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Long-Term Associations between Greenness and Air Pollution with Risk Factors for Cardiovascular Disease: A Cohort Study

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Extended Abstract

Epidemiological studies show that both increasing air pollution and less exposure to greenness may lead to the development of cardiovascular disease (CVD) [1, 2]. However, limited longitudinal studies identified the associations between residential greenness and CVD risk factors, such as blood pressure (BP) [3], blood lipids [4] and blood sugar [5]. We examined the associations between long-term exposure to greenness and air pollution with BP (i.e., systolic blood pressure (SBP) and diastolic blood pressure (DBP)), blood lipids (i.e., total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG)) and fasting glucose (FG) using workers cohort study from Electricity Generating Authority of Thailand (EGAT) in Bangkok metropolitan region (BMR), Thailand.

This study was based on 2,027 participants from the EGAT1 cohort study (2002-2017; aged 52-71 years at the baseline) [6]. Outcome variables were measured in 2002, 2007, 2012, and 2017. The amount of greenness in each participant's sub-district was measured using the satellite-derived Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI). The average concentration of each air pollutant (i.e., particulate matter with an aerodynamic diameter ≤10 μm (PM10), ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), and carbon monoxide (CO)) at the sub-district level in BMR from 2002 to 2017 was generated using the kriging method [7]. Exposure periods were averaged to 1 year prior to each participant's follow-up date. We applied linear mixed effects models to analyze the association of greenness and air pollution with outcome variables. Each participant was assigned as a random intercept in our models to control the autocorrelation of repeated measurements for the same participant. Outcome variables (SBP, DBP, TC, LDL-C, HDL-C, TG, and FG) were transformed using a log10 function to improve normality and stabilize variances.

During the follow-up period, participants' average exposure to PM10 was 46.6 $\mu g/m^3$, which nearly exceeded Thailand's annual PM10 standard (50 $\mu g/m^3$). After adjusting for potential confounders (e.g., age, sex, body mass index, smoking status,

alcohol consumption, education level, income, and prevalence and treatment of hypertension, diabetes, and hypercholesterolemia), an interquartile range increment of PM10, O3, SO2, and CO was associated with elevated TC [2.4% (95% Confidence Interval (CI): 1.6, 3.3), 1.5% (0.9, 2.0), 2.6% (1.3, 3.9), and 2.4% (1.6, 3.2), respectively] and LDL-C [2.0% (0.8, 3.3), 1.5% (0.6, 2.3), 3.1% (1.2, 5.1), and 2.6% (1.4, 3.8), respectively]. PM10, O3, and CO were negatively associated with HDL-C [-2.0% (-2.8, -1.2), -0.8% (-1.3, -0.2), and -1.7 (-2.6, -0.8), respectively]. Elevated FG levels were also inversely associated with higher PM10 [1.9% (1.2, 2.6)], SO2 [2.7% (1.6, 3.8)], and CO [1.9% (1.2, 2.5)]. Moreover, we also observed the positive associations between PM10 and SO2 with SBP and DBP. In two-pollutant models, associations between all air pollutants and outcome variables were not essentially changed. However, we were unable to find a clear association between NDVI and EVI for all outcome variables.

These findings suggest that exposure to air pollution may increase the risk of CVD. In areas with high levels of air pollution, green spaces might not have a beneficial effect on health outcomes.

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