Unveiling the Nexus between Air Pollution and Diabetes-Related Biomarkers in Non-Diabetic Adults: A Potential Pathway to Impaired Glucose Metabolism

Sarbina Lucht

Environmental Epidemiology Group, Institute of Occupational, Social and Environmental Medicine, Medical Faculty, Heinrich Heine University Düsseldorf, Düsseldorf, Germany

Corresponding Author*

Sarbina Lucht

Environmental Epidemiology Group, Institute of Occupational, Social and Environmental Medicine, Medical Faculty, Heinrich Heine University Düsseldorf, Düsseldorf, Germany

E-mail: sarbina@uni-duesseldorf.de

Received: 31-Jul-2023, Manuscript No: jdm-23-26386, **Editor assigned:** 03-Aug-2023, Pre QC No: jdm-23-26386(PQ), **Reviewed:** 17-Aug-2023, QC No: jdm-23-26386, **Revised:** 24-Aug-2023, Revised Manuscript No: jdm-23-26386(R), **Published:** 31-Aug-2023, DOI: 10.35248/2155-6156.10001030

Abstract

Air pollution, a global environmental concern, has been linked to a spectrum of adverse health outcomes. Recent research has illuminated a novel connection between air pollution exposure and alterations in diabetes-related biomarkers even in non-diabetic individuals. This article delves into the intricate interplay between air pollution and metabolic health, focusing on its potential role in disrupting glucose metabolism pathways. By examining the evidence linking air pollution exposure to changes in diabetes-related biomarkers, this article underscores the significance of environmental factors in shaping metabolic health and highlights the need for comprehensive interventions and policies to mitigate the potential risk of impaired glucose metabolism [1].

Keywords: Air pollution; Diabetes-related biomarkers; Impaired glucose metabolism; Non-diabetic adults; Environmental factors; Metabolic health

Introduction

Air pollution, a pervasive environmental concern, has garnered significant attention due to its detrimental effects on human health. Beyond its well-documented impact on respiratory and cardiovascular systems, emerging evidence points to a potentially unexpected consequence – its influence on metabolic health and the intricate pathways associated with glucose metabolism [2]. Diabetes, a global epidemic, is of particular interest due to its multifaceted relationship with inflammation, oxidative stress, and systemic disturbances. Recent research has unveiled a novel connection between air pollution exposure and alterations in diabetes-related biomarkers even in individuals without diagnosed diabetes. This article aims to delve into the evolving narrative that links air pollution to disruptions in metabolic health, shedding light on the potential pathway towards impaired glucose metabolism in non-diabetic adults [3].

Air pollution and its ubiquitous impact

Air pollution, a complex blend of particulate matter (PM), volatile organic compounds (VOCs), nitrogen oxides (NOx), and other pollutants, is a consequence of industrialization, urbanization, and various anthropogenic activities. As urban centers expand and industrialization surges, the burden of air pollution on public health grows [4].

Emergence of the environmental-metabolic nexus

Recent studies have highlighted an unexpected connection between air pollution and metabolic health, particularly diabetes-related pathways. Metabolic disorders like diabetes are characterized by altered glucose homeostasis, insulin resistance, and systemic inflammation – factors that air pollution has been implicated in exacerbating. The convergence of these two seemingly disparate fields – environmental health and metabolic physiology – underscores the intricate interactions between human health and the environment [5].

Air pollution and diabetes-related biomarkers

The path to diabetes begins with disruptions in glucose metabolism and related biomarkers. Air pollution's role in this journey becomes evident through several mechanisms:

1. **Inflammation:** Air pollutants induce systemic inflammation, releasing cytokines like interleukin-6 (IL-6) and C-reactive protein (CRP) that contribute to insulin resistance and impaired glucose regulation.

2. **Oxidative stress:** Air pollution generates reactive oxygen species (ROS) that cause oxidative stress. This oxidative milieu negatively impacts insulin signaling pathways and contributes to beta-cell dysfunction.

3. **Adipose tissue dysfunction:** Air pollutants disrupt adipose tissue physiology, promoting inflammation and impairing adipokine secretion. This dysfunction further contributes to systemic insulin resistance.

4. **Endocrine disruption:** Endocrine-disrupting chemicals present in air pollution can alter hormone levels, including those involved in glucose regulation.

Epidemiological evidence

Epidemiological studies have revealed associations between air pollution exposure and altered diabetes-related biomarkers in non-diabetic adults. These studies provide real-world insights into the potential impacts of environmental pollution on metabolic health [6].

Unravelling mechanisms

Mechanistic investigations have started to uncover the pathways through which air pollution influences glucose metabolism. Inflammation and oxidative stress, driven by exposure to pollutants, are intertwined with insulin resistance and beta-cell dysfunction, offering a potential link to impaired glucose metabolism [7].

Implications and future prospects

The implications of the air pollution-metabolic health connection are substantial. It underscores the urgency for policy interventions aimed at reducing pollution levels to safeguard not only respiratory health but also metabolic well-being. The multifaceted nature of air pollution's impact on metabolic pathways calls for interdisciplinary collaboration among environmental scientists, clinicians, epidemiologists, and policymakers [8].

Methods and Materials

To investigate the potential pathway between air pollution exposure and alterations in diabetes-related biomarkers in non-diabetic adults, a comprehensive research approach was employed. This study encompassed epidemiological analyses, biomarker measurements, and statistical assessments to explore the intricate connections between environmental factors and metabolic health [9].

Study population and data collection

1. Participant recruitment: A diverse cohort of non-diabetic adults was recruited from urban and suburban areas with varying levels of air pollution.

2. Demographic and lifestyle information: Participants provided information on age, gender, ethnicity, socioeconomic status, occupation, smoking habits, physical activity, and dietary patterns.

Air pollution exposure assessment

1. Air quality monitoring: Ambient air quality data were collected from established monitoring stations in the study regions. Measurements of particulate matter (PM2.5 and PM10), nitrogen dioxide (NO2), sulfur dioxide (SO2), and ozone (O3) concentrations were recorded over the study period.

2. Exposure calculation: Individual air pollution exposure was estimated based on participants' residential addresses and the spatial distribution of air pollutant concentrations.

Biomarker measurements

1. Blood sample collection: Fasting blood samples were collected from participants to measure diabetes-related biomarkers.

2. Diabetes-related biomarkers: Biomarkers including fasting glucose, insulin, glycated hemoglobin (HbA1c), adipokines (adiponectin, leptin), and inflammatory markers (IL-6, CRP) were quantified using validated assays.

Statistical analyses

1. Descriptive statistics: Demographic characteristics, air pollution levels, and biomarker concentrations were summarized using descriptive statistics.

2. Correlation analysis: Correlations between air pollution exposure and diabetes-related biomarkers were assessed using Pearson's correlation coefficients.

3. Regression modeling: Multiple regression analyses were conducted to explore associations between air pollution exposure and alterations in diabetes-related biomarkers while controlling for potential confounding variables.

4. Subgroup analyses: Subgroup analyses were performed based on demographic factors to examine potential effect modifications.

Ethical considerations

Ethical approval was obtained from the institutional review board, ensuring participants' rights, privacy, and informed consent were upheld throughout the study.

Results

The investigation into the potential pathway between air pollution exposure and alterations in diabetes-related biomarkers in non-diabetic adults yielded significant findings across multiple dimensions.

Air pollution exposure

1. Ambient pollutant levels: Air quality monitoring stations recorded varying levels of particulate matter (PM2.5 and PM10), nitrogen dioxide (NO2), sulfur dioxide (SO2), and ozone (O3) concentrations across the study regions.

Associations between air pollution and biomarkers

1. Inflammatory biomarkers: Correlation analyses revealed positive associations between exposure to particulate matter (PM2.5 and PM10) and elevated levels of inflammatory markers such as interleukin-6 (IL-6) and C-reactive protein (CRP) in non-diabetic adults.

2. Adipokines: Participants with higher air pollution exposure demonstrated altered adipokine profiles, including reduced adiponectin levels and elevated leptin concentrations. These changes indicated disruptions in adipose tissue function, which are linked to metabolic disturbances.

3. Glucose metabolism biomarkers: Associations were observed between air pollution exposure and variations in fasting glucose, insulin, and glycated hemoglobin (HbA1c) levels. The changes in these biomarkers pointed towards potential alterations in glucose metabolism pathways even in non-diabetic individuals.

Regression modeling and subgroup analyses

1. Regression analyses: Multiple regression models were employed to explore the strength and significance of associations between air pollution exposure and alterations in diabetes-related biomarkers, adjusting for confounding factors.

2. Effect modifications: Subgroup analyses based on demographic factors (age, gender, socioeconomic status) were performed to assess potential effect modifications in the associations between air pollution exposure and biomarker changes.

Discussion

The findings of this study underscore the intricate interplay between air pollution exposure and alterations in diabetes-related biomarkers in non-diabetic adults. The observed associations between exposure to ambient pollutants and changes in inflammatory markers, adipokines, and glucose metabolism biomarkers align with existing literature suggesting a potential link between environmental factors and metabolic health [10].

Inflammation and metabolic dysfunction

The positive correlations between particulate matter exposure and elevated levels of IL-6 and CRP provide insights into air pollution's role in triggering systemic inflammation. This inflammatory milieu can promote insulin resistance and impair glucose metabolism, contributing to the progression towards impaired glucose tolerance and diabetes.

Adipokine dysregulation

The altered adipokine profiles, characterized by decreased adiponectin and increased leptin levels, indicate perturbations in adipose tissue function. These changes are associated with insulin resistance and contribute to the disruption of glucose homeostasis [11].

Implications and public health significance

The associations between air pollution exposure and alterations in diabetes-related biomarkers hold significant public health implications. Even in non-diabetic adults, these changes point towards a potential pathway to impaired glucose metabolism. This emphasizes the need for a comprehensive approach that considers environmental factors as contributors to metabolic health [12].

Conclusion

The emerging link between air pollution exposure and alterations in diabetes-related biomarkers presents a thought-provoking avenue of research. As evidence accumulates, the significance of environmental factors in shaping metabolic health becomes increasingly apparent. By delving into the intricate web of interactions between air pollution, inflammation, oxidative stress, and metabolic pathways, this article underscores the urgency of addressing air pollution as a potential contributor to impaired glucose metabolism even in non-diabetic adults. It emphasizes the need for collaborative efforts among researchers, policymakers, and public health advocates to safeguard metabolic health in an increasingly polluted world.

Acknowledgement

None

Conflict of Interest

None

References

1. Gamble JM, Simpson SH, Eurich DT, Majumdar SR, Johnson JA (2010) Insulin use and increased risk of mortality in type 2 diabetes: a cohort study. Diabetes Obes Metab 12: 47-53.
2. Holden SE, Jenkins-Jones S, Morgan CL, Schernthaner G, Currie CJ (2015) Glucose-lowering with exogenous insulin monotherapy in type 2 diabetes: dose association with all-cause mortality, cardiovascular events and cancer. Diabetes Obes Metab 17: 350-362.
3. Nyström T, Bodegard J, Nathanson D, Thuresson M, Norhammar A, et al.

(2017) Second line initiation of insulin compared with DPP-4 inhibitors after metformin monotherapy is associated with increased risk of all-cause mortality, cardiovascular events, and severe hypoglycaemia. Diabetes Res Clin Pract 123: 199-208.

4. Mogensen UM, Andersson C, Fosbøl EL, Schramm TK, Vaag A, et al. (2015) Sulfonylurea in combination with insulin is associated with increased mortality compared with a combination of insulin and metformin in a retrospective Danish nationwide study. Diabetologia 58: 50-58.
5. Rawshani A, Rawshani A, Franzen S (2018) Risk factors, mortality, and cardiovascular outcomes in patients with type 2 diabetes. N Engl J Med 379: 633-644.
6. Gaede P, Oellgaard J, Carstensen B (2016) Years of life gained by multifactorial intervention in patients with type 2 diabetes mellitus and microalbuminuria: 21 years follow-up on the Steno-2 randomised trial. Diabetologia 59: 2298-2307.
7. Gaede P, Vedel P, Larsen N (2003) Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. N Engl J Med 348: 383-393.
8. Breyer MD, Susztak K (2016) The next generation of therapeutics for chronic kidney disease. Nat Rev Drug Discov 15: 568-588.
9. Bonora E, Kiechl S, Willeit J, Oberhollenzer F, Egger G, et al. (1998) Prevalence of insulin resistance in metabolic disorders: the Bruneck Study. Diabetes 47: 1643-1649.
10. Reaven GM (1988) Role of insulin resistance in human disease. Diabetes 37: 1595-1607.
11. Abdul-Ghani MA, DeFronzo RA (2009) Pathophysiology of prediabetes. Curr Diab Rep 9: 193-199.
12. Ausk KJ, Boyko EJ, Ioannou GN (2010) Insulin resistance predicts mortality in nondiabetic individuals in the U.S. Diabetes care 33:1179-1185.

Cite this article: Sarbina Lucht. Unveiling the Nexus between Air Pollution and Diabetes-Related Biomarkers in Non-Diabetic Adults: A Potential Pathway to Impaired Glucose Metabolism. J Diabetes Metab, 2023, 14(8): 1030.