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Interdependence Between Elevated Systolic/Diastolic Blood Pressure and Type 2 Diabetes Severity

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ABSTRACT

Objective: *The goal of this study was to investigate the association between T2DM and changes in systolic and diastolic blood pressure.*

Methods: *I randomly selected approximately 1,760 individuals from December 2021 to February 2025. All adult Saudi men and women aged 25–100 who visited Primary health clinics PHCs during the study period are eligible. Diabetic patients with HbA1C levels over 6.4% were cases, while non-diabetic volunteers with less than 5.7% were controls.*

Results: *Diabetics had a mean systolic blood pressure of 133.76 (mean standard deviation of 17.186), while non-diabetics had a mean systolic blood pressure of 123.32 (mean standard deviation of 17.217). The mean diastolic blood pressure of diabetics was 78.27 (mean standard deviation = 11.478), while that of non-diabetics was 75.71 (mean standard deviation = 12.082).*

Conclusions: *T2DM prevalence was associated with an increase in mean systolic and diastolic blood pressure. T2DM is prevalent among elderly Saudis with a lower level of education. Systolic and diastolic blood pressures can be useful to identify early-onset or prediabetes in at-risk groups with a family history of T2DM.*

Keywords
Type 2 diabetes, Systolic, Diastolic, Blood pressure, Chronic diseases.

Introduction

Type 2 diabetes mellitus (T2DM) is a challenging chronic disease characterized by substantial phenotypic variance [1]. Various factors influence diabetes, making it a complex, multifactorial disease. Thus, multimodal treatment must incorporate cardiovascular variables. This method of care involves lifestyle changes, blood pressure (BP), cholesterol, and strict metabolic control [2]. T2DM patients are more likely to die from cardiovascular diseases (CVDs), especially in low- and middle-income countries. Researchers have extensively researched new preventative methods to prevent or delay T2DM-related CVDs [3]. High-risk patients benefit from aggressive risk factor management, including medication for high blood pressure and low-density lipoprotein cholesterol, besides other dyslipidaemias, glycaemic management, renal protection, and lifestyle changes [4].

High blood glucose increases blood viscosity, reducing pancreatic blood flow in T2DM. A BP increase of a few points may be a compensatory reaction that helps the islet cells of the pancreas to receive blood. BP's effect on T2DM beta-cell function is mysterious. A temporary connection was discovered between slightly higher systolic blood pressure (140–150 mmHg) and improved beta-cell function in T2DM patients with HbA1c levels over 10%, but this effect was not seen in patients with HbA1c levels under 10% in the early stages of diabetes [5]. The purpose of this study was to examine the relationship between T2DM and systolic and diastolic blood pressure changes.

Materials and Methods

About 31 primary health clinics (PHCs) in the Hail region of northern Saudi Arabia provided samples for this descriptive study, serving the local population. I selected about 1,760 participants using a simple random method from December 2021 to February 2025. All adult Saudi men and women aged 25 to 100 who visited PHCs during the study period, whether they have diabetes or not, are eligible for inclusion. Cases were people with diabetes whose HbA1C levels were more than 6.4%, and controls were people without diabetes whose HbA1C levels were less than 5.7%. I adopted the recent American Diabetes Association (ADA) guidelines for the definition of diabetes and prediabetes. For hypertension we depended on the office blood pressure measurement, home measurements, and the 24-hour blood pressure measurements (ABPM).

Blood Sample

We took venous blood from each participant for HbA1c estimation. A1C readings below 5.7% are considered normal, 5.7% to 6.4% indicate prediabetes, and 6.5% and above indicate diabetes.

Data Analysis

Using SPSS, the analysis yielded frequencies, cross-tabulations, and statistically significant results. I gave a 95% confidence interval to the chi-square test results. To be considered statistically significant, the P-value had to be less than 0.05.

Results

I investigated 880 males and 880 females in this study. Their ages ranged from 20 to 100 years, with a mean age of 48. 890 (50.6%) of the 1760 people were diabetic patients, and 870 (49.5%) were not.

Table 1: Demographic characteristics of the study population.

Variable	Males	Females	Total
Age			
< 25 years	160	115	275
26-40	165	204	369
41-55	202	297	499
56-70	223	204	427
71+	130	60	190
Total	880	880	1760
Education level			
Illiterate	266	448	714
Read and write	65	72	137
Primary	106	79	185
Intermediate	91	48	139
Secondary	158	85	243
Higher education	181	92	273
Total	867	824	1691

Most participants were aged 41–55, followed by 56–70 and 26–40 years, with 499/1760 (28.4%), 427/1760 (24.3%), and 369/1760 (21%), respectively. However, as seen in Fig. 1, the proportions of age within each gender vary. The majority of participants were illiterate, followed by those with higher education and those with secondary education, comprising 714/1760 (40.6%), 273/1760 (15.5%), and 243/1760 (13.8%), respectively. As seen in Figure 1, the proportions of schooling within male and female groupings vary substantially (See Table 1 and Figure 1).

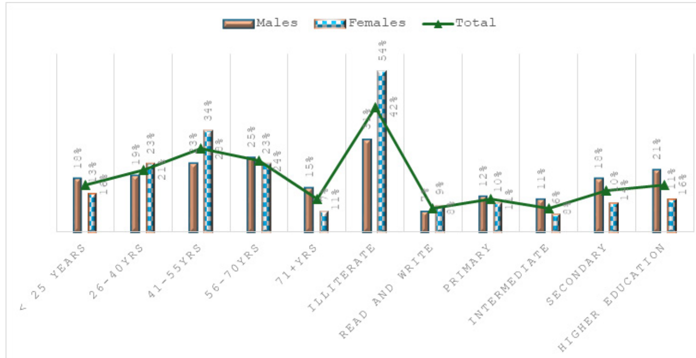

Figure 1: Proportions of Demographic Characteristics Within Gender.

Among the 890 diabetic patients, 436/890 (49%) were males and 454/890 (51%) were females. There were 444 (870) men and 426 (870) women among the 870 non-diabetics. Most diabetics were aged 56-70, then 41-55, and 71+, accounting for 319 (36%), 309 (35%), and 136 (15.3%), respectively, whereas the majority of non-diabetics were aged 26-40, then 25, and 41-55, accounting for 265 (30.5%), 253 (29%), and 190 (22%), respectively. Illiterates exceed diabetics, 491 (55.2%), and non-diabetics, 223 (25.6%), as indicated in the graph. Table 2 and Figure 2.

Table 2: Demographic characteristics based on diabetic status.

Variable	Diabetic	Non-diabetic	Total
Gender			
Males	436	444	880
Females	454	426	880
Total	890	870	1760
Age			
< 25 years	22	253	275
26-40	104	265	369
41-55	309	190	499
56-70	319	108	427
71+	136	54	190
Total	890	870	1760
Education level			
Illiterate	491	223	714
Read and write	92	45	137
Primary	84	101	185
Intermediate	64	75	139
Secondary	68	175	243
Higher education	55	218	273
Total	854	837	1691

The mean systolic blood pressure for diabetics was 133.76±17.186 (mean Std. deviation), while it was 123.32±17.217 (mean Std. deviation) for non-diabetics. Diabetics had a mean diastolic blood pressure of 78.27±11.478 (mean Std. deviation), while non-diabetics had a mean diastolic blood pressure of 75.71±12.082 (mean Std. deviation).

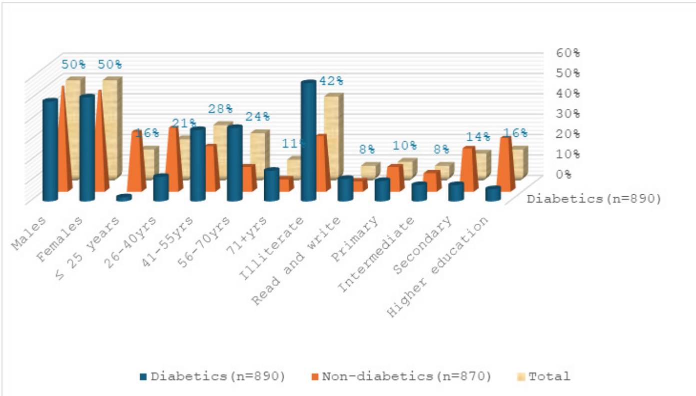

Figure 2: Proportions of demographic characteristics by diabetic status.

Abnormally high systolic blood pressure was discovered in 347/890 (40%) diabetes patients, but not in 168/870 (19.3%) non-diabetics. The odds ratio (OR) and 95% confidence interval (95% CI) were as follows: OR (95% CI) = 2.6703 (2.1524 to 3.3128), P < 0.0001.

We found abnormally high diastolic blood pressure in 215/890 (24.2%) diabetes patients, but not in 137/870 (15.7%) non-diabetics. The odds ratio (OR) and 95% CI were as follows: OR (95% CI) = 1.7042 (1.3427 to 2.1630), P < 0.0001, as indicated in Table 3 and Figure 3.

Table 3: Blood pressure measurements based on diabetic status.

Variable	Diabetic	Non-diabetic	Total
Systolic			
<120	246	490	736
120-139	297	212	509
140-149	186	92	278
150-159	75	34	109
160+	86	42	128
Total	890	870	1760
Diastolic			
<80	413	456	869
80-89	262	277	539
90-99	167	105	272
100-109	41	25	66
110+	7	7	14
Total	890	870	1760

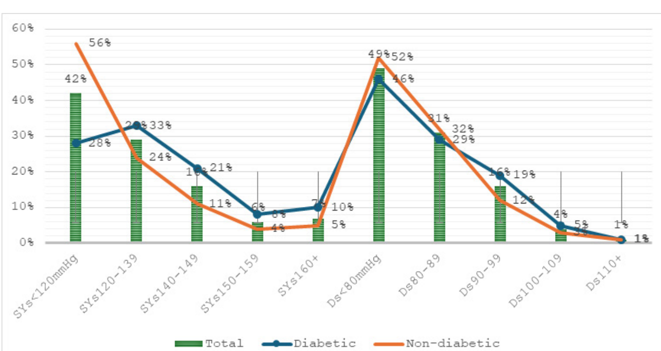

Figure 3: Blood pressure measurements based on diabetic status.

Table 4: Blood pressure by gender.

Variable	Males	Females	Total
Systolic blood pressure			
<120	362	374	736
120-139	256	253	509
140-149	134	144	278
150-159	55	54	109
160+	73	55	128
Total	880	880	1760
Diastolic			
<80	397	472	869
80-89	316	223	539
90-99	113	159	272
100-109	47	19	66
110+	7	7	14
Total	880	880	1760

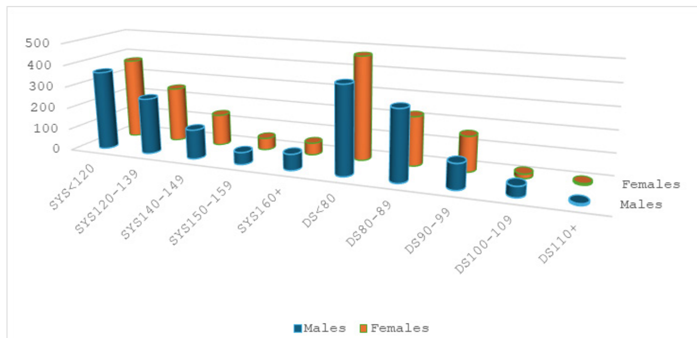

Figure 4: Blood pressure by gender.

Discussion

It is well established that diabetes and hypertension raise the risk of cardiovascular disease [6]. In this study, we assessed the relationship between T2DM and systolic and diastolic blood pressure changes. I found that diabetes significantly increases mean systolic and diastolic blood pressure compared to non-diabetics. T2DM patients have higher total blood pressure, according to previous research [6]. A recent study examined the ability of various blood pressure measurements to predict diabetes development in non-diabetic first-degree relatives (FDRs) of patients with T2DM. Their findings indicate that both systolic and diastolic BP are equally accurate as mean arterial pressure (MAP) in predicting the development of diabetes [7]. In T2DM, the 24-hour pulse pressure and systolic night-day ratio predict cardiovascular events and must be considered when assessing CVD risk [8].

There is no specific information on how SBP and DBP affect CVD outcomes. Genetics makes some conditions, like coronary artery disease (CAD), myocardial infarction (MI), stroke, heart failure (HF), arterial fibrillation (AF), chronic kidney disease (CKD), and type 2 diabetes, more likely to cause high SBP and DBP. The multivariable MR study found that for every 10 mmHg increase in SBP, the risk of CAD increased by 1.23, stroke by 1.39, ischemic stroke by 1.44, heart failure by 1.42, atrial fibrillation by 1.26, and type 2 diabetes by 1.26. The distinction between SBP and DBP outcomes necessitates additional investigation into therapeutically targetable factors [9]. Even without cardiovascular disease or CKD, T2DM causes vascular stiffness. In T2DM, DBP and the albumin-to-creatinine ratio are risk factors for vascular stiffness [10]. High systolic blood pressure and HbA1c are risk factors for albuminuria and impaired renal function in type 2 diabetes. To stratify T2DM based on the progression of albuminuria, we use HbA1c and SBP cutoffs. They may be useful clinical benchmarks for diabetic kidney disease management [11]. Researchers have not thoroughly studied the relationship between long-term blood pressure variability (BPV) and T2DM incidence, but they have reported the presence of short-term BPV. Long-term SBP fluctuation was also significantly associated with an elevated incidence of T2DM, regardless of preexisting age, sex, BMI, SBP, and lifestyle variables [12].

The results of this study indicate that diabetes is more prevalent among elderly adults with a low level of education. However, older age has been associated with numerous comorbidities, including T2DM [13]. A recent study identified the factors that mediated the association between educational attainment and newly diagnosed cases of T2DM among the elderly. Recent reports from Saudi Arabia indicate that individuals aged 45 and older, particularly in the country's two largest cities, Riyadh and Jeddah, have the highest prevalence of T2D. The prevalence of T2DM is higher in urban regions (25.5%) than in rural areas (19%) [14]. In Saudi Arabia, age is the best predictor of diabetes and prediabetes, with obesity following closely behind. Almost half of the population aged 50 and over had diabetes, and another 10–15% had prediabetes, leaving just a very small minority with normal blood sugar levels [15].

The incidence of T2DM clearly followed a socioeconomic gradient, with the least educated people having the highest chance of developing the condition [16]. In many developed nations, the incidence of T2DM varies greatly by level of education. Previous research has suggested that differences in exposure to overweight or obesity between socioeconomic categories may help explain this disparity [17].

Structural, demographic, and economic changes in the Middle East, especially in Saudi Arabia, have occurred recently. As a result, people's habits have changed, including an increase in unhealthy eating and inactivity. The rise of chronic diseases like T2DM is a public health issue [18]. Saudi Arabia is one of the countries most affected by diabetes mellitus (DM). According to the International Diabetes Federation, diabetes affected nearly 3.8 million Saudis in 2014 [14]. Researchers found a strong link between self-management of diabetes and the rise in prevalence rates in Saudi Arabia [19,20].

Although the current study offered important information on the relationship between T2DM and SBP and DBP fluctuations, it has certain limitations, including its cross-sectional design, non-matching age between patients and controls, and a lack of consideration of hypertension.

In conclusion, the prevalence of T2DM was associated with a statistically significant increase in the mean systolic and diastolic blood pressure. T2DM is widespread among elderly Saudis with a low level of education. For early-onset or prediabetes identification, we can use systolic and diastolic blood pressures to screen at-risk populations with a family history of T2DM.

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