

# Prevalence of Diabetes Mellitus in two Vicinal Nations



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**Abstract ; Aim:** Due to the chronic nature of diabetes mellitus and its dangerous effects on people, it is moving towards epidemic proportions. We proposed this work for evaluating the predictive measure of diabetic population of India, Pakistan and world. In this work diabetic people of age 20-79 years are considered as this age group is suffering more by this disease. The aim of this study is to estimate the prevalence of diabetes in these two nations covering all the regions of the country.

**Materials and Methods:** Mathematical analysis has been done for showing the rapid prevalence of diabetic population of age more than 20 years and less than 79 years. Karl Pearson's coefficient of Correlation is calculated to find the relativity of prevalence of diabetic people of this age group of both the countries. Regression equations are evaluated to find the various predictive factors for the diabetic populations of countries.

**Results:** The study represented the value of the coefficient of correlation between the diabetic population of India and Pakistan is 0.89, between India and world is 0.77 and between Pakistan and world is 0.98. All these values are positive.

**Conclusion:** The Pearson correlation coefficient test showed that there is a positive and strong correlation between diabetic population (20-79 years age) in both the countries as well as in world. From Regression equation future prediction of increasing number of diabetic patients can be made.

**Keywords:** Diabetes Mellitus; Prevalence; Correlation technique; Regression, Mathematical Analysis

## I. INTRODUCTION

Each organ in our body requires energy for normal functioning. Some tissues use fat or protein as energy, while some others like brain and red blood cells only use glucose. As the food is eaten, it breaks into glucose and the amount of glucose in our body rises. This blood glucose is never being used by the cells without insulin. These cells need a helper like insulin which helps them to use glucose and then converted into energy. After increasing the glucose concentration in the blood,  $\beta$  - cells in pancreas secrete insulin hormone for the glucose to be used by the cells. Both endocrine and exocrine functions are done by pancreas.

There are different types of cells in pancreas like  $\alpha$  - cells and  $\beta$  - cells. Both types of cells secrete hormones of different kinds.

$\beta$  - cells secrete insulin that is used by the cells for using glucose and conserving the extra glucose in liver in the form of glycogen. On the other side  $\alpha$  -cells secrete glucagon which works opposite to the insulin. It helps to make use of stored glycogen in the liver by the blood cells. When the concentration of blood becomes low then glycogen is converted to glucose and mobilized. On the other hand, if  $\beta$  - cells in pancreas do not secrete enough insulin or the body acquires resistance towards the insulin secreted by the  $\beta$ -cells i.e. body does not respond to the insulin produced in our body itself then level of glucose in our body increases. This high level of glucose causes DM "diabetes mellitus".

There are mainly three kinds of diabetes mellitus: Type-1, Type-2 and GDM "Gestational Diabetes Mellitus". Type-1 diabetes arises by body's failure to produce insulin. In this situation the person requires injection of insulin. It was previously known as "Insulin-Dependent Diabetes Mellitus (IDDM)" as the patient becomes dependent on external insulin. Insulin can be taken by the patient in the form of injection or through insulin pumps. It is also known as juvenile diabetes as it often begins in childhood. Type-2 Diabetes Mellitus arises due to negligible response of body towards insulin produced by the body itself. This type of diabetes was recently known as NIDDM (Non-Insulin Dependent Diabetes Mellitus) or Adult Onset Diabetes. In this type of diabetes pancreatic  $\beta$ -cells produce proper amount of insulin but the tissues and cells in the body become resistant to this insulin i.e. they do not respond to this insulin. Due to this null response of the body, amount of glucose in the blood increases which causes diabetes. This kind of diabetes happens when pregnant women without a previous investigation of diabetes develop a high blood glucose level. The fetus grows as the placenta supports to them. Placenta secretes such type of hormones that help in development of fetus. But due to these hormones insulin resistance gets developed in the mother's body. So for mother, it is very hard to use insulin, developed by her body itself. Thus due to this insulin resistance glucose is not used by the mother and its level in blood increases that causes gestational diabetes mellitus. In most of the cases of gestational diabetes, it cures automatically after the delivery but in some cases it becomes type 2 diabetes. These all types of diabetes without appropriate treatment can cause numerous complexities [5].

Diabetes is expanding everywhere throughout the world [6]. India drives the world with biggest number of diabetic patients gaining the questionable refinement of being named the "diabetes capital of the world" [1]. Type 2 diabetes is more common than type 1 diabetes. As compared to rural areas the prevalence of type 2 diabetes mellitus is 4-6 times higher in urban areas [7]. In Pakistan, Diabetes has become one of the major epidemic diseases.

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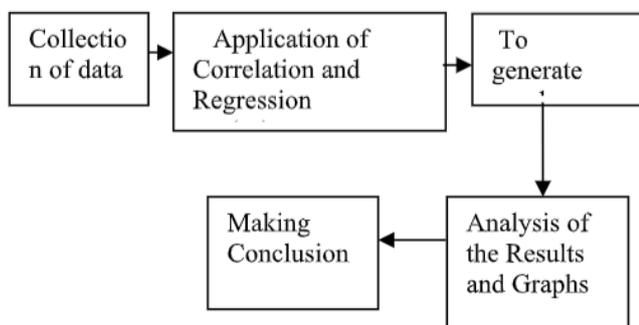
Adult diabetes has risen as a noteworthy issue in Pakistan demonstrating the critical requirement for arranging preventive programs for diabetes [3].

In this paper, we have done the study of prevalence of diabetes from 2011 to 2015 in India and Pakistan using correlation technique. Diabetes has become a major challenge in both the countries as its prevalence is increasing rapidly [1-4]. Diabetes cannot be cured completely but it can be controlled completely.

Before 1947 India and Pakistan were not the separate countries. But due to some reasons they became separate. There is no major difference between the culture of India and Pakistan. People of both the countries have about same lifestyle and eating habits. That's why there is a positive correlation between the prevalence of diabetes mellitus in both countries. The main cause of prevalence of diabetes mellitus is modern life style like physical inactivity, eating habits etc.

In this work, we have used mathematical tools known as correlation and regression to study the prevalence of diabetic patient's populations in these two countries and also in world. Co-efficient of correlation is a number that refers to the degree of relationship between two or more variables. It is one of the most useful statistical tool which is easy to access and shows whether and up to how much extent pairs of variables are related. It measures the strength of association between two variables. A correlation is one of the most useful statistical tool which is easy to access. It is a number that refers to the degree of relationship between two or more variables. There is a high correlation if there is the existence of a strong link between the two sets. The positive correlation will exist if the values increase or decrease simultaneously and the negative correlation will exist if one value increases while other decreases and vice-versa. Regression analysis is used to predict the future population of diabetic patients based on the past analysis. It shows a linear relationship in the form of an equation which is easy to understand and analyze.

II. PROPOSED FRAMEWORK



III. MATHEMATICAL ANALYSIS

**“Karl Pearson’s coefficient of correlation”**:: In Statistics, “Karl Pearson’s coefficient of correlation” is widely used to measure the degree of relationship between the variables. It is calculated by using the following formula:

$$r_{xy} = \frac{N \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{\sqrt{[N \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2][N \sum_{i=1}^n y_i^2 - (\sum_{i=1}^n y_i)^2]}}$$

Where  $N$  = “Number of pairs of values”

$$\sum_{i=1}^n x_i y_i = \text{“Sum of the products of paired values”}$$

$$\sum_{i=1}^n x_i = \text{“Sum of x values”}$$

$$\sum_{i=1}^n y_i = \text{“Sum of y values”}$$

$$\sum_{i=1}^n x_i^2 = \text{“Sum of squares of x values”}$$

$$\sum_{i=1}^n y_i^2 = \text{“Sum of squares of y values”}$$

**Regression Analysis:** For describing the linear relationship between variables, regression is used. It is calculated by using the following formula:

$$Y = aX + b$$

$$a = \frac{(\sum_{i=1}^n y_i)(\sum_{i=1}^n x_i^2) - (\sum_{i=1}^n x_i)(\sum_{i=1}^n x_i y_i)}{N(\sum_{i=1}^n x_i^2) - (\sum_{i=1}^n x_i)^2}$$

$$b = \frac{N(\sum_{i=1}^n x_i y_i) - (\sum_{i=1}^n x_i)(\sum_{i=1}^n y_i)}{N(\sum_{i=1}^n x_i^2) - (\sum_{i=1}^n x_i)^2}$$

Year	India (million)	Pakistan (million)	World (million)	Reference
2011	61.3	6.3	366	[9]
2012	63.01	6.6	371	[12]
2013	65.07	6.76	398	[11]
2014	66.8	6.944	422	[14],[13]
2015	69.2	6.9	646	[10]

**Table 2: Diabetic Population (%) of age 20-79 years**

Year	India (%)	Pakistan (%)	World (%)	Reference
2011	8.31	6.72	8.3	[9]
2013	8.56	6.76	8.3	[11]
2015	8.7	6.9	8.8	[10]

**Table 3: Coefficient of Correlation**

	India (%)	Pakistan (%)	World (%)
India (%)	1		
Pakistan (%)	0.890748	1	
World (%)	0.774404	0.977356	1

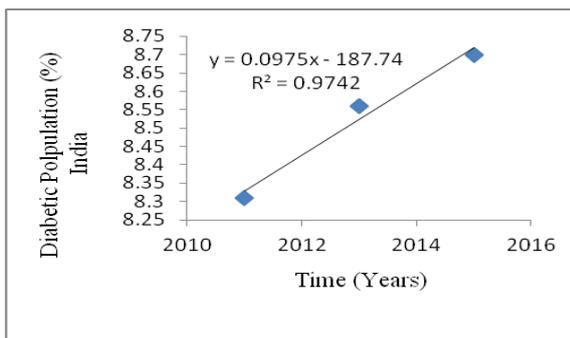
**Table 4: Regression Values for diabetic population (%) of India**

Data		Prediction	
Year(x)	Diabetic population (%) of India (y)	Diabetic population of India (ŷ)	Error (e)
2011	8.31	8.32833333	-0.018333
2013	8.56	8.52333333	0.0366667
2015	8.7	8.71833333	-0.018333

**Table 5 Predictive Factors for diabetic population of India**

Covariance(x,y)	0.26
Varp(x)	2.666667
Slope b	0.0975
Intercept a	-187.744
Average (x)	2013
Standard Deviation(x)	2
Average (y)	8.523333
Standard Deviation(y)	0.197569

The table 1 is showing the diabetic population (20-79 years age) of India and Pakistan as well as of world from 2011 to 2015. Table 2 is showing the percentage of diabetic population (20-79 years age) of India, Pakistan and world. Coefficient of correlation between India and Pakistan, India and world, Pakistan and world for the above data is shown in the table 3. Table 4 represents the regression values of diabetic population (%) of India for different years from 2011 to 2015. In table 5 there are the predictive factors for diabetic population of India.



**Figure 1: Regression line between diabetic population of India (%) with increasing time (years)**

Figure 1 is showing that diabetic population of India is increasing rapidly with time. The data from 2011 to 2015 has been taken. The above data is representing the linear relationship between diabetic populations with time.

Table 6 represents the regression values of diabetic population (%) of Pakistan for different years from 2011 to 2015.

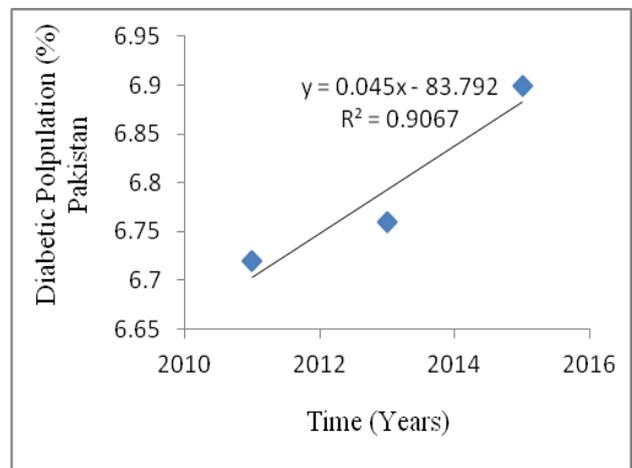
**Table 6: Regression Values for diabetic population of Pakistan**

Data		Prediction	
Year(x)	Diabetic population (%) of Pakistan (y)	Diabetic population of Pakistan (ŷ)	Error (e)
2011	6.72	6.70333333	0.0166667
2013	6.76	6.79333333	-0.033333
2015	6.9	6.88333333	0.0166667

In table 7 there are the predictive factors for diabetic population of Pakistan.

**Table 7 Predictive Factors for diabetic population of Pakistan**

Cov(x,y)	0.12
Varp(x)	2.666667
Slope b	0.045
Intercept a	-83.7917
Average (x)	2013
Standard Deviation(x)	2
Average (y)	6.793333
Standard Deviation(y)	0.094516



**Figure 2: Regression line between diabetic population of Pakistan (%) with increasing time (years)**

Figure 2 is showing that diabetic population of Pakistan is increasing with time. It is representing the linear relationship of diabetic population with time from 2011 to 2015.

Table 8 represents the regression values of diabetic population (%) of world for different years from 2011 to 2015.

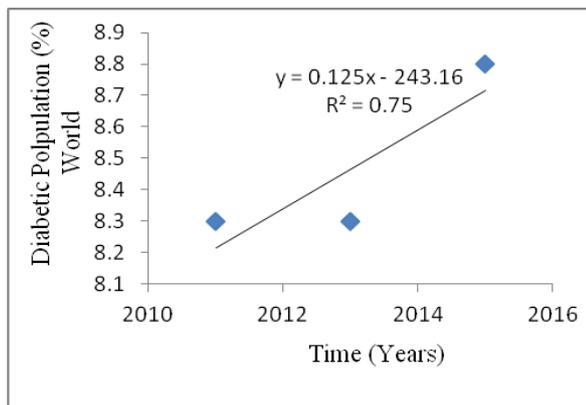
**Table 8: Regression Values for diabetic population of world**

Data		Prediction	
Year(x)	Diabetic population(%) of world (y)	Diabetic population of world ( $\hat{y}$ )	Error (e)
2011	8.3	8.21666667	0.08333333
2013	8.3	8.46666667	-0.166667
2015	8.8	8.71666667	0.08333333

In table 9 there are the predictive factors for diabetic population of world.

**Table 9 Predictive Factors for diabetic population of world**

Cov(x,y)	0.333333
Varp(x)	2.666667
Slope b	0.125
Intercept a	-243.158
Average (x)	2013
Standard Deviation(x)	2
Average (y)	8.466667
Standard Deviation(y)	0.288675



**Figure 3: Regression line between diabetic population of World (%) with increasing time (years)**

Figure 3 is showing that diabetic population is increasing with time worldwide. This figure is representing the linear relationship of diabetic population with time from 2011 to 2015.

#### IV. RESULTS

The value of the coefficient of correlation between the diabetic population of India and Pakistan is 0.89, between India and world is 0.77 and between Pakistan and world is 0.98. These values are positive. Regression equation of diabetic population of India and Pakistan is  $y = 0.0975x - 187.74$ , India and world is  $y = 0.045x - 83.792$ , and Pakistan and world is  $y = 0.125x - 243.16$ .

#### V. CONCLUSION

This work presents the prevalence of diabetes mellitus in India and Pakistan. We have used correlation and regression techniques to analyze the data for diabetic patient's population in both the countries. The Pearson correlation coefficient test showed that there is a positive and strong correlation between diabetic population (20-79 years age) in both the countries as well as in world. From regression

equation future prediction of number of diabetic patients can be made. The message from this work is that diabetes is increasing in both the countries with a positive correlation means there is some similarity in lifestyle and culture. So it should be improved to control the no. of increasing cases of diabetic patients. It is evident from this work and the previous studies [1-4] that people need to be alert because diabetes mellitus is spreading among the people of both the countries and worldwide also. Diabetes mellitus can be prevented through healthy eating habits and physical exercises [8]. It is suggested for future scope that the data can be taken in the form of male, female and children separately for making it more analytical.

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