winter and summer mortality due to cardiovascular and cancer causes.

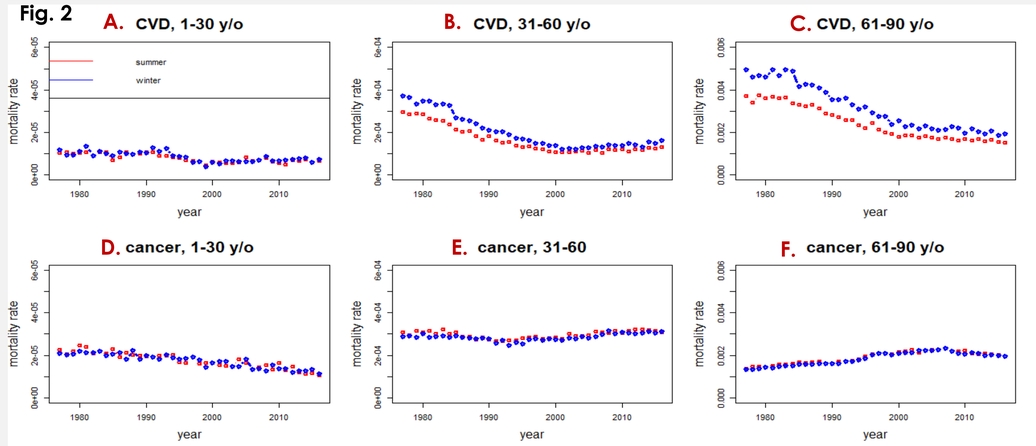
Results

Fig. 1



- 1977-2016, temperature increased ~1/1.5˚ in summer/winter (Fig. 1).
- The CVD mortality rates diseased in summer and in winter (Fig. 2. A, B, C).
- The changes in mortality rates of cancer were less consistent (Fig. 2. D, E, F).

Fig. 2



- The winter/summer CVD mortality ratio decreased significantly across years in >31 y/o age groups (Fig. 3).
- The winter/summer cancer mortality ratio did not change with time (Fig. 4)

Fig. 3 cardiovascular dz

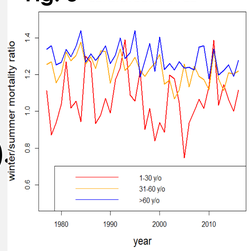
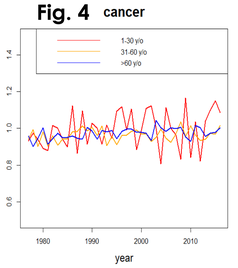


Fig. 4 cancer



Multivariate regression models

	Cardiovascular diseases			Cancer		
	1-30 y/o	31-60 y/o	61-90 y/o	1-30 y/o	31-60 y/o	61-90 y/o
Summer mean temp	0.09 (0.09)	0.01 (0.61)	0.01 (0.78)	0.12 (0.01)	0.00 (0.85)	0.01 (0.19)
Winter mean temp	-0.03 (0.39)	-0.04 (0.01)	-0.04 (0.02)	0.02 (0.41)	-0.02 (0.07)	-0.01 (0.06)
Adjusted R-squared	0.06	0.14	0.10	0.16	0.04	0.10

Conclusions

- This methodology evaluates long-term effect of temperature, while human adaptation and change in medical care over the years are taken into account.
- Our findings suggested that climate change is associated with warmer winters, and warmer winters are associated with decreased winter/summer cardiovascular mortality.