

Diabetes and Hypertension

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ABSTRACT

Hypertension and obesity increase the risk of long-term vascular complications of type 2 diabetes mellitus (T2DM), including stroke, chronic kidney disease, heart disease, peripheral vascular disease, and death. The relative risk of cardiovascular disease for persons with diabetes is double or more than that of persons without diabetes although the absolute risk of cardiovascular disease varies around the world. The present study has been conducted on 100 clinically diagnosed diabetic patients belonging to different areas of Jammu who were visiting Government Medical Hospital for the treatment of the disease. The fasting blood glucose (FBG) level estimation of the selected patients has been done by using standardized digital glucometer. The determination of hypertension among the selected diabetics has also been done by the measurement of their systolic and diastolic blood pressure using stethoscope and mercury sphygmomanometer. Two consecutive blood pressure readings were taken for each patient and the average of the two readings has been recorded as the blood pressure of the selected diabetic patient. The present study results revealed that 40.00 per cent of the diabetic patients also had obesity and they were diagnosed with the condition between the age group of 40-50 years. The prevalence of hypertension has been observed among 54.00 per cent of the diabetic patients and they were diagnosed with the condition at the age of 40-50 years.

Keywords: Diabetes mellitus, Fasting blood glucose level, Hypertension, Heart disease

INTRODUCTION AND REVIEW OF LITERATURE

Diabetes mellitus (DM) is nowadays known as a major public health problem worldwide because of its continuously increasing prevalence and the risk of

associated cardiovascular and renal diseases. Indeed, 382 million people were estimated to have DM in 2013; the number of people with DM is predicted to reach 592 million by 2035. In contrast, this disease affected only 30 and 157 million people in 1985 and 2000, respectively. According to data from occidental settings and most developed areas in low and middle income countries, the increase of diabetic patient's number is mainly due to the increasing figures of obese people and aging of the general population. The association between DM and obesity with or without other cardiovascular risk factors is known as the 'diabesity'. It also has an insulin resistance pattern, which is clinically determined by the criteria of the metabolic syndrome (MS).^[1] Most patients with type 2 diabetes are obese, and the global epidemic of obesity largely explains the dramatic increase in the incidence and prevalence of type 2 diabetes over the past 20 years. Currently, over a third (34%) of U.S. adults are obese (defined as BMI >30 kg/m²), and over 11% of people aged ≥20 years have diabetes, a prevalence projected to increase to 21% by 2050.^[2] Hypertension and obesity are responsible for increasing the risk of long-term complexities of type 2 diabetes mellitus which include stroke, chronic kidney diseases, peripheral vascular diseases and death.^[3] Overweight and obesity have increased dramatically, with adverse public health implications. Above-normal body mass index (BMI) is associated with decreased functional ability and health status and increased risk of chronic conditions such as diabetes and hypertension, which often cause further decrements in health.^[4]

Relation between Obesity and T2DM

Obesity is the "accumulation of adipose tissue to excess and to extent that impairs physical and psychosocial health and well-being".^[5] According to WHO report, the worldwide obesity has doubled since 1980. In 2008, more than 1.4 billion adults were either obese or overweight having age group more than 20 years. Of these approximately more than 200 million were obese while about 300 million women were affected.^[6] The epidemiology and occurrence of T2DM is nearly related with body mass index (BMI). It is estimated that there is seven times greater risk of an individual to be diabetic than healthy one, with a threefold rise in menace for overweight people.^[7] A recent study has suggested that the threat of T2DM is observed in those individuals who have BMI greater than 40 as compared to those who have lower BMI range i.e. in between 30- 39.5.^[8] Not every obese individual develops diabetes and therefore, obesity alone is not sufficient to cause T2DM. The relationship between obesity and T2DM is complicated by the effects of several modifying factors. These factors include duration of obesity, distribution of body fat, physical activity (PA), diet, and genetics/ethnicity. Due to abdominal obesity the fat cells secrete pro-inflammatory chemicals, which makes the body cells less sensitive to the insulin. These chemicals also deteriorate the function of responsive cells and their capacity to respond to insulin.^[9] Excess weight is an established risk factor for type 2 diabetes, yet most obese individuals do not develop type 2 diabetes. Recent studies have identified "links" between obesity and type 2 diabetes involving proinflammatory cytokines (tumor necrosis factor and interleukin-6), insulin resistance, deranged fatty acid metabolism, and cellular processes such as mitochondrial dysfunction and endoplasmic reticulum stress.^[2] More importantly, indexes of obesity play an unusual role in screening T2DM and determining high risk individuals. Several measurements of

obesity, including body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-stature ratio (WSR), are significantly associated with T2DM. BMI is the marker most commonly used to identify the risk of future T2DM.^[10] Compared with BMI, central obesity indices, such as WC, WHR and WSR, appeared to be more strongly associated with T2DM.

Relation between Hypertension and T2DM

Diabetes mellitus and hypertension are inter-related diseases that strongly predispose an individual to atherosclerotic cardiovascular disease. Hypertension is about twice as frequent in individuals with diabetes as in those without. The prevalence of coexisting hypertension and diabetes appears to be increasing in industrialized nations because populations are aging and both hypertension and non insulin dependent diabetes mellitus incidence increases with age. Indeed, an estimated 35-75% of diabetic cardiovascular and renal complications can be attributed to hypertension.^[11] Hypertension is present in up to 75 per cent individuals who are affected with T2DM.^[12] By doing health care and diabetes management, the middle aged and older adults having hypertension and T2DM may live for many years but both of these diseases have deteriorating effect on cardiovascular and brain health.^[13] As both hypertension and DM are highly associated with obesity, it is not surprising that their co-existence is particularly common in obese individuals. Both hypertension and DM increase significantly with increasing age and their co-existence is highest in older individuals. Patients with DM more commonly present with isolated systolic hypertension and are more resistant to treatment. The co-existence of DM and hypertension significantly increase the risk for coronary heart disease, left ventricular hypertrophy, congestive heart failure and stroke compared with either condition alone. In addition, both hypertension and DM are present in all prediction models for the

occurrence of stroke in patients with atrial fibrillation. Micro vascular complications are also more common in patients with co-existent hypertension and DM and both retinopathy and nephropathy are more prevalent in patients with DM and hypertension. [14]

Thus, the present study has been planned to observe the prevalence of obesity and hypertension among clinically diagnosed diabetes patients and to study the association of diabetes mellitus with obesity and hypertension.

MATERIALS AND METHODS

The planned study has been conducted on 100 clinically diagnosed diabetic patients belonging to different areas of Jammu who were visiting Government Medical Hospital for the treatment of the disease. The fasting blood glucose (FPG) level estimation of the selected patients has been done by using standardized digital glucometer. The blood glucose test was performed by piercing the skin (typically on finger) to draw the blood, then applying the blood to a chemically active disposable "test strip" which is connected with a digital meter. Within several seconds, the level of blood glucose was shown on the digital display. Recorded the readings and then compared the level of FPG to the values given by ADA (2013) [15] to find out the current status of diabetes among all the patients. The determination of hypertension among the selected diabetics has also been done by the measurement of their systolic and diastolic blood pressure using

stethoscope and mercury sphygmomanometer. Two consecutive blood pressure readings were taken for each patient and the average of the two readings has been recorded as the blood pressure of the selected diabetic patient. The patient was labeled according to the categories of hypertension recommended by Joint National Committee. Further weight and height measurements were recorded for each patient and body mass index (BMI) was calculated. The value of calculated BMI has been used to determine the level of obesity amongst the diabetic patient according to WHO (2000) classification. [16] The data thus collected has been put to statistical analysis including Mean, Standard deviation (SD), Chi-square test and Pearson's correlation coefficient.

RESULTS AND DISCUSSION

Table 1 reveals that majority of the diabetic patients i.e. 42.00 per cent were belonging to 50-60 years of age and 37.00 per cent of them were belonging to 40-50 years of age. 16.00 per cent were belonging to 30-40 years of age, while 3.00 per cent of them were belonging to 60-70 years of age. Only 2.00 per cent were belonging to 20-30 years of age. Among males, the majority of diabetic patients i.e. 46.34 per cent were belonging to 50-60 years age group and 31.71 per cent were belonging to 40-50 years of age. 17.07 per cent were belonging to 30-40 years age group. 4.88 per cent were belonging to 60-70 years of age. None of the males were belonging to 20-30 years of age.

Table 1: Distribution of Selected Patients According To Their Age

Age Groups (Yrs)	Total No. of Patients	Males	Females	r-value
20-30	2	0(0.00)	2(3.39)	-0.32627
30-40	16	7(17.07)	9(15.25)	Non-significant
40-50	37	13(31.71)	24(40.69)	
50-60	42	19(46.34)	23(38.98)	
60-70	3	2(4.88)	1(1.69)	
Total	100	41(100.00)	59(100.00)	
Chi-square value =6.78 p<0.05 Significant				

Among females, the majority of diabetic patients i.e. 40.69 per cent were belonging to 40-50 years of age and 38.98 per cent of them were belonging to 50-60

years of age. 15.25 per cent of female patients were belonging to 30-40 years of age while 3.39 per cent were belonging to 20-30 years of age. Only 1.69 per cent of

females were belonging to 60-70 years of age. The chi-square value shows the statistically significant association between the age of diabetic males and females. While the Pearson's coefficient of correlation (r) for the age of diabetic males and females was found to be statistically non-significant.

Thus, it is revealed from the present study results that the occurrence of diabetes is increasing with advancing age, majority being affected between 50-60 years of age. Similar observations have been reported that people in their 40's are more prone to develop T2DM. [17]

Table 2 depicts the distribution of patients on the basis of their fasting plasma glucose (FPG) level which was recorded on the spot at the time of examination using glucometer. It shows that the majority of diabetic patients i.e. 49.00 per cent FPG level greater than 126 mg/dl and were categorized as diabetes as per ADA, (2013) classification. While 28.00 per cent of them had FPG level range between 100-125 mg/dl and thus they have been classified as pre-diabetes. Normal range of FPG has been observed among 23.00 per cent patients.

Table 2: Distribution of selected patients on the basis of their Fasting Plasma Glucose Level

Category Of FPG (As Per ADA, 2003)	Total No. of Patients	Males	Females	r-value
Pre-diabetes (100-125 mg/dl)	28	15(36.58)	13(22.04)	0.283091
Diabetes (>126mg/dl)	49	22(53.66)	27(45.76)	
Normal (99 or below)mg/dl	23	4(9.76)	19(32.20)	
Total	100	41(100.00)	59(100.00)	Non-Significant
Chi-square value = 6.89		p<0.05 Significant		

Among males, majority of the patients i.e. 53.66 per cent had FPG level greater than 126 mg/dl and were classified as diabetes while 36.58 per cent who had FPG between 100-125 mg/dl have been classified as pre-diabetes. Normal range of FPG i.e. 99 or below has been observed among 9.76 per cent patients. Among females, majority of the patients i.e. 45.76 per cent had FPG level greater than 126 mg/dl and were classified as diabetes

followed by 32.20 per cent who had FPG level range is 99 or below mg/dl and thus they were being classified as normal. 22.04 per cent patients had FPG level in between 100-125 mg/dl and were classified as pre-diabetes. The chi-square value shows the statistically significant association between FPG of male and female diabetic patients while the r-value for the FPG of male and female diabetics has been found to be statistically non-significant.

Table 2(a): Mean value of Fasting Plasma Glucose Level among diabetic males and female patients

Variable	Males		Females		Difference	p-value
	Mean	SD	Mean	SD		
Fasting Plasma glucose	174.42	100.61	142.8814	77.26733	31.54	<0.01

The mean value for the FPG level of male diabetic patients has been found to be 174.42±100.61 mg/dl while that among female diabetics it has been found to be 142.8814±77.26733 mg/dl. This difference between the FPG of male and female diabetic patients selected for the present study was found to be statistically significant.

It is thus predicted from the present study findings that majority of diabetic

patients had their FPG level greater than 126 mg/dl at the time of data collection which may be due to irregular medication, diet taken or due to irregular physical activity. The present study findings has been found to be similar with ICMR-INDIAB study, conducted in Tamil Nadu reflected that there was also higher prevalence of diabetes (10.4 per cent) as compared to pre-diabetes (8.3 per cent). [18] However study

found that higher prevalence of pre-diabetes than the diabetes. [19]

Table 3: Distribution of selected patients on the basis of Duration of Diabetes

Duration Of Diabetes (Yrs)	Total No. of Patients	Males	Females
0-5	62	26(63.41)	36(61.02)
5-10	30	12(29.27)	18(30.51)
10-15	6	3(7.32)	3(5.08)
15-20	2	0(0.00)	2(3.39)
Total	100	41(100.00)	59(100.00)
Chi -square value = 2.70 p<0.05 Non-Significant			

It has been shown from the Table 3 that majority of diabetic patients (62.00 per cent) were had diabetes from 0-5 years. 30.00 per cent of patients were suffering from diabetes from 5-10 years. 6.00 per cent patients had diabetes from 10-15 years and 2.00 per cent of them were affected from 15-20 years. Among males, majority of patients i.e. 63.41 per cent were having diabetes from 0-5 years while 29.27 per cent patients suffered from diabetes from 5-10 years. 7.32 per cent patients had diabetes from 10-15 years. None of the male patients had diabetes from 15-20 years. Among females, majority of patients i.e. 61.02 per cent was had diabetes from 0-5 years. 30.51 per cent patients were suffering from diabetes from 5-10 years. 5.08 per cent patients had diabetes from 10-15 years. Only 3.39 per cent female patients had diabetes from 15-20 years of age. The chi-square value shows the association between the duration of diabetes among male and female diabetics.

It is revealed from the present study results that majority of the patients were suffering from diabetes from past 0-5 years. While only female patients (3.39 per cent) were found to be suffering with diabetes from longer period of time i.e. 15-20 years. However, it had reported that the duration of diabetes was longer among males than females. [20]

From the Table 4 it is revealed that majority of diabetic patients i.e. 40.00 per cent were diagnosed diabetes during 40-50 years age group followed by 29.00 per cent who acquired diabetes between 30-40 years age group. 26.00 per cent patients had

diabetes from 50-60 years age group followed by 5.00 per cent patients who had diabetes between 20-30 years of age.

Table 4: Distribution of selected patients on the basis of their Age at Diagnosis of Diabetes

Age at Diagnosis of Diabetes (Yrs)	Total No. of Patients	Males	Females
20-30	5	3(7.32)	2(3.39)
30-40	29	8(19.52)	21(35.59)
40-50	40	15(36.58)	25(42.38)
50-60	26	15(36.58)	11(18.64)
Total	100	41(100.00)	59(100.00)
Chi-square value =7.24 p<0.05 Significant			

Among males, majority of the patients i.e. 36.58 per cent had diabetes during 40-50 years age group followed by 36.58 per cent who acquired diabetes between 50-60 years age group. 19.52 per cent patients suffered from diabetes between 30-40 years age group followed by 7.32 per cent patients who had diabetes from 20-30 years age group. Among females, majority of patients i.e. 42.38 per cent had been diagnosed diabetes during 40-50 years age group followed by 35.59 per cent who acquired diabetes between 30-40 years age group. 18.64 per cent patients had diabetes in 50-60 years age group followed by 3.39 per cent patients who had diabetes between 20-30 years of their age. The chi-square value shows the statistically significant association between age at diagnosis of diabetes among male and female diabetic patients.

It is concluded from the present study observations that the majority of the diabetic patients were diagnosed with the disease between 40-50 years of their age which is similar to the study which shows that 21.1% of the diabetic people were affected by diabetes during their productive period (age group of 15-35) of life. These patients are more prone to various diabetic complications even when they are young. 64.4% of the diabetic patients were within the age group of 35-55 which shows that the prevalence of diabetes increased with age.

Table 5 depicts the distribution of diabetic patients on the basis of their calculated BMI. It shows that the majority of patients i.e. 47.00 per cent had their BMI

in between 18.5-22 as per classification, WHO, 2000 and they were categorized as Normal. 18.00 per cent patients had BMI in the range between 25-29.9 and were classified as obese class I. 13.00 per cent of the patients had BMI value less than 18.5

and were categorized as underweight while another 13.00 per cent had BMI in between 23-24.9 and thus were identified as pre-obese diabetic patients. Only 9.00 per cent patients were belonging to obese class II category having BMI greater than 30.

Table 5: Distribution of Selected Patients According To the Value of their Calculated BMI

Category of BMI	Total No. of Patients	Males	Females	r-value
Underweight (<18.5)	13	5(12.19)	8(13.56)	Non-Significant
Normal (18.5-22)	47	20(48.79)	27(45.77)	
Pre-obese (23-24.9)	13	6(14.63)	7(11.86)	
Obese class I (25-29.9)	18	10(24.39)	8(13.56)	
Obese class II (>30)	9	0(0.00)	9(15.25)	
Total	100	41(100.00)	59(100.00)	
Chi-square value =5.70 p<0.05 Non-Significant				

Among males, majority of the patients i.e. 48.79 per cent were Normal followed by 24.39 per cent who were classified as obese class I. 14.63 per cent of them were categorized as pre-obese while 12.19 per cent of male diabetic patients were found to be underweight and none of them was having BMI in the category of obese class II. Among females, majority of the patients i.e. 45.77 per cent were Normal and 15.15 per cent of them were classified

as obese class II. 13.56 per cent of them were categorized as underweight while 13.56 per cent of the female diabetic patients were classified as obese class I. Only 11.86 per cent female patients were categorized as pre-obese. The chi-square value shows the statistically non-significant association between BMI of male and female diabetic patients, while the r-value for the BMI of both the diabetics has been found to be statistically non-significant.

Table 5(a): Mean Value of BMI among Diabetic Male and Female Patients

Variable	Males		Females		Difference	p-value
	Mean	SD	Mean	SD		
BMI	22.23	3.47	23.34	5.43	1.11	Non-significant

The mean value for the BMI of male diabetics has been found to be 22.23±3.47 while that among female patients it has been found to be 23.34±5.43. The difference between the BMI of both the patients has been found to be statistically non-significant. .

diabetic patients i.e. 47.00 per cent was normal according to their BMI, ranging between 18.5-22. However, it was reported in study, that 24.4% of the diabetic patients were overweight and 5.6% obese, which revealed that obesity plays a role in causing diabetes. [21]

It is shown from the present study observations that maximum number of

Table 6: Distribution of Selected Patients on the Basis of Prevalence of Hypertension

CATEGORY OF BP (As per JNC, 2003).	Total No. of Patients	Males	Females	r-value
Normal (SBP:<120; DBP<80)	46	16(39.03)	30(50.85)	SBP = 0.321325 Significant
Pre-hypertensive (SBP:120-139; DBP:80-89)	40	20(48.78)	20(33.90)	
Hypertensive stage 1 (SBP:140-159; DBP:90-99)	12	5(12.19)	7(11.86)	DBP = 0.304077 Significant
Hypertensive stage 2 (SBP:>160; DBP:>100)	2	0(0.00)	2(3.39)	
Total	100	41(100.00)	59(100.00)	
Chi-square value =10.58 p<0.05 Significant				

Table 6 depicts the distribution of patients on the basis of their BP as per JNC, 2003 classification. It shows that majority of the diabetic patients i.e. 46.00 per cent had BP in between normal range i.e. less than 120mm Hg and less than 80mm Hg followed by 40.00 per cent who had systolic BP between 120-139mm Hg and diastolic B.P between 80-89mm Hg ranges and were classified as pre-hypertensive. 12.00 per cent were found to be categorized as hypertensive stage 1, having systolic B.P between 140-159mm Hg and diastolic BP between 90-99mm Hg. While 2.00 per cent of the patients were identified as Hypertensive stage 2 as they were having their systolic BP greater than 160mm Hg and diastolic BP greater than 100mm Hg. Among males, majority of patients i.e. 48.78 per cent had their value of systolic BP in between 120 -139mm Hg and diastolic BP between 80-89mm Hg and were classified as pre-hypertensive while 39.03 per cent who had systolic BP less than 120 and diastolic level less than 80, were classified as Normal. 12.19 per cent were belonging to hypertensive stage 1 having systolic B.P

between 140-159mm Hg and diastolic between 90-99mm Hg. None of the male patients belong to Hypertensive stage 2 having systolic level greater than 160mm Hg and diastolic level greater than 100mm Hg.

Among females, majority of the patients i.e. 50.85 per cent had their BP less than 120mm Hg to less than 80mm Hg, were classified as Normal and 33.90 per cent of them had systolic level in between 120-139mm Hg and diastolic BP between 80-89mm Hg and were classified as pre-hypertensive. 11.86 per cent were belonging to hypertensive stage 1 having systolic B.P between 140-159mm Hg and diastolic between 90-99mm Hg. Hypertensive stage 2 range is systolic B.P greater than 160mm Hg and diastolic BP greater than 100mm Hg which has been observed among 3.39 per cent female patients. The chi-square value shows the statistically significant association between the prevalence of hypertension among diabetic patients. The r-value for the systolic BP and diastolic BP of diabetic males and females has been found to be statistically significant.

Table 6(a): Mean Value of SBP and Mean DBP among Diabetic Male and Female Patients

Variable	Males		Females		Difference	p-value
	Mean	SD	Mean	SD		
Systolic blood pressure (SBP)	121.12	10.00	124.03	18.16	2.91	<0.01
Diastolic blood pressure (DBP)	78.58	6.21	79.59	7.86	1.01	<0.05

The mean value for the SBP and DBP of male diabetic patients has been found to be 121.12±10.00 mm Hg and 78.58±6.21 mm Hg respectively while among female diabetics it was found to be 124.03±18.16 mm Hg and 79.59±7.86 mm Hg, while the difference between SBP and DBP of both male and female diabetics has been found to be statistically significant. It has been shown from the present study results that 54.00 per cent of diabetics including both males and females were suffering from hypertension too. A Study shows that Hypertension was present in 36 (56.25%) females and 28 (43.75%) males. BP was normal in 55 (22%), 131 (52.4%) patients were pre-hypertensive, 45 (18%)

patients were in stage-1 hypertension, and 19 (7.6%) had stage-2 hypertension. ^[11]

It has been observed from the Table 7 that majority of the diabetic patients i.e. 55.56 per cent suffered from hypertension between 40-50 years of age and 35.18 per cent of them acquired hypertension from 50-60 years of age. 7.4 per cent patients had hypertension at 30-40 years of age and 1.85 per cent of them were affected from the disease between 20-30 years of age.

Table 7: Distribution of Selected Patients on the Basis of their Age at Occurrence of Hypertension

Age at Occurrence of Hypertension (Yrs)	Total No. of Patients	Males	Females
20-30	1(1.85)	0(0.00)	1(3.33)
30-40	4(7.41)	1(4.17)	3(10.00)
40-50	30(55.56)	12(50.00)	18(60.00)
50-60	19(35.18)	11(45.83)	8(26.67)
Total	54(100.00)	24(100.00)	30(100.00)
Chi-square value =6.97 p<0.05 Significant			

Among males, the majority of the patients i.e. 50.00 per cent were affected from hypertension between 40-50 years of age and 45.83 per cent of them had hypertension at 50-60 years of age while 4.17 per cent patients acquired hypertension between 30-40 years of age. None of the male patients were affected from the disease between 20-30 years of age. Among females, majority of patients i.e. 60.00 per cent acquired hypertension between 40-50 years of age and 26.67 per cent of them had hypertension at the age between 50-60 years. 10.00 per cent of the patients suffered from hypertension between 30-40 years of age and only 3.33 per cent female patients were affected from the disease at 20-30 years of their age. The chi-square value shows the statistically significant association between age at occurrence of diabetes among both male and female diabetics.

Thus, it is inferred that majority of diabetics are hypertensive too and they acquired hypertension between 40-50 years of age. According to another study, the occurrence of hypertension among individuals was more common between 40-60 years of age. [21]

CONCLUSIONS

The prevalence of diabetes was found to be more among females than males that too in the age group of 40-50 years. The mean age of female and male diabetics was found to be 46.74 and 49.56 respectively. The FPG level in majority of the patients were found to be more than 126 mg/dl which indicates that they may had adopted proper disease management strategies such as dietary and lifestyle modifications. The duration of diabetes was found to be longer i.e. Up to 15-20 years among females than males and among majority of diabetics, both males and females it was diagnosed between the age of 40-50 years. There are 40.00 per cent of the diabetic patients who also had obesity, determined on the basis of their calculated BMI values and they were diagnosed with the condition between the

age of 40-50 years. The prevalence of hypertension has been observed among 54.00 per cent of the diabetic patients and they were diagnosed with the condition at the age of 40-50 years.

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