How to Cite:
Hussein, M. A., Farman, K. S., & Ismail, M. M. (2022). The effect of particulate pollution on patients with type 2 diabetes and insulin resistance. *International Journal of Health Sciences*, *6*(S4), 7853–7860. https://doi.org/10.53730/ijhs.v6nS4.10427

The effect of particulate pollution on patients with type 2 diabetes and insulin resistance

Mohammed Ali Hussein
Al Muqdad College of Education, University of Diyala, Diyala, Iraq
Corresponding author email: mohmedm@uodiyala.edu.iq

Khansaa Salman Farman
College of Education for Pure Science, University of Diyala, Diyala, Iraq

Muna Mohammed Ismail
College of Veterinary Medicine, University of Diyala, Diyala, Iraq

***Abstract*---**Diabetes mellitus is a metabolic disease characterized by high blood sugar levels for long periods. This disease is widely spread among the world population, and an increase in its incidence is currently observed, and this is mainly due to a sedentary lifestyle and an excessive caloric diet. In order to know the role of particulate air pollutants and their impact on type 2 diabetes, this study came as it included 90 people from Diyala Governorate / central Iraq (males only), their ages ranged between (24-60) years and they were distributed among 25 individuals with type 2 diabetes. 2 working in gas stations and 40 people working in gas stations also at risk of pollution and 25 people in a control group and for the period from January 2, 2021 to March 5, 2021 for the winter season, and for the period from July 15, 2021 to August 22 2021 for the summer, as the study was conducted in the winter and summer seasons. The results of the statistical analysis showed a significant difference $P<0.05$ in the values of PM1 in the summer compared to the winter season, and the results showed a significant increase in the values of PM2.5 in the summer than in the winter season, and also indicated that the data values of the summer season were higher than the winter season with respect to For PM7, the results showed a higher values of summer data than winter data for PM10, and also indicated that there was a rise in TSP values in the summer compared to the winter. The results of insulin were also higher in summer than in winter, and showed a higher level of morning glucose in summer than in winter, and a higher level of insulin resistance in summer than in winter. It is concluded from this change in the data that the effect of the season factor and the particulate matter on the health of the workers in the stations, as these substances affect in a negative and relative manner

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
Manuscript submitted: 9 March 2022, Manuscript revised: 18 May 2022, Accepted for publication: 27 June 2022

and according to the duration, percentage and intensity of the substance to which they are exposed.

***Keywords*---**type 2 diabetes mellitus, particulate matter, insulin.

Introduction

Diabetes mellitus is one of the major metabolic diseases of the twenty-first century and is a metabolic disorder characterized by elevated blood glucose in the context of insulin resistance and relative insulin deficiency. (DM) a major public health problem (1). According to WHO estimates, diabetes is the seventh leading cause of death in 2016 (2). One of the reasons for fluctuations in physiological and metabolic factors may be related to temperature, which has a prominent role in reducing insulin sensitivity and weakening beta cells, as increased exposure to air pollution can lead to increased insulin resistance and thus a higher incidence of diabetes and heart disease. Physicians should take into account the environmental exposure of patients when making examination and treatment decisions for them (3). Environmental pollution is able to affect the balance of multiple endocrine axes in humans, and this negative result occurs due to the effects of synthetic chemicals that are widespread on a large scale. The concern is due to the large and increasing burden of these compounds in the basic environmental components (air, water, soil) and in the chain Food and daily used consumer goods include diseases that increase the incidence of infection and direct and indirect high health costs resulting from exposure to endocrine-disrupting chemicals worldwide (4). Exposure to air pollution can affect human health in many different ways potentially leading to a significant risk of morbidity and mortality as air pollution has become the largest environmental risk factor for a variety of chronic diseases (5) .

Aim of the study

1. Studying the effect of exposure to a number of pollutants, including particulates (PM1, PM2.5, PM7, PM10 TSP) and their relationship to insulin resistance and secondary clinical infections during the winter and summer seasons.
2. Studying and determining the relationship between temperature and some vital indicators (age, body mass index, fasting blood sugar, insulin hormone, and insulin resistance) .

Materials and working methods

The study was conducted on 90 people (males only) and for two different seasons, winter and summer, they were subjected to the same physiological tests and the same environmental tests at their place of work. The totals were divided into three groups: The first group: the group of 40 people exposed to the risk of pollutants (males only), The second group: the group of patients with diabetes, numbering 25 patients (males only), the third group: the healthy group, numbering 25 patients (males only). Samples were collected from three fuel stations in Diyala governorate, inside Baquba city, which are (Oil Depot , Ashnouna Fuel Station

,Old Baquba Fuel Station) for the period from (2/January/2021) to (5/March/ 2021) for the winter season and for the period from (15 / July / 2021) until (22 / August / 2021) for the summer season .

Sample collection

5 ml of venous blood was withdrawn from the three groups (diabetes patients, exposed to pollutants, and healthy subjects), then the blood was placed in clean, dry Gel tubes and left at a temperature of 37 °C for 30 minutes, then the blood serum was separated by centrifugation (3000 cycles/min) for 10 minutes. 10 minutes and then store the blood serum to measure the hormone insulin.

Fasting Blood Glucose (FBG) test

The fasting blood sugar was measured for each person in the study by the enzymatic colorimetric method and using the German-made test kit from Accue check company. The value of insulin resistance was estimated by the following equation:
HOMA-IR = (Glucose mg/dl× Insulin µlU/ml) /405

Insulin of Hormone test

This test depends on the principle of enzyme-linked immunosorbent absorption (ELISA) and by (solid phase sandwich) method, where the holes are covered with monoclonal antibody and unite with the site of the single antigen present on the surface of the insulin molecule.

Statistical Analysis

The statistical program SPSS version 20 was used to analyze the data to study the effect of different factors on the studied traits, and the significant differences between the means were compared with the least significant difference (LSD) test, and the chi-square test (2x) was used to compare the significant differences between the studied proportions.

Discussion and Results

The relationship between diabetes and its relationship to exposure to air pollution has been studied, which includes the emission of smoke from cars, factory smoke and other types of fine particles, which are believed to have an important role in raising the incidence of type 2 diabetes, as continuous exposure contributes to several types of exposure to a number of particulates, including (PM1, PM2.5, PM7, PM10, TSP) .

Table (1-1) Explain the values of the study

Diabetic Patients Mean ± SD	exposed to pollutants Number Mean ± SD	Control Number Mean ± SD	Variable
25	40	25	Number (male)
12	12	-	Number of hours of daily exposure (hour)
5.283± 48.800 *	8.259± 43.075 *	5.303± 31.280 *	Age (year)
20.416±6.822	15.901±7.983	-	Number of years of service

Table (2-1) Explain the values of the study in winter

3.949± 18.531 *	5.134± 14.917 *	1.771± 7.790 *	Insulin hormone
209.720 * 57.039±	17.995± 116.825	8.740± 102.680	Fasting blood glucose (mg/dL)
3.259± 9.572*	1.822± 4.371*	0.470± 1.974*	Insulin resistance (IR)

SD: standard deviation , P < 0.05

Table (3-1) Explain the values of the study in summer

3.157±19.746*	3.344±16.038*	1.920±8.869*	Insulin hormone
69.143±242.000*	38.602±129.850*	6.082±99.600*	Fasting blood glucose (mg/dL)
3.571±11.722*	2.373±5.216*	0.554±2.194*	Insulin resistance (IR)

SD: standard deviation , P < 0.05

Table (1-1) indicates that there is a significant difference in the service period rates (exposure duration) among patients with type 2 diabetes working in gas stations compared to workers at gas stations exposed to pollutants, as it reached (6.822 ± 20.416, 7.983 ± 15.901) years, respectively. With a probability level of P<0.05. A study (6), which emphasized the harmful effects of exposure to ambient air pollutants on diabetic patients, indicated that diabetic patients may be more likely to be exposed to air pollutant complications. Table (2-1) indicates that there are significant differences between insulin hormone levels among patients with type 2 diabetes and workers in gas stations exposed to pollutants compared to the control group in the winter season, which amounted to (18,531 ± 3.949, 14.917 ± 5.134, 7.790 ± 1.771) µIU/ ml, respectively, with a probability level of P<0.05, and the same was the case for the summer season, as significant differences were found between the levels of the insulin hormone among patients with type 2 diabetes and workers exposed to pollutants at gas stations compared to the control group as shown in Table (3-1), which amounted to (19.746 ± 3.157, 16.038 ± 3.344, 8.869 ± 1.920) µIU/Ml, respectively, with probability level P < 0.05. A study (7), which indicated that there is an association between air pollution and the risk of diabetes, including insulin resistance (IR), lipid

accumulation and impaired glucose metabolism, as well as exposure to particulate matter PM2.5 led to hepatic insulin resistance, non-alcoholic steatohepatitis and impaired metabolism. Hepatic glucose. Emerging evidence supports that exposure to surrounding microparticles (PM2.5) is associated with insulin resistance (IR) and fat accumulation in the liver. Table (2 -1) indicates that there are significant differences between fasting blood sugar levels among patients with type 2 diabetes compared with the group of workers at gas stations and the control group, and there were no differences between workers at gas stations exposed to pollutants compared to the control group in the winter season. 209.720 ± 57.039, 116.825 ± 17.995, 102.680 ± 8.740) mg/dL, respectively, with probability level P<0.05. And in the summer table (3-1) show significant differences were found between fasting blood sugar levels among patients with type 2 diabetes and workers exposed to pollutants in gas stations compared to the control group, which amounted to (242,000 ± 69.143, 129.850 ± 38.602, 99.600 ± 6.082) mg/dL, respectively, with a probability level P< 0.05 . Monitoring of metabolic indicators such as fasting glucose, blood pressure, body weight, blood lipids, and Hba1c is essential in the clinical control of patients with diabetes because high blood pressure, obesity and dyslipidemia are known risk factors for atherosclerosis and are common in diabetic patients as well (8). The pancreas, vascular system, brain, liver, intestine, fat, muscle, organs, and other tissues influence fasting blood glucose levels through insulin resistance or impaired insulin signaling (9). Also, abnormal FBG levels were an important factor in impaired lipid metabolism caused by air pollution. The risk of air pollution on dyslipidemia was stronger through higher FBG concentration and the modulating effects of FBG were more pronounced among males and persons under 65 years of age. And those who suffer from overweight and obesity (10). Table (2-1) indicates that there are significant differences between the levels of insulin resistance among patients with type 2 diabetes and workers in gas stations exposed to pollutants compared to the control group in the winter season, which amounted to (9.572 ± 3.259, 4.371 ± 1.822, 1.974 ± 0.470), respectively. With a probability level of P<0.05, there are also significant differences between the levels of insulin resistance among patients with type 2 diabetes and workers exposed to pollutants in gas stations compared to the control group table (3-1) which amounted to (11.722 ± 3.571, 5.216 ± 2.373, 2.194 ± 0.554), respectively. (11) refers to the important role of insulin resistance and obesity in the pathogenesis of type 2 diabetes and its role in the pathophysiology of this disease, as the greater the individual's insulin resistance, the greater the insulin secretion to prevent the development of type 2 diabetes. Increases an individual's risk of developing high blood pressure and dyslipidemia, which is characterized by high plasma triglycerides (TG) and low cholesterol concentrations.Insulin resistance has been defined as a disorder in which a combination of genetic factors, inactivity, diet and obesity lead to a range of metabolic dysregulation, causing conditions including diabetes, high blood pressure, malignant tumors, atherosclerosis and dyslipidemia (12) .

Table (1-1) indicates that there are significant differences between the age levels of patients with type 2 diabetes and workers in gas stations exposed to pollutants compared to the control group in the winter season, which amounted to (48.800 ±5.283, 43.075 ±8.259, 31.280 ±5.303) years, respectively. With a probability level of P<0.05, and for the summer season, significant differences were also found

between the levels of the age factor among patients with type 2 diabetes and workers exposed to pollutants in gas stations compared to the control group, which amounted to (49.3200 ± 5.193, 43.5250 ± 10.407, 31.5600 ± 5.378) years, respectively. . A study (13) which confirmed the increase in the prevalence of metabolic syndrome (Mets) with age, as well as an increase in the prevalence of diabetes, as metabolic syndrome (Mets) was associated with an increased risk of developing type 2 diabetes and cardiovascular disease (CVD), which is manifested MetS-related cardiovascular disease risk across a broad spectrum of glycemic disorders that results in an increase in overall CVD mortality in people with MetS.

Table (4) It shows the study values of microparticles for the winter and summer seasons

Particles	Summer Mean±SD	Winter Mean±SD
PM1	0.003 ±0.002	0.002 ±0.002
PM2.5	0.040 ±0.027	0.011 ±0.007
PM7	0.140 ±0.089	0.120 ±0.105
PM10	0.230 ±0.137	0.170 ±0.115
TSP	0.339 ±0.204	0.249 ±0.159

Measuring particulate matter inside gas stations

A group of important particulate matter was measured, including (PM1, PM2.5, PM7, PM10, TSP) in table (4-1) which are believed to have a role in contributing to many diseases, especially diabetes. Aerodynamic ≤ 10 μm (PM10) or 2.5 μm (PM2.5) as a measure is supported by health studies that show strong associations between ambient particulate mass concentrations and a wide range of adverse health effects according to the World Health Organization. Particulate matter is just as important in causing these health effects as the particulates associated with combustion are believed to be more harmful to health than the particulates not generated by (14). PM2.5 needs accurate and sensitive devices to detect it due to its small size, as it is one of the most widely studied air pollutants due to its association with increased risks of cardiovascular disease, lung disease, kidney disease and other non-communicable diseases, as well as the risk of diabetes. When their levels rise, these particles form a mist in the atmosphere and enter the human respiratory system and enter his lungs (15). PM10 particles are called aerosols, or suspended particles with a diameter of less than 10 μm. They are solid or liquid particles that are suspended in the air. These particles are often called thoracic particles. Particulate matter (PM) pollution is closely associated with haze and adverse health effects. Furthermore, there is increasing evidence of the effects of particulate matter with aerodynamic diameters less than 10 and 2.5 micrometers (PM10 and PM2.5) on cardiovascular disease (CVD) and respiratory disease (16).

References

1. ALKhalidy, N. T. T., AL-Samarraie, A. K. Y., & Rajeb, T. M. A. (2017). Visfatin Level and its Relation with Obesity and Insulin Resistance In Iraqi Type 2

Diabetes Mellitus Patients. IRAQI JOURNALOF COMMUNITY MEDICINE, 30(1).
2. Andrade, E. F., de Oliveira Silva, V., Orlando, D. R., & Pereira, L. J. (2019). Mechanisms involved in glycemic control promoted by exercise in diabetics. Current diabetes reviews, 15(2), 105-110.
3. Bowe, B., Xie, Y., Li, T., Yan, Y., Xian, H., & Al-Aly, Z. (2017). Associations of ambient coarse particulate matter, nitrogen dioxide, and carbon monoxide with the risk of kidney disease: a cohort study. The Lancet Planetary Health, 1(7), e267-e276.
4. Dang, J., Yang, M., Zhang, X., Ruan, H., Qin, G., Fu, J., ... & Moore, J. (2018). Associations of exposure to air pollution with insulin resistance: a systematic review and meta-analysis. *International journal of environmental research and public health*, *15*(11), 2593.
5. Di Ciaula, A., & Portincasa, P. (2021). The role of environmental pollution in endocrine diseases. Endocrinology and systemic diseases, 435-465.
6. Health Effects Institute(HEI) . Panel on the Health Effects of Traffic-Related Air Pollution. (2010). Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects.
7. Herman, H., Ardani, I. G. A. I., Aryani, L. N. A., Windiani, I. G. A. T., Adnyana, I. G. N. S., & Setiawati, Y. (2022). Signs and symptoms of depression in children and adolescents with type 1 diabetes mellitus: A case report. *International Journal of Health & Medical Sciences*, *5*(1), 150-153. https://doi.org/10.21744/ijhms.v5n1.1861
8. Kawada, T., Otsuka, T., Endo, T., & Kon, Y. (2011). Prevalence of the metabolic syndrome and its relationship with diabetes mellitus by aging. *The aging male*, *14*(3), 203-206.
9. Kloog, I., Nordio, F., Zanobetti, A., Coull, B. A., Koutrakis, P., & Schwartz, J. D. (2014). Short term effects of particle exposure on hospital admissions in the Mid-Atlantic states: a population estimate. PloS one, 9(2), e88578
10. Rusdiana, M. S., & Amelia, R. (2018). The effect of diabetes self-management education on Hba1c level and fasting blood sugar in type 2 diabetes mellitus patients in primary health care in Binjai City of North Sumatera, Indonesia. *Open access Macedonian journal of medical sciences*, *6*(4), 715.
11. Sailani, M. R., Metwally, A. A., Zhou, W., Rose, S. M. S. F., Ahadi, S., Contrepois, K., ... & Snyder, M. P. (2020). Deep longitudinal multiomics profiling reveals two biological seasonal patterns in California. *Nature communications*, *11*(1), 1-12.
12. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. *International Journal of Health Sciences*, *5*(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864
13. World Health Organization . (2019) . WHO global ambient air quality database (update 2018). World Health Organization: Geneva, Switzerland.
14. World Health Organization. (2018). WHO global ambient air quality database (update 2018). World Health Organization: Geneva, Switzerland.
15. Xu, M. X., Ge, C. X., Qin, Y. T., Gu, T. T., Lou, D. S., Li, Q., ... & Tan, J. (2019a). Prolonged PM2. 5 exposure elevates risk of oxidative stress-driven nonalcoholic fatty liver disease by triggering increase of dyslipidemia. Free Radical Biology and Medicine, 130, 542-556.
16. Yan, L., Pang, Y., Wang, Z., Luo, H., Han, Y., Ma, S., ... & Zhang, R. (2022). Abnormal fasting blood glucose enhances the risk of long-term exposure to

air pollution on dyslipidemia: A cross-sectional study. *Ecotoxicology and Environmental Safety*, *237*, 113537.
17. Zhang, N., Wang, L., Zhang, M., & Nazroo, J. (2019a). Air quality and obesity at older ages in China: The role of duration, severity and pollutants. *PloS one*, *14*(12), e0226279.
18. Zhang, Q., Zhao, G., Yang, N., & Zhang, L. (2019b). Fasting blood glucose levels in patients with different types of diseases. *Progress in molecular biology and translational science*, *162*, 277-292.