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Examining the relationship between risk factors-hypertension, body mass index (BMI), and smoking- and the development of type 2 diabetes mellitus

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Abstract
Diabetes, a disease related to metabolism, is characterized by the body's inability or ineffectiveness to create enough insulin to regulate blood glucose levels. Diabetes increases the probability of acquiring a number of long-term conditions, such as heart disease, lack of vision, amputation, kidney disease, and melancholy. There is a paucity of data on hypertension, (BMI), and smoking and their association with T2DM. This investigation aims to clarify the correlation between risk factors (including overweight, hypertension, smoking) and Type 2 diabetes. This study included one hundred participants, fifty of whom had type 2 diabetes and fifty of whom were healthy controls. Age and sex of the patients and controls were matched. The mean age of participant was 52.88. The female/ male ratio was (52/48= 1.08). In contrast to the control, the patients' mean systolic blood pressure was greater, with a significant difference in mean observed. Regarding of BMI, there was no discernible difference in the mean BMI of the patients and the control. There were no considerable variations between the smoking status of the control group and the patients. In conclusion this research indicates that women are more probably to develop diabetes type 2. There was a substantial difference between hypertension and type 2 diabetes, but not between smoking and BMI.

Keywords: Type 2 diabetes mellitus, hypertension, smoking, risk factors, body mass index (BMI), epidemiological study

Introduction
Diabetes is a chronic illness caused by either insufficient insulin production or insufficient insulin uptake by the body. Blood sugar regulation is regulated by the hormone insulin. Uncontrolled diabetes often leads to hyperglycemia which causes significant deficits in the body over time to many different components, including the neurons and blood vessels [9]. More than fifty million individuals worldwide-men, women, and children of all ages have diabetes, according to a study published on June 22, 2023. Over the next 30 years, that number will almost double to 1.3 billion people, with increases observed in every country [13]. The population of Iraq with diabetes is 1.4 million. Age-adjusted type 2 diabetes prevalence ranges from 8.5% to 13.9% [1]. Obese individuals have a seven-fold increased chance of developing diabetes. An excessive amount of body fat will block the production of hormones that deliver insulin to cells [17]. In addition, Patients with diabetes have twice as many cases of hypertension as people without the disease [15]. One of the most fundamental controllable risk factors for diabetic mellitus is smoking [24]. This research aims to clarify the correlation between risk factors (including overweight, hypertension, smoking) and Type 2 diabetes.

Methodology
This study included 100 subjects of both sex and age above 18 years were included and classified as Fifty patients with type 2 DM and 50 apparently healthy individuals as control. Collected between January 2022 and April 2023. Demographic data for each participant were written in a questionnaire form which were prepared previously. A portion of the participants were chosen at random from the Imam Hassan Diabetic and Endocrine Center outpatient clinic in Kerbala; the remaining patients were diabetic patients admitted to AL Hussain Teaching Hospital. Blood glucose were measured using on.

Call Plus instrument, (USA) according to the manufacturer instructions [3]. The person must be fasting or eat food two hours before the measurement procedure. Diastolic and Systolic Blood pressure of the participant was made by using Electronic blood pressure monitor device in compliance with the manufacturer's guidelines [10]. Vitality scale instrument was used to measure participants' length, and Balance pesapersone apparatus was used to test participants' weight. Utilizing the following mathematical formula, the individuals (BMI) was determined: BMI= weight (kg) / height (m^2) as described previously [14].

Statistical analysis

Statistical analysis is often used to analyze quantitative data, and presents techniques for categorical and continuous data, as well as basic inference procedures. Data collection is the first step in the process, which tests the relationship between two sets of statistical data. In this study all data are presented as frequency and percentage. Version 26 of SPSS was employed and the independent t-test (two-tailed) and dependent t-test (two-tailed) for variables that had a normally distributed distribution. For variables that did not have a normally distributed distribution, we used the Mann-Whitney U test, the Wilcoxon test, and the Chi-square test. $M < 0.05$ was seen as statistically significant.

Ethical approval

The human ethics committee of the AL Hussain teaching hospital, the pediatric teaching hospital, and the Imam Hassan diabetic and endocrine center in Kerbala authorized the study. Each participant in the study was informed about its purpose and required to sign a consent form. Also, the patient received an assurance that his information would remain confidential.

Results and Discussion

One hundred patients and apparently healthy individuals were enrolled in this study (50 were type 2 DM patients and 50 Healthy control). Patients and controls were matched in sex and age. The mean age of participant was 52.88. The female/ male ratio was (52/48= 1.08), as shown in Table 1 and 2. Comparable results was documented by previous study conducted in Britain in which the patients' average age was 54.6 years, and the ratio of women to men was (1.22) [11]. Additionally, identical results were reported by a research carried out in Iraq, where patients' mean age was 51.4 years and their female to male ratio was 1.19 [8]. According to earlier research, individual with type 2 diabetes who get the disease before the age of 55 may exhibit more aggressive phenotypes than people who get the disease later in life. These characteristics include increased blood pressure, BMI, lipid concentrations, and a faster decline in glycemic control. Identification of female as significant risk factor for poor glycemic control is important given that female to have a higher prevalence than male in countries like Iraq.

Table 1: Mean age of participant

Age in Years			
Type of sample	**Mean**	**N**	**Std. Deviation**
Control	52.88	50	11.195
Patient	52.88	50	11.195
Total	52.88	100	11.139

Table 2: Distribution of participant according to sex

		Control N (%)	Patient N (%)	Total N (%)
Sex	Female	26(52)	26(52)	52(52)
	Male	24(48)	24(48)	48(48)
Total		50	50	100

This study showed that the mean blood glucose was significantly higher among Type 2 DM patients, as shown in Table 3. Lower glucose mean was documented in another study in Iraq in which the mean blood glucose for control group was 92.6 while the mean of blood glucose for type 2 DM patients was 193 [7]. In another study documented lower glucose mean in which the mean blood glucose for control group was 91.8 while the mean of blood glucose for type 2 DM patients was 132.8 [12].

Table 3: Mean of Blood glucose

Patient's blood sugar in (mg/dl) unite			
Type of sample	**Mean**	**N**	**Std. Deviation**
Control	104.32	50	13.570
Patient	192.62	50	57.069
P value	0.000		

The findings of this investigation indicated that female patients had considerably greater blood sugar means than male patients, according to Table 4.

Table 4: The mean of blood glucose according to Sex

Patient's blood sugar in (mg/dl) unite				
Patient-Control	**Sex**	**Mean**	**N**	**Std. Deviation**
Patients	Female	205.35	26	57.606
	Male	178.83	24	54.314
Control	Female	102.15	26	15.413
	Male	106.67	24	11.091
Total	Female	153.75	52	66.765
	Male	142.75	48	53.231
	P-value	0.000		

Table 5 showed significant variation in the mean of systolic blood between patients and control, higher mean was seen in patients. Similar results were reported in an earlier study carried out in Iraq's Basra [7]. An earlier study conducted in Helsinki, Finland, found no differences. However, the higher mean was found in patient [23]. Type 2 diabetes is directly associated with elevated SBP. According to one theory, type 2 diabetes is caused by excessive blood pressure that first appears as vasoconstriction, which affects circulation and elimination of glucose in peripheral tissues like skeletal muscles and adipose tissue.

Table 5: Differences in Systolic blood pressure mean values

Systolic pressure in (mmHG) unite			
Type of sample	**Mean**	**N**	**Std. Deviation**
Control	123.18	50	15.347
Patient	135.54	50	16.427
P value	0.000		

Table 6 of the current research indicates that there was no statistically significant difference in the mean of diastolic blood pressure between the control group and patients. Previous investigations have reported similar findings [7, 4]. The average diastolic blood pressure for our study, conducted at the Department of Diabetes between December

15, 2020, and March 15, 2021, was 83 mmHG.

Table 6: Differences in Diastolic blood pressure mean values

Diastolic blood pressure in (mmHG) unite			
Type of sample	**Mean**	**N**	**Std. Deviation**
Control	80.62	50	8.146
Patient	83.64	50	10.546
P value	0.112		

Concerning distribution of participant according to Hypertension, there was significant difference between patients and control. About 52% of patients had hypertension in comparison to 22% of healthy participant, as shown in Table 7. Similar finding was recorded by previous studies [7, 2]. In a 2022 study examining 1,253 participants in Bangladesh to examine the connection between blood pressure and diabetes, it was discovered that 446 individuals had diabetes but no blood pressure, and 807 individuals had diabetes and blood pressure. In both men and women, hypertension is connected to the beginning of T2DM. Medication for hypertension and overweight is a prerequisite for this association. Depending on the kind of drug, using hypertension medications is thought to raise the risk of diabetes; this link varies by ethnicity.

Table 7: Distribution of participant according to Hypertension

		Control N (%)	**Patient N (%)**	**Total N (%)**
Hypertension	No	39 (78.0)	24 (48.0)	63 (63.0)
	Yes	11 (22.0)	26 (52.0)	37 (37.0)
Total		50 (100)	50 (100)	100 (100)
P-Value		0.003		

Regarding to BMI There was no appreciable variation in the average BMI of the patients and the control group, as shown in Table 8 similar finding was documented by previous studies [12, 15]. In research conducted on 3,916 people to study connection diabetes and obesity, it was found that 3,116 (86.0) people did not have diabetes, including 1,259 (43.6) people who had obesity, while 596 (14.0) people had diabetes, including 294 (52.1) people has obesity. According to the study, obesity and excess weight play a significant role T2DM and its connected issues in both genders within the category of obesity ($25 < BMI \leq 29.99$), there was a greater probability of having diabetes mellitus in both men and women. Additionally, Weight control is essential for avoiding complications from diabetes mellitus since a person's proportionate chance of developing a problem increases with a BMI of even slightly above 25. Numerous current weight-loss initiatives, such as dietary, behavioral, and physical activity modifications, are effective in helping people lose weight over the long term and significantly lower the occurrence of diabetes.

Table 8: BMI mean level between patients and control

BMI			
Type of sample	**Mean**	**N**	**Std. Deviation**
Control	27.6036	50	4.00340
Patient	29.0018	50	4.83297
P value	0.118		

Regarding DM and hypertension in the family history, the current study showed non-significant differences between patients and control, as shown in Table 9 and 10. Similar finding was found in two previous studies conducted separately in 2020, one of them in Uganda and the other in Ethiopia. In the first study, 19.58% of patients had a family history of diabetes mellitus (DM), and 81.42 percent did not have a history of the disease. In contrast, 83.33 percent of controls had a history of DM and 16.67% did not. In the second, 23.7% of patients and 72.3% of controls, respectively, had a family history of high blood pressure and did not, whereas 33.0% of the control group had a history of high blood pressure [15, 19]. People who had multiple relatives diagnosed with diabetes were even more at risk. Major risk factors such as absence of exercise and BMI failed to account for much of the risk connected with family history. This study showed correlation among hypertension and the period of diabetes and insulin use in people with T2DM. The percentage probabilities were approximately 18% greater for cases than for controls for every 5-year increase in the period of diabetes mellitus when insulin used. It indicates that the length of diabetes may also have an impact on the relationship between insulin use and hypertension. Despite the need for more research to understand this connection, type 2 diabetes patients using insulin may have had poor glycemic control owing to insulin resistance. It is possible that the combination of insulin resistance, weight gain brought on by insulin, and lengthier duration of diabetes contributed to the development of hypertension in this group. Because patients and healthcare providers are insufficiently prepared to begin insulin therapy on schedule, this could be explained by the known risk that exists among insulin users prior to the introduction of insulin, with the exception of metformin users. Consequently, following a treatment failure, they are more likely to begin using insulin Due to the inadequate health system in resource-constrained nations like Ethiopia, which causes lengthy follow-up intervals and treatment failure delays the duration of treatment failure is considerably more noticeable.

Table 9: Cross-tabulation between patients and control according to the family history of DM

			Type of sample		**Total**
			Control	**Patient**	
Family history of DM	No	Count	19	20	39
		% within type of sample	38.0%	40.0%	39.0%
	Yes	Count	31	30	61
		% within type of sample	62.0%	60.0%	61.0%
P-value		1.00			

Table 10: Cross-tabulation between patients and control according to family history of Hypertension

			Type of sample		**Total**
			Control	**Patient**	
Family history of Hypertension	No	Count	17	22	39
		% within type of sample	34.0%	44.0%	39.0%
	Yes	Count	33	28	61
		% within type of sample	66.0%	56.0%	61.0%
P-value		0.41			

There were no discernible variations in the smoking status was observed between patients and control, as shown in Table 11. A 2020 study found no difference in statistic between 95.3% of the control group, who did not smoke, and 4.7% of the patient group, who did smoke. Of the

patient group, 94.4% are non-smokers and 5.6% are smokers [24]. Additionally, a different study conducted in 2021 found no evidence of a major distinction between the groups: 73.3% of the control group were non-smokers and 26.7% were smokers, whereas 75.72% of the patient group did not smoke and 24.28% of the patient group smoked [7]. Shuai Yuan and Susanna C. Larsson, on the other hand, found a substantial difference: 63% of patients did not smoke, and 37% of patients smoked, compared to 90% of the control group who did not smoke and 10% of the control group who did smoke [16]. The results of the current research conform with a causal connection between starting to smoke and a higher risk of type 2 diabetes. While a number of extensive research studies suggest that quitting smoking raises the risk of T2DM in the near term, which is mediated by BMI, the risk significantly declines over time after stopping. It is uncertain exactly the processes constitute the connection between smoking and T2DM. There are several reasonable explanations, including the detrimental effects of smoking on the mass and function of islet β-cells [9, 21], obesity, the gastrointestinal tract [22], inflammation [6] and the nervous system [21, 22]. It has been demonstrated that nicotine, a major bioactive component of cigarettes, impairs islet β-cell mass and function [20, 18], disrupting glucose homoeostasis, which is a major factor in the onset of type 2 diabetes [21]. Additionally, smoking impairs the gastrointestinal tract's ability to function [13], for example, by lowering bile acids, which are essential for regulating the digestion of glucose [21]. It has recently been discovered that smoking contributes to alterations in the composition of the gut microbes [20], This might be very important in the pathophysiology of type 2 diabetes [21]. Moreover, smoking cigarettes affects the neurological system functions, including the vague nerve [11], the cerebral cortex [5], and the circadian rhythmicity [15], which have an essential role in controlling the metabolism that include the breakdown of glucose [6].

Table 11: Cross-tabulation between patients and control according to Smoking status

			type of sample		Total
			Control	Patient	
Smoking	No	Count	41	37	78
		% within type of sample	82.0%	74.0%	78.0%
	Yes	Count	9	13	22
		% within type of sample	18.0%	26.0%	22.0%
Total		Count	50	50	100
		% within type of sample	100.0%	100.0%	100.0%
P-value		0.470			

This study showed Negative significant correlation between blood sugar level and Systolic blood pressure among patients with T2DM where as non-significant negative correlation was observed with BMI and Diastolic blood pressure, as shown in Table 12. Among healthy participant, no significant correlation was observed. Table 13 illustrates a negative, non-significant relationship among blood glucose level and Systolic/Diastolic blood pressure. In individuals with T2DM, a prior study found a significant connection between blood sugar level and systolic blood pressure ($p< 0.01$), while A positive relationship between BMI and diastolic blood pressure (P= -0.208.) [9]. Another study shows positive connection among blood glucose level and Systolic blood pressure among patients with T2DM. Whereas positive correlation was observed with BMI and Diastolic blood pressure in healthy participant, there was no discernible connection [8]. Type 2 diabetes is directly connected with elevated SBP. According to one theory, type 2 diabetes is caused by high blood pressure that first appears as vasoconstriction, which affects flow of blood and elimination of glucose in surrounding tissues such as muscle mass and fat tissue. This method may aid in explaining why therapeutic modifications to the renin or angiotensin systems may offer some defense against the onset of type 2 diabetes. In patients from rural India, another study demonstrates a strong correlation in diastolic blood pressure and body mass index (BMI). Gaining weight appears to be a significant risk factor for the initiation of hypertension. Additionally, it has been demonstrated that the most successful non-pharmacological therapy strategy for obese hypertensive and diabetic individuals is weight loss.

Table 12: Correlation among patients

		Blood sugar in (mg/dl) unite	BMI	Systolic pressure in (mmHG) unite	Diastolic pressure in (mmHG) unite
Blood sugar in (mg/dl) unite	Pearson Correlation	1	-.113	-.311*	-.222
	Sig. (2-tailed)		.434	.028	.121
	N		50	50	50
BMI	Pearson Correlation		1	.153	-.091
	Sig. (2-tailed)			.290	.528
	N			50	50
Systolic pressure in (mmHG) unite	Pearson Correlation			1	.349*
	Sig. (2-tailed)				.013
	N				50
*. Correlation is significant at the 0.05 level (2-tailed).					

Table 13: Correlation among Control

		Blood sugar in (mg/dl) unite	BMI	Systolic pressure in (mmHG) unite	Diastolic pressure in (mmHG) unite
Blood sugar in (mg/dl) unite	Pearson Correlation	1	.020	-.122	-.244
	Sig. (2-tailed)		.892	.400	.088
	N		50	50	50
BMI	Pearson Correlation		1	-.093	-.127
	Sig. (2-tailed)			.521	.378
	N			50	50
Systolic pressure in (mmHG) unite	Pearson Correlation			1	.680**
	Sig. (2-tailed)				.000
	N				50
**. Correlation is significant at the 0.01 level (2-tailed).					

Conclusion

This study shows that female is more prone to type 2 DM and had higher mean of blood glucose mean. Both type 2 diabetes and obesity create serious threats to public health. Type 2 diabetes is far more likely to occur in obese people, which makes the connection between the two disorders significant. While there is a chance that T2D promotes hypertension, there is also a chance that hypertension develops T2D. Hypertension increases the risk of developing diabetes by affecting insulin sensitivity and causing damage to blood vessels, which can lead to complications associated with diabetes. No significant difference Smoking was with T2DM. However, it contributes to insulin resistance and impairs glucose metabolism, increasing the likelihood of developing diabetes. Additionally, smoking exacerbates complications of diabetes, such as cardiovascular diseases.

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