The Rises of Coronavirus Disease (COVID-19) death rate in Japan with high $PM_{2.5}$

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Research Article

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Abstract

Currently vulnerable age groups in most countries are affected by the respiratory -coronavirus disease 2019 (COVID-19). Long-term-exposure to high levels of $PM_{2.5}$ (particulate matter with aerodynamic diameter ≤ 2.5μm) is also associated positively with repository deaths. The aim of this study is to find if high $PM_{2.5}$ levels affect COVID-19 caused deaths in Japan. COVID-19 caused death and tested positive cases in all prefectures during the study period from Feb. 18 up to Apr. 16, 2020 are analyzed. $PM_{2.5}$ caused deaths from 2010 to 2017 are calculated based on $PM_{2.5}$-relative risk (RR) of 1.04 (95% CI: 1.01 – 1.08) from the World Health Organization-Air Quality Guidelines (WHO–AQG). The findings of this study show that old people who are living in prefectures with high levels of $PM_{2.5}$ are the most vulnerable to COVID-19. The estimated death cases from 2010 to 2017 are about 115,532 (95% CI: 28,883 - 231,064) cases. Thus; policy decision makers could consider $PM_{2.5}$ data to support their efforts not only to minimize the spread of COVID-19, but also to improve air quality.

Introduction

A recent study from Wuhan, China, by Zhou F., et al., (2020) has shown an association between adverse health effects among elders and COVID-19. Another recent study from United State by Wu X., and Nethery R., (2020) has examined the association between long-term exposure to air pollution and COVID-19 deaths, they found a strong association between elevated $PM_{2.5}$ and increased COVID-19 death rates. In Japan, the information issued by the Ministry of Health, Labor and Welfare (MoHLW) show that, up to April 16, 2020, there are 4,168 tested positive and 81 death cases caused by COVID-19 (Ogiwara K, 2020). Long-term-exposure to high levels of $PM_{2.5}$ (particulate matter with aerodynamic diameter ≤ 2.5μm) is also associated positively with repository deaths (Pope III *et al.*, 2002; Pope III and Dockery, 2006; Lippmann, 2009; Jerrett *et al.*, 2009). Additionally, in Japan there are many published studies listed in Nawahda (2012 and 2014) about the effects of $PM_{2.5}$ on human health. Thus; the information about the distribution of $PM_{2.5}$ levels and COVID-19 deaths and tested positive cases, from Feb. 18 up to Apr. 16th, 2020, in all prefectures in Japan are analyzed. The deaths due to long-term exposure to $PM_{2.5}$ are calculated from 2010 to 2017 based on the relative risk (RR) of 1.04 (95% CI: 1.01 – 1.08). This RR value is associated with 10 μgm^{-3} change in $PM_{2.5}$ mean annual concentration (Pope III et al., 2002). The findings of this study show that old people who are living in prefectures with high levels of $PM_{2.5}$ are the most vulnerable to COVID-19. Thus; this study provides a better understand of possible association between air quality management and COVID-19 and the corresponding policies to minimizing the adverse effects on human health.

Methodology

$PM_{2.5}$ monitoring data

Daily $PM_{2.5}$ data for an 8-year period (2010 – 2017) from 1,064 Air Quality monitoring Systems (AQMSs) in Japan are made available by the National Institute of Environmental Studies (NIES). These AQMSs (Fig. 1.) are deployed by the Ministry of Environment (MoE) and local governments. The mean annual concentrations of $PM_{2.5}$ from 2011 to 2017 are shown in Fig.2.

Coronavirus COVID-19 Japan Cases

MoLHW provides the following information related to COVID-19 cases in Japan; tested positive, with symptoms, discharged, PCR tested, serious, deaths, and by ages for all prefectures in Japan. Fig. 3., shows the number of reported death cases up to April 16th , 2020, most of the cases belong to +60-year age group.

Effect of long-term eexposure to $PM_{2.5}$

The annual deaths caused by long-term exposure to high levels of $PM_{2.5}$ are calculated as follows,

$$death(x,t) = pop(x,i)\ M_b\ \beta_{PM2.5} \triangle PM_{2.5}(x,t) \qquad (1)$$

where x is the prefecture index, t is the year of simulation, pop is the exposed population, i is the index of age group, $\triangle PM_{2.5}$ is the change in the annual mean levels, M_b is the annual mean baseline death rate, and $\beta_{PM2.5}$ equals 0.004 (Nawahda, 2014). An increase of 10 μgm^{-3} annual mean of $PM_{2.5}$ caused a 4% (95% CI: 1.01–1.08) increase in death rate for the age group of +30-year (Pope III *et al.,* 2002).

The Population of all 47 prefectures in Japan in 2015 is collected from the database of the Official Statistics of Japan (e-stat, 2015). The population is divided into four age groups, 0-14; 15-64; 65-74; and +75. The corresponding percentage of each age group is as follows, 13.76%; 66.08%; 11.05%; and 9.11%, respectively. The corresponding baseline mortality (per one thousand) of each group is as follows, 0.3; 2.25; 14.28; and 59.01, respectively (Nawahda, 2014). The first two age groups are ignored due to the limitation of Eq. (1) that is valid for +30-year age groups.

Results And Discussion

The calculated annual deaths in all prefectures in Japan from 2010 to 2017 caused by exposure to $PM_{2.5}$ > 10 μgm^{-3} for the +65-year age groups are listed in Table 1.

Table 1. Total death cases caused by exposure to $PM_{2.5}$ in Japan from 2010 to 2017.

Year	Death cases	95% CI	
2010	20,469	5,117	40,938
2011	18,826	4,707	37,652
2012	18,044	4,511	36,087
2013	17,776	4,444	35,552
2014	15,728	3,932	31,455
2015	10,957	2,739	21,914
2016	7,063	1,766	14,126
2017	6,669	1,667	13,339

The calculated death cases due to exposure to $PM_{2.5}$>10 μgm^{-3} during the study period from 2010 to 2017 are shown in Fig. 4. The death cases among the +75-year age group are around 3.4 times as much as the third age group. Better air quality of the year 2017 compared to 2010 could save the lives of around 13,600 inhabitants. Figure 5, shows that that old people who are living in prefectures with high $PM_{2.5}$ levels are the most vulnerable to COVID-19.

The calculated death cases due to exposure to $PM_{2.5}$ in all prefectures in Japan are estimations based on RR value of 1.04. These estimations are conservative; if a higher value of RR is considered, e.g. 1.08 (Jerrett *et al.*, 2009) for $PM_{2.5}$ levels > 10 ugm-3, the estimated deaths will increase accordingly. In 2009 Japan Ministry of Environment (MoE) adopted the following air quality standards of $PM_{2.5}$; 15 μgm^{-3}/35μgm^{-3} (mean annual standard / 24 hours standard). These standards are similar to the U.S.EPA $PM_{2.5}$-guidelines (USEPA, 2010) but different from the World Health Organization-Air quality Guidelines (WHO-AQG), which are; 10 μgm^{-3}/20 μgm^{-3} (WHO, 2005). According to Figures 2 and 6 the mean annual standard is met almost in all prefectures in Japan. This indicates a yearly improving air quality. However; during the study period the 24 hours standard is exceeded mainly in the southern prefectures in Japan. This could be due to the yellow dust storms.

There is uncertainty in the method of estimating the effects of long-term exposure to high levels of $PM_{2.5}$ as discussed in (Nawahda, 2014). This uncertainty is mainly caused by using a non-Asian CR function and population data (e.g. counts, percentage of each age group, and the corresponding baseline mortality) of the 8-year study period.

Conclusion

The aim of this study is to find if $PM_{2.5}$ affects COVID-19 caused deaths in Japan. COVID-19 caused death and tested positive cases in all prefectures during the study period from Feb. 18 up to Apr. 16, 2020 are analyzed. The prefectures with high levels of $PM_{2.5}$ have the highest COVI-19 death and tested positive cases. Accordingly; old people living in places with high concentration of $PM_{2.5}$ are the most vulnerable to COVID-19. The findings of this study are a step towards a better understanding of the association between $PM_{2.5}$ and COVID-19. $PM_{2.5}$ caused deaths from 2010 to 2017 are calculated based on $PM_{2.5}$-relative risk (RR) of 1.04 (95% CI: 1.01 – 1.08) from the World Health Organization-Air Quality

Guidelines (WHO–AQG). The estimated death cases from 2010 to 2017 are about 115,532 (95% CI: 28,883 - 231,064) cases. Thus; policy decision makers could consider $PM_{2.5}$ data to support their efforts in minimizing the spread of COVID-19.

Declarations

The author of "The Rises of Coronavirus Disease (COVID-19) death rate in Japan with high PM2.5" declares no competing interests.

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Figures

Figure 1

Location of the PM2.5 AQMSs in Japan, 2017. (the numbers attached to the prefecture name refer to the number of stations)

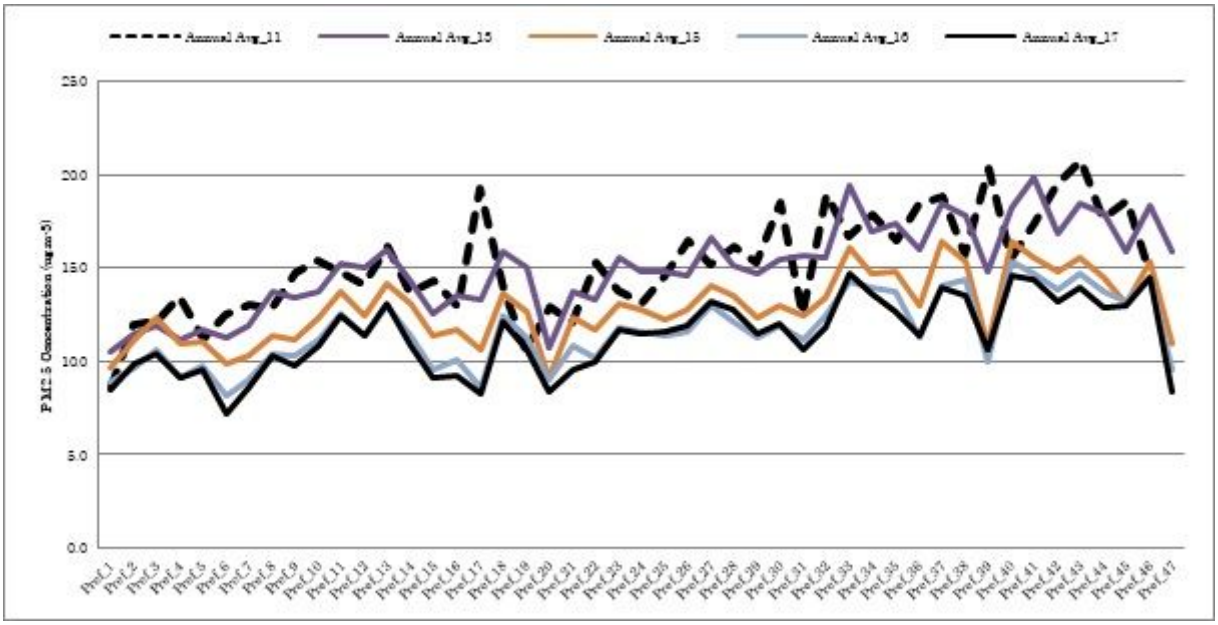

Figure 2

Mean annual concentration of PM2.5 in Japan from 2011 – 2017.

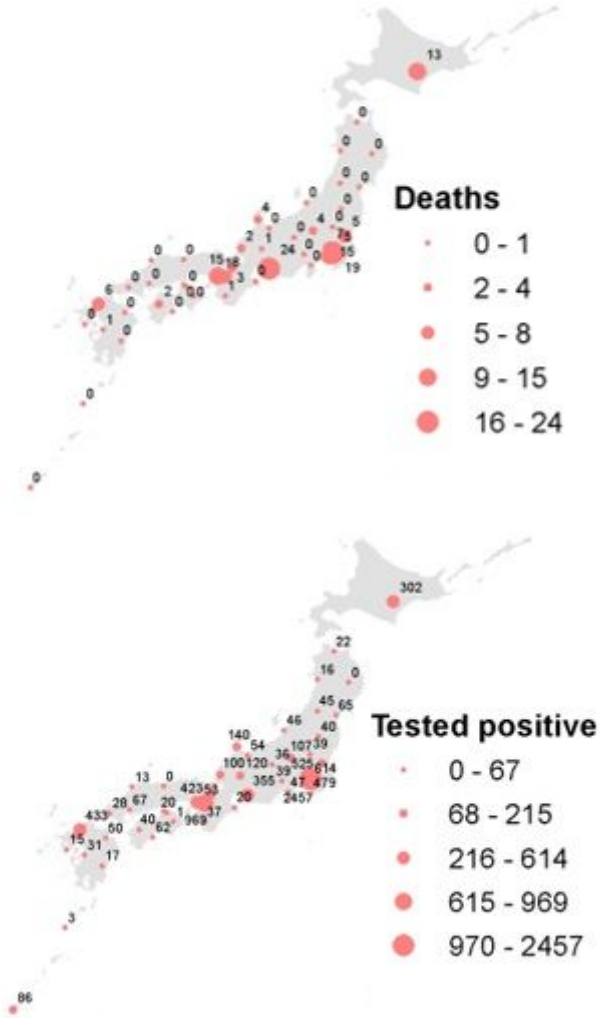

Figure 3

Distribution of COVID-19 related tested positive and death cases up to April 16th, 2020, Japan.

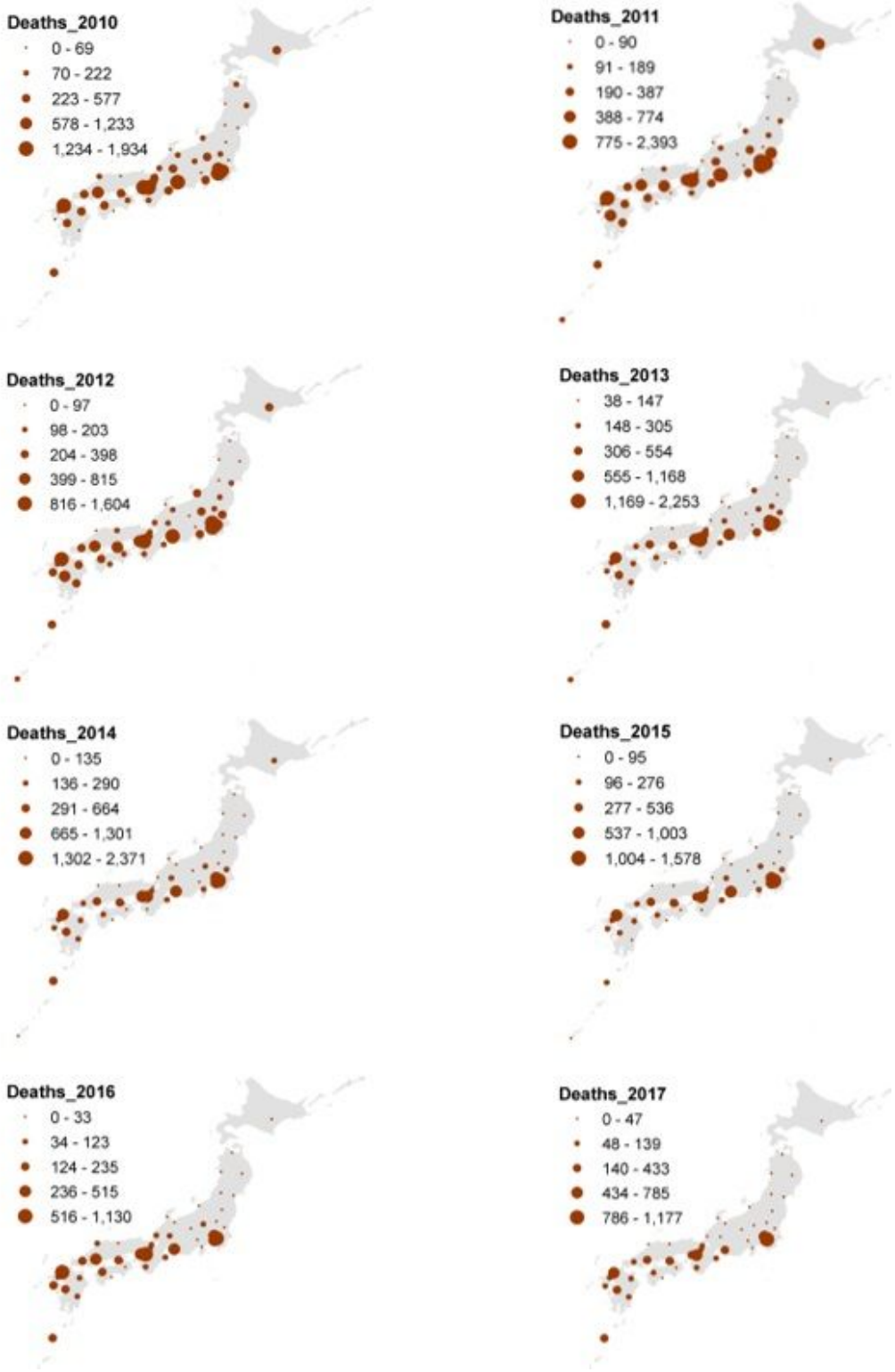

Figure 4

Distributed death cases for the age groups +65 years in Japan from 2010 to 2017.

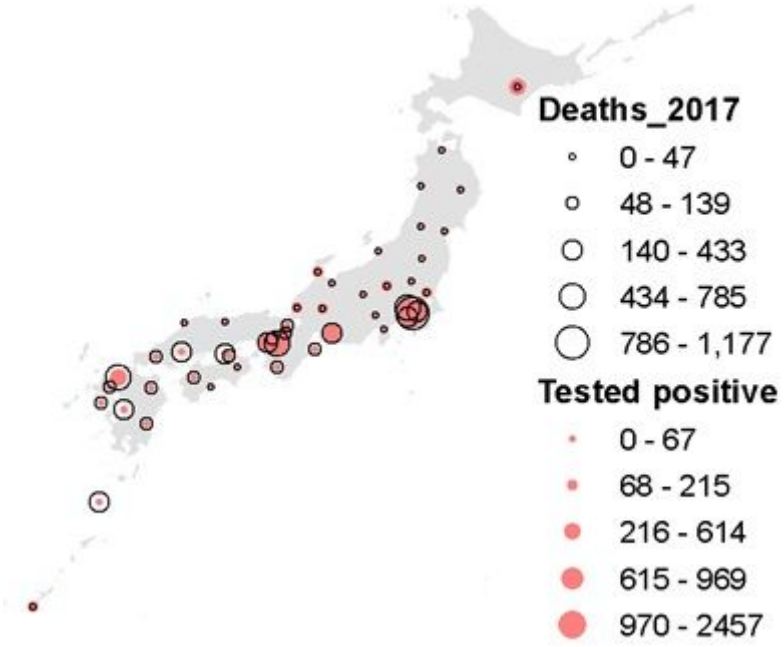

Figure 5

Distribution of deaths and reported tested positive COVID-19 cases (up to April 16, 2020) in Japan.

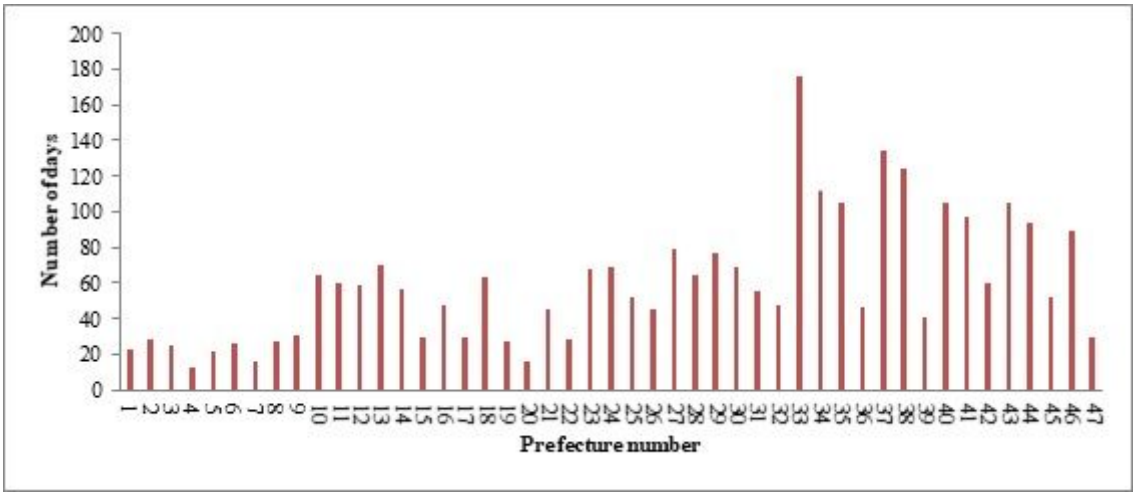

Figure 6

Number of days PM2.5 exceeded the 24 hours standard (35 μgm-3) during the period from 2010 to 2017.