Health Effects of Particulate Matter

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The World Health Organization (WHO) estimates that the number of premature deaths by the air pollution amounts to 3 million a year. In addition, the International Agency for Research on Cancer (IARC), affiliated organization under WHO, has defined the particulate matter as the first rate carcinogens (Group 1: substances causing carcinogens in human body). Consequently, the particulate matter has emerged as the most important risk to the health in the world.

The size and composition of particulate matter in air pollutants is very complex and diverse, and the health effects of particulate matter can vary depending on particle size, surface area, chemical compositions, and etc. Depending on the size of particulate matter, PM$_{10}$ is 10 $\mu$m or less, and PM$_{2.5}$ is 2.5$\mu$m or less. PM$_{2.5}$ penetrates into the alveoli by not getting caught in the respiratory tract because of its small size, and it becomes more injurious to health since its components include heavy metals or ions that promote inflammatory response.

1. Mortality Effect of Particulate Matter

In 1993, Dockery et al. carried out various environmental epidemiological studies on the particulate matter and health effects, addressing the close relationship between the particulate matter and mortality in six major cities in the U.S. In addition, according to the epidemiological studies in several cities in the U.S., Europe and Asia, short-term exposure of PM$_{10}$ and PM$_{2.5}$ was related to mortality, and large-scale cohort studies in Europe and U.S. showed that long-term exposure to PM$_{10}$ and PM$_{2.5}$ was significantly concerned with the risk of mortality. The results of the time series analysis of the mortality risk by short-term exposure of PM$_{10}$ and PM$_{2.5}$ in Seoul from 2006 to 2010 are shown in <Fig. 1> and <Table 1>. As shown in <Fig. 1>, PM$_{10}$ and PM$_{2.5}$ were significantly associated with an increase the risk of cardiovascular disease mortality.

![Fig. 1](image)

*Effects of PM$_{10}$ and PM$_{2.5}$ on Cardiovascular Disease Mortality*

(a) Effects of PM$_{10}$ on Cardiovascular Disease Mortality

(b) Effects of PM$_{2.5}$ on Cardiovascular Disease Mortality
Table 1. Short-term Effects of PM\(_{10}\) and PM\(_{2.5}\) on Mortality

<table>
<thead>
<tr>
<th>Particulate Matter</th>
<th>Cause of Mortality</th>
<th>Percent increase in daily mortality when PM(<em>{10}) and PM(</em>{2.5}) increases by 10(\mu)g/m(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>PM(_{10})</td>
<td>All-cause</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular</td>
<td>0.76</td>
</tr>
<tr>
<td>PM(_{2.5})</td>
<td>All-cause</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular</td>
<td>1.63</td>
</tr>
</tbody>
</table>

The results of the quantitative evaluation on the mortality effects of PM\(_{10}\) and PM\(_{2.5}\) are shown in Table 1. In all age groups, the increase in all-cause mortality associated with a 10\(\mu\)g/m\(^3\) increase in PM\(_{10}\) was 0.44% (95% Confidence interval [CI] : 0.25~0.63%), and increasing PM\(_{2.5}\) concentration by 10 \(\mu\)g/m\(^3\) increases the all-cause mortality by 0.95% (95% CI : 0.57~1.34%). Furthermore, the increase in PM\(_{10}\) and PM\(_{2.5}\) concentrations significantly associated with the risk of cardiovascular mortality. Especially, PM\(_{10}\) and PM\(_{2.5}\) are found to significantly affect the development or aggravation of cardiovascular diseases, and the mortality risk of cardiovascular disease is higher than that of the all-cause mortality. Comparing the mortality effect of PM\(_{10}\) and PM\(_{2.5}\), PM\(_{2.5}\) has both the higher all-cause mortality and cardiovascular disease mortality than PM\(_{10}\).

2. Morbidity Effect of Particulate Matter

The particulate matter causes an inflammatory reaction in the bronchioles, which increases the symptoms of respiratory diseases such as inhalation airway irritant, coughing and dyspnea, and also aggravates respiratory diseases such as asthma and chronic bronchitis. In addition, particulate matter has also considered as a major cause of cardiovascular diseases such as irregular cardiac impulse, myocardial infarction and stroke. Table 2 shows the results of evaluating the disease effects of short-term exposure to PM\(_{2.5}\) in Seoul from 2007 to 2015. In all age groups, the increase in hospitalization of cardiovascular diseases associated with a 10\(\mu\)g/m\(^3\) increase in PM\(_{2.5}\) was 4.99% (95% CI : 3.55~6.44%). Moreover, PM\(_{2.5}\) concentration in Seoul significantly increases the hospitalization risk of myocardial infarction and asthma, and visiting risk of asthma emergency room statistically.
Table 2. Short-term Effects of PM$_{2.5}$ on Morbidity

<table>
<thead>
<tr>
<th>Particulate Matter</th>
<th>Health Effect</th>
<th>Percent increase in daily mortality when PM$<em>{2.5}$ and PM$</em>{10}$ increases by 10µg/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>Hospitalization of Cardiovascular Diseases</td>
<td>4.99</td>
</tr>
<tr>
<td></td>
<td>Hospitalization of Myocardial Infarction</td>
<td>1.57</td>
</tr>
<tr>
<td></td>
<td>Hospitalization of Asthma</td>
<td>1.36</td>
</tr>
<tr>
<td></td>
<td>Visiting Asthma Emergency Room</td>
<td>2.29</td>
</tr>
</tbody>
</table>

References

- Gong, Sungyong(2012), *A Study on the Health Impact and Management Policy of PM$_{2.5}$ in Korea*, KEI.
- Lee, Changhoon(2016), *An Integrated Approach Environmental Valuation*, KEI.