Effects of The Frequency of Blood Glucose Checking to Control Type 2 Diabetes in Bangladesh

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***Abstract:** Diabetes is considered to be one of the major health threats affecting people nowadays which mainly occurs as a result of insulin secretion disorder and can affect anyone irrespective of gender and age. Also diabetes itself has its different forms or types like type 1, type 2 or gestational diabetes. The causes, effects and treatments are thus not same for all people affected from diabetes according to different types. This study collects a sample of 918 individuals in Bangladesh with both type one and type 2 diabetes to distinguish between the causes of individual causes of each type. Also, this study tried to examine the effects of the frequency of blood glucose checking to control type 2 diabetes as it is found that type 2 is the most serious problem of diabetes in the developing countries like Bangladesh. For these purposes two models Logistic Regression Model and Poisson Count Model are used in this study and it is found that those people who check their blood glucose more frequently are more careful about their disease and they are more conscious about the way of controlling.*

Keywords—diabetes; insulin; secretion; logistic; Poisson; blood glucose.

INTRODUCTION

According to WHO [1], diabetes mellitus (DM) is defined as a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbance in carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both [2]. In most cases diabetes is caused by a failure of the β-cell mass, mainly due to an immune process that is automatic (type 1 etiological process) and/or additional need for insulin due to insulin hindrance (type 2 process) [3]. Both types of diabetes are thought to include different stages of disease, ranging from non–insulin-requiring to insulin-requiring for control or survival. According to this classification given by the World Health Organization, it is possible to operate both the processes in a single patient. About 3000 years before diabetes was first recognized as the oldest disease in men [4]. Type 1 and type 2 DM was clearly distinguished first in 1936 [5]. According to WHO, the approximate number of people having diabetes mellitus all over the world in the year 2000 was 177 million that will rise up to 336 million by the year 2030 [1]. For the treatment purpose and prevention of diabetes with its associated complications an estimated $727 billion was spent in 2017 that is almost an 8% increase from that of 2015. This cost is estimated to be $776 billion in 2045 [6]. The cost for people with diabetes is mostly related to direct (cost of medicine, hospital and diagnosis) and indirect (premature death, productivity loss from disability) [7]. In developing countries the rate of increase in much higher than in the developed countries. The prevalence of diabetes has been increasing more rapidly in the South East area of Asia [6]. Almost 90%-95% diabetes positive cases in this area are of type 2 [8, 9]. The approximate rate of diabetes among adults in Bangladesh was 9.7% in 2011 and it is projected $13.7

million by 2045 [6]. As a low middle income country like Bangladesh the cost of diagnosis, diets and treatments for diabetes is an extra burden. Moreover, the long term effects of DM includes damage and dysfunction of cardiovascular system, eyes, nerves and kidneys [10]. This study aims to find out which factors are responsible for the type 1 and type 2 diabetes. Also, one of the objective of this study is to find way how type 2 diabetes can be controlled and whether the frequency of blood glucose checking is a significant factor or not for controlling diabetes.

METHODOLOGY

For this study the target population is all people of Bangladesh having diabetes at any period if their whole life. As it is not possible to study the whole population due to different constraints, a sample is selected following appropriate way of selecting a sample. A convenience sample procedure is used to collect the information of 918 individuals having diabetes. Pearson correlation coefficient and chi-square test are used to see statistical relationship between two variables. A binary logistic regression model is performed to examine the effects of covariates namely types of medicine taken, status of mental pressure, weight, age, and gender of respondents on the types of diabetes whether it is type 1 or type 2 diabetes. A Poisson regression model is fitted to see how people are concerned about their diabetes status that is how frequently they check their blood glucose level with some associated factors like educational qualification of respondents, occupation, physical exercise, types of medicine taken, age and weight.

REGRESSION MODEL

The response variable "Type of Diabetes" is of binary whether it is type 1 or type 2. Hence logistic regression model

is used for the purpose of modeling type of diabetes with the covariates mentioned. If there are n independent responses $Y_1, Y_2, \ldots, Y_i, \ldots, Y_n$ with probability of success π_i. Then the probability mass function (pmf) of y_i is

$$f(y_i) = \pi_i^{y_i}(1 - \pi_i)^{1-y_i}; \ y_i = 0,1; 0 < \pi_i < 1 \ \ldots\ldots (i)$$

Then the mean response is $E(y_i) = \pi_i$. In logistic regression model, logit link function is used to make a bridge between mean responses π_i and the linear predictor $x_i'b$ as follows

$$ln\left(\frac{\pi_i}{1-\pi_i}\right) = x_i'b \ Or \ \pi_i = \frac{e^{x_i'b}}{1+e^{x_i'b}} \ \ldots\ldots (ii)$$

The regression model given in equation (ii) is a logistic regression model where $x_i = (x_{i1}, x_{i2}, \ldots, x_{ij}, \ldots, x_{ip})'$ is the $p \times 1$ vector of covariates linked with response and $b = (b_1, b_2, \ldots, b_j, \ldots, b_p)'$ be the corresponding vector of covariates.

POISSON REGRESSION MODEL

To find out the effects on covariates on how frequently the people check their blood glucose level, a Poisson count model is fitted. If there are n independent responses $Y_1, Y_2, \ldots, Y_i, \ldots, Y_n$ with mean number of response m_i. Then the probability mass function (pmf) of y_i is

$$f(y_i, m_i) = \frac{e^{-m_i}m_i^{y_i}}{y_i!}; \ y_i = 0,1,2, \ldots \ldots$$

Poisson count model is a member of generalized linear model (GLM) where the link function used is the log link function. The model is as follows

$$ln(m_i) = x_i'b \ \ldots\ldots (iii)$$

The regression given in (iii) is the Poisson regression model where $x_i = (x_{i1}, x_{i2}, \ldots, x_{ij}, \ldots, x_{ip})'$ is the $p \times 1$ vector of covariates linked with response and $b = (b_1, b_2, \ldots, b_j, \ldots, b_p)'$ be the corresponding vector of covariates.

RESULTS

The coefficients of logistic regression model along with the estimates of the covariates, their odds ratio and p-value are given in the table (1) below. It is found from table (1) that the individuals taking insulin have 22.7% higher odds of having diabetes compared to those taken both pills and insulin. On the other hand, individuals who takes only pill are at higher risk of having type 2 diabetes than type 1 diabetes compared to the individuals taking both pills and insulins. It is also found that mental pressure is not a significant factor to discriminate between type 1 and type 2 diabetes. As weight grows it is found that people are less risk of type 1 diabetes but at more risk of type 2 diabetes. Same is true for the individuals with growing age. From the table it is also found that having type 1 or type 2 diabetes does not depend on gender of individuals.

Table1: Coefficient of Logistic Regression Model to examine diabetes types among different covariates together with their odds ratio and p-value.

Variables		b	SE(b)	Odds ratio	p-value
Types of medicine taken	Pill	0.197	0.219	1.227	0.043
	Insulin	0.871	0.218	2.392	0.000
	Both	-	-	-	-
Having mental pressure	Yes	-0.329	0.237	0.719	0.166
	No	0.239	0.252	1.279	0.344
	Sometimes	-	-	-	-
Wight		0.012	0.007	1.012	0.031
Age		0.008	0.006	0.992	0.034
Gender	Male	-0.042	0.1462	0.958	0.772
	Female	-		-	-

The coefficients of Poisson regression model along with the estimates, their odds ratio and p-values are given in the table (2) below. Table (2) demonstrate that males are more likely to check their blood glucose level than females. The individuals who does not have any education are less frequent to check their blood glucose compared to the individuals with higher education. Primary and secondary educated are also less frequent in checking their blood glucose compared to the higher educated individuals but in

case of secondary educated individuals the result is not significant. People with severe mental pressure are more frequent to check their blood glucose level compared to those who have mental pressures occasionally. Also those who does not have any type of mental pressure are more likely to check blood glucose than having occasional mental pressure. People with doing physical exercise are more careful about their blood glucose and check them frequently compared to those who do not do physical exercise. Age is

also a significant factor for frequency in checking blood glucose that is older people are more frequent in checking blood glucose than their younger counterpart. Same is true for the variable weight. Individuals with growing weight are more frequent in checking blood glucose. Occupation is a significant factor on the number of times one check his/her blood glucose level. Govt. and private service holders are significantly less likely to check their blood glucose level than the housewives. On the other hand retired persons from work are significantly more likely to check their blood glucose than the housewives.

Table2: Analysis with Poisson Regression Model of how often people check their blood glucose level together with associated factors, their odds ratio and p-values.

Variables		b	Odds ratio	SE (b)	p-value
Gender	Male	-0.149	0.861	0.338	0.005
	Female	-	-	-	-
Education	No education	-0.309	0.734	0.159	0.041
	Primary	-0.232	0.793	0.157	0.023
	Secondary	-0.256	0.774	0.162	0.102
	Higher	-	-	-	-
Having mental pressure	Yes	0.165	1.179	0.159	0.001
	No	0.252	1.286	0.161	0.006
	Sometimes	-	-	-	-
Doing physical exercise	Yes	0.122	1.129	0.149	0.026
	No	-	-	-	-
Age		0.435	1.544	0.144	0.005
Weight		0.007	1.007	0.172	0.006
Occupation	Govt. service	-0.066	0.936	0.174	0.000
	Private service	-0.123	0.884	0.071	0.003
	Business and others	0.342	1.407	0.186	0.112
	Retired from work	0.458	1.581	0.185	0.000
	Housewife	-	-	-	-

DISCUSSION

From the result section it is clear that using both pill and insulin as a treatment of type 2 diabetes is better than only to use pill or only insulin. Growing weight is so harmful for type 2 diabetes. Elder people are also at high risk of type 2 diabetes. Mental pressure is not a significant factor to determine type 1 and type 2 diabetes. Weight is a significant factor for type 2 diabetes as it can easily be guessed that growing weight can puss to any type of disease and it is not exceptional for diabetes. Age is also a significant factor for diabetes. It is not the case that the prevalence of diabetes is higher among the male and lower among the female and vive- versa. Male individuals are more likely to check their blood glucose level than females. The individuals who does not have any education are less frequent to check their blood glucose compared to the individuals with higher education. Primary and secondary educated are also less frequent in checking their blood glucose compared to the higher educated individuals but in case of secondary educated individuals the result is not significant. People with severe mental pressure are more frequent to check their blood glucose level compared to those who have mental pressures occasionally. Also those who does not have any type of mental pressure are more likely to check blood glucose than having occasional mental pressure. People with doing physical exercise are more careful about their blood glucose and check them frequently compared to those who do not do physical exercise. Age is also a significant factor for frequency in checking blood glucose that is older people are more frequent in checking blood glucose than their younger counterpart. Same is true for the variable weight. Individuals with growing weight are more frequent in checking blood glucose. As people check their blood glucose more frequently they will be conscious about their diabetes and take steps to control the disease.

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