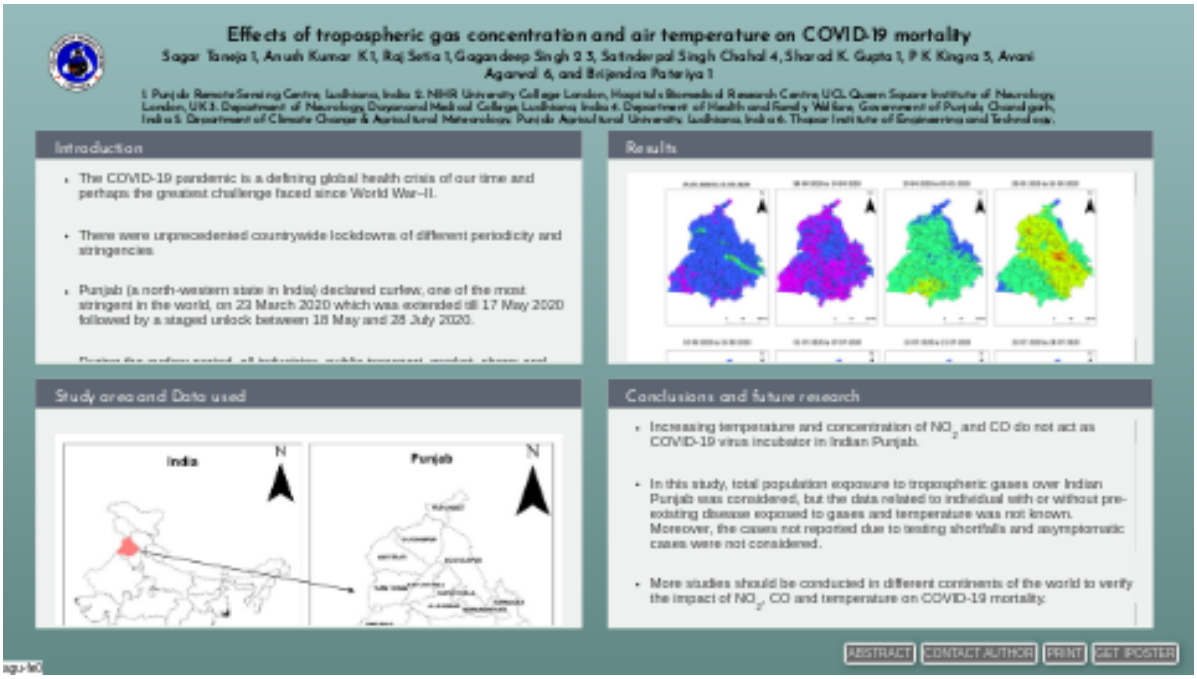
Effects of tropospheric gas concentration and air temperature on COVID-19 mortality



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PRESENTED AT:

AGU FALL MEETING
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INTRODUCTION

- The COVID-19 pandemic is a defining global health crisis of our time and perhaps the greatest challenge faced since World War–II.

- There were unprecedented countrywide lockdowns of different periodicity and stringencies

- Punjab (a north-western state in India) declared curfew, one of the most stringent in the world, on 23 March 2020 which was extended till 17 May 2020 followed by a staged unlock between 18 May and 28 July 2020.

- During the curfew period, all industries, public transport, market, shops and construction works remain/ed suspended , but many relaxations (including opening of industries) were given during subsequent period.

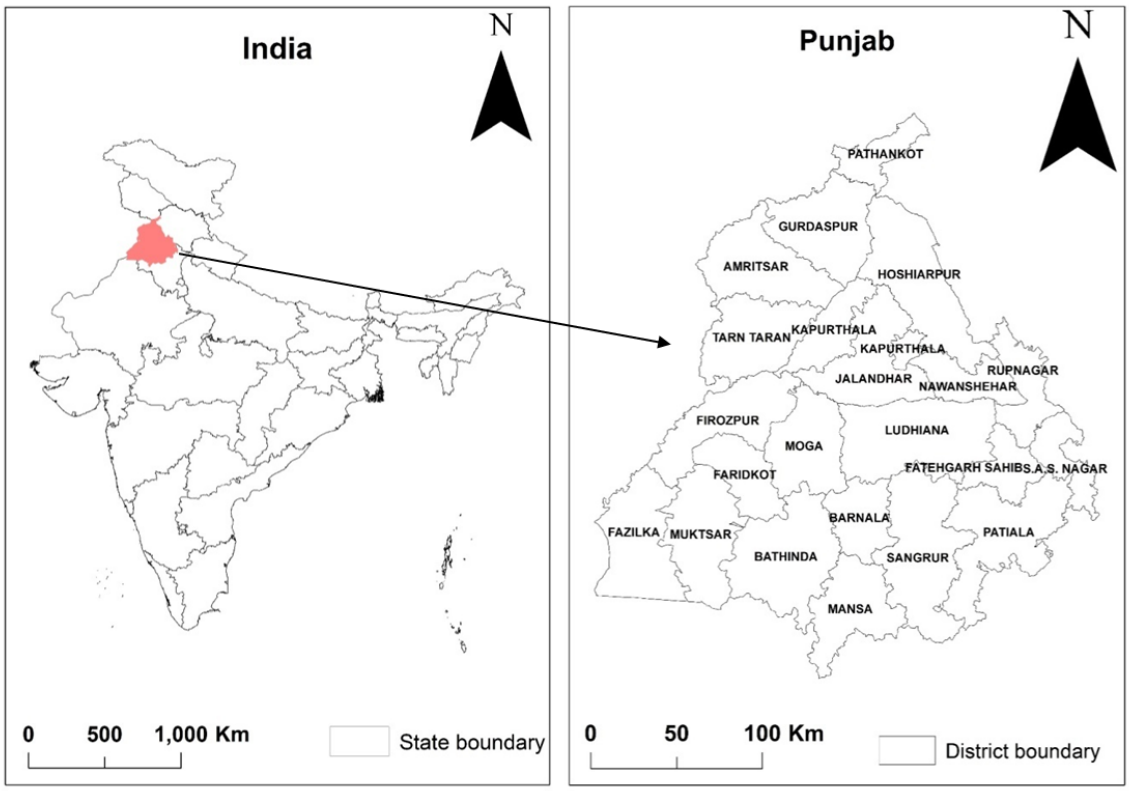
- The lockdown in Indian Punjab led to a dramatic reduction in vehicular emissions and hence, air pollution. Moreover, there occurred a slow rebound in its aftermath.

Objectives:

- To examine the link between mortality due to COVID-19 and air pollution

- To assess the variations in air temperature and tropospheric NO2 and CO concentration during the COVID 19 curfew/unlock period and their relationship with COVID-19 mortality.

STUDY AREA AND DATA USED



Data used:

- **Census data** - 193 towns with population more than 10,000 in Punjab.
- **Daily temperature** from Punjab Agricultural University, India.
- **Tropospheric concentration of NO_2** (spatial resolution 7 x 7 km^2) and **CO** (spatial resolution 3.5 x 7 km^2) from Sentinel-5P satellite.
- **Vertical airflow (omega)** at spatial resolution of 0.25^o x 0.25^o,produced at 850 hPa from March to July 2020.
- **Daily active fire counts** from VIIRS (spatial resolution of 375 x 375 m^2) onboard the Suomi NPP satellite.
- **COVID-19 mortality** between 23 March and 28 July 2020 from Department of Health and Family Welfare, Government of Punjab.

Calculation of mortality rate using the following equation:

$$\text{Mortality (\%)} = d(t)/c(2t)$$

Where,

t = time over the numbers are calculated (here, 7 days)

d(t) = number of deaths,

c(t) = number of confirmed cases

RESULTS

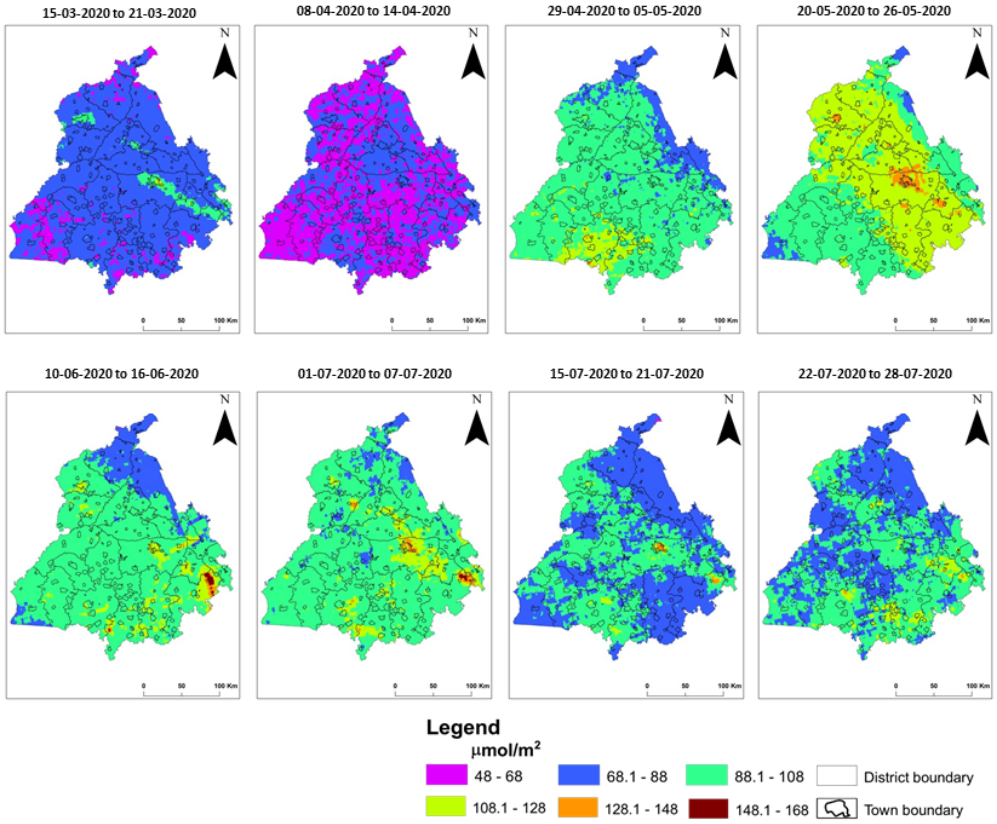


Fig. 1: Spatio-temporal variability in tropospheric NO2 concentration over Indian Punjab from 15 March to 28 July 2020.

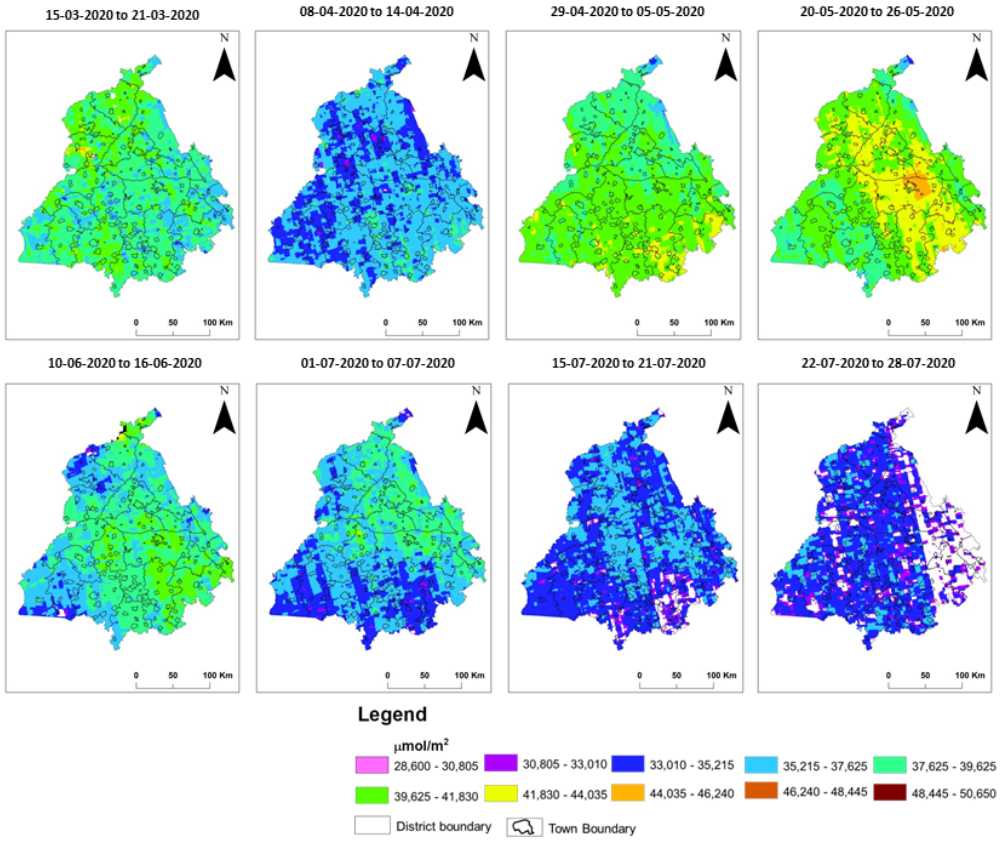


Fig. 2: Spatio-temporal variability in tropospheric CO concentration over Indian Punjab from 15 March to 28 July 2020.

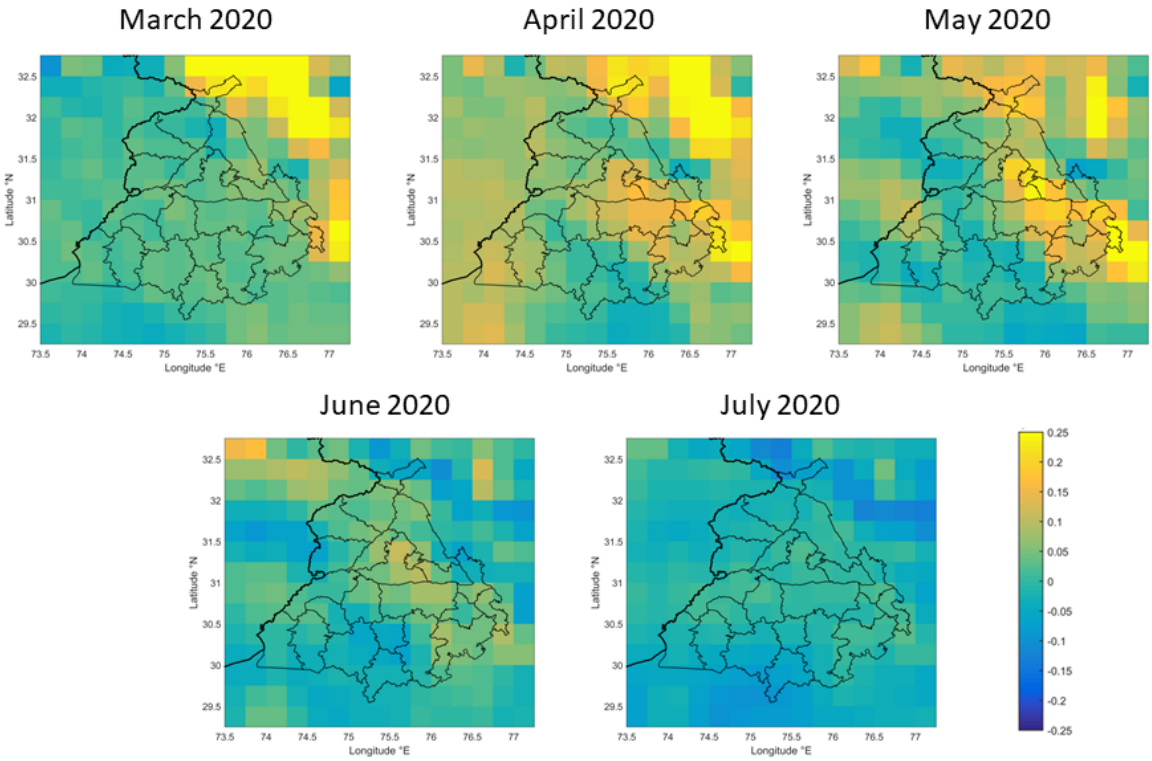


Fig. 3: Vertical airflow (omega) over Indian Punjab during March- July 2020 at 850 mb (~1500 m above sea level).

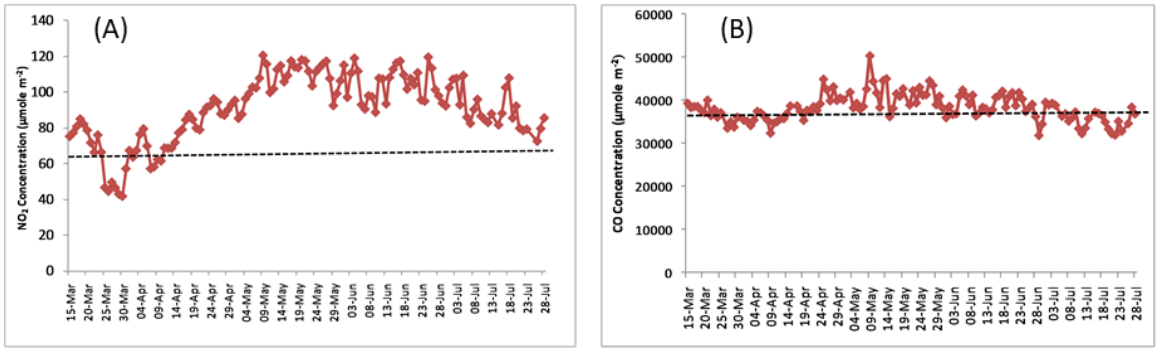


Fig. 4: (A) Daily changes in NO2 concentration (µmole m-2) in Indian Punjab from 15 March to 28 July 2020. Horizontal line indicates the NO2 concentration on the first day of curfew (22 March, 2020). (B) Daily changes in CO concentration (µmole m-2) in Indian Punjab from 15 March to 28 July 2020. Horizontal line indicates the CO concentration on the first day of curfew (22 March, 2020).

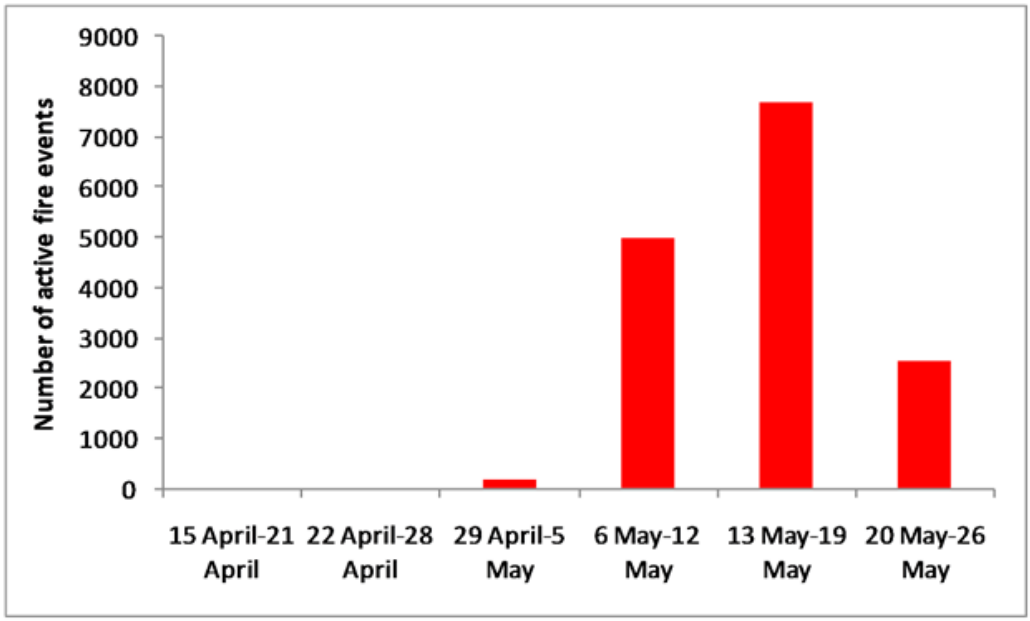


Fig. 5: Number of active fire events due to wheat crop residue burning from 15 April to 28 July 2020 in Indian Punjab

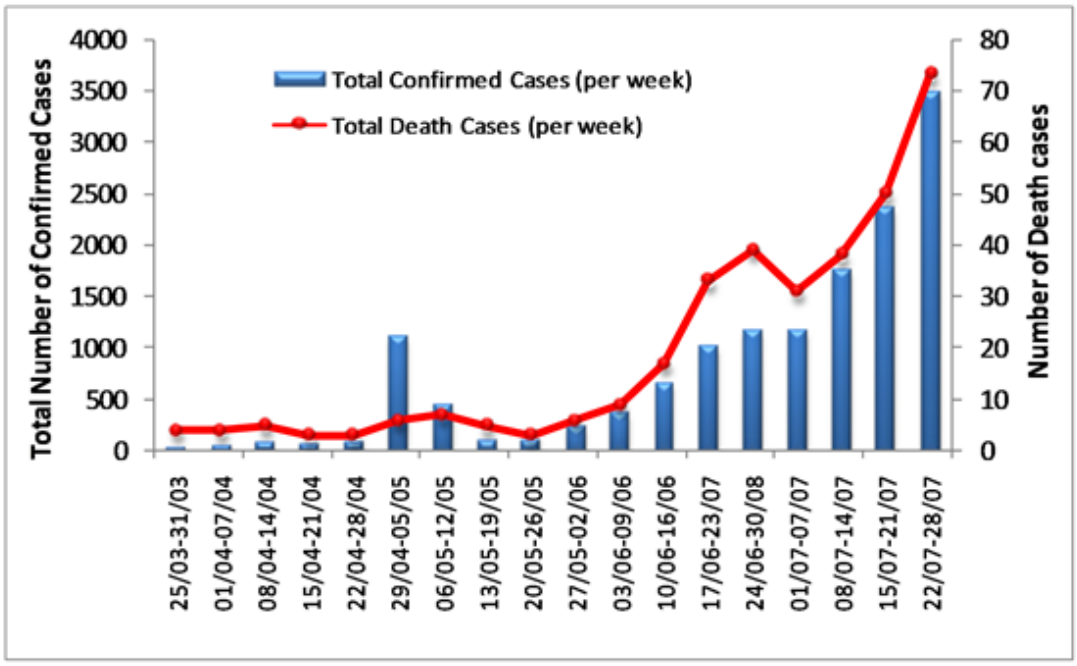


Fig. 6: Number of positive cases and deaths per week due to COVID-19 during 25 March to 28 July 2020 in Indian Punjab

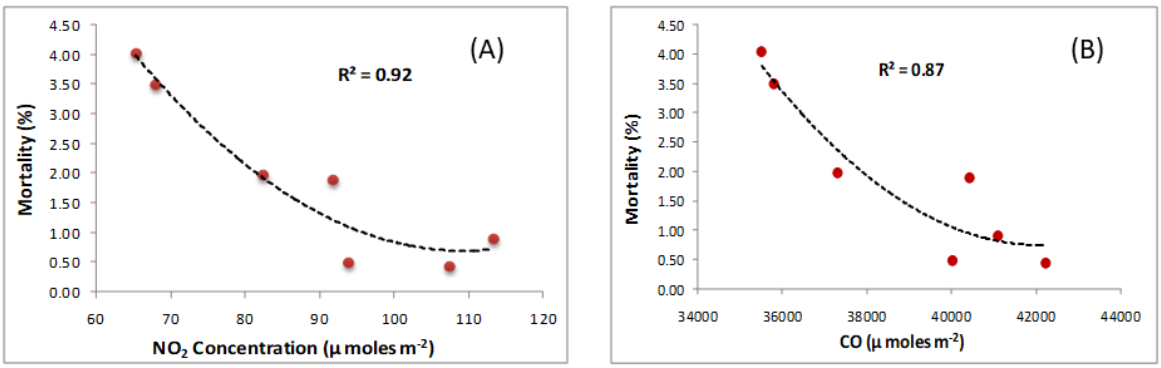


Fig. 7: Relationship between mortality per week (%) and (A) NO_2 concentration, (B) CO concentration during 25 March to 28 July 2020 in Indian Punjab

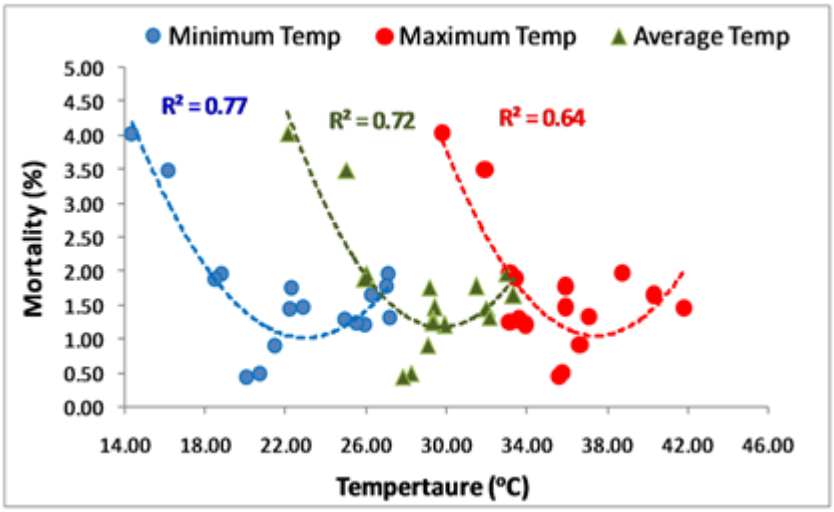


Fig. 8: Relationship between mortality per week (%) and temperature during 25 March to 28 July 2020 in Indian Punjab

CONCLUSIONS AND FUTURE RESEARCH

- Increasing temperature and concentration of NO_2 and CO do not act as COVID-19 virus incubator in Indian Punjab.

- In this study, total population exposure to tropospheric gases over Indian Punjab was considered, but the data related to individual with or without pre-existing disease exposed to gases and temperature was not known. Moreover, the cases not reported due to testing shortfalls and asymptomatic cases were not considered.

- More studies should be conducted in different continents of the world to verify the impact of NO_2, CO and temperature on COVID-19 mortality.

- Additional factors like age, pre-existing diseases and climate factors like relative humidity and ultraviolet radiations require further research.

Acknowledgement:

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ABSTRACT

We assessed the effect of temperature and tropospheric concentration of Nitrogen dioxide (NO_2) and Carbon monoxide (CO) before and during the COVID 19 curfew/lockdown period (22 March-19 May 2020) on mortality due to COVID-19 in Indian Punjab. Time series daily data of TROPOspheric Monitoring Instrument on board Sentinel-5 Precursor was used to study the spatio-temporal changes in NO_2 and CO from 15 March to 19 May 2020. Visible Infrared Imaging Radiometer Suite onboard Suomi NPP satellite was used to detect the active fires (from 15 April to 19 May 2020) due to crop residue burning. The COVID-19 mortality was calculated from number of deaths relative to number of cases preceding two weeks of deaths due to COVID-19 virus. The weekly (15-21 March 2020) averaged tropospheric concentration of NO_2 and CO was higher before the first day of curfew (22 March 2020). The concentration of NO_2 decreased during the curfew period followed by increasing concentration from 11 April to 19 May 2020 and the concentration of CO increased from 19 April to 19 May 2020. There was a continuous increase in daily air temperature from 15 March to 19 May 2020. Mortality due to COVID-19 virus was significantly negatively correlated with NO_2, CO and temperature. These results show that increasing temperature and concentration of NO_2 and CO decrease COVID-19 mortality, but further studies should be conducted in different continents of the world to verify the impact of NO_2, CO and temperature on COVID-19 mortality.