Sarcouncil Journal of Medical Series

ISSN(Online): 2945-3550

Volume- 03| Issue- 08| 2024

Research Article **Received:** 21-06-2024 | **Accepted:** 22-07-2024 | **Published:** 05-08-2024

Cellular and Molecular Pathophysiology of Diabetes Mellitus

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Abstract: This study evaluated the results of Cellular and Molecular Pathophysiology of Diabetes Mellitus among 90 diabetic patients aged 20-50 years from various Iraqi hospitals. The study presents a diabetes patient evaluation system that includes various units for collecting patient information, constructing regression models, processing data, calculating coefficients, assessing risk levels, and preparing for follow-ups. The system aims to identify risk factors contributing to complications and assign scores based on their magnitude. The system also incorporates diabetes test reports, which include Level I Level 4 comprehensive diagnostic reports, and a five-level dynamic report, which provides a comprehensive overview of diabetes progression and treatment effects. The study found that diabetes prevalence among individuals over 31 years is 40 (44.4%), with males having a higher incidence (55.5%). Obesity and weight gain increase the prevalence. The pathogenesis of type 2 diabetes mellitus is essentially characterized by the paucity of insulin, which is also associated with the resistance of this hormone to action. This resistance has also been linked to the presence of certain plasmatic inflammatory cytokines and high cell levels of fat, which leads to increased lipid breakdown rather than glucose transport.

Keywords: Molecular, Pathophysiology, Patients, HbA1C, BMI, Type 2 diabetes, Hypoglycemia.

INTRODUCTION

Diabetes is a chronic metabolic disease. In recent years, with the improvement of living standards, the incidence of type 2 diabetes has increased rapidly in my country. There is a trend for type 2 diabetes to appear at a younger age, which represents a serious threat to the public health of the people of our country [Banday, M. *et al*., 2020]. Diabetes can lead to very serious complications, such as cardiovascular disease. Therefore, studying the causes of diabetes and finding effective treatments has become an urgent scientific issue that needs to be solved [Galicia-Garcia, U. *et al*., 2020].

One of the principal pathophysiological mechanisms of type 2 diabetes is insulin resistance. Insulin is the principal hormone that regulates blood sugar levels in the body, and PI3K (phosphatidylinositol 3-kinase) is the most significant molecule in regulating the insulin-mediated signaling pathway. PI3K consists of the catalytic subunit p110 and the regulatory subunit p85 and plays a pivotal role in regulating cell metabolism [Kyrou, I. *et al*., 2020].

The above studies reveal for the first time the regulatory function of PAQR3 on the insulin signaling pathway and suggest that changes in the expression of PAQR3 are a potential mechanism leading to type 2 diabetes. The research results were published online on 18 October in Diabetes, a journal trusted internationally for its contributions to the field of diabetes research.

In normal individuals, the hormone insulin, produced by beta cells in the pancreas, regulates blood glucose levels. In the event of an excess of glucose in the blood, insulin stimulates cells to absorb an adequate quantity of glucose from the bloodstream in order to obtain the energy they require. In this instance, the immune system initiates an attack and ultimately destroys the insulin-producing beta cells within the pancreas [Bailey, C.J. *et al*., 2019]. This results in a complete deficiency of insulin. Consequently, the presence of antibodies to insulin or islet cells within the bloodstream is indicative of an autoimmune disease. This, in turn, leads to lymphocyte infiltration and islet destruction. The destruction of the islets may take time, but the onset of the disease is rapid, occurring within days or weeks [Li, G. *et al*., 2020].

Over time, repeated episodes of hypoglycemia can result in loss of consciousness due to hypoglycemia. [Kaneto, H] The body and brain no longer manifest the signs and symptoms of low blood sugar, such as tremors or an irregular

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DOI- https://doi.org/ 10.5281/zenodo.13225219

heartbeat. In such instances, the risk of developing severe, life-threatening hypoglycemia is heightened. Severe hypoglycemia is a medical emergency that requires immediate attention. It can result in the onset of seizures and cerebral damage [Zhang, X. *et al*., 2010].

A severe reduction in blood sugar levels that results in loss of consciousness is referred to as insulin shock. [Kaneto, H. *et al*., 2002]

[Brooks-Worrell, B. *et al*., 2011] The metabolic processes of individuals with diabetes are distinct from those of individuals without diabetes. In individuals with type 2 diabetes, insulin becomes less effective, whereas in those with type 1 diabetes, insulin levels in the body are markedly reduced.

There is a robust correlation between BMI and body fat. One factor associated with insulin resistance is blood fatty acid (FA) levels. Fatty acid levels are a robust indicator of muscle insulin resistance. In individuals with obesity, particularly those with type 2 diabetes, there is an increase in the content of adipose tissue within skeletal muscle. Electron microscopy has revealed a reduction in mitochondrial volume in the muscles of patients with type 2 diabetes [Brooks-Worrell, B.M. *et al*., 2011; Wilkin, T.J, 2001].

MATERIAL AND METHOD

Collection Data

Data were collected from several different hospitals in Iraq. In this study, 90 diabetic patients were collected and were distributed to several different ages, from 20 years to 50 years. This study was designed to evaluate the results of Cellular and Molecular Pathophysiology of Diabetes Mellitus.

Study Design

The study reveals a diabetes patient evaluation system, which includes a patient information collection unit, a regression model construction unit, a data processing unit, a regression coefficient calculation unit, a risk level assessment unit, and a follow-up preparation unit through logistic regression analysis. The invention is to find the risk factors that Contribute to the occurrence of complications for the patient and assign corresponding scores according to their magnitude. Through the accumulation of risk factors, the patient's symptoms are recorded objectively, and the risk of complications is judged based on the accumulation of scores.

The primary purposes of diabetes test reports are as follows: (1) Level I Test Report: This is the form typically employed in laboratory settings for the reporting of test results. (2) Third-level subdiagnostic report: Based on examinations related to glucose metabolism, the abnormal state of glucose metabolism is determined. (3) Level 4 comprehensive diagnostic report: analysis of the patient's glucose metabolism status based on the results of glucose metabolism tests, analysis of the cause and pathogenesis of diabetes based on pancreatic beta cell function, and diabetes-related autoimmune antibody test results. In addition to the aforementioned diagnostic report content, it can also include testing for complications caused by hyperglycaemia, such as blood and kidney function associated with diabetic nephropathy, urine albumin/creatinine test, and so forth. (4) Five-level dynamic report: A dynamic report combines the patient's previous blood sugar levels with glycated hemoglobin levels in order to provide a comprehensive overview of the progression of diabetes and to evaluate the effects of treatment.

Aim of study

A cross-sectional study in Iraq aimed to evaluate the results of the Cellular and Molecular Pathophysiology of Diabetes Mellitus.

RESULTS

Table 1: General characteristics of the Iraqi patient respondents in this study

Parameter	Value
Age	
20-29	20 (22.2)
30-39	30 (33.3)
>40	40 (44.4)
BMI	
24-27	50 (55.5)

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28-31	20 (22.2)
>31	20 (22.2)
Duration of TD	
1	40 (44.4)
2	30 (33.3)
3	15 (16.6)
4	5 (5.5)
Comorbidities	
1	66 (73.3)
2	14 (15.5)
3	10 (11.1)
Education	
Primary	11 (12.2)
Secondary	39 (43.3)
College	30 (33.3)
High	10 (11.1)
Insulin resistance	
Yes	60 (66.6)
No	30 (33.4)
Smoking	
Yes	30 (33.4)
No	60 (66.6)
Sex	
Male	50 (55.5)
Female	40 (44.4)
Insulin	
Yes	35 (38.8)
No	55 (61.1)

Table 2: Classification of patients according to the symptoms and causes prevalent in this study

Parameter	**F (%)**
symptoms	
Thirst	20 (22.2)
Urinating often	15 (16.6)
Very intense hunger	15 (16.6)
Low weight	10 (11.1)
Tired	15 (16.6)
Blurred vision.	15 (16.6)
Causes	
weight	30 (33.3)
Genetics	14 (15.5)
Hypertension	16 (17.7)
Hypercholesterolemia	30 (33.3)

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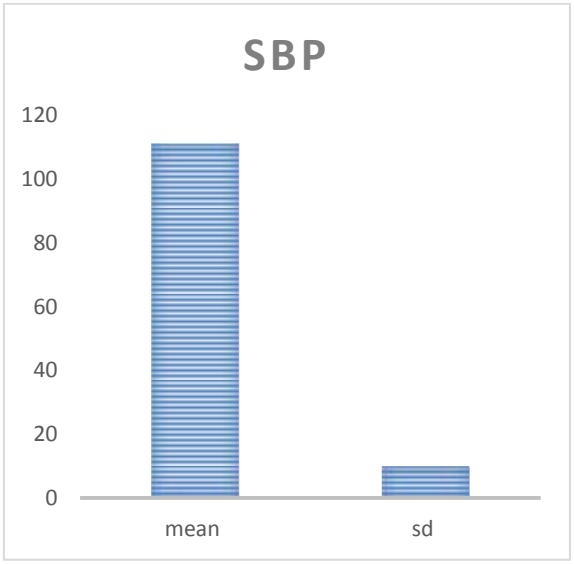

Figure 1: Evaluation of systolic blood pressure outcomes in diabetic patients

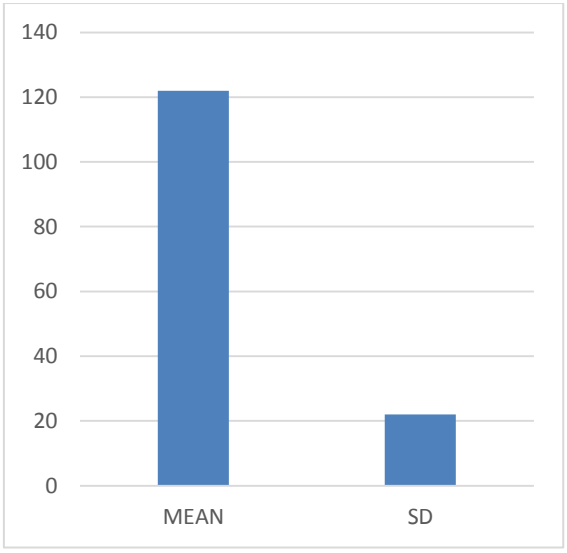

Figure 2: Evaluation of DBP outcomes in diabetic patients

Table 3: Evaluation of laboratory results extracted from diabetic patients

Parameter	Mean	Sd
HbA1C%	8.6	2.5
Albuminuria (mg/g)	166.6	20.9
BNP (pg/ml) median	110.8	30.9
Creatinine	1.1	3.8
CRP	1.8	1.2
WBC	10.1	1.8
Hematocrit g/dl	40.2	4.2
Platelet count 103/mm^3	266.6	77.9
MPV	9.1	1.1
Percentage of nitrophils	68.8	8.6
NLR	5.2	3.2
RDW	15.1	1.5

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Table 4: Final outcomes according to Total cholesterol, HDL, LDL, Triglyceride, urea

PARAMETER	Mean	Sd
Cholesterol MMOL/L	201.55	44.6
HDL MMOL/L	40.8	20.2
LDL MMOL/L	130.9	30.2
Triglyceride MMOL/L	200.9	123.54
UREA	40.9	15.5

Table 5: Classification of risk factors in this study on diabetic patients according to logistic regression

Parameter	CS (OI)	P VALUE
Cholesterol	2.9-4.21 (3.88)	<0.001
age	1.8-2.2 (2.0)	0.06
Obesity	1.99-3.11 (2.5)	0.67
HDL	3.8-5.3 (4.2)	<0.001
Triglyceride	2.88-4.1 (3.5)	<0.001
Sex	1.1-1.7 (1.4)	0.98
HbA1C%	3.4-5.9 (4.3)	<0.001

DISCUSSION

Diabetes is a group of metabolic diseases characterized by chronic hyperglycemia caused by multiple causes. It is caused by defects in insulin secretion and/or action [Donath, M.Y. *et al*., 2009]. Test results are an important basis for diagnosis, treatment and condition monitoring of diabetes. Correct analysis of test results is of great importance for disease diagnosis, differential diagnosis, pathological process judgement, and treatment effect evaluation. According to the underlying cause of diabetes, it can be classified into four main categories: [Mellbin, L.G. *et al*., 2012; Ghosh, P. *et al*., 2015] type 1 diabetes, type 2 diabetes, special types of diabetes, and gestational diabetes. There are a multitude of test items for each of these categories, reflecting the diverse pathological changes associated with them. The objective of this consensus is to facilitate the analysis of the pathological significance contained in the test report data, reduce the time required for reviewing the test report, and enhance the effectiveness of the test report in clinical practice. [Kodama, K. *et al*., 2012]

The prevalence of diabetes among individuals aged >31 years in this study were 40 (44.4%), with a higher incidence among males (55.5%) than females (44.4%). The prevalence of diabetes has increased among individuals who are obese and who have gained a significant amount of weight. The diagnosis of diabetes is based on the measurement of fasting venous plasma glucose (short-term fasting blood glucose), random venous plasma glucose (short-term fasting blood glucose), or 2-hour blood glucose and glycated hemoglobin after an oral glucose tolerance test (OGTT). Treatment is a comprehensive management plan based on a combination of lifestyle intervention and weight control, glycemic lowering, blood pressure lowering, lipid-lowering, and antiplatelet therapy.

[Moreno-Navarrete, J.M. *et al*., 2010] Type 2 diabetes is more prevalent in adults, typically manifesting after the age of 30. However, its onset is not uncommon in younger individuals, and the associated symptoms are often relatively mild. A significant proportion of patients do not present with any symptoms when seeking medical attention or undergoing physical examinations due to the chronic complications and related diseases that are often present. It is recommended that you undertake a diagnostic examination. A family history is often present [Willis, E.L. *et al*., 2011]. Diabetic ketoacidosis is a rare occurrence that may be precipitated by a number of factors, including stress, severe infection, or the interruption of treatment. Clinically, it often occurs simultaneously or successively with obesity, dyslipidemia, hypertension, and other diseases. The clinical symptoms and signs are indicative of severe metabolic disorders caused by hyperglycemia, where the typical symptoms are described as "three more and one less." Any polyuria, polydipsia, and unexplained weight loss accompanied by fatigue. Nevertheless, a considerable proportion of patients exhibit no specific symptoms and only discover hyperglycemia during physical or medical

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examinations due to the presence of other diseases. Once complications arise in some patients, they may experience symptoms such as blurred vision, itchy skin, and susceptibility to infection [Exner, M. *et al*., 2002].

This study revealed that glycated hemoglobin (HbA1c) is a crucial indicator for monitoring disease progression and assessing long-term blood sugar control. This information can inform the need for modifying the treatment plan. In medical institutions that adopt standardized testing methods and undergo strict quality control (US National Glycated Hemoglobin Standardization Program (NGSP), Glycated Hemoglobin Harmonization Research Program (CGSP)), HbA1c ≥ 6.5% can be used as a supplementary diagnostic criterion for diabetes. In the following conditions, such as sickle cell disease, pregnancy (2nd and 3rd trimester), glucose-6-phosphate dehydrogenase deficiency, AIDS, dialysis, recent blood loss or transfusion, and erythropoietin therapy, venous plasma glucose levels are used to diagnose diabetes where can result in elevated cholesterol levels and blood pressure, both of which increase the risk of cardiovascular disease. Furthermore, elevated blood sugar levels may damage the arterial walls, facilitating the accumulation of fat within them, thereby increasing the risk of myocardial infarction [Fujii, J. *et al*., 2005].

This study demonstrates the magnitude of the burden imposed by no communicable diseases and the risk factors involved. According to logistic regression to evaluate the risk factors, the factors that contributed most in this study were found to be cholesterol, age, obesity, HDL, triglycerides, and sex, where Obesity increases the risk of diabetes, high blood pressure, coronary heart disease, and stroke, some types of cancer, sleep apnea and osteoporosis. It also negatively affects reproductive performance. It has been estimated that overweight and obesity - defined as BMI ≤ 25 kg/m2 and ≤ 30 kg/m, respectively - account for 4.3 million deaths worldwide annually and 6.93 million deaths. Adjusted life years and Elevated blood pressure is associated with an increased risk of developing diabetes and other diseases. It is a significant contributor to premature mortality worldwide, with complications from high blood pressure responsible for 4.9 million deaths annually. Reports indicate that high blood pressure is a contributing factor in at least 45% of deaths. At the global level, 51% of deaths are attributed to stroke. According to 2015 statistics, high blood pressure affects one in four men and one in five women. These diseases represent a greater burden in low- and middle-income countries, where they account for two-thirds of cases. This is attributable to the high prevalence of risk factors in those countries.

CONCLUSION

Diabetes is a chronic disease that is caused by a number of risk factors and is characterised by severe complications that diminish the quality of life. However, various branches of scientific knowledge have assisted in forecasting, identifying, healing, and managing the distinct kinds of this ailment. The treatment choice is determined by the prognosis and diagnosis, as well as the pathophysiological mechanism. It is important to note that these drugs have varying side effects. Recent research has helped to determine the proper use and cocktail mix of these drugs.

Some of the most important features were intended; however, there are other features that should also be mentioned. Nitric oxide synthase is a critical element for endothelial function in insulin action. It is one such feature alongside regulatory hormones like amylin and glucagon, among others. Other examples include gestational diabetes, insulin gene transcription, insulin clearance, and insulin-related hypertension, which is often referred to as steroid-induced diabetes mellitus due to its cause being long-term use of glucocorticoids or pharmacological doses of cortisol and other central regulators besides leptin.

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Source of support: Nil;
Conflict of interest: Nil.

Cite this article as:
Hussein, A.J. and Noaman, B.M. "Cellular and Molecular Pathophysiology of Diabetes Mellitus." *Sarcouncil Journal of Medical Series* 3.8 (2024): pp 1-7.

Publisher: SARC Publisher