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Visual Status of DM Patients and Some of Its Causal Parameters: A Case Study from Rajshahi Medical College Hospital

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Abstract

The aim of the study is to investigate the visual status of the diabetic mellitus patients using authors' surveyed data from Rajshahi Medical College Hospital, Bangladesh. As the causal parameters influencing visual status, suitable combinations of probable potential variates are designed and tested for independence. The association of visual status with regularity in 'Visit to Doctor for Visual Status (VisitD)', 'Family History of Diabetes (DiaHF)', 'Diabetes Sufferings Time (DiaSuf)', and 'Body Mass Index (BMI)' has been assured by the chi-square statistic. Further, the value of statistic of the logistic regression with binomial link confirms of having significant joint effect of the predictors to the model. The complexity of visual status effect is ascertained by odds of the logit model may reduce with the increasing BMI and having DiaHF. Although negative contribution of short time diabetes sufferings group is assessed in comparison with long time sufferings group for DiaSuf, positive contribution of groups 'Visit regularly', and 'Visit when need' have been found in comparison to 'Don't visit doctor' of the parameter VisitD.

As family history of diabetes is beyond our control, keeping BMI in the optimal level and maintaining regularity in visiting doctor together with proper management of diabetes, visual status may remain in good level that could be an important massage for the concerning patients and the related health sectors of the country.

Keywords: Diabetes mellitus; Visual status; Ophthalmology; Categorical analysis; Chi-square test; Odds ratio; Body mass index

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Introduction

As serious problem blindness has been identified in the world by the World Health Organization (WHO). Such risk of visual impairment may cause by some factors. The emotional distress and low socialization [1,2] are considered as the nuisance of quality life and occurring of such problem are noticed as 0.5% for Singapore, 0.3%, for Malaysia, 0.6%, for Taiwan, 4.3% for India and 1.5% for Bangladesh. The scarcity of balanced diets and the aforesaid cause may affect somewhat the visual status of the people of Bangladesh as well as the countries in the subcontinent. WHO declared that 161 million person's world-wide have visual impairment including 37 million blind and 124 million with visual impairment less severe than blindness following their estimation. Due to uncorrected refractive error 82 to 117 million people are suffering from visual impairment problem is remarkable [3].

Actually, blindness is the level of visual acuity and it can be defined either in terms of best-corrected distance visual acuity or presenting distance visual acuity in the better eye. The visual acuity are considered as it confined in the levels of <3/60 or <6/60 in the better eye [4,5]. Refractive error is noted as one of the leading causes of visual impairment in the different parts of the world [6]. Sometimes visual acuity may cause the poor vision due to uncorrected high refractive error and sometimes that are found to be happen in the school-going children.

Mondal et al. [7] conducted a hospital-based study in a girls' high school in Tarakeswar, Hooghly of West Bengal, India. They assessed the proportion of visual acuity and visual impairment among the students in a Rural High School along with its association with covariates of some other

Table 1: Summary statistics of assigned variables of visual status.

Variable	Category	n	%	Variable	Category	n	%
Sex	Female	44	61	DiaSuf	Long Time	31	43.1
	Male	28	39		Short Time	41	56.9
BMI	15 to 20	4	5.6	DiaHF	No	56	77.8
	20 to 25	16	22		Yes	16	22.2
	25+	52	72	VisitD	No	37	51.4
MSta	Married	57	79		When need	16	22.2
	Un-Married	13	18		Yes	19	26.4
	Widow	2	2.8	DiaConM	Food Control	6	8.3
ResSta	Rural	55	76		Insulin	15	20.8
	Urban	17	24		Tablet	51	70.8

factors. Among the socio-demographic factors the authors were taken Age, Religion, Education of Father and Per Capita Income (PCI) as socio-demographic variables. Diet and physical factors had no role with visual acuity was identified by their study. Lamoreux et al. [8] accomplished a study on the Singapore Malay Eye population to determine the prevalence and impact of visual impairment. They recognized the association between visual impairment and the main causes of vision loss, and falls. Marzieh et al. [9] Studied using cross-sectional data of 40 years to 80 years adults aged residing in Yazd district using the data of period 2010 to 2011 and they were determined the prevalence and causes of blindness and visual impairment. Cataract is one of the main causes of blindness over the world and the significance of identifying factors to delay or prevent the onset of cataract cannot be overemphasized [10,11].

Body Mass Index (BMI) is an indicator of overweight are seen to use the public health problem with increasing prevalence in many affluent societies as well as in developing countries [12-14]. The unfavorable BMI can induce permanent health risks at the early stage of human development and sometimes it can found to be risk factor for type 1 diabetes development of child's [15,16]. The people having BMI are greater than 25 kg/m^2 are considered as overweighed. The chronic diseases diabetes make barrier to produce and good use of insulin in the human body. But this insulin made by the pancreas that acts as the key to let glucose from our daily food consumption from blood stream into cell.

Sometimes the overweighed and obsess character may caused at risk for many metabolic and cardiovascular diseases including type 2 diabetes of people. Currently, 300 million people are considered to be obese and due to this rising trend, it is anticipated that this figure could double by the year of 2025 [17,3]. Although about 7.1 million people of Bangladesh are suffering from diabetes according to the estimate of the International Diabetes Federation, almost an equal number with undetected cases have suspected which may lead to stroke, heart attack, chronic kidney diseases, neuropathy, visual impairment and amputations [18]. Several studies have paid close attention to the intergenerational cycle of diabetes mellitus and worldwide 451 million people were estimated to be at least adults with diabetes in 2017 [19,20]. Even if the trans-generational inheritance of metabolic disease remains controversial, family history of diabetes was found to be a non-modifiable risk factor for the prevalence of obesity, metabolic syndrome and hypertension [21]. Zhu et al. [22] were investigated the prevalence and risk factors of under corrected refractive error (URE) among diabetes patients in the Baoshan

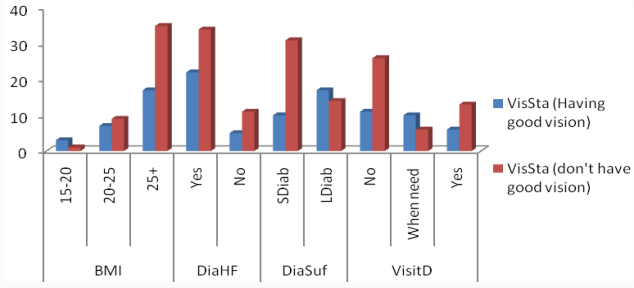

Figure 1: The patients' visual status against covariates.

District of Shanghai following a population-based survey. They advised to give more attention to the persons who belongs to some sort of risk factors like diabetic with poor vision so that it could be corrected.

As therefore, how do such probable parameters contribute to the betterment of visual status of Diabetes Mellitus (DM) patients for Rajshahi Medical College Hospital of Bangladesh could be determined as the objective of this study following the author's surveyed data?

Data Description and It Sources

The precision of any scientific research depends on the quality of data as well as the proper collection technique. Data collection methodology and collection period with clinical trials are discussed accordingly.

Collection period and procedure

As a non-probability sampling, the purposive sampling has used frequently in the medical research. Following such sampling methodology, the data in this research have collected from the Rajshahi Medical College Hospital (RMCH) outdoor for the period of August 2017 to October 2017. Subject of all ages and both sexes will be collected randomly from Department of Ophthalmology (Both from indoor and outdoor) at Rajshahi Medical College Hospital using a well-structured questionnaire. The data of 72 diabetes patients who were facing visual problems have collected and the reliability of the collected data have been tested.

Upon verbal consent of the diabetic patient, visual acuity has been measured by using snellens visual acuity chart without correction, with pinhole/corrected vision with glass. An E chart was used for the illiterate patients. Posterior segment was examined by direct and indirect ophthalmoscope. Slit lamp biomicroscopic examinations of fundus were done by slit lamp and Volkmann +78 lens. Color fundus photography, fundus fluorescein angiogram and Optical Coherence Tomography (OCT) were used in some selected cases.

Statistical Methodology

The contributory parameters for the visual status of the patients have been assessed following by the statistical methodologies are discussed bellow.

Chi-square test

According to the properties of the variables the associations of covariates can be tested by Likelihood Ratio Chi-square statistic, simply chi-square or other statistics like Cramer's V, Kendall's tau-b, Kappa statistics. The Null Hypothesis, H_0: There is no association between these variables have been analyzed using chi-square statistic as.

$$\chi^2 = \sum\sum \frac{(f_{ij} - E_j)^2}{E_j} \sim \chi^2(r-1)(c-1) \quad (1),$$

Where, $(r\text{-}1)(c\text{-}1)$ is the df and f_{ij}= Observed Frequency and E_{ij}= Expected Frequency.

Wilks [23] showed that $-2\log\Lambda$ has a limiting null chi-squared distribution as $n\to\infty$. Let Λ denote the ratio of the maximized likelihoods, which cannot exceed 1. The Wilk's statistic, denoted by G^2 is

$$G^2 = -2\ln(\Lambda) = -2[L\ (H_0) - L\ (H_1)]$$
$$= -2\left[\sum_i\sum_j n_{ij}\ \mathrm{h}\left(\frac{m_j}{n_j}\right) - \sum_i\sum_j n_j\ \mathrm{h}\left(\frac{n_j}{m_j}\right)\right] \quad (2),$$

In the general case, the likelihood is maximized when $\hat{\pi}_{ij} = \frac{n_j}{n}$ and $m_{ij}=n\pi_{ij}$ they $\{\hat{m}_{ij}\}$ are called estimated expected frequencies for the cell counts $\{n_{ij}, j=1, 2,..., J\}$. For large samples, G^2 has a chi-squared null distribution with $(I\text{-}1)(J\text{-}1)d.f.$

Logistic regression analysis

Logistic regression is frequently used to express the relationship between a binary response variable with a set of explanatory variables(s). Although the risk factors are based on the assumption that the independent variables are normally distributed with equal variances in the simple linear regression such assumptions are violated in some practical situations which are frequently found in the nominal or ordinal scaled data. The logistic regression model (see Cox [24] with appropriate assumptions for the response variable (Visual Status), Y of two categories (1= having good vision and 2= don't have good vision) will discuss accordingly. The probability of given is Y=1 given X is

$$\mathbf{P}(Y=1|X=x) = \pi = \frac{\exp\left(\sum_{j=0}^{n}\beta_j x\right)}{1+\exp\left(\sum_{j=0}^{n}\beta_j x\right)} \quad \text{and}$$

$$1-\pi = \frac{1}{1+\exp\left(\sum_{j=0}^{n}\beta_j x\right)}$$

$$g(.) = \mathrm{h}\left(\frac{\pi}{1-\pi}\right) = \sum_{j=0}^{n}\beta_j x \quad (1),$$

where β_j are parameters, odds= $\frac{\pi}{1-\pi}$ and $g(.)$ is the logistic transformation lies between 0 to 1.

Thus, the logarithmic of odds is modeled as a linear combination of the predictors and the parameters of the model will be estimated by Maximum Likelihood Estimation (MLE) method.

As a data analysis tools R programming has been used and the results are presented in the Discussion of the Results section.

Discussion of Results

In this study 72 patients who are suffering from diabetes have considered with some of their specific covariates on the visual status based on the review of literature and intuition. The probable influential covariates were considered as: Sufferings of Visual Complications (Vis Com), Visit to Doctor for Visual Status (Visit D), Family History of Diabetes (DiaHF), Diabetes Sufferings Time (DiaSuf), Body Mass Index (BMI), Present Visual Status (VisSta), Diabetes Control Method (DiaConM). Together with these, Sex, Marital Status (MSta) and Residential Status (RSta) have examined as the preliminary sources of statistics. The categorized levels of the covariates are as- BMI (Kg./m^2): [15-20, 20-25, 25+]; DiaConM: [Food Control and exercise, Tablet, Insulin]; DiaHF: [Yes, No]; VisCom: [Non-Abnormalities Detected (NAD), Proliferative Diabetic Retinopathy (PDR), Non-Proliferative Diabetic Retinopathy (NPDR), Pri-Proliferative Diabetic Retinopathy (PPDR), Neuropathy (NuPath), Immature Cataract (ImCat), Maculapathy (MacPath), Glucoma, Chronic Dacryocystites (ChrDac)]; VisitD: [Yes, No, When need] and DiaSuf: [LDiab, SDiab].

The descriptive statistics of the probable covariates of DM patients of Rajshahi Medical College Hospital are enlisted in Table 1.

It is noticed from Table 1 that about 61% female and 39% male; 79% married, 18% unmarried and rest 3% widow; about 6% posses BMI category 15-20, 22% 20-25 category and 72% belongs to 25+ category. Among the patients 76% comes from rural area and 24% comes from urban area. About 43% of the respondents are suffering from diabetes of long-time category and 57% from short time category. Family history of diabetes is an important parameter in this study show that about 78% of the respondents don't have family history but 22% have had family history. As reliever from any complication is depend on the proper medication and timely visit to the doctor, we consider regularly visit to the doctor as a covariate and it is noticed from Table 1 that there are about 51% patients don't visit regularly to the doctor, 22% visit when they feel problem and rest 26% visit regularly for their visual complications. Diabetes control method is an important issue and the summary statistics shows that 8% control food and do exercises, 71% take tablet and 21% use insulin as a management of diabetes. The statistics have plotted against the visual status are shown in Figure 1.

The noticeable homogenous pattern can be studied from the contingency table (see Statistical Methodology Section). The similarities or the differences of some attributes can be tested using the relative frequencies of the attributes can be a precise way in the medical aspects which have been popularized by Agresti. Further a partitioning may show than an association primarily reflects differences between certain categories or groupings of categories [25].

Do the data reveal a relationship between the patients' visual status with related covariates or not is our confined attention in this study? Such question has been verified by the contingency table test of different combinations of covariates of patients. The association of visual status with regularity in visit to doctor, family history of diabetes, sufferings level of diabetes and BMI of patients has been examined following chi-square statistics (χ^2=108.480, df=64, p-value =0.000) and the result confirmed the rejection of null hypothesis of no association among the levels of the covariates. Thus, the variations of the levels of covariates VisitD, DiaHF, DiaSuf, BMI, VisSta with the levels of visual status of the diabetic patients are not independent. The different categories of VisitD, DiaHF, VisSta and DiaSuf are significant (χ^2=41.450, df=18, p-value =0.001) indicating that these covariates are also independent. The χ^2 value 48.570 (df=37, p-value =0.097) is rejected at 10% error confirm implying that the covariates VisitD, DiaSuf and VisCom independent. The χ^2 value 9.066 (df=4, p-value =0.059) also reject null hypothesis of independence of DiaHF, VisSta and DiaSuf. Similarly, the different categories of VisitD with assigned level of visual status of patients are found to be significant (χ^2=5.504, df=2, p-value =0.064) indicating that this covariate may be influenced with the assorted categories of visual status of patients. But the insignificant relationship between the different levels of DiaConM (χ^2=0.688, df=2, p-value =0.709) with the classified categories of visual

Table 2: Estimated parameters of logistic model of visual status of patients.

Variable	Estimate (β)	Standard Error ($SE(\beta)$)	Test Statistic	P value	OR (95% CI)
(Intercept)	4.655	2.356	1.976	0.048	
BMI	–0.183	0.087	–2.105	0.035	0.833 (0.702 to 0.987)
DiaSuf					
LDiab	---	---	---	---	1
SDiab	–1.534	0.59	–2.599	0.009	0.216 (0.068 to 0.686)
VisitD					
No	---	---	---	---	1
Yes	0.234	0.713	0.329	0.742	1.264 (0.313 to 5.110)
When need	1.367	0.698	1.963	0.049	3.935 (1.002 to 15.452)
DiaHF					
No	---	---	---	---	1
Yes	–0.289	0.731	–0.396	0.692	0.749 (0.179 to 3.136)
Null Deviance: 95.265; Residual Deviance: 79.350					
G^2 Statistic = 15.915 (AIC: 91.35)					

status of patients has found to be remarkable.

As such the dependent variable, visual status having two groups with significant differences with covariates VisitD, DiaHF, DiaSuf and BMI may be fitted by the logistic regression model of the data sets. As therefore, the visual status of the patients who are suffering from diabetics have been regressed with these four explanatory variables in this research under the binomial link function.

The G^2 statistics is very useful in the categorical analysis of data where the difference in deviations of the null and reduced models is measured. In this case the difference between the deviances tells us whether or not the two models fit the data. Although the Wald test tends to be less reliable and lacks power due to small sample sizes [25,26] the G^2 statistics involved with likelihood ratio statistic may reduce such problems. Further dealing with the models with numerous parameters, a lot of scope to test several reduced models are evident for the real-world data sets.

The value of the G^2 statistic of testing null hypothesis of having no effect of the predictors BMI, DiaSuf, VisitD and DiaHF in the model is found to be 15.915. As the calculated value exceeds the critical value, the null hypothesis of having joint effect equals to zero of these predictors is rejected and the test is significant.

The 95% confidence intervals of the odds ratios are given in the last two columns of the Table 2. If the interval is below 1 the variable lowers significantly the relative odds. On the other hand, if the interval lies above 1 the relative odds is significantly increased by the variable. The OR is 0.833 which implies that changes of deviance from BMI decreased with 16.70% odds of the model. The increase of BMI of the patients has negative impact on the visual status is confirmed by the estimate of BMI as –0.183.

A unit increase of patients for short time diabetes sufferings compared with the reference category (Long time) and keeping BMI, VisitD and DiaHF fixed decreases the relative odds are found to be 0.216. Among the three levels of the predictor variable, VisitD, don't visit regularly` were selected as reference category. In comparison with the reference category 'Visit regularly' and 'Visit when need' have positive relation to having good visual status of the patents and the respective odds are 1.264 and 3.935. Thus, the progress in visual status have noticed for the patient's categories 'visited doctors regularly' and 'visit when need'. Further, the patients having DiaHF have negative impact on the visual status indicating that they lessen their visual status.

Conclusion

It is worldwide recognized that among the non-communicable diseases diabetes caused morbidity and also make troubles for the patients' visual impairment. The challenge of this research was to identify the probable risk factors influencing the visual status of the assigned patients. Patients have been investigated through ocular examination at the eye unit of Rajshahi Medical College Hospital, Bangladesh and categorized them as *having good vision or don't having good vision groups* to create predictor variable according to the eye conditions.

A probable set of variables (VisCom, VisitD, DiaHF, DiaSuf, BMI, DiaConM, Sex, MSta and RSta) have introduced as the causal parameter and preliminary statistics described in the result discussion section. The test of similarities and/or differences of probable causes may be the precise and popular way in medical aspects has considered [25] to establish the relationship of variables. The result revealed that the variations of the levels of causal variates VisitD, DiaHF, DiaSuf, BMI, VisSta with the levels of visual status of the diabetic patients are not independent. As therefore verification of the confined attention of existing relationship between the patients' visual status with its causal variables have determined by logistic regression model with binomial link. The value of the G^2 statistic confirmed of having joint effect to the predictors and the complexity on visual status effect ascertained by odds of the logit model. It is evident from the fitted model that visual problems may occur due to increased BMI and having DiaHF. Furthermore, the patients in the groups 'visit doctor regularly' and 'visit doctor when needs' may alleviate visual problems than the patients of 'not visit' group. Finally, patients who are suffering from diabetes need to keep the optimal BMI level, maintain regularity in visiting doctor and proper management of diabetes for the betterment of their visual status.

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