Air pollution as a non-conventional coronary disease progression risk factor in diabetic patients

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INTRODUCTION

Coronary artery disease presents one of the current epidemiological challenges and remains a leading cause of death. The European Registry confirmed the crucial role of risk factor control as a predictor of the risk of significant adverse events [1].

Type 2 diabetes mellitus (T2DM) is one of well-described cardiovascular disease (CVD) risk factors and a leading cause of mortality. Clinical trials and epidemiological studies pointed out the significance of successful control of multiple risk factors in diabetic patients, which can reduce the risk of CVD events by over 50% [2].

Air pollution, which is one of the non-conventional risk factors for coronary artery disease, is getting scientific attention nowadays [3]. Up to 12% of annual global mortality is reported to be related to ambient air pollution [4]. The relationship between acute and chronic exposure to inhaled particulate matter and systemic inflammatory activation, resulting in cardiovascular morbidity, has been reported [5]. Exposure to environmental factors affects arterial blood pressure, increases insulin resistance, and accelerates atherogenesis [6, 7]. Our previous analysis presented a positive correlation between chronic exposure to ambient particulate matter (PM10) and coronary artery disease progression [8].

This study aimed to compare the risk of coronary artery disease progression in diabetic patients measured by the Gensini score in chronic coronary syndrome related to air pollution exposure.

MATERIAL AND METHODS

The retrospective two-center analysis included consecutive patients presenting with chronic coronary syndrome who were referred for repeated coronary angiography due to the presentation of *de novo* anginal symptoms between 2019 and 2022. During each hospitalization, coronary artery disease was estimated by the Gensini score [9].

Patients with either acute coronary syndromes or who had a surgical revascularization history were excluded from the analysis. Patients with type 1 diabetes mellitus or insulin-dependent were excluded from the analysis, too.

The patient's exposure to ambient air pollution was assessed by applying available air quality data from the State Environmental Monitoring in Poland, established under the Act of Inspection of Environmental Protection to provide reliable data on the state of the environment (Supplementary material, *Appendix 1*). The methodology parallels those previously applied in our reports [10].

Statistical analysis

Statistical analysis was performed using JASP statistical software (JASP Team; 2023. Version 0.18.1). P <0.05 was considered significant (Supplementary material, *Statistical analysis*).

The study was approved by the Ethics Committee of Poznan University of Medical Sciences, Poznań, Poland (969/23 on December 6, 2023).

RESULTS AND DISCUSSION:

The 126 patients (79 [63%] men and 47 [37%] women) at a median age of 70 (63–76) years underwent elective coronary angiography due to the clinical presentation of angina equivalent. The group was characterized by the co-existence of arterial hypertension (n = 77; 61%), dyslipidemia (n = 75; 60%), diabetes mellitus (n = 38; 30%), atrial fibrillation (n = 9; 7%), chronic thyroid disease (n = 8; 6%), obstructive pulmonary disease (n = 7, 6%), kidney chronic disease (n = 7; 6%), and peripheral artery disease (n = 14; 11%) (Supplementary material, *Table S1*). Patients were allocated to two groups: diabetic patients (n = 38) and non-diabetic patients (n = 88).

Repeated angiography was performed within a time interval of 371 (118–882) days. Patients were referred for repeated angiograms based on persistent clinical symptoms that were quantified as angina equivalent despite optimal pharmacotherapy. There was no distinction in time intervals between both groups (P = 0.68) or the value of glycated hemoglobin (initial 6.1% [5.3–6.7] vs. repeated hospitalization: 5.9% [5.1–6.6]; P = 0.87).

The repeated angiography showed a difference in atherosclerosis progression between diabetic and non-diabetic groups measured by the Gensini score with initial results (6 [0–15] vs. 2 [0–10]; P <0.001) (Supplementary material, *Table S2*).

Air pollution exposure was calculated separately for every patient enrolled in the analysis. The median values of ambient pollutants during the exposure time were included in the analysis. The median values of particulate matter 2.5 microns or less (PM2.5) were 15.9 (14.05–18.5) ug/m^3, of fine particles measuring 10 microns or less (PM10) – 23.0 (21.2–26.1) ug/m^3 and of nitric dioxide (NO_2) – 12.7 (10.8–18.9) ug/m^3. No differences existed between ambient pollutant exposure in the diabetic and non-diabetic groups (Supplementary material, *Table S3*).

The analyzed group's angiographic results (presented as Gensini score differences) were correlated with ambient air pollutant exposure and demonstrated a significant correlation with PM2.5 (r = 0.196; P = 0.046). There was no relation between the obtained angiographic results and PM10 exposure (r = 0.190; P = 0.053) or NO_2 (r = 0.192; P = 0.051) (Supplementary material, *Figure S1*).

A correlation was found between Gensini score progression and exposure to PM2.5 (r = 0.419; P = 0.03) and PM10 (r = 0.44; P = 0.02), as presented in Figure 1.

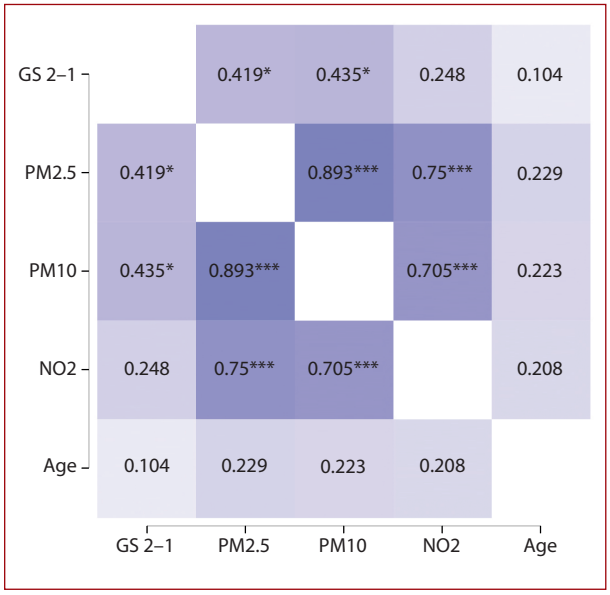

Figure 1. Possible correlations between Gensini score progression (GS2-1), ambient air pollutants (PM2.5, PM10, N02), and age in diabetic patients

Abbreviations: GS, Gensini score; NO_2, nitric dioxide; PM2.5, particle matters with a maximum diameter of 2.5 micrometers; PM10, issues of the particle with a diameter between 2.5 and 10 micrometers

The multivariable regression analysis for the Gensini score progression showed the predictive value of combined PM2.5, diabetes, and defined coronary disease (Supplementary material, *Table S4*). The receiver operating characteristic curve analysis was characterized by an area under the curve for the mentioned three characteristics of 0.749, yielding sensitivity of 78.4% and specificity of 65.4%.

Atherosclerosis development and progression is a multifactorial process resulting from the interaction between chronic and acute processes, representing the interplay between genetic predisposition, lifestyle, coexisting illnesses, and external factors. Our analysis points out the significance of one of the non-conventional risk factors, ambient pollution, in a T2DM subgroup predisposed to atherosclerosis development. In T2DM, immune system activation is related to the overproduction of inflammatory mediators by adipocytes and fat tissue macrophages [11]. The relationship between ambient air components and type 1 diabetes remission was presented in previous reports [12].

Air pollution is considered the most ominous environmental risk factor for disease and premature death, including fine particles as the main hazardous constituent. The inhaled particulate matters are claimed to contribute to mitochondrial damage that exacerbates oxidative stress and promotes pro-inflammatory cytokines [13].

While large-volume epidemiological studies presented the relation between ambient fine particulate matter concentration and increased cardiovascular risk [14], our personalized analysis indicates that the diabetic subgroup

with coronary artery disease is especially vulnerable to environmental factors. Our results show that these patients should be considered more susceptible to further atherosclerosis progression due to exposure to air pollutants.

The personalized analysis required individual air pollution exposure calculation, resulting in a limited number of enrolled patients.

CONCLUSION

Chronic exposure to ambient air pollution, especially PM2.5, may predispose to coronary artery atherosclerosis progression in patients presenting with anginal equivalent. Non-conventional, environmental factors may have a more causative role in diabetic patients, especially those with already confirmed coronary atherosclerosis.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/polish_heart_journal.

Article information

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