Applied Mathematical Sciences, Vol. 6, 2012, no. 66, 3259 - 3266

Influence of Hypertension and Diabetes Mellitus on Family History of Heart Attack in Male Patients

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Abstract

The aim of this study was to evaluate the influence of hypertension and diabetes mellitus on family history of heart attack. According to previous research findings, both hypertension and diabetes mellitus increases the chance of having a stroke, heart attack, heart failure and kidney disease. Patients with diabetes and hypertension have a higher incidence of coronary artery disease compared to the patients with diabetes or hypertension alone. In this present paper, we present the results that gained from multiple logistic regression method and biplot analysis. The logistic regression method was used to model the relationship between the ordinal outcome variable while biplots is a graphical plot that representing relationship between categories and between variables. This can provide a useful model for patient assessment and provide essential information to guide the treatment of person's management.

Keywords: Biplot Analysis and Logistic Regression

INTRODUCTION

At present, most of people lifestyles have grown very hectic due to the busy lifestyles. Consequently, the time for rest and relaxation become very limited. Excess workload from office has caused psychological tensions. This situation in our body can be translated as tensions raise the adrenaline in the blood and this causes our blood pressure rise. When the blood pressure rise, the pressure force blood against the walls of arteries. This increases the risk of stroke, aneurysm, heart failure, heart attack and kidney damage [4]. High blood pressure and diabetes mellitus share certain physiological traits and they usually tend to occur together. Patient with diabetes mellitus will increases the amount of fluid in the body, when fluid in the body increase, it will lead to corresponding increases in blood pressure [6]. Besides that, diabetes also increased arterial stiffness and it decreases the ability of the blood vessels to stretch. As a result the averages of blood pressure increase. According to the previous research, researcher found that common biological traits of the two diseases are likely to occur together simply because they share a common set of risk factors [3].

In this paper, patient with high blood pressure and diabetes mellitus have been analyzed in order to identify the factors that contribute to the heart attack. Fort the purpose of this study, we have employed the medical data. The main objective of this paper is to identify the factor that associated with these diseases. The advantage of such model is that, we can make some statistical inferences concerning some aspect of a study.

DATA AND METHODS

For the first objective we studied male patients with high blood pressure and type 2 diabetes mellitus. A total of 92 eligible patients were selected. They were diagnosed to have diabetes mellitus and high blood pressure (140mmHg or higher) based on WHO criteria. A fasting plasma glucose level >126 mg/dl (7.0 mmol/l) or a casual plasma glucose >200 mg/dl (11.1 mmol/l) meets the threshold for the diagnosis of diabetes. The selected variables are: Family history of heart attack (Fhha), total cholesterol (Choltot), incident (new) coronary heart disease (Incchd) and Height (cm). For the second objective, we explain the links between the variables (hypertension, diabetes incident of coronary heart disease (Incchd), height, total of cholesterol level (Choltot) and family history of heart attack (Fhha)) through biplot technique which is applying the multivariate PCA technique.

Sample size calculation for the first objective:

The calculation of sample size can be done using Power and Sample Size Calculation (PS) software or manual calculation, with the significance level (α) 0.05 and the power of study (1-β) of 80%. The detectable hazard ratio of the presence of prognostic factor relative to absence of prognostic factors was decided by the researcher and expert opinion by clinicians [5]. Below is the Two Proportions formula:

$$n = \frac{p_0(1-p_0)+p_1(1-p_1)}{(p_0-p_1)^2}(z_\alpha + z_\beta)^2$$

where:

P_0 = Based on literature review

P_1 = Based on expert opinion

$z_\alpha = z_{0.05} = 1.9600$ (one tailed)

$z_\beta = z_{0.20} = 0.8416$ (one tailed)

Table 1.1 Sample Size Calculation

No	Objective	*P_1	P_0	Type 1 error	Power	Sample Size
1	Patients with diabetes and hypertension having a heart attack. [4]	0.13	0.40	5%	80%	38 patients

Calculation

$$n = \frac{0.13(1-0.13)+0.40(1-0.40)}{(0.13-0.40)^2} \times (1.96+0.84)^2 = 37.97 \approx 38 \text{ patients}$$

After adding 20% estimated missing data, we get $n = 38 + (0.2 \times 38) = 45.6 \approx 46$ per group, which can be obtained as follows:

i. Patients with heart attack among hypertension and diabetes patients = 46 patients

ii. Patients with Non-heart attack among hypertension and diabetes patients = 46 patients

Therefore, a total patient to be sampled is $(46 \times 2) = 92$ patients.

Sample size calculation for the second objective:

The sample sizes required at analysis stage are as follows.

Anticipated population proportion (p) = 0.5

Level of significance = 5% (0.05)

Absolute precision (Δ) = $\pm 5\%$

$$= \left(\frac{1.96}{0.05}\right)^2 0.5(1-0.5)$$

$$= 384.16 \approx 385 \text{ respondents.}$$

According to Lwanga and Lemeshow, [7].

In this case the response rate is estimated at only 75%, then add another 25% for data collection stage. So, we get $n = 385 + (0.25 \times 385) = 481.25 \approx 482$. Samples of 482 respondents are required at the analysis stage. For this analysis, we use 482 respondents.

Logistic Regression Models

To explore the underlying association between family history of heart attack (FHHA) and the selected explanatory variables, a set of logistic regression models is fitted in this section. Let us define the following dichotomous variables for the family history of heart attack.

$Y = 0$ if there is no family history of heart attack

$Y = 1$ if there is family history of heart attack

Then let us define the following model:

$$G(X) = \beta_0 + \beta_1 \text{ Incchd} + \beta_2 \text{ Choltot} + \beta_3 \text{Height}$$

Then the logistic regression models for the above is

$$P(Y_{ij} = 1 \mid X_{ij}) \frac{e^{g(X_{ij})}}{1 + e^{g(X_{ij})}}$$

Table 1 shows the estimates for model above. It is clearly observed from the results that Incchd ($p<0.25$) has been positively associated with the Fhha. Choltot ($p<0.25$) and height ($p<0.25$) negatively associated with the Fhha ($p<0.25$). Mickey and Greenland (1989) recommendation that 0.25 level be used as a screening criterion for variable selection in logistic regression. According to them, traditional level (such as 0.05) often fails to identify variables known to be important.

Table 1. Estimates of parameters of logistic regression model for hypertension and diabetes mellitus on family history of heart attack.

Variables	Beta	S.E.	Wald	df	Sig.	Exp(B)
Incchd	0.968	0.488	3.924	1	0.048	2.631
Choltot	-0.008	0.006	1.493	1	0.222	0.992
Height	-0.048	0.034	1.979	1	0.160	0.953
Constant	8.738	6.044	2.090	1	0.148	6233.180

Notes : All the significant at 25% level

We can write the result as;

Predicted logit of (FHHA)

$$= 8.738 + 0.968 \times \mathit{Incchd} + (-0.008) \times \mathit{Choltot} + (-0.048) \times \mathit{Height} \qquad (1)$$

According to the model a three-predictor logistic model was fitted to the data. From the model, Incchd ($p<0.25$) and was positively related to FHHA, Choltot ($p<0.25$) and Height ($p<0.25$) variables were negatively related to FHHA. For each point increase on the Choltot score, the odds of being FHHA decrease from 1.0 to $e^{-0.008} (= 0.9920)$ and for the Height it is decrease from 1.0 to $e^{-0.048} (= 0.9531)$. The statistical significance of individual regression coefficient is tested by using

Wald Chi-Square Statistic (Table 1). According to the Table, Incchd, Choltot and Height were significant predictors. The inferential goodness-of-fit test is the Hosmer-Lemeshow (H-L), [2] test that yielded a $\chi(3)$ of 6.912 and was insignificant $(p > 0.05)$, suggesting that the model was fit to the data well. In other words, the null hypothesis of a good model fit to data was tenable (Hosmer and Lemeshow, 2000)

Receiver Operating Characteristic Curve (ROC)

The ROC curve is a fundamental tool for diagnostic test evaluation. It's a graphical plot of the sensitivity which measure of the overall performance of a diagnostic test. ROC Curve take on any value between 0 and 1, since both the *x* and *y* axes have values ranging from 0 to 1. The closer the area is to 1.0, the better the test is, and the closer the area is to 0.5, the worse the test is. The larger the area, the better the diagnostic test achieved. If the area is 1.0, we have an ideal test, because it achieves both 100% sensitivity and 100% specificity. If the area is 0.5, then we have a test which has effectively 50% sensitivity and 50% specificity, Ahmad et al. [8, 9]. In practice, a diagnostic test is going to have an area somewhere between these two extremes.

Table 2. Area Under the Curve

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.627	0.042	0.004	0.545	0.709

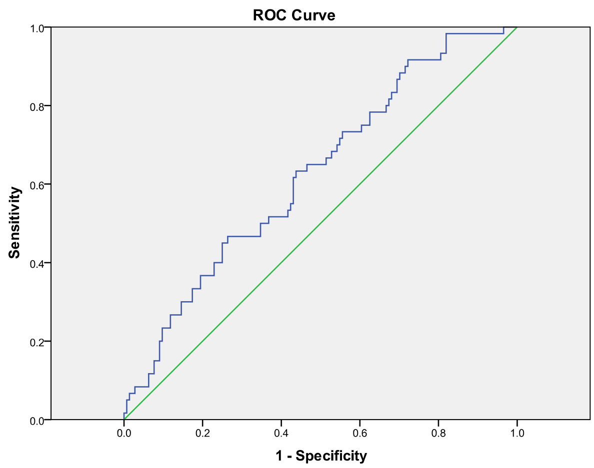

Fig.1. ROC Curve

Area under the ROC curve is 0.627 (95% CI: 0.545, 0.709). It is significantly different from 0.5 (p-value <0.05). The model can accurately discriminate 62.7% of the cases.

Biplot

In another attempt to explain the links between the variables, we applied the multivariate PCA technique to the most relevant of the previously considered variables for patients with high blood pressure and Type II Diabetes Mellitus. The resulting biplot graph (Figure 2) suggests that, cholesterol level, coronary heart disease and family history of heart attack are near hypertension while the height close to normal blood pressure. Borderline is not associated with any particular studied variables.

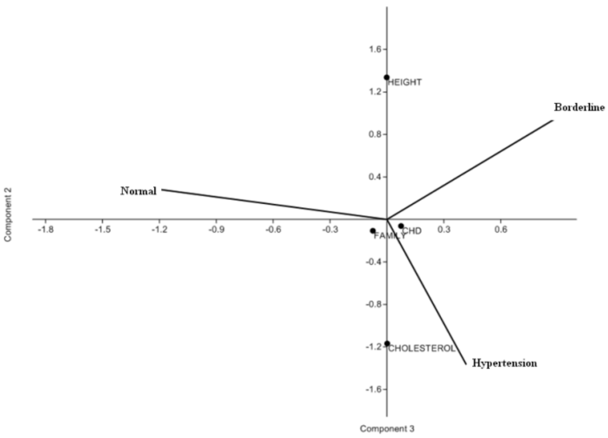

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Fig.2. Biplot of the two principal components obtained by PCA (Hypertension variable with other study variables)

Using the same data we extend the analysis with the three different diabetes status (normal, borderline and diabetes). The output of the result in the Figure 3 suggests that, coronary heart disease and family history of heart attack are near borderline of diabetes disease while the height closes to diabetes [1], point out that the adult height is negatively associated with the risk of diabetes. The results from biplot above shows that the variables of height is associated with diabetes disease.

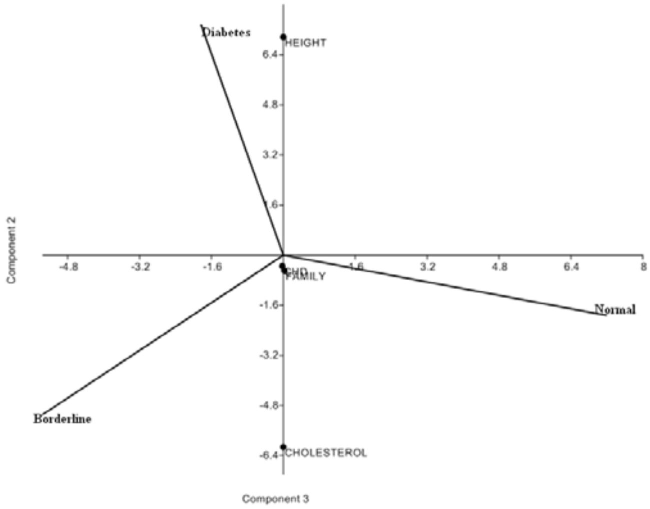

Fig.3. Biplot of the two principal components obtained by PCA
(Diabetes variable with other study variables)

SUMMARY AND CONCLUSIONS

Over the last decade the logistic regression model has become a standard method of analysis in many situations. Logistic regressions are used extensively in the medical research and also help to make medical decisions. This paper examines the factors that influencing the hypertension and diabetes mellitus on family history of heart attack. We used, two different methods

(i) Multiple Logistic Regression Models
(ii) Biplot Analysis

The first model uses the binary logistic model for explaining the probability of occurrence of heart attack within patient which suffering from diabetes and hypertension. There are three variables (Incident of coronary heart disease, total of cholesterol and height) were identified to the relationship of probability of family history heart attack. It is surprising that, the incident of coronary heart disease occurs almost three times $(\hat{\varphi} = 2.6)$ as often among patients with family history heart attack than patients with non-family history heart attack in the study population. The results from biplot (see Figure 2) suggest that family history heart attack, coronary heart disease and cholesterol are near to hypertension status. This indicates that they are strongly correlated to each other. The variable height is near to borderline of hypertension. This finding may provide us with a better understanding of the relation among the variables

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Received: February, 2012