

Exposition of Discriminatory Variables in a Family of Hypertensive and Non hypertensive Diabetic Patients: A Case Study of Komfo Anokye Teaching Hospital – Kumasi, Ghana

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Abstract
This study sought to expose variable(s) capable of predicting hypertensive status of diabetic patients. To this end, data on 260 diabetic patients at the Komfo Anokye Teaching Hospital's Diabetic Centre in Ghana were collected using data extraction form.

The majority (144) of the 260 diabetic patients representing about 55% were also hypertensive as against 116 (45%) who were not hypertensive. Frequency analysis also revealed female dominance as far as the two diagnoses (Diabetes with hypertension and diabetes without hypertension) were concerned. However, the percentage of females in diabetes with hypertension (77%) was greater than the percentage of females in diabetes without hypertension (67%). The minimum age of hypertensive diabetic patients was 30 years as against 11 years for those diagnosed as non-hypertensive diabetic.

A discriminant analysis was adopted to expose the discriminatory variables as far as the two diagnoses were concerned. The study indicated a strong association between diagnosis (diabetes with hypertension and diabetes without hypertension) and body mass index (BMI), and to some extent, also between diagnosis and age. BMI and age were identified as principal discriminating variables for separating patients diagnosed with diabetes with hypertension from those with diabetes without hypertension.

The index of discrimination (canonical correlation) associated with the resulting discriminant model was 0.42 (42%). This is good since it is greater than 30. The hit ratio, (or the percentage of cases correctly classified) is 0.654 or 65.4%. Also, leave-one-out cross-validation which was used instead of an independent holdout sample correctly classified 64.2% of the cases.

Finally, it was concluded that ageing and extra BMI gained are risk factors for diabetic patients to develop hypertension. Therefore, the model was good for prediction.

Keywords: Diabetes, Hypertension, Model, Discriminant Analysis, Ghana

1. Introduction

The study sought to model and predict hypertensive diabetic and non-hypertensive diabetic patients. It sought to predict the presence or absence of a hypertension given that the person has diabetes, by finding out clearly which of the studied variables was responsible using discriminant analysis.

Diabetes is a medical condition whereby the body is unable to physiologically regulate Blood Glucose Level (BGL), resulting in too much glucose (a sugar) in the blood. There are basically two types of diabetes. These are Type 1 and Type 2. A person with Type 1 diabetes cannot make any insulin (the pancreas stops producing insulin). A person with Type 2 diabetes has adequate insulin, but the cells have become resistant to it or the body does not respond properly to it. The National Institutes of Health state that 95% of all diabetes cases are Type 2. The reason; it is a lifestyle disease, triggered by obesity, lack of exercise etc. Other factors are ageing and to some degree, genetic predisposition as reported in National High Blood Pressure Education Programme Working Group report on Hypertension in diabetes in 1994. The study as a results focused on Type 2 diabetes.

Hypertension on the other hand means High Blood Pressure (HBP). It is a medical condition that occurs when the pressure inside arteries is too high. Hypertension is an extremely common comorbidity of diabetes, affecting 20 - 60% of people with diabetes. Hypertension is also a major risk factor for cardiovascular events, such as myocardial infarction and stroke, as well as for microvascular complications, such as retinopathy and nephropathy. Cardiovascular disease is the most costly complication of diabetes and is the cause of 86% of deaths in persons with diabetes (Wingard and Barrett-Conner, 1995).

However, until recently, little research had been done specifically in patients with diabetes and hypertension. Among policy makers at international and national levels, awareness about the public health and clinical importance of diabetes and hypertension remains very low.

Epidemiological studies and therapeutic trials have often used different criteria to define hypertension in diabetic patients. Studies in the general population indicate an increased risk of cardiovascular disease with an increase in the level of blood pressure. Thus, an increase in diastolic or systolic blood pressure of 5 mmHg is associated with a concomitant increase in cardiovascular disease of 20 - 30% (MacMahon et al, 1990). Studies in diabetic populations have shown a markedly higher frequency of the progression of diabetic retinopathy when diastolic blood pressure is in excess of 70 mmHg (Janka et al, 1989).

Blood pressure (BP) is usually represented as two numbers, for example: 116/72 or 116 over 72. The top number is called the systolic pressure. It indicates the peak pressure in the arteries generated when the heart beats. The bottom number is called the diastolic blood pressure. It indicates the pressure in the arteries when the heart is relaxing between heartbeats.

Clinical indicators such as blood haemoglobin (Hb), BP, and BGL of a healthy person may not be the same when the person is not healthy. While results from laboratory with respect to a person's blood type, presence or absence of disease pathogens, blood haemoglobin etc. constitute the main determinants of presence or absence of a particular disease in the person, one cannot ignore the effects of some risk factors (e.g. age, sex, weight, height, etc.) which expose people to be less or more prone to the acquisition of some diseases, of which diabetes and hypertension may not be exception. Most recent studies have found obesity which is measured by body mass index (BMI) as a risk factor for developing hypertension (Vega, 2001).

People sometimes acquire certain diseases as a result of their lifestyles. Sometimes, knowingly or unknowingly, people prepare fertile grounds for diseases to thrive. Some of these are excessive drinking of alcohol, smoking, eating habit, lack of regular exercise etc.

Researchers continue to find risk factors for the various cardiovascular diseases but a key question that still remains unanswered is why some people develop only diabetes and others are living with both diabetes and hypertension. This study attempts to provide answers to this key question by searching for determinants discriminating people living with diabetes and hypertension from those who live with diabetes alone.

The significance of the study stems from the fact that diabetes and hypertension are life threatening medical conditions all over the world. According to World Health Organisation (WHO) and International Diabetes Federation (IDF) report in 2004, 3.2 million deaths are attributable to diabetes alone every year worldwide. The report stated that, one in 20 deaths is attributable to diabetes; 8700 deaths every day; 6 deaths every minute.

In 2002, a report in American Family Physician, a peer-reviewed journal, stated that hypertension and diabetes mellitus are common diseases in the United States and that patients with diabetes have a much higher rate of hypertension than would be expected in the general population (Harris et al, 1998). Moreover, hypertension is twice as common in persons with diabetes as it is in others (Epstein and Sowers, 1992). Similar study has reviewed that hypertension is an extremely common comorbidity of diabetes, affecting 20 - 60% of people with diabetes (Wingard and Barrett-Connor, 1995). The report stated that prevalence of hypertension in the diabetic population is 1.5 - 3 times higher than that of non-diabetic age-matched groups. National High Blood Pressure Education Program Working Group report on hypertension in diabetes states that "Obesity may be a common link between the two disorders".

A study conducted to determine the prevalence of hypertension in newly diagnosed type 2 diabetic patients and its association with risk factors for cardiovascular and diabetic complications. A cross-sectional study was employed to select newly diagnosed type 2 diabetic patients (n = 3648, mean age 52 years, 59% male) recruited for the UK Prospective Diabetes Study (UKPDS). Some of the measurements taken were blood pressure, body mass index, and waist-hip ratio (Turner, 1993). In the end, the results was that hypertensive patients had a greater mean body mass index (30.1 versus 28.0 kg/m2, $P < 0.0001$) than the normotensive patients. They also had higher fasting plasma triglyceride (1.94 versus 1.69 mmol/l, $P < 0.0001$) and insulin (15.0 versus 12.8 mU/l, $P < 0.0001$) levels but these associations disappeared or weakened when obesity was taken into account. The conclusion was that hypertension is common in newly diagnosed type 2 diabetes and is associated with obesity.

In 2002, guidelines from the American Diabetes Association (ADA) and National Kidney Foundation (NKF) recommended that blood pressure be decreased to less than 130/80 mm Hg, with an optimal target of below 120/80 mm Hg, especially in patients with proteinuria or renal insufficiency. The study pointed out that strategies to attain this goal include lifestyle modifications and pharmacologic therapy.

In the Dietary Approaches to Stop Hypertension trial, lifestyle modifications such as exercise and a diet low in salt and high in potassium have clearly been shown to decrease blood pressure (Moore et al, 2001).

2. Materials and Methods

2.1 The Research Design

The study was carried out at the Diabetic Centre of Komfo Anokye Teaching Hospital in Kumasi in Ashanti Region, Ghana. The hospital was established in 1955 and became a Teaching Hospital in 1975, for the training of medical students from Kwame Nkrumah University of Science and Technology (KNUST), School of Medical Sciences (SMS), Kumasi in Ashanti Region, Ghana.

The Diabetic Centre which is a specialist centre was however set up in 2000 to treat and manage diabetic patients. The centre is therefore a referral centre where diabetic patients are referred to.

The target population was the population diagnosed with diabetes in Ghana. The study population was the population diagnosed with diabetes at Komfo Anokye Teaching Hospital-Kumasi. Cluster sampling was adopted to select the clients to be part of the study. The various clinic days in September, 2014 were considered as clusters because of the heterogeneous nature of the clients with respect to their hypertensive status, gender, and background. Information from the clients' folders from the selected clusters was recorded. Because of inadequate information in the clients' folders, the clients were contacted to respond to some additional questions.

The procedure was that, after interviewing the client, his or her folder would be traced and the rest of the information captured from the folder. A well-designed data extraction form was used to collect the needed information from the clients and their folders. As a result, the nature of the research design was conclusive. The extracted information was subjected to vigorous quantitative analysis. The research tested specific hypotheses and examined the strength of the model.

Descriptive research design was employed. A clear statement of the problem, a prior formulation of specific hypotheses and detailed information needs were stated. Also, the needed information was collected from the sample of the population elements only once and this made the study a cross-sectional. The study employed single cross-sectional design. This means that only one sample of respondents from the study population was involved in the study. In all, 260 diabetic patients were involved in the study.

The analysis of the data was divided into two: the first part was purely descriptive analysis. The second part which was largely inferential analysis focused on discriminant analysis: testing of model adequacy, parameter estimation and testing, correlation, and classification analysis. The analyses were carried out using Statistical Product and Service Solution (SPSS: IBM version 20). The variables under consideration here are age, weight, height, Systolic pressure, diastolic pressure, blood glucose level (BGL).

2.2 Measured Variables

Classification Variables

The information were obtained from the diabetic patients using the following measured variables. Classification variables such as gender of the patients: (Male or Female), the age of the patients (Below 25yrs, 25- 35, 36-59 and, 60 and above). With regards to the age, the actual ages of the patients were also recorded.

Marital status of the patients were also sought (Single, Married, Divorced Widowed and Other). The educational level of the patients (None, First cycle, Second cycle, Tertiary, and Other). Again, the occupation of the patients were sought (Student, Civil Servant, Retired, Farming, Trading, Industry, Unemployed, and Other).

Lifestyles and Risk Variables

Quite a number of lifestyle and risk variables were measured. Majority of these variables were dichotomous ('Yes' or 'No' responses). These include the smoking status, alcoholism, salt usage, and exercise with reference to their past. In addition to the above, the weights and heights of the patients were also measured. The weights and the heights were subsequently used to derive the patients' body mass index (BMI).

Patients' Clinical Indicators and Family Clinical History

The following clinical indicators of the patients and their family clinical history were also recorded. Among them are the blood pressure (systolic and diastolic) and the blood glucose level. The hypertensive status of the diabetic patients (diabetes with hypertension or diabetes without hypertension) were also recorded.

The study also sought to know from those who reported diabetes with hypertension, which of the conditions (hypertension and diabetes) they developed first, the number of years the second condition was developed after the first condition.

We wish to indicate that for the purposes of the selected model, not all the measured variables were used.

2.3 The Model Specification: *Theory of Discriminant Analysis*

In order to achieve the objectives, discriminant function analysis was used to provide a model for sorting the diabetic patients into those suffering from diabetes with hypertension and those suffering from diabetes without hypertension. The intention was to see which of the studied variables discriminates between the two medical conditions (diabetes with hypertension and diabetes without hypertension) and construct the model base on that. All the independent variables used were continuous in order to satisfy the condition of discriminant analysis which does not make use of categorical independent variables.

Discriminant analysis model is useful for situations where we want to build a predictive model of group membership based on observed characteristics of each case. The procedure generates a discriminant function (or, for more than two groups, a set of discriminant functions) based on linear combinations of the predictor variables that provide the best discrimination between the groups. The functions are generated from a sample of cases for which group membership is known; the functions can then be applied to new cases with measurements for the predictor variables but unknown group membership. Unlike regression analysis, the dependent variable is always categorical while the independent variables are wholly continuous variables.

Here, based on some measurements and indicators of variables that the researcher thinks they are important for discriminating between for instance people diagnosed with diabetes with hypertension and those diagnosed with diabetes without hypertension, we would want to combine some information (variables) in a function to determine how well a variable can discriminate between the two groups of people.

The Discriminant function $D = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$, where *D*, the dependent variable, is the discriminant score, β_S are the discriminant coefficients or weights and X_S, are the predictor variables or independent variables. It allows one to estimate coefficients of the linear discriminant function, which looks like the right side of a multiple linear regression equation. The coefficients, or weights (β_S), are estimated so that the groups differ as much as possible on the values of the discriminant function. This occurs when the ratio of between-group sum of squares to within-group sum of squares for the discriminant scores is at a maximum. Any other linear combination of predictors will result in a smaller ratio. For instance, assuming $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \ldots\ldots, \beta_k$, are the coefficients for age, weight, height, BP, Hb, up to the last variable *k* respectively, then the corresponding discriminant analysis model is given by $D = \beta_0 + \beta_1(\text{age}) + \beta_2(\text{weight}) + \ldots + \beta_k(\text{variable}\,k)$. If these variables are useful for discriminating between the two groups of people, the values of *D* will differ for the two groups of people. This test is carried out by a test statistic called Wilks' lambda (Wilks' λ).

3. Results

3.1 Presentation of the Results of the Preliminary Analysis

The majority (55%) of the diabetic patients were also hypertensive. As one of the clients said, quote "We are told that the two conditions (diabetes and hypertension) are couple" unquote. Frequency analysis also revealed female dominance as far as the two diagnoses were concerned. However, the percentage of females in diabetes with hypertension (77%) was greater than the percentage of females in diabetes without hypertension (67%).

Table 1: *Comparative Analysis of Descriptive Statistics of the Diagnoses*

Diagnosis	Variables	Sample Size	Minimum Value	Maximum Value	Mean
Diabetes with hypertension	Age (yrs)	144	30	82	55.5
	Weight (kg)	144	34.0	122.6	70.7
	Height (metres)	144	1.18	1.81	1.63
	BMI	144	14.38	54.58	26.84
	Systolic BP	144	130	240	132
	Diastolic BP	144	70	140	80
	BGL	144	6.2	33.2	14.3
Diabetes without hypertension	Age (yrs)	116	11	80	46.5
	Weight (kg)	116	31.2	116.7	63.6
	Height (metres)	116	1.45	1.89	1.63
	BMI	116	14.85	41.84	23.84
	Systolic BP	116	100	170	132
	Diastolic BP	116	60	110	80
	BGL	116	4.4	37.5	14.3

The minimum age of hypertensive diabetic patients was 30 years as against 11 years for those diagnosed as non-hypertensive diabetic. The minimum and maximum values of most of the studied variables have been provided in Table 1. The mean BMI of the hypertensive diabetic clients (26.83) kg/m^2 is higher than that of the non-hypertensive diabetic clients (23.84) kg/m^2. Obviously, we were not expecting both the systolic BP and diastolic BP of the two different clients to be the same since HBP means hypertension. The mean BGL of the hypertensive diabetic clients (13.660)mmHg is quantitatively not much different from that of the non-hypertensive diabetic clients (14.333)mmHg. However, in the final analysis, we will find out whether the differences being observed here are true differences or not.

3.2 Discriminant Analysis Model Specification

The statistical tool adopted is discriminant analysis as indicated in the methodology. All analyses assume the risk value (α) = 0.05 level of significance.

The null hypothesis that, in the population, the means of all discriminant functions in all groups are equal was statistically tested. The test statistic; Wilks' λ, associated with the function was 0.826, which was transformed to chi-square: $\chi^2(2,\ N = 260) = 49.123,\ p = 0.000 < 0.05.$ This is statistically significant beyond the 0.05 level of significance (i.e. there is a significant discrimination and that the variables discriminate between the groups). From the group means and standard deviations in Table 2, it appears that the two groups are more widely separated in terms of age than the other variables. This is followed by BMI and BGL in that order.

Table 2: *Group Means and Standard Deviations*

Diagnosis	Variable	Mean	Std. Deviation
Diabetes with hypertension	Age	55.5000	10.31124
	BMI	26.8356	5.59632
	BGL	13.6597	4.57702
Diabetes without hypertension	Age	46.5345	15.14649
	BMI	23.8391	4.68472
	BGL	14.3328	5.59095
Total	Age	51.5000	13.43524
	BMI	25.4987	5.40959
	BGL	13.9600	5.05552

This is supported by the fact that age has the smallest univariate Wilks' λ = 0.890. There also appears to be more of separation on BMI (Wilks' λ = 0.924) than BGL (Wilks' λ = 0.996).

The above revelation (the rank order of importance of the variables) is again boosted by the relative magnitude of the structure correlations (discriminant loadings) given in Table 3 below. The structure correlations represent the simple correlations between the predictor variables and the discriminant function. The higher the correlation (loading), the more important the variable in question is to the formation of the discriminant function.

Table 3: *Structure Correlation Matrix*

No.	Variable	Structure Correlation
1	Age	0.768
2	BMI	0.625
3	BGL	- 0.161

In this case, age (0.768) is the most important variable, followed by BMI (0.625) and BGL (- 0.161) in that order.

The pooled within-groups correlation matrix indicates low correlations between the predictors as the correlations ranged from – 0.020 to – 0.160. Clearly, none of them was anywhere near -1 or 1. Therefore, multicollinearity (interdependency or interrelationship of the predictor variables) is unlikely to be a problem. Multicollinearity is not a desirable property in discriminant analysis.

The significance of the univariate F ratios indicates that when the predictors are considered individually, age; Wilks' λ = 0.890, F (1, 258) = 32.038, (p-value = 0.000 < risk value = 0.05) and BMI; Wilks' λ = 0.924, F (1, 258) = 21.253, (p-value = 0.000 < risk value = 0.05) significantly differentiate between hypertensive and non-hypertensive diabetic patients. BGL [Wilks' λ = 0.996, F (1, 258) = 1.139, (p-value = 0.287 > risk value = 0.05)] was however not a significant discriminator.

Because there are two groups, only one discriminant function was estimated. The unstandardized canonical discriminant function coefficients (eigenvector weights) for age, BMI and BGL are used to form the unstandardized discriminant functions below;

$$\mathrm{D}^{\bullet} = -6.366 + 0.062(\mathrm{Age}) + 0.123(\mathrm{BMI}) + 0.003(\mathrm{BGL}) \qquad (1)$$

and

$$\mathrm{D}^{\bullet\bullet} = -6.302 + 0.061(\mathrm{Age}) + 0.123(\mathrm{BMI}) \qquad (2)$$

where $D^{\bullet}$ is the linear combination of the initial unstandardized discriminant function and $D^{\bullet\bullet}$ is the linear combination of the final unstandardized discriminant function. Equation (1) which is the initial model, includes all the selected variables and Equation (2) which is the final model, includes only the significant variables.

The eigenvalue associated with the function (Equation 2) is 0.21 and it accounts for 100 percent of the explained variance. The canonical correlation, an index of discrimination, associated with the function is 0.42, which is worthwhile to interpret since it is greater than 0.30. This measures the extent of association between the discriminant scores and the groups. It is a measure of association between the single discriminant function and the set of dummy variables that define the group membership. The square of this correlation, $(0.42)^2 = 0.18$, indicates that 18 percent of the variance in the dependent variable (diagnosis) is explained or accounted for by the model. Also, the discriminant functions based on the standardized canonical discriminant coefficients are given by:

$$D^{\circ} = 0.782(\text{Age}) + 0.643(\text{BMI}) + 0.017(\text{BGL}) \qquad (3)$$

and

$$D^{\circ\circ} = 0.780(\text{Age}) + 0.641(\text{BMI}) \qquad (4)$$

where 3 and 4 are the initial and final models respectively. D° and $D^{\circ\circ}$ are the linear combinations of the initial and final standardized discriminant functions respectively. Note that in the absence of multicollinearity as we have witnessed here, the magnitude of the standardized coefficients can serve as rank order of importance of the variables similar to the magnitude of the structure correlation matrix. The standardized coefficients are used as multipliers when the variables have been standardized to a mean of 0 and a variance of 1.

Table 4: *Classification Results Based on the Analysis Sample*

			Predicted group membership		
Diagnosis			Diabetes with hypertension	Diabetes without hypertension	Total
Original	Count	Diabetes with hypertension	98	46	144
		Diabetes without hypertension	44	72	116
	%	Diabetes with hypertension	68.1	31.9	100.0
		Diabetes without hypertension	37.9	62.1	100.0
Cross-validated	Count	Diabetes with hypertension	97	47	144
		Diabetes without hypertension	46	70	116
	%	Diabetes with hypertension	67.4	32.6	100.0
		Diabetes without hypertension	39.7	60.3	100.0

Table 4 shows the classification results based on the analysis sample. Cross validation was done only for those cases in the analysis. In cross validation, each case is classified by the function derived from all cases other than that case. The hit ratio, (or the percentage of cases correctly classified) wsa calculated to be 0.654 or 65.4%. Also, leave-one-out cross-validation which was used instead of an independent holdout sample correctly classified 64.2% of the cases.

4. Discussion

The majority (144) of the 260 diabetic patients representing about 55% were also hypertensive as against 116 (45%) who were not hypertensive. Frequency analysis also revealed female dominance as far as the two diagnoses (Diabetes with hypertension and diabetes without hypertension) were concerned. However, the percentage of females in diabetes with hypertension (77%) was greater than the percentage of females in diabetes without hypertension (67%).

The dominance of hypertensive patients in the diabetic family is supported by the 2002 report in American Family Physician, a peer-reviewed journal, which stated that hypertension and diabetes mellitus are common diseases in the United States and that patients with diabetes have a much higher rate of hypertension than would be expected in the general population. Moreover, hypertension is twice as common in persons with diabetes as it is in others (Epstein and Sowers, 1992). Again, the results is similar to a study conducted by Wingard and Barrett-Connor in 1995 which reviewed that hypertension is an extremely common comorbidity of diabetes, affecting 20 - 60% of people with diabetes. The report stated that prevalence of hypertension in the diabetic population is 1.5 - 3 times higher than that of non-diabetic age-matched groups.

From Table 1, the mean BMI of the hypertensive diabetic clients (26.84) kg/m^2 is higher than that of the non-hypertensive diabetic clients (23.84) kg/m^2. Our discriminant analysis clearly found BMI significant in predicting who is hypertensive diabetic and it completely agrees with the report that "obesity may be a common link between the two disorders" by National High Blood Pressure Education Program Working Group in 1994.

In fact, our finding was also in line with a study conducted to determine the prevalence of hypertension in newly diagnosed type 2 diabetic patients and its association with risk factors for cardiovascular and diabetic complications. A cross-sectional study was employed to select newly diagnosed type 2 diabetic patients (n = 3648, mean age 52 years, 59% male) recruited for the UK Prospective Diabetes Study (UKPDS). Some of the measurements taken were blood pressure, body mass index, and waist-hip ratio. At the end, the results was that hypertensive patients had a greater mean body mass index (30.1 versus 28.0 kg/m2, $P < 0.0001$) than the normotensive patients. They also had higher fasting plasma triglyceride (1.94 versus 1.69 mmol/l, $P < 0.0001$) and insulin (15.0 versus 12.8 mU/l, $P < 0.0001$) levels but these associations disappeared or weakened when obesity was taken into account (Turner et al, 1993). The conclusion was that hypertension is common in newly diagnosed type 2 diabetes and is associated with obesity.

The most recent guidelines from the American Diabetes Association (ADA) and National Kidney Foundation (NKF) recommend that blood pressure be decreased to less than 130/80 mm Hg, with an optimal target of below 120/80 mm Hg, especially in patients with proteinuria or renal insufficiency.(American Diabetes Association, 2002).

The minimum age of hypertensive diabetic patients was 30 years as against 11 years for those diagnosed as non-hypertensive diabetic. The mean age of the hypertensive diabetic patients was 55.5 years as against that of non-hypertensive diabetic patients, 46.5 years. The discriminant analysis also found age a significant predictor of a diabetic hypertensive patient. This implies that a diabetic patient must check his/her hypertensive status when ageing.

5. Conclusion

The discriminant model obtained from the study is appropriate for discriminating between hypertensive diabetic and non-hypertensive diabetic patients. We believe that the model will go a long way to help health professionals and researchers in their campaign to sensitize the general public about diabetes and hypertension and carry out further research in the area respectively.

The variables responsible for discriminating between the two medical conditions (diabetes with hypertension and diabetes without hypertension) are age and BMI of the patients.

Finally, we concluded that ageing and extra BMI gained are risk factors for diabetic patients to develop hypertension in addition. The model is good for prediction and has overall correct classification of 66.5 percent.

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