Health benefits of reducing ambient levels of fine particulate matter: a mortality impact assessment in Taiwan

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ABSTRACT

BACKGROUND AND AIM

While numerous studies have found a relationship between long-term exposure to airborne fine particulate matter ($PM_{2.5}$) and higher risk of death, few investigations examined the contribution that a reduction of exposure to ambient $PM_{2.5}$ levels might exert on mortality rates. This study aimed to collect data on changes in annual average ambient levels of $PM_{2.5}$ from 2006 to 2020 and consequent health impact in public health in 65 municipalities in Taiwan. Avoidable premature mortality was used here as an indicator of adverse health impact or health benefits.

METHOD

Annual $PM_{2.5}$ levels were averaged for the years 2006, 2010, and 2020. In accordance with World Health Organization (WHO) methodology, differences were estimated in the number of deaths attributed to ambient $PM_{2.5}$ exposure which were derived from concentration-response data from prior epidemiological studies.

RESULTS

$PM_{2.5}$ concentrations were found to have been decreased markedly throughout Taiwan over the two-decade study. As the $PM_{2.5}$ concentrations fell, so was the health burden as evidenced by number of deaths concomitantly reduced from 22.4% in 2006 to 8.47% in 2020. Data demonstrated that reducing annual mean levels of $PM_{2.5}$ to PM_{10} ug/m^3 was associated with decrease in the total burden of mortality, with a 2.22-13.18% fall in estimated number of $PM_{2.5}$-related deaths between 2006 and 2020.

CONCLUSIONS

Based upon these results, these declines in ambient PM2.5 levels were correlated with significant improvement in public health (health benefits) and diminished number of deaths in Taiwan.

Table 1. Summary statistics of municipality-specific annual average $PM_{2.5}$ levels in 2006, 2010, and 2020.

Year	25%	50%	mean	75%	SD
			municipality-specific annual average $PM_{2.5}$ levels		
2006	24	31	34.39 (7.00 ~ 92.00)	41	14.03
2010	22	29	31.59 (7.00 ~ 74.00)	40	13.00
2020	9	12	14.03 (3.00 ~ 33.00)	18	6.50

SD is standard deviation; 25%, 50% and 75% are percentiles.

Table 2. Expected number and fraction of $PM_{2.5}$-attributable deaths in Taiwan in 2006, 2010 and 2020 and health benefits of achieving the WHO guidelines among people aged 30 years and older.

Year	Estimated number of $PM_{2.5}$-related deaths (95% CI)[a]	AF (95% CI)[a]	Premature deaths avoided by attaining WHO guideline (95% CI)[a]	Percentage reduction in premature deaths (95% CI)[a]
2006	10241.05 (6570.50 ~ 13934.04)	22.4% (14.37 ~ 30.48)	6028.23 (4115.85 ~ 7735.30)	13.18% (9 ~ 16.92)
2010	10395.05 (6689.79 ~ 14101.77)	20.5% (13.19 ~ 27.81)	6012.60 (4094.01 ~ 7734.54)	11.86% (8.07 ~ 15.25)
2020	5391.24 (3537.15 ~ 7180.18)	8.47% (5.56 ~ 11.29)	1415.03 (947.01 ~ 1849.66)	2.22% (1.49 ~ 2.91)

[a]95% Confidence Interval.
[b]The fraction of all-cause deaths attributable to PM2.5 (AF).