Finding Influencing factors and probability to develop Diabetes Mellitus among adult hypertensive population in Puducherry (UT), South India: Hospital based retrospective study

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Abstract: Background: *Diabetes Mellitus is a chronic disease or a group of metabolic diseases in which there are high blood sugar levels over a prolonged period. Now, it is a major public health problem in all over the world. Type 2 DM begins with insulin resistance, a condition in which cells fails to respond to insulin properly. The primary cause is excessive body weight and not enough exercise. Type 2 DM may be treated with medications with or without insulin.*
Materials and Methods:Study Design: *Hospital based retrospective study.* ***Study Settings:*** *Aravind Eye Hopital, Thavalakuppam, Pondicherry.* ***Sample Size:*** *200.* ***Sampling Technique:*** *Simple Random Sampling technique.****Study Period:*** *January to March 2013.* ***Study Participants:*** *Patients with and without Type 2 DM and with those who are having hypertension with aged ≥ 34 years were included in this study.* ***Study Variables:*** *age, gender, HbA_1C, HDL, triglyceride, family history of DM, duration of hypertension.* ***Study Tool:*** *Pre-designed and pre-tested questionnaire was used for data collection.* ***Statistical Analysis:*** *Mean, S.D, Proportion, Univariate and for finding the probability of developing DM by using Binary logistic regression analysis.* ***Softwares Used:*** *Microsoft Excel software 2010 was used for data entry and data analysis was done by using statistical software SPSS 20 version.****Statistical Significance:*** *If $p < 0.05$ was taken to be statistically significant.*
Results: *Among 200 patients, 134 (67%) were male and 66 (33%) female and the mean age of the patient was 56.54 ± 9.51 years (range: 34 – 83 years). The mean values of HbA_1C, HDL, triglyceride, family history of DM, duration of hypertension were 7.27 ± 2.64% (range: 3.1 – 13.2 %), 39.84 ± 7.65 (range: 20 – 65) in mg/dl, 70.63 ± 11.94 (range: 44 – 116) in mg/dl, and 6.22 ± 3.82 years (3 – 24 years) respectively. All these factors were statistically significant found by binary logistic regression model except the factor gender.*
Conclusion: *This study concluded that the HbA_1C and the family history of DM are the most prominent and independent risk factors for the progression or developing Type 2 diabetes mellitus in a hypertensive adult individual. The other co-factors like age, HDL, triglyceride, duration of hypertension were also independently associated with the development of DM except the factor gender.*
Key Words: *diabetes mellitus, hypertension, influencing factor, probability, prediction, Puducherry*

I. Introduction:

Diabetes Mellitus is a chronic disease or a group of metabolic diseases in which there are high blood sugar levels over a prolonged period. It is a major public health problem in all over the world. DM is also called as "non-insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes". Type 2 DM begins with insulin resistance, a condition in which cells fails to respond to insulin properly. The primary cause is excessive body weight and not enough exercise. Type 2 DM may be treated with medications with or without insulin. Prevention and treatment by taking a healthy diet, doing physical exercise, not using of the habit of smoking and maintaining a normal body weight. Proper control of blood pressure and proper foot care is essential for the people with Type 2 DM. Type I DM must be controlled with the insulin injections. Insulin and some oral medications can cause the low blood sugar level in the human beings. We can control the gestational diabetes after the baby birth by controlling the blood glucose level or other method [1,2].

In the year 2013, there are 382 million people have diabetes in worldwide with type 2 diabetes and making up about 90% of the cases. This is equal to 8.3% of the worldwide adult's population and with equal rates in both the genders (men and women). 15 to 5.1 million deaths per years in between 2012 and 2013, these deaths make the 8th leading cause of death in the world. DM is the overall at least doubles the risk of the death.

Number of people with DM is expected to rise to 592 million by the year 2035. Globally, the economic costs of DM was estimated in 2013 was $548 billion and in USA it was estimated in 2012 as $245 billion [2]. Type 2 DM development involves a various personal and socio – economic cost, and is now being recognized as a major public health problem in both developed and developing countries [3].

II. Subjects and Methods:

Data Collection:
We done a hospital based retrospective study and the sample size was 200 patients with and without DM and those who are having hypertension was selected by using simple random sampling method. In this study, both genders were included. This study was done in January to March 2013in Aravind Eye Hospital, Thavalakuppam, Puducherry (Union Territory), South India.

Selection Method of the Study Participants:
Inclusion Criteria: Those who are having hypertension, with and without Type 2 Diabetes Mellitus at least one year and willing to participate were included in this study. Patients with aged ≥ 34 years were included by using pre-designed and pre-tested questionnaire.
Exclusion Criteria: Those who are affected by the other chronic diseases like heart disease, asthma, breast cancer, allergy, Glaucoma, not willing to participate in the study and non- residence of Puducherry were excluded from this study.

Classification of Blood Pressure (BP) or Hypertension for adults: [4]

Category	Systolic BP (mmHg)	Diastolic BP (mmHg)
Optimal	< 120	< 80
Normal	120 – 129	80 – 84
High Normal	130 – 139	85 – 89
Grade 1 Hypertension (mild)	140 – 15990 – 99	
Grade 2 Hypertension (moderate)	160 – 179	100 – 109
Grade 3 Hypertension (severe)	≥ 180	≥ 110
Isolated Systolic Hypertension	≥ 140	< 90

Classification and definition of Diabetes Mellitus: [2]
Type I DM: The body's failure to produce enough insulin. This form as previously referred to as insulin – dependent diabetes mellitus (IDDM) or juvenile diabetes.
Type 2 DM: It begins with insulin resistance, a condition in which cells fails to respond to insulin properly. As the disease progresses a lack of insulin may also develop. This form was previously referred to as non – insulin dependent diabetes mellitus or adult onset diabetes. Its causes by excessive body weight and not doing enough exercise.
Gestational Diabetes: It is the third main form and it occurs when the pregnant women without a previous history of diabetes develop a high blood glucose level.

Software used for Data entry, Compilation and Statistical Analysis:
Microsoft Excel 2010 was used for data entry and data analysis was done by using statistical software SPSS 20 version. In our study, the following statistical analysis was used. Quantitative data were expressed in descriptive statistics like., Mean, Standard Deviation and Proportions. In our study, the statistical analysis was performed in two ways: (a). Uni-variate (Spearman's rho Correlation) and (b). Binary Logistic Regression analysis [5].If $p<0.05$ was taken to be statistically significant. In Univariate Analysis: the association between DM and the study variables like, age, HbA$_1$C, Triglycerides, HDL, Duration of hypertension were appropriately evaluated through by using Spearman's rho correction and for gender, Family History of DM by the non-parametric statistics: Mann Whitney U test. In Binary logistic regression analysis: The patients with and without DM were taken as a dependent variable. Predictors were found from odds ratio with 95% Confidence Intervals.

Finding of Odds Ratio and probability of developing DM in a hypertensive individual: [6]

Binary Logistic Regression equation is given by,

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \ldots\ldots\ldots + \beta_nX_n$$

By substituting β_i – values, and X_i – values with significant (i = 1, 2, 3, 4, ………n) and to find the value of Y.

And find out the odds ratio by the given formula:
$$\frac{P}{1 - P} = e^Y$$

From the above formula, we have to find the P – value. This P – value was the probability (or) chance to develop diabetes mellitus in a hypertensive individual. The variables which were proven significant at the Univariate analysis were entered as an independent variables and forward selection of variables was performed.

III. Results:

Among 200 patients, 134 (67%) were male and 66 (33%) female. The mean age of the study participants was 56.54 ± 9.51 years (range: $34 - 83$) years. In our study, most of the participants 79 (39.50%) under the age groups of $56 - 65$ years and followed by 77 (38.50%) were $46 - 55$ years. The mean values of HbA_1C, HDL, triglyceride, duration of hypertension were $7.27 \pm 2.64\%$ (range: $3.1 - 13.2$ %), 39.84 ± 7.65 (range: $20 - 65$) in mg/dl, 70.63 ± 11.94 (range: 44 - 116) in mg/dl and 6.22 ± 3.82 years (range: $3 - 24$ years) respectively. By Univariate analysis, there was a positive association between Type 2 DM and age was obtained by Spearman's rho (r)= 0.353, p<0.001 highly statistically significant. Negative association was found in between HbA_1C levels and DM, Spearman's rho (r) = 0.796, p<0.001 and which was highly significant. Triglyceride, HDL, Duration of DM were -0.388, -0.291, -0.571 respectively highly significant (p< 0.001) with the development or progression of DM.

In our study, the factors like age, gender, HbA_1C levels, HDL, triglyceride, family history of DM, duration of DM were statistically significant in Univariate analysis. But, in the Binary Logistic Regression model, all the factors were as statistically significant except the factor gender. From this analysis, the following results have been obtained that the Hosmer – Lemeshow test for goodness of fit shows that the chi-square value is 7.97 with p>0.05. HbA_1C was found to a strong independent risk factor of DM: OR = 3.26 (95% C.I: 2.63 – 4.64) and the family history of DM was also one of the independent strongest predictor of DM, OR = 5.73 (95%C.I: 3.60 – 7.91). In this study, we found the other independent risk factor for type 2 diabetes was as shown in the following **[Table – 1].**

Table: 1   List of all the variables in the equation and its Exp (B) and 95% Confidence Intervals

Variables in the equation	B	Sig.	Exp(B)	95% C.I. for EXP(B)	
				Lower	Upper
Age (X_1)	0.137	0.044**	1.147	1.004	1.310
Gender (X_2)	-1.051	0.341*	0.350	0.040	3.036
HbA_1C (X_3)	-2.507	0.000***	3.263	2.630	4.640
Triglyceride (X_4)	0.135	0.008***	0.874	0.790	0.966
HDL (X_5)	0.294	0.009***	0.745	0.598	0.928
Family history of DM (X_6)	3.927	0.004***	5.739	3.606	7.916
Duration of DM (X_7)	-0.597	0.041**	0.550	0.310	0.976
Constant (β_0)	**1.257**	**0.778***	**3.514**		

*Not Significant (p > 0.05)   **Significant (p < 0.05) ***Highly Significant (p < 0.01)

Odds Ratio: By substituting the significant clinical values of an individual without DM in the Binary Logistic Regression equation and it was given by,

$$Y = \beta_0 + \beta_1X_1 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7$$

Then, we found the Y value as follows.

Y = 1.645, From the Y – value we have found e^Y = 5.181,

From odds ratio formula,
$$\frac{P}{1 - P} = e^Y$$

We have got P – value as follows,

P = Probability of developing DM in an individual = 0.83 (or) 83% (in percentage)

IV.   Discussion:

In this study, we have found that the mean age was 56.54 ± 9.51 (Mean $\pm$ SD) years, the similar result have reported by Lerner N et al [7]. Age was the higher risk factor for developing Type 2 DM [22]. Gender didn't show any statistical association with the development of Type 2 DM have found by BalakrishnanValliyot et al [14]. In our study also, the gender wasn't a significant risk factor for developing Type 2 DM. In some other studies, HbA$_1$C levels and the family history of DM are the independent and strong risk factor for developing type 2 diabetes in an individual [7, 8, 9]. HDL is an independent risk factor of type 2 DM, the similar results have been found in Zietz B et.al [10]. HDL was a risk factor of development of non – insulin dependent diabetes in middle aged British men [11, 12]. A study was done by Amir Tirosh et al [13] and demonstrated that the changes in triglyceride levels in over a time and it became a risk factor for diabetes in healthy young men [12, 13]. Similar results were found in our present study that Triglyceride level is a risk factor for the progression or development of Type 2 DM in an individual.

BalakrishnanValliyot et al. [14] have reported that the genetic factor was a strong risk factor in the progression (or) the development of DM, the same report was given by RemaMet. al [15]. The same type of results was found in our present study. Another one study by Shashank R Joshi et al has suggested that the pedigree analysis was an excellent tool to study the genetic factor in development of Type 2 DM. From this study, the findings were very important in planning the prevention strategy and it will help to identify the potential individuals who have a high chance to develop DM [16]. Wisconsin Epidemiologic Study of Diabetic Retinopathy III (WESDR – III) study reported that a prevalence of 10.4% among siblings through family history [17]. Pincus G et. al and Taylor SI et. al were reported in their respective studies that a strong genetic association in the development of insulin resistance and the progression of Type 2 DM [18,19]. High blood pressure (hypertension) can lead to and make the worse many complications of diabetes and other diabetes related diseases. Most of the people with diabetes and development of hypertension during in their life period [20]. Hypertension is a most significant risk factor in the development of Type 2 DM [14, 22].   In our present study, the duration of hypertension in hypertensive persons was found as 6.22 ± 3.82 years. The similar result in the VALUE trial study was done in Norway by Aksnes TA et al [21] was reported that DM often develops in patients with hypertension and predictors of DM development in hypertensive's at risk of developing the disease.

V.   Conclusion:

This study concluded that the HbA$_1$C and the family history of DM are the most prominent and independent risk factors for the progression or developing Type 2 diabetes mellitus in a hypertensive adult individual. The other co-factors age, HDL, triglycerides, duration of hypertension were also independently associated with the development of DM except the factor gender. So, by testing the levels of Blood pressure (hypertension), HbA$_1$C, Triglycerides and HDL in their blood periodically and controlling them within the prescribed or under the normal level by using the available modern facilities then, one can prevent themselves from the progression or development of DM or postpone it to some extend in their life period.

Acknowledgement:

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