POLISH HEART JOURNAL

Kardiologia Polska
The Official Peer-reviewed Journal of the Polish Cardiac Society since 1957

Online first
This is a provisional PDF only. Copyedited and fully formatted version will be made available soon

ISSN 0022–9032 e-ISSN 1897–4279

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

Authors: Tomasz Urbanowicz, Krzysztof Skotak, Ireneusz Domański-Giec, Michał Lesiak, Krzysztof Filipiak, Aleksandra Krasińska-Płachta, Michał Bączek, Wojciech Gutkowski, Beata Wożakowska-Kapłon, Marek Jemielity, Andrzej Tykarski

Article type: Short communication

Received: July 28, 2024

Accepted: October 17, 2024

Early publication date: October 25, 2024

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

Short title: Air pollution and diabetes

Tomasz Urbanowicz[1], Krzysztof Skotak[2], Ireneusz Domański-Giec[3], Michał Lesiak[4], Krzysztof Filipiak[5, 6], Aleksandra Krasińska-Płachta[7], Michał Bączek[3, 8], Wojciech Gutkowski[9], Beata Wożakowska-Kapłon[3, 8], Marek Jemielity[1], Andrzej Tykarski[6]

[1]Department of Cardiac Surgery and Transplantology, Poznan University of Medical Sciences, Poznań, Poland
[2]Institute of Environmental Protection — National Research Institute, Warszawa, Poland
[3]Department of Cardiology, 1st Clinic of Cardiology and Electrotherapy, Swietokrzyskie Cardiology Center, Kielce, Poland
[4]1st Cardiology Department, Poznan University of Medical Sciences, Poznań, Poland
[5]Institute of Clinical Science, Maria Sklodowska-Curie Medical Academy, Warszawa, Poland
[6]Department of Hypertensiology, Angiology and Internal Medicine, Poznan University of Medical Sciences, Poznań, Poland
[7]Department of Ophthalmology, Poznan University of Medical Sciences, Poznań, Poland
[8]Collegium Medicum, Jan Kochanowski University, Kielce, Poland
[9]Laboratory of Hemodynamics, Swietokrzyskie Cardiology Center, Kielce, Poland

Correspondence to:
Assoc. Prof. Tomasz Urbanowicz, MD, PhD,
Department of Cardiac Surgery and Transplantology,
Poznan University of Medical Sciences,
Długa 1/2, 61–848 Poznań, Poland,
phone: +48 61 854 92 10,
e-mail: turbanowicz@ump.edu.pl

INTRODUCTION

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

Diabetes mellitus type 2 (T2DM) is one of the well-described cardiovascular disease risk factors (CVD) events in this population and is a leading cause of mortality. The clinical trial and epidemiological studies pointed out the significance of successful control of multiple risk factors in diabetic patients that can reduce by over 50% the risk of CVD events [2].

Air pollution is one of the non-traditional risk factors for coronary artery disease that 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, is claimed [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].

The study aimed to compare coronary artery disease progression risk 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 presented a surgical revascularization history were excluded from the analysis. Patients with type 1 diabetes mellitus or insulin-dependent were excluded from the analysis.

The patient's exposure to ambient air pollution was used by applying available air quality data. The State Environmental Monitoring in Poland was used. State Environmental Monitoring was 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 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 from 6 December 2023).

RESULTS AND DISCUSSION:

The 126 patients (79 [63%] men and 47 [37%] women) with 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 divided into two groups: diabetic patients (n = 38) and non-diabetic patients (n = 88).

The repeated angiography was performed within a time interval of 371 (118–882) days. Patients were referred for repetitive 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) nor the value of glycemic hemoglobin (initial 6.1% [5.3–6.7] vs. repeated hospitalization: 5.9% [5.1–6.6]; P = 0.87).

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

Air pollution exposure was calculated for every patient enrolled in the analysis separately. The median values of ambient pollutants through the exposure time were taken into 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, accompanied by fine particles in size of 10 microns or less (PM10) median values of 23.0 (21.2–26.1) ug/m^3 and followed by nitric dioxide (NO_2) measurements of 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, revealing a significant correlation with PM2.5 (r = 0.196; P = 0.046). There was no relation between obtained angiographic results and PM10 exposure (r = 0.190; P = 0.053) nor 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 (P = 0.44; P = 0.02) as presented in Figure 1.

The multivariable regression analysis for the Gensini score progression revealed 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

the area under the curve for the mentioned three characteristics 0.749, yielding a sensitivity of 78.4% and a 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-traditional 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 a main hazardous constituent. The inhaled particulate matters are claimed to contribute to mitochondrial damages that exacerbate oxidative stress and pro-inflammatory cytokines [13].

While the large-volume epidemiological studies presented the relation between ambient fine particulate concentration and increased cardiovascular risk [14], our personalized analysis points out the diabetic subgroup as especially vulnerable to environmental factors in coronary artery disease progression. Our results show that diabetic patients with defined coronary disease should be considered more susceptible to further atherosclerosis progression by exposure to air pollutants.

The personalized analysis required individual air pollution exposure calculation, resulting in the 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 patients. Non-traditional, environmental factors may have a more causative role in diabetic patients, especially those with already proven coronary atherosclerosis.

Supplementary material

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

Article information

Conflict of interest: None declared.

Funding: None.

REFERENCES

1. Kerneis M, Cosentino F, Ferrari R, et al. Impact of chronic coronary syndromes on cardiovascular hospitalization and mortality: the ESC-EORP CICD-LT registry. Eur J Prev Cardiol. 2022; 29(15): 1945–1954, doi: 10.1093/eurjpc/zwac089, indexed in Pubmed: 35653582.
2. Wong ND, Sattar N. Cardiovascular risk in diabetes mellitus: Epidemiology, assessment and prevention. Nat Rev Cardiol. 2023; 20(10): 685–695, doi: 10.1038/s41569-023-00877-z, indexed in Pubmed: 37193856.
3. Braunwald E. Air pollution: Challenges and opportunities for cardiology. Eur Heart J. 2023; 44(19): 1679–1681, doi: 10.1093/eurheartj/ehac791, indexed in Pubmed: 36617273.
4. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: A systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020; 396(10258): 1223–1249, doi: 10.1016/S0140-6736(20)30752-2, indexed in Pubmed: 33069327.
5. Marchini T, Zirlik A, Wolf D. Pathogenic role of air pollution particulate matter in cardiometabolic disease: Evidence from mice and humans. Antioxid Redox Signal. 2020; 33(4): 263–279, doi: 10.1089/ars.2020.8096, indexed in Pubmed: 32403947.
6. Bhatnagar A. Cardiovascular effects of particulate air pollution. Ann Rev Med . 2022; 73(1): 393–406, doi: 10.1146/annurev-med-042220-011549, indexed in Pubmed: 34644154.
7. Yu YL, An DW, Chori BS, et al. Blood pressure and hypertension in relation to lead exposure updated according to present-day blood lead levels. Kardiol Pol. 2023; 81(7-8): 675–683, doi: 10.33963/KP.a2023.0142, indexed in Pubmed: 37366260.
8. Urbanowicz T, Skotak K, Olasińska-Wiśniewska A, et al. Long-term exposure to PM10 air pollution exaggerates progression of coronary artery disease. Atmosphere. 2024; 15(2): 216–229, doi: 10.3390/atmos15020216.

9. Urbanowicz T, Skotak K, Filipiak KJ, et al. Long-term exposure of nitrogen oxides air pollution (NO) impact for coronary artery lesion progression-pilot study. J Pers Med. 2023; 13(9): 1376, doi: 10.3390/jpm13091376, indexed in Pubmed: 37763144.
10. Rampidis GP, Benetos G, Benz DC, et al. A guide for Gensini Score calculation. Atherosclerosis. 2019; 287: 181–183, doi: 10.1016/j.atherosclerosis.2019.05.012, indexed in Pubmed: 31104809.
11. Lopes-Virella MF, Virella G. The role of immune and inflammatory processes in the development of macrovascular disease in diabetes. Front Biosci. 2003; 8: s750–s768, doi: 10.2741/1141, indexed in Pubmed: 12957881.
12. Ciepłucha W, Cieluch A, Jaz K, et al. Lower air ozone concentration is associated with clinical remission in type 1 diabetes diagnosed in adulthood: a prospective, observational study in Wielkopolska region, Poland. Pol Arch Intern Med. 2024; 134(1): 16636, doi: 10.20452/pamw.16636, indexed in Pubmed: 38164523.
13. Zhang RD, Chen C, Wang P, et al. Air pollution exposure and auto-inflammatory and autoimmune diseases of the musculoskeletal system: A review of epidemiologic and mechanistic evidence. Environ Geochem Health. 2023; 45(7): 4087–4105, doi: 10.1007/s10653-023-01495-x, indexed in Pubmed: 36735155.
14. Liang R, Chen R, Yin P, et al. Associations of long-term exposure to fine particulate matter and its constituents with cardiovascular mortality: A prospective cohort study in China. Environ Int. 2022; 162: 107156, doi: 10.1016/j.envint.2022.107156, indexed in Pubmed: 35248978.

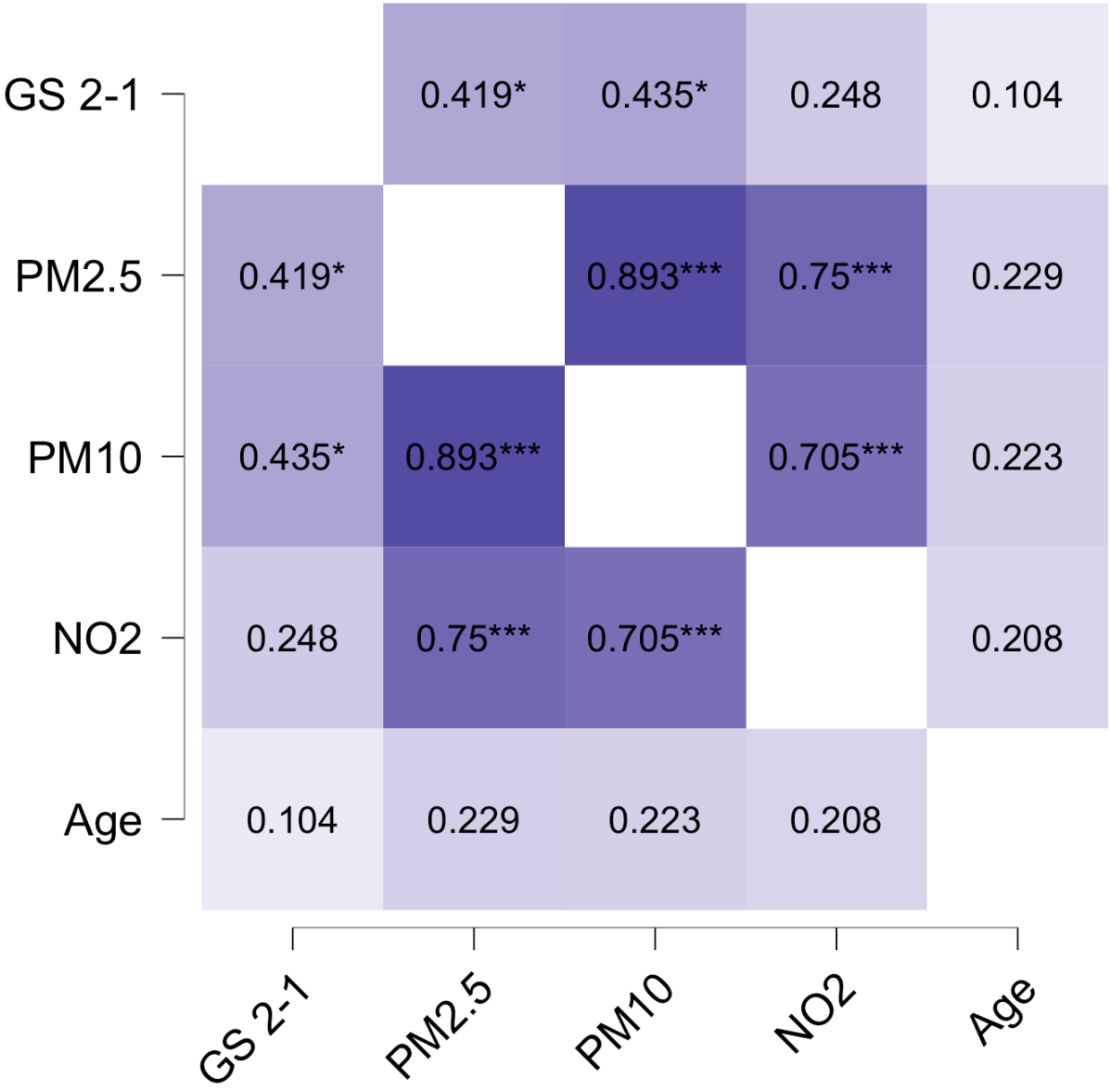

Figure 1. Possible correlations between Gensini score progression (GS2-1) and ambient air pollutants (PM2.5, PM10, N02) and age in diabetic patients

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