Evaluation of Long-term Trends and Seasonal Variations of Air Quality and Resulting Health Impact in a Sub-tropical City in Taiwan

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Abstract

In light of potential seasonal shifts due to climate change and a lack of insight into the current air pollution after emission-control policies were implemented, this study aims to re-evaluate temporal variations in CO, NO_2, O_3, $PM_{2.5}$, PM_{10}, and SO_2 concentrations in Taipei using Seasonal-Trend decomposition based on LOESS. Moreover, to determine whether health impacts from air pollution are truly reflected by changes in individual air pollutant concentrations, considering exposure to multiple pollutants simultaneously, we constructed a tailored Air Quality Health Index (AQHI) for Taipei and investigated its variations. This study also integrated the detailed data from Taiwan's National Health Insurance Database to compare these trends with the changing air pollutants and AQHI. Our findings demonstrate that the seasonality of CO, NO_2, $PM_{2.5}$, and PM_{10} concentrations was characterized by an increase in winter and a decrease in summer. In contrast, O_3 concentrations presented bimodal peaks in April and September, while SO_2 levels were higher in the summer. Over seven years, Taipei experienced annual reductions of 0.03 ppm CO, 1.05 ppb NO_2, 1.07 µg/m3 $PM_{2.5}$, 2.28 µg/m3 PM_{10}, and 0.29 ppb SO_2, whereas O_3 pollution remained constant. Correspondingly, the yearly percentage of days above WHO standards for CO, NO_2, $PM_{2.5}$, and PM_{10} decreased, while that for O_3 stabilized. Our results also indicate that recent health threats from air pollution have been significantly less severe, with the majority of days where AQHI classified in low or moderate categories, highlighting the payoff of intensified government efforts.

Keywords: Temporal variations; Air quality; Taipei; AQHI.