# Association between $PM_{2.5}$ and mortality of stomach and colorectal cancer in Xi'an: a time-series study

Crystal Jane Ethan[a], Kingsley Katleho Mokoena[a], Yan Yu[a*], Karabo Shale[b], Yameng Fan[a], Jie Rong[a] & Feng Liu[c]

[a] School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an, 710061, P.R. China;
[b] Cape Peninsula University of Technology, Cape Town, 8000, South Africa;
[c] Shaanxi Provincial Center for Disease Control and Prevention, Xi'an, 710054, P.R. China.

## Background (Aims)

Globally, fine particulate matter has been associated with several health problems including cancer. However, most studies focused mainly on lung cancer. Stomach and colorectal cancers play significant roles in increasing public health's cancer globally. This study focused on investigating a possible significant association between exposure to fine particulate matter ($PM_{2.5}$) and mortality due to stomach and colorectal cancer in Xi'an from 2014 to 2016.

## Methods

Cancer mortality and population data were collected for six districts (Beilin, Yanta, Weiyang, Lianhu, Gaoling, and Huyi) within Xi'an from the Centers for Disease Control and Prevention, Shaanxi (Xi'an), and city-wide daily average air pollution ($PM_{2.5}$, $PM_{10}$, $O_3$, $SO_2$, $NO_2$) and meteorological data (temperature (° C), and relative humidity (%)) representative of the entire city were collected from the Xi'an Environmental Protection Bureau (on-line) covering January 2014 to December 2016. Using time-series analysis, the study applied both single and multi-pollutant(s) approaches for investigations; and $PM_{2.5}$ was the pollutant of interest. Generalized additive model (GAM) was the core statistical method used with the addition of distributed lag model (DLM) to observe delayed effects.

## Conclusion

Though this study has reported significant associations, it will be beneficial for the public's health if more studies further investigate the relationship between exposure to $PM_{2.5}$ and other cancer mortality.

## References

1. Brunekreef B, Holgate ST (2002) Air pollution and health. Lancet 360: 1233-1242.

## Results

**Table 1:** Descriptive statistics of daily stomach and colorectal cancer mortality in Xi'an (2014-2016).

| Variable | Mean(SD) | Min | P(25) | Median | P(75) | Max | Cases |
|---|---|---|---|---|---|---|---|
| ***Stomach cancer mortality*** | 1.9(1.13) | 1 | 1 | 2 | 2 | 11 | 1 |
| Male | 1.35(1.41) | 1 | 1 | 2 | 2 | 6 | 1 |
| Female | 0.54(0.66) | 1 | 1 | 1 | 2 | 4 | 1 |
| <65 years | 0.6(0.65) | 1 | 1 | 1 | 1 | 5 | 1 |
| ≥65 years | 1.27(1.3) | 1 | 1 | 2 | 2 | 7 | 1 |
| ***Colorectal cancer mortality*** | 1.71(0.9) | 1 | 1 | 1 | 2 | 6 | 1 |
| Male | 1.02(1.14) | 1 | 1 | 1 | 2 | 4 | 1 |
| Female | 0.69(0.83) | 1 | 1 | 1 | 2 | 2 | 1 |
| <65 years | 0.54(0.7) | 1 | 1 | 1 | 2 | 3 | 1 |
| ≥65 years | 1.17(1.26) | 1 | 1 | 2 | 2 | 6 | 1 |

**Table 2:** Descriptive statistics of air pollutants concentration and meteorological parameters in Xi'an (2014-2016).

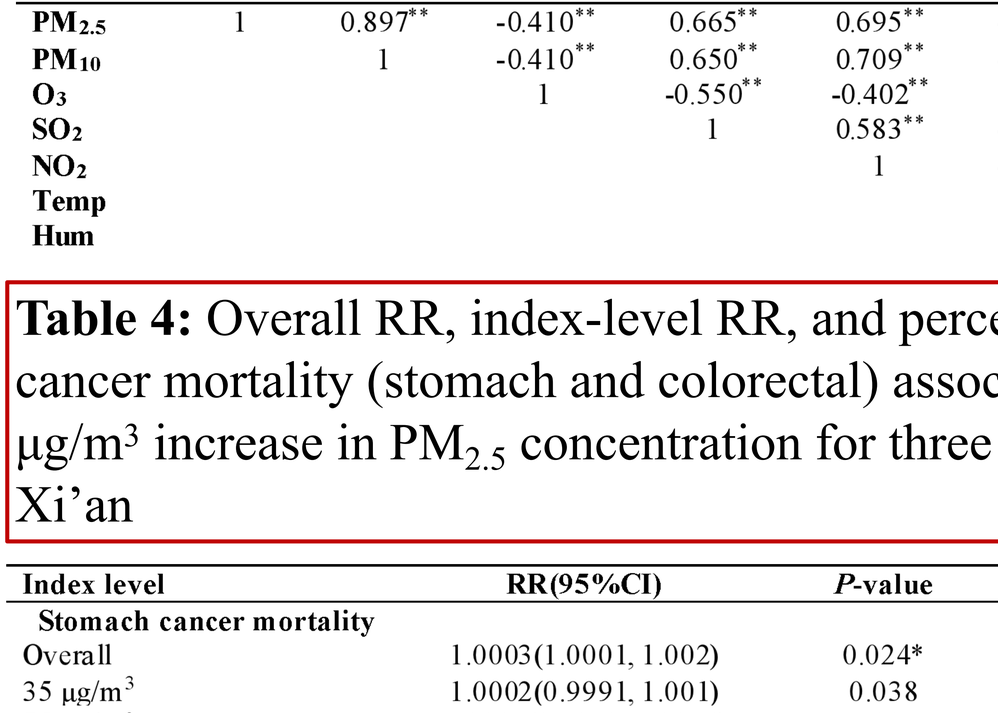
| Air pollutants | Mean(SD) | Min | P(25) | Median | P(75) | Max | Days |
|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ (μg/m$^3$) | 67.5(54.1) | 11 | 35 | 51 | 79 | 527 | 1091 |
| $PM_{10}$ (μg/m$^3$) | 137(81) | 17 | 81 | 115 | 173 | 659 | 1091 |
| $O_3$ (μg/m$^3$) | 42(27) | 5 | 19 | 35 | 61 | 141 | 1091 |
| $SO_2$ (μg/m$^3$) | 24.2(21) | 2 | 10 | 17 | 32 | 145 | 1091 |
| $NO_2$ (μg/m$^3$) | 47(17) | 13 | 33 | 43 | 55 | 111 | 1091 |
| **Weather parameters** | | | | | | | |
| Temperature (°C) | 14.5(9.9) | -8 | 6 | 16 | 23 | 34 | 1096 |
| RH (%) | 67(16) | 21 | 56 | 67 | 79 | 100 | 1096 |

**Table 3:** Correlation coefficients between daily air pollutants concentration and meteorological parameters in Xi'an.

| $R^2$ | $PM_{2.5}$ | $PM_{10}$ | $O_3$ | $SO_2$ | $NO_2$ | Temp | Hum |
|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ | 1 | 0.897** | -0.410** | 0.665** | 0.695** | -0.464** | 0.119** |
| $PM_{10}$ | | 1 | -0.410** | 0.650** | 0.709** | -0.457** | -0.076* |
| $O_3$ | | | 1 | -0.550** | -0.402** | 0.785* | -0.239** |
| $SO_2$ | | | | 1 | 0.583** | -0.709** | -0.205** |
| $NO_2$ | | | | | 1 | -0.413** | -0.031 |
| Temp | | | | | | 1 | 0.051 |
| Hum | | | | | | | 1 |

**Table 4:** Overall RR, index-level RR, and percent increase for cancer mortality (stomach and colorectal) associated with 10 μg/m$^3$ increase in $PM_{2.5}$ concentration for three index level in Xi'an

| Index level | RR(95%CI) | *P*-value | Percent increase |
|---|---|---|---|
| **Stomach cancer mortality** | | | |
| Overall | 1.0003(1.0001, 1.002) | 0.024* | 0.03 |
| 35 μg/m$^3$ | 1.0002(0.9991, 1.001) | 0.038 | 0.02 |
| 75 μg/m$^3$ | 1.0003(0.9989, 1.0016) | 0.031 | 0.03 |
| 115 μg/m$^3$ | 1.0005(0.9984, 1.0026) | 0.027 | 0.05 |
| **Colorectal cancer mortality** | | | |
| Overall | 0.9985(0.9973, 1.0004) | 0.047 | -0.15 |
| 35 μg/m$^3$ | 0.9989(0.9975,1.0003) | 0.069 | -0.11 |
| 75 μg/m$^3$ | 0.9987(0.9970,1.0004) | 0.134 | -0.13 |
| 115 μg/m$^3$ | 0.9987(0.9971,1.0004) | 0.253 | -0.13 |




(a) Stomach cancer (b) Colorectal cancer

**Fig. 1:** Cancer mortality [(a) and (b)] per season from 2014-2016