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Letter to the Editor

In-Depth Investigation of Biological Association for Particulate Matter on Systemic Stress Biomarkers

Hee-Tae Roh [1], ****Taikyeong Ted. Jeong*** [2]

1. *Division of Sports Science, College of Arts and Sports, Sun Moon University, Asan-si, Korea*
2. *School of Artificial Intelligence Convergence, Hallym University, Gangwon-do, Korea*

***Corresponding Author:** Email: ttjeong@hallym.ac.kr

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Dear Editor-in-Chief

Air pollution and particulate matter (PM) is one of the factors that is destroying the natural environment and the ecosystems of various species, and threatens human health. In particular, among air pollutants, PM, which can be classified as coarse PM (PM_{10}: ≤10μm), fine PM ($PM_{2.5}$: ≤2.5μm), and ultrafine PM ($PM_{0.1}$: ≤0.1μm), based on size, are inhalable pollutants (1,2).

Silico investigation has showed that PM exposure can negatively affect various organs, including the lungs, heart, brain, pancreas, and uterus, to cause not only cancer, but also respiratory diseases, cardiovascular diseases, diabetes, and other neurodegenerative diseases such as Alzheimer's disease, leading to increasing premature mortality rate (1,2). In particular, children, along with the elderly and patients with chronic disease, are considered susceptible to PM exposure (3). Kulkarmi et al (4) have reported the biological association between PM exposure and lung dysfunction by demonstrating a dose-response relationship between PM exposure and carbon in respiratory macrophages in children who had been exposed to PM generated by automobile exhaust gas.

Meanwhile, excessive oxidative stress (OS) was suggested as one of the major mechanisms through which PM exposure leads to health hazards (1,2). However, there is limited research in-depth investigating the changes in OS levels because of PM exposure, in different age groups.

Consequently, we aimed to analyze the level of malondialdehyde (MDA) that reflects lipid peroxidation in the body, and the activities of the antioxidants superoxide dismutase (SOD) and catalase (CAT) to assess the changes in systemic OS levels because of PM exposure, and identify the differences in its levels, based on age. Ultimately, the distribution of age groups according to OS level can be said to be the result of in-depth research. Moreover, the biological correlation between exhibition PM and OS level provides conclusive evidence that it is meaningful as a biomarker.

For experiment, 56 four-week-old C57BL/6 male mice were purchased from Samtako bio-Korea Inc. where located in Korea, and 28 mice each were randomly assigned to the juvenile and adult groups. The juvenile group was used in the experiment after a week of adaptation, while the adult group was used in the experiment after being bred post the age of thirty weeks, and the specific group classification was as follows: Juvenile control (JCO) group (n=14); Juvenile PM administered (JPM) group (n=14); Adult control

(ACO) group (n=14); and Adult PM administered (APM) group (n=14).

The animal experiments were approved by the National Research Foundation of Korea (no. 2019R1F1A1064296).

The PM was acquired from Sigma-Aldrich which located in USA as fine dust (PM_{10}-like, ERM-CZ120), certified by the European Reference Materials to have components and concentrations similar to real PM_{10}. For PM treatment, 15μg of PM was suspended in 200μl saline, and 0.5μg per g of body weight was injected into the tail vein of the mice, as described previously (5). In contrast, only 200μl saline was injected into the JCO and ACO group mice. At 4 and 8 week of PM treatment, 7 mice per group were anesthetized with ethyl ether, and the blood collected from the abdominal inferior vena cava was analyzed using ELISA kits from MyBioSource, in USA, for serum MDA (#MBS741034), SOD (#MBS034842), and CAT (#MBS704962) levels.

All statistical analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA). Differences between groups were assessed using the one-way analysis of variance and Tukey test, and the statistical significance level was set at P<0.05.

Changes in the systemic OS biomarkers of juvenile and adult mice, based on PM administration, are shown in Fig. 1. At 4 week of PM administration, the JPM group exhibited significantly higher MDA (P<0.05) and lower SOD (P<0.05) levels than the other three groups (JCO, ACO, and APM). At 8 week of PM administration, the APM group exhibited a significantly higher MDA level than the JCO and ACO groups (P<0.05), while the JPM group exhibited a significantly higher MDA level (P<0.05) than the other three groups (JCO, ACO, and APM). Moreover, at 8 week of PM administration, the JPM and APM groups exhibited significantly lower SOD and CAT levels than the JCO and ACO groups (P<0.05).

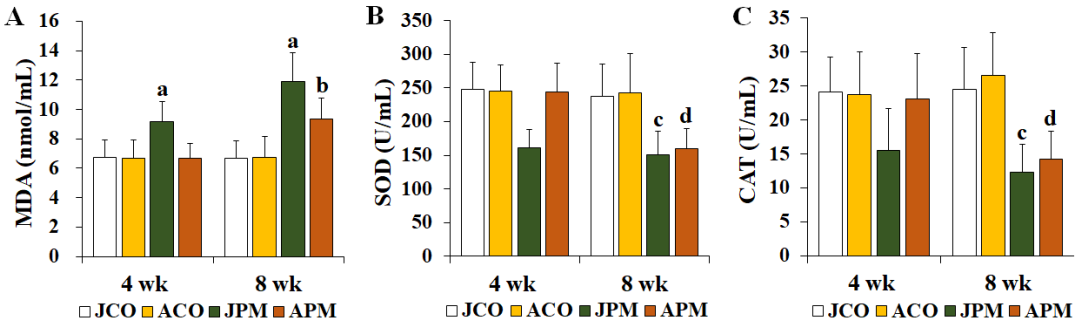

Fig. 1: Changes in serum (A) MDA, (B) SOD, and (C) CAT levels according to PM administration. Data are presented as mean±standard deviation. [a]versus JCO, ACO, and APM groups (P<0.05); [b]versus JCO and ACO groups (P<0.05); [c]versus JCO group (P<0.05); [d]versus ACO group (P<0.05)

PM exposure could increase systemic OS levels. In addition, our findings suggest that exposure to PM at the immature stage when growth is underway can induce relatively higher OS compared to that in the mature stage. The overall experimental results can serve as a cornerstone for research on animal nervous tissue by not only examining PM content but also examining the effects at different ages to examine biological correlations.

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Conflict of interest

The author declare that there is no conflict of interest.

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